



# Antimicrobial stewardship verification in the Australian chicken meat industry

by Professor Darren Trott and Dr Stephen Page  
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by Professor Darren Trott and Dr Stephen Page

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#### **Researcher Contact Details**

Name: Professor Darren Trott  
Address: The University of Adelaide, Mudla Wirra Rd,  
Roseworthy SA 5071

Phone: 08 8313 7989  
Email: darren.trott@adelaide.edu.au

In submitting this report, the researcher has agreed to AgriFutures Australia publishing this material in its edited form.

#### **AgriFutures Australia Contact Details**

Building 007, Tooma Way  
Charles Sturt University  
Locked Bag 588  
Wagga Wagga NSW 2650

02 6923 6900  
info@agrifutures.com.au  
www.agrifutures.com.au

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# Foreword

Resistance to antimicrobials presents a major health issue for humans and animals. The development of antimicrobial stewardship (AMS) programs is one of the major initiatives that can safeguard currently registered antimicrobial agents in the future. The Australian chicken meat industry has been a global leader in the implementation of AMS principles since the 1980s. In 2017, AgriFutures Australia funded the development and implementation of AMS programs in Australian chicken meat companies to formalise AMS efforts and to provide direction on areas for further improvement. The current project was undertaken to independently verify the existence and maturity of the AMS programs implemented by the six major chicken meat companies that produce 90% of Australian chicken meat.

Three organisations have mature AMS programs in place, while the other three had comprehensive animal health plans that incorporated AMS principles. Antimicrobial use is historically low in the Australian chicken meat industry. Only antimicrobials of low importance are used to prevent coccidiosis and necrotic enteritis, and on rare occasions, used to treat *E. coli* and *Staphylococcus* infections, or spotty liver disease. Culture and susceptibility testing is conducted before treatment in all cases; results indicate bacteria remain susceptible to antimicrobials. Alternatives to antimicrobials have been investigated by all organisations, which have adopted many management strategies over time that eliminate the need for antimicrobial treatments. Overall, the results of this project verify that AMS principles have been adopted by the Australian chicken meat industry. Continuing efforts to further reduce, replace and refine antimicrobials are ongoing.

This report for the AgriFutures Chicken Meat Program adds to AgriFutures Australia's diverse range of more than 2,000 research publications. It forms part of our Growing Profitability arena, which aims to enhance the profitability and sustainability of our levied rural industries.

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**John Smith**  
General Manager, Research  
AgriFutures Australia

# About the Authors

Professor Darren Trott [BSc (Hon), BVMS (Hon), PhD] is Professor of Veterinary Microbiology at the University of Adelaide and Director of the Australian Centre for Antimicrobial Resistance Ecology. He has published or co-authored over 170 peer-reviewed scientific papers and reports, including many on the ecology and surveillance of antimicrobial resistance in Australia. He led the team that produced a federal Department of Agriculture-funded report on antimicrobial resistance and antibiotic usage in animals and agriculture in Australia. With Dr Sam Abraham from Murdoch University, he has undertaken the first pilot AMR surveillance studies in healthy Australian livestock. He is also a voting member of the Clinical Laboratory Standards Institute (CLSI) Veterinary Antimicrobial Susceptibility Testing Sub-Committee. He works collaboratively with Australia's animal industries, pharmaceutical companies, the Department of Agriculture and Water Resources, and various stakeholder groups. With Dr Stephen Page and industry veterinarians, he has developed an Antimicrobial Stewardship Program for application to the Australian beef feedlot industry.

Dr Stephen Page [BSc (Vet) (Hons), BVSc (Hons), DipVetClinStud, MVetClinStud, MAppSc (EnvTox), MANZCVS (Pharmacology)] is a consultant veterinary clinical pharmacologist and toxicologist, and founder and sole director of Advanced Veterinary Therapeutics, a consulting company that has provided advice on appropriate use of veterinary medicines to veterinarians, veterinary organisations (Australian Veterinary Association, World Veterinary Association, World Organisation for Animal Health), state and national government departments and statutory bodies (APVMA, Department of Agriculture, Department of Health, US Environmental Protection Agency), and global organisations (OIE, FAO, Chatham House).

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We would like to acknowledge AgriFutures Australia for funding this antimicrobial stewardship project. We would also like to acknowledge the assistance of veterinarians and animal health managers of the Australian Chicken Meat Federation (ACMF) for their willingness to be interviewed and to provide data for verification of antimicrobial stewardship principles and practices within their organisations.

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# Executive Summary

## What the report is about

Antimicrobial resistance (AMR) is a major issue facing human and animal health. The development of antimicrobial stewardship (AMS) programs is one of the major initiatives that can safeguard currently registered antimicrobial agents into the future. In 2017, AgriFutures funded the development and implementation of AMS programs in Australian chicken meat companies (PRJ-010520). The current project was undertaken to independently verify the existence and maturity of the AMS program developed and maintained by the six companies that produce 90% of Australian chicken meat.

## Who is the report targeted at?

This report is targeted at Australian chicken meat producers. It is also indirectly targeted at Australian consumers and government.

## Where are the relevant industries located in Australia?

The Australian Chicken Meat Federation (ACMF) members comprise the five state chicken meat councils (QLD, NSW, VIC, SA and WA), the Australian Chicken Growers' Council and the Australian Poultry Industries Association. The latter represents the chicken meat processors that produce 90% of Australia's chicken meat. Member companies include Baiada, Inghams Enterprises, Cordina Farms, Turosi, Hazeldenes and Golden Cockerel. Major regions of chicken meat production in Australia include the outskirts of the Sydney metropolitan area, Central Coast Plateau, Newcastle, Tamworth and Griffith (NSW); Redland Bay south of Brisbane, and other areas to the south, south-west and north of Brisbane (QLD); Mornington Peninsula, east of Melbourne, and Geelong and Bendigo (VIC); the outskirts of Adelaide to Port Wakefield and along the mid to lower River Murray and Lakes (SA); and the outer metropolitan areas of Perth (WA).

## Background

AMR is well accepted as a global public health priority and an important emerging animal health issue. Antimicrobial use contributes to the selection of AMR and, consequently, only necessary and high-quality use of antimicrobial agents is considered appropriate. The Australian meat chicken industry is historically a low user of antimicrobial agents. Recent surveys of AMR in bacterial commensal species isolated from Australian meat chickens have revealed very low levels of AMR. Despite this favourable position, the implementation of formal and systematic antimicrobial stewardship plans (ASPs) by the large chicken meat-producing companies will support the continued low frequency of antimicrobial use and AMR. The development of AMS programs in both human and animal health is an essential feature of the Australian Government's national AMR strategy (<https://www.amr.gov.au/australias-response/national-amr-strategy>).

## Aims/objectives

The main aim of this project was to develop an independent AMS verification and self-assessment tool that could be used to determine the maturity of the ASPs adopted by the six main chicken meat-producing companies. The main project objectives were to:

- 1) Develop and road test a draft AMS questionnaire modelled on the World Health Organization's Joint Expert Evaluation (JEE) public health assessment tool
- 2) Provide the revised questionnaire to company veterinarians with instructions to complete the self-assessment

- 3) Conduct independent interviews with each company veterinarian to verify the scores assigned and rescore if required
- 4) Review the final scores and report key findings to industry.

## **Methods used**

An open-ended questionnaire design and a simplified (1–5) scoring system were developed as a self-assessment tool and applied to assess the five components (the 5Rs) of an AMS program (Responsibility, Review, Reduce, Replace, Refine) adopted by each company. Confidential interviews were conducted with veterinarians from each company and the scores assigned by the company to each ‘R’ were reviewed and rescored. The final step in each interview was a detailed discussion about the next key steps in the AMS program established by each company.

## **Results/key findings**

Three of the six organisations interviewed have developed mature ASPs covering all AMS aspects of the 5Rs (Responsibility, Review, Reduce, Replace and Refine). These have been reviewed once (one organisation, scoring 24/25) or more than once (two organisations, scoring the maximum 25/25). For the remaining organisations (one scoring 21/25, and two scoring 22/25), while they did not have specific ASPs developed, their animal health plans covering antimicrobial use were significantly robust, mature and the subject of regular reviews. Consequently, they scored highly on the principles of Reduce, Replace and Refine.

Antimicrobial use is historically low in the Australian chicken meat industry, which was evident in the current antimicrobial use practices of each organisation. Diseases for which antimicrobials were indicated included prevention of coccidiosis and necrotic enteritis, and occasional treatments for *E. coli* and *Staphylococcus* infections, and spotty liver disease. For these infections, only antimicrobials rated by the Australian Strategic and Technical Advisory Group on AMR (ASTAG) as of low importance, such as amoxicillin and tetracyclines, were used. No resistance issues were noted. Alternatives to antimicrobials, in particular for maintaining gut health, including probiotics, prebiotics, enzymes and essential oils, have been investigated by each organisation.

## **Implications for relevant stakeholders**

The results of the AMS verification process dovetail with the recent Australian chicken meat industry pilot AMR surveillance studies by Dr Sam Abraham and Professor Darren Trott that confirmed the low-resistance status of key bacterial species isolated from Australian meat chickens. A noteworthy AMS measure is that critically important antimicrobials, such as fluoroquinolones, third-generation cephalosporins and colistin, have never been approved for use or used in the Australian chicken meat industry. The industry is already adopting many management strategies that eliminate the need for antimicrobial treatments. Outbreaks of disease requiring antimicrobial intervention are rare, and in many cases, can be effectively treated and/or prevented by adopting good animal husbandry, biosecurity and focusing on gut health. Where antimicrobials are used, such as to treat rare outbreaks of colibacillosis, the bacteria remain susceptible to antimicrobials that are used to treat, such as amoxicillin and tetracyclines.

## **Recommendations**

It is recommended that the AMS verification project be extended to include a re-evaluation of the revised self-assessment tool and a 1–5 rating scale to obtain quantitative and qualitative AMS data. The six ACMF organisations should be resurveyed to confirm the further development and maturity of their ASPs. An abstract should be submitted to the 2021 Australian Veterinary Antimicrobial Stewardship (AVAMS) Conference.



# Introduction

Antimicrobial resistance (AMR) is considered one of the biggest threats to human and animal health today (Department of Health and Department of Agriculture, 2015; 2020; O'Neill 2016). All users of antimicrobial agents have a responsibility to ensure that these agents are used only when necessary.

The Australian chicken meat industry takes the issue of AMR very seriously. It has a long history of developing and introducing initiatives to enhance infection prevention and control and to encourage the restriction of antimicrobial use to essential situations (Hewson 2018). The codes of practice and guidelines introduced progressively since the 1980s have evolved into the antimicrobial stewardship (AMS) plans of the 2000s. AMS and good stewardship practice (GSP) concerns much more than just judicious or prudent use of antimicrobial agents (Lloyd and Page 2018). Indeed, the current focus is on continuous improvement and ways to reduce, replace, and refine antimicrobial use (Page et al. 2014) while maintaining the highest standards of chicken health, which enables close alignment with the Australian (Australian Government 2015; 2020) and global (WHO 2017) strategies for AMR and antimicrobial use minimisation.

The long history of conservative regulation and use of antimicrobial agents in the Australian chicken industry has resulted in the unique situation where many of the critically important antimicrobial classes for human medicine have never been available, and therefore, not used in chicken production, which is in contrast to the situation in most other countries. For example, the focus of the British Poultry Council (BPC) (2018) AMS program has been the reduction or elimination of the use of fluoroquinolones, third-generation cephalosporins and colistin – all antimicrobial classes never approved for use in Australian poultry (Abraham et al. 2019). Thus, Australian chicken meat industry AMS programs can focus on more advanced aspects of stewardship, to minimise the impact of antimicrobial use on human health while fulfilling the responsibility of managing bird health and welfare.

AMS, as defined by Guardabassi and Prescott (2015), is ‘the multifaceted and dynamic approaches required to sustain the clinical efficacy of antimicrobials by optimizing drug use, choice, dosing, duration, and route of administration, while minimising the emergence of resistance and other adverse effects’. AMS is multifaceted and complex, involving many elements and requiring clear thinking. The dynamic approach reflects the fact that, just like AMR, AMS is not a stationary practice; it is forever changing and the direction of change, using a continuous improvement model, is guided by the multifaceted AMS team. Optimising drug use, choice, dosing, duration and route of administration is very challenging because it is inevitably not a fixed and predictable equation. It does not mean ‘one dose suits all’ because each circumstance may need a different approach, which may also include no antimicrobial use. Minimising the emergence of AMR is a necessary and demanding goal, but one for which there is insufficient guidance. Only by monitoring responses to treatment or non-treatment and undertaking surveillance of AMR can any insight into resistance minimisation be gleaned.

The 5R framework for AMS was developed to provide a systematic and comprehensive approach to AMS planning, implementation and monitoring (Lloyd and Page, 2018; Page et al. 2014; Prescott and Boerlin 2016; Weese et al. 2013) to allow a potentially complex process to be both practical and effective. The 5Rs include Responsibility, Review, Reduce, Replace, and Refine. Key elements of each ‘R’ are listed in Table 1. AMS is a continuous process with a goal of defining and applying best practice, AMR minimisation, and optimal control of animal health. Good stewardship practice (GSP) describes the development, implementation and continuous improvement of the AMS plan (ASP). The first Australian Veterinary Antimicrobial Stewardship (AVAMS) Conference was held in November 2018. It provided a comprehensive overview of the current situation (AVAMS 2018) and initiatives introduced by the various livestock industries as well as actions and plans in companion animal practice.

Importantly, AMS and GSP are continuously evolving with ongoing learning from actual experience. Critical review and measurement are essential features. Independent and objective evaluation, as described in this report, underpins and defines progress.

**Table 1. Explanatory details covering the 5Rs of Antimicrobial Stewardship (adapted from Lloyd and Page (2018)).**

Antimicrobial Stewardship Category (5Rs)	Key features
Responsibility	<p>Executive or senior management support (leadership commitment)</p> <p>Dedication to optimising antimicrobial prescribing and animal safety (accountability)</p> <p>Collaborative and participatory team approach (effective communication with all stakeholders)</p> <p>Skilled leadership and social cohesion</p>
Review	<p>The basis of continuous improvement</p> <p>Audit of current antimicrobial use practice, infection prevention and control measures, and antimicrobial resistance status</p> <p>Quantitative and qualitative assessments of antimicrobial use (Appropriate [Optimal, Adequate], Inappropriate [Suboptimal, Inadequate])</p> <p>Appropriate use compared to local or national antimicrobial use guidelines</p> <p>Assessment of educational needs, review of the literature and other sources of information on AMR and AMS</p>
Reduce	<p>Better infection prevention and control measures (biosecurity*)</p> <p>* External (bioexclusion) and internal (biocontainment) principles, improving individual animal resilience to infection (genetic selection, vaccines, identifying modifiable risk factors)</p>
Replace	<p>Use of alternative nonantimicrobial measures, wherever possible and appropriate</p> <p>Quality and strength of the evidence supporting the use of the selected alternative approach</p> <p>Credible, efficacious, cost-effective and measurable</p>

Refine	<p>Initiating and implementing an antimicrobial therapeutic plan*</p> <p>* Uncertainty of diagnosis of bacterial infection is a major driver of antimicrobial overuse and antimicrobial resistance selection in humans.</p> <p>5 rights of antimicrobial selection (right drug, right time, right dose, right route, right duration)</p> <p>Appropriate use of diagnostic tests, including culture and susceptibility testing (affordable, sensitive, specific, user-friendly, rapid and robust, equipment-free, and deliverable)</p>
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# Objectives

Objective 1: To review the key elements of the AMS plan (Responsibility, Review, Reduction, Replacement, Refinement) and develop a self-assessment program to measure implementation of each element by each of the largest chicken meat companies in Australia.

Objective 2: To apply a participatory approach, with open dialogue with each company to ensure compliance with the self-assessment program, and to conduct a two-part audit (self-assessment and scoring, interview and audit by an independent third party; and rescore, discussion of the results with each company).

Objective 3: To analyse the results of the two assessments to identify overall industry knowledge gaps against international benchmarks for inclusion in the final implementation plan.

Objective 4: To approach smaller chicken meat companies with a more tailored AMS assessment tool and auditing system, and obtain important whole-of-industry perspectives on AMS.

Objective 5: To present the final model for ongoing sustainable independent verification of the AMS programs that respects and reflects the different needs of each company, and collectively, the smaller producers and the expectations/recommendations from various international bodies.

# Methodology

## Review of existing literature

The project team reviewed the following literature before the design and delivery of the self-assessment tool.

1. Certified Responsible Antibiotic Use (CRAU) (<http://battlesuperbugs.com/crau-standard>)

2. Australian Pork Industry Quality Assurance Program (APIQ) (<http://www.apiq.com.au/>)

3. Livestock Production Assurance (LPA) program

(<https://www.mla.com.au/meat-safety-and-traceability/red-meat-integrity-system/about-the-livestock-production-assurance-program/lpa-audits/>)

4. McDonald's Quality Assurance programs (not publicly available)

5. ECDC (European Centre for Disease Prevention and Control), EFSA BIOHAZ Panel (European Food Safety Authority Panel on Biological Hazards), CVMP (EMA Committee for Medicinal Products for Veterinary Use). 2017.

6. ECDC, EFSA and EMA Joint Scientific Opinion on a list of outcome indicators as regards surveillance of AMR and antimicrobial consumption in humans and food-producing animals. EFSA Journal 15(10):70pp (<http://dx.doi.org/10.2903/j.efsa.2017.5017>).

7. Australian Commission on Safety and Quality in Health Care (ACSQHC). 2016. AURA 2016: First Australian report on antimicrobial use and resistance in human health. ACSQHC, Sydney.

The literature was also searched for examples of AMS program quality assessment and verification in both human and veterinary applications. No veterinary or animal science papers were identified when the terms 'antimicrobial stewardship' and 'verification' or 'scoring' were entered into the PubMed and Web of Science search engines. One human paper developed an AMS evaluation and scoring system for hospitals in the UK (Scobie et al. 2019), but it was far too complex and of low practical relevance for application in the Australian chicken meat industry. The review paper by Lloyd and Page (2018) was therefore used as the main guide for developing the draft questions for self-assessment.

## Good Stewardship Practice (GSP) verification self-assessment tool

The verification tool was designed along similar lines to the World Health Organization's Joint External Evaluation (JEE) process

(<https://www.cdc.gov/globalhealth/healthprotection/fieldupdates/winter-2017/jee-global-preparedness.html>), developed with CDC and Global Health Security Member Countries to evaluate a country's preparedness to 'prevent, detect and respond to public health risks.' The JEE uses a standardised assessment and evaluation process across 19 core public health capacities, assigning a score of 1–5 (see below) to each. The JEE is undertaken firstly as a self-assessment. An experienced team of international experts then visits each country to review the report and scores for each category, asking pertinent questions and raising issues of concern or clarification. They then either confirm the score or recommend a rescore, justified with a list of areas of suggested improvement. During the face-to-face interview, discussion resolves any disagreements in score assignment between the two parties. The process is designed to be supportive and conciliatory, with the JEE team and the

country's Department of Health working together to identify areas that need resourcing for improvements to be made.

In summary, JEE's main objectives are to:

- establish a baseline measurement for a country's capacity
- inform national policy and planning
- target resources to areas of greatest need
- track progress towards IHR compliance
- highlight priority areas for improvement.

The simplified scoring system adopted by the JEE is as follows:

#### JEE Scoring System

Score    Status level

- 1        No capacity
- 2        Limited capacity
- 3        Developed capacity
- 4        Demonstrated capacity
- 5        Sustainable capacity

This scoring system was modified and applied to AMS programs in the Australian chicken meat industry (Table 2). With a score of 1–5 for each of the five components, a company's final score could potentially range from 5 to 25.

**Table 2: Good stewardship practice scoring system applied to assess Antimicrobial Stewardship Plans developed by each Australian Chicken Meat Federation company according to the 5Rs (Responsibility, Review, Reduce, Replace, Refine).**

Score	Status level	Explanation
1	No capacity	No stewardship framework for this 'R' exists.
2	Limited capacity	A stewardship framework for this 'R' has been discussed but is neither in place nor regularly reviewed.
3	Developed capacity	A stewardship framework for this 'R' has been put in place but it has not been reviewed.

Score	Status level	Explanation
4	Demonstrated capacity	A stewardship framework for this 'R' has been put in place and has been reviewed once, with a plan put in place for regular review (at least once per year).
5	Sustainable capacity	A stewardship framework for this 'R' has been put in place and is regularly reviewed along the lines of good stewardship practice (GSP) using the continuous improvement model.

## **Drafting and road testing the good stewardship practice (GSP) verification self-assessment tool**

In June 2019, a draft of the questionnaire was presented to the Project Steering Committee, which included one industry representative. After road testing, the design of the questionnaire was reviewed and altered to have clearer distinctions between evidence of GSP and the provision of commercial-in-confidence data by each company. The final questionnaire approved by the Steering Committee is presented in Appendix 1.

## **Delivery of the GSP verification self-assessment tool to industry and face-to-face interviews**

At the end of June 2019, an introductory letter and the final form of the questionnaire were sent to industry veterinarians representing each of the six ACMF member companies. Each organisation was given two months to review and answer the questions. Face-to-face interviews were conducted in September 2019. Each organisation was randomly assigned a code (ACMF01–ACMF06) to de-identify the data. Because each organisation could potentially be identified by the information in the answers, responses for each GSP component were pooled and are discussed together in this report. Between them, the six companies represent 90% of all meat chickens produced in Australia (<https://www.chicken.org.au/the-acmf/>).

# Results

The following is a summary of the results of the GSP for AMS. Two organisations scored the maximum 25/25, one organisation scored 24/25, another two scored 22/25 and the remaining organisation scored 21/25.

## Responsibility

Three organisations scored 3 for this component, one scored 4, and two scored 5.

Organisations that scored 3 did not have formalised Antimicrobial Stewardship Plans (ASPs) in place but had Veterinary Health Plans in place. As part of these veterinary health and treatment plans, they had regular meetings to discuss the reduction, replacement and refinement of antimicrobial treatments. They were therefore scored a 3 because they are considered to be acting under the principles of AMS but have not yet initiated a specific AMS document and detailed ASP.

One organisation that scored a 3 had standard operating procedures (SOPs) in place and held regular meetings between the key livestock management staff. No formal AMS document had been developed, but the decisions are based on reducing medications. Every three months, team discussions are held to review performance and disease in the field, with loosely based discussion around the 5Rs, cost saving, prudent use, weighing up benefits and costs of antimicrobial use versus other non-antimicrobial control measures. All key livestock management staff decisions are documented, even though no formal ASP is in place, with records dating back to 2015. Furthermore, upper management for the company are aware and have a key say on decisions about antimicrobial treatments.

Another organisation had no structured meetings in place, but a circular movement of notifications in the farming department informs the necessity to treat a flock with antimicrobials.

For the organisations scoring 4 and above (three out of the six companies), formalised ASPs were in place. Two companies (since 2016 and 2017, respectively) had reviewed their ASPs more than once. At one organisation, the veterinarian was responsible for developing the ASP, which has been in place since 2017, but it had not been reviewed since inception. However, the company's reviews of antimicrobial use were consistent with the aims of the three Rs (reduce, replace, refine) long before stewardship became the descriptor of choice for antimicrobial use policy. In this organisation, all senior managers are highly aware of ASP/AMS and discuss it regularly, but not in a formal setting. Regular AMS meetings are not held because very little antibiotic is used, but bird health and antibiotic use are discussed regularly.

At a second organisation, overall responsibility for the development and execution of the ASP lies with the CEO. The ASP is managed by senior management and the day-to-day application of the plan is managed by the company veterinarians. An ASP has been in place since 2017, with technical meetings held quarterly.

At the third organisation, the senior veterinarian, part of the company's senior management team, coordinates the ASP, in consultation with other company 'stewards' who manage decisions related to bird health, management and nutrition. The senior veterinarian makes ultimate decisions about antibiotic use and continuous improvement opportunities. AMS meetings are held annually when the annual report is completed. Prescribing guidelines for all bacterial diseases encountered and a list of antibiotic options for treatment (ranked from first option to last option) are used, but are based on culture and susceptibility testing.



## Review

One organisation scored a 3 out of a possible 5 for this R. It has committed to developing an ASP in 2020. The farming team monitor animal health for any outbreak of infectious disease, but do not document changes to the treatment plan relevant to AMS because antimicrobial use, excluding ionophores, is so low. The last disease outbreak occurred in 2014 and farm management is amended before any antimicrobial use is indicated. Bacterial diseases and animal health are discussed at a high level in senior leadership meetings. Resources are available but not yet used in a co-ordinated manner. The two major issues for the company are avoiding becoming complacent and improving the sustainability of their AMS program.

All other organisations scored a 4 or 5 for this R, even though some did not have a recognised ASP in place because treatment protocols/decisions are regularly reviewed (every three months to every year). In one organisation, review of the veterinary health plan is based on early identification and response to bacterial challenges in the field, regularly supported by diagnostics to identify the cause of disease. When using in feed medication, there is a requirement to rotate antimicrobials, every three to four months (i.e. take out the treatment option and replace with an alternative antimicrobial for three to four months before reintroducing the original antimicrobial to avoid resistance). Zinc bacitracin, avilamycin, flavophospholipol and virginiamycin are the only antimicrobials used on record (apart from ionophores), but virginiamycin was last used in 2017. The organisation's veterinarian wants to improve necrotic enteritis control using non-antimicrobial methods.

At another organisation, there is ongoing evaluation on how performance standards are changing, e.g. changes in biosecurity, evaluation of diseases, observing trends and avoiding antimicrobial treatments where possible. The veterinary health plan is to be updated yearly. At the end-of-year review meeting, antimicrobial use is compared to the previous year. The drug register gives insight on a quarterly basis into what drugs are being used.

Amendments to the ASP are reviewed and agreed within the AMS team and then circulated to a wider stakeholder group for review and approval.

At another organisation, the ASP is reviewed annually only, given there are minimal opportunities for Reduction and Refinement because it is already advanced. Goals and objectives are outlined under each R in the plan; the use is monitored according to these targets. Where the target is not met or there is opportunity for improvement, it is discussed; either the objective is revised or usage practices are brought back into line with goals of use. Antibiotic use trends and performance/welfare assessment indicators (including mortality) are built into the annual report. Treatment indications, whether culture and susceptibility is performed and response to treatment, are recorded and assessed against the Prescribing Guidelines. Withholding periods are recorded on veterinary scripts and results from the National Residue Survey are relied on for verification. Use is quantified, and quality of use assessed and reviewed annually in relation to goals. The goal of this organisation is to try to further Reduce and Refine antimicrobial use without compromising performance or welfare, ensuring ongoing collaboration throughout the organisation and alignment with objectives of the Australian Chicken Meat AMS program.

Representatives from all organisations that participated in this project attended the AVAMS conference in November 2018, and agreed it was an important forum to exchange ideas and to learn more about AMS principles and practices. All veterinarians attend Australian Veterinary Poultry Association meetings as part of continuous professional development.

## Reduce

All organisations scored a 5 for this R. They are adopting prudent use guidelines although some have not formalised them into an ASP. Organisations are awaiting the publication of the Australian Veterinary Association's antimicrobial prescribing guidelines in poultry that will then be applied

across industry. Historically, most organisations use very little antibiotics to treat birds with bacterial disease. Antimicrobial use is already at historically low levels in most organisations and many cannot realistically make more reductions (Table 3 lists diseases provided by each company where antimicrobials are indicated). There is no reliance on any one medication. Antimicrobial treatments are administered to less than 0.2% of flocks per annum using a low-importance antimicrobial (amoxicillin or tetracycline).

One organisation remarked that removal of the bacterial challenge is cost effective, providing other solutions work. Some alternatives are twice the price, and half as effective as the antimicrobial they are replacing. In-house trials with alternatives to antimicrobials (probiotics, prebiotics, essential oils) have, in some circumstances, allowed the phasing out of zinc bacitracin for necrotic enteritis control in meat chickens. One veterinarian reiterated that a good starting point is a quality day-old chick and avoiding antimicrobial interventions in the first week of life. Good egg hygiene and hatchery hygiene are essential to achieve this goal. All-in-all-out production systems, cleaning of sheds, tunnel ventilation, use of foggers, and phasing out of old housing have all led to significant improvements in chicken health. Litter management remains one of the last issues to be fully resolved due to its complexity. All companies do laboratory diagnostic testing to support use of relevant and effective antimicrobials. Review of antimicrobial use to understand efficacy is ongoing. Currently, the industry mainly uses antibiotics to prevent coccidiosis and necrotic enteritis. At all organisations, the target is 0% use of antibiotics of highest importance to human health (ASTAG 2018), which is close to being achieved across the industry.

**Table 3. The most frequent indications identified by the survey respondents for antimicrobial administration in the Australian chicken meat industry (Note: not all columns were completed).**

Indication	Antimicrobial Choice	Dose	Route	Duration	Notes on any possible steps taken to reduce usage
Necrotic enteritis	Zinc bacitracin, previously virginiamycin (now rarely used)  Avilamycin	recommended	#	#	#
Necrotic enteritis (2 cases in 12 months)	Amoxicillin	recommended	#	#	#
Spotty liver in breeders	Chlortetracycline	recommended	In water	#	#
Spotty liver in breeders	Oxytetracycline	#	#	#	Broilers not treated
Coccidiosis	Ionophores	recommended	per os (p/o)	Observe withholding period	On the way out due to alternatives

Hatchery <i>E. coli</i>	Amoxicillin or trimethoprim-sulphonamide	recommended	p/o	Observe withholding period	Antibiotic intervention is so low as to not warrant vaccination
Dysbacteriosis	Avilamycin	recommended	p/o	Observe withholding period	#
Colibacillosis (rare)	Amoxicillin	25 mg/kg/day	p/o	3–4 days	High dose, short duration  Excellent response to treatment
Fowl cholera	Depopulate first, breeders processed outside company	#	#	#	Biosecurity before antibiotics
<i>Staphylococcus</i> arthritis*	Not often treated but have used amoxicillin	#	#	#	Make sure vets have agreed before amoxicillin is used. Euthanasia is sometimes a better option than antibiotics.

\**Staphylococcus* arthritis: Antibiotics may not be justified; the company reporting this issue now quantifies the benefits versus risks of using antibiotics. Culture and susceptibility testing is undertaken on all diagnostic submissions and guides antimicrobial choices. However, the consensus is that antibiotics are not the answer; rather, management changes should be investigated first. In 2015, veterinarians were more tempted to use antibiotics, but now there is more robust review and challenge of the process.

#Information not provided

## Replace

All organisations scored a 5 for this category, except for one organisation that scored a 4. Across the board, the practice of all-in-all-out production is applied. It is the ultimate approach to biosecurity and disease prevention, and has resulted in large-scale improvements over time. Most organisations remarked that vaccines and genetic selection are also at optimum levels, whereas biosecurity, housing and management are always a work in progress where improvements can be made.

## Biosecurity

All biosecurity practices are considered important to reduce antimicrobial use and must be continually improved. For example: ‘You think you have everything in place and then something happens to identify a break in the system.’ However, because antimicrobial use in the Australian meat chicken industry is already at negligible starting levels, a few major gaps have been identified that contribute to use of antibiotics specifically.

The organisation that scored a 4 are trying to improve their biosecurity, but it is a challenge because of their location. Foot dips, hand sanitisers, biosecurity plans and SOPs are in place; however, a score of 4 was applied because of human breaches and the fact that the current system is not foolproof. The aim of this organisation is to develop automated biosecurity systems, such as geofencing of farms and key fob entry. Tracking regular onsite entry of people is the main challenge to overcome and removing the use of a manual visitor’s book. Development of an automatic wheel wash is needed to prevent breaches because it takes human error out of the equation. Continuous improvements to biosecurity, including better clean outs and proper disinfection of shed environments, were also noted as being extremely beneficial.

In another case, better biosecurity practices included improvements to the shower-in-shower-out facilities, as well as a better shed design, which was a big factor in reducing disease incidence. Similarly, being able to effectively track human movements was listed as one of the biggest challenges: ‘You can educate but can’t prevent movements’. Vehicle waste removal practices have been changed since the recent *Salmonella* Enteritidis outbreak that further highlighted the importance of people, vehicle and equipment movements in biosecurity. It was noted that litter material is becoming harder to source; reuse of litter may need to be considered, which brings its own biosecurity issues if not managed appropriately. This is a potential issue because single-use litter is preferred over reuse, with straw an alternative to wood shavings. Furthermore, multi-age, multi-shed pickup increases the risk of containment being breached. Root-cause analysis of biosecurity issues often comes after the breach, rather than proactively using the continuous improvement model to prevent breaches in the first place.

At another organisation, it was remarked that compliance with the biosecurity manual for chicken farmers was essential to prevent breaches. Ongoing improvements and fine-tuning included compliance with audit processes and installation of automatic gates. The veterinarian uses the threat of *Salmonella* Enteritidis together with infectious laryngotracheitis virus transmission to motivate farmers to maintain and improve biosecurity.

At other organisations, it was reported that all biosecurity practices are in line with the national chicken meat biosecurity manual. Biosecurity is encapsulated in the Antibiotic Use Policy and outlined as part of the AMS program. Adherence to biosecurity manuals and having internal procedures to ensure compliance were important features.

## Non-antimicrobial alternatives

Several organisations indicated that effective vaccines, genetic selection, nutrition, housing, lower stocking densities, altered equipment specifications (e.g. reduced flow rates of drinkers), use of enzymes in feed, and changed brooding practices had affected antimicrobial use. Probiotics, prebiotics, other dietary additives (essential oils, organic acids), good breeder health management, and good hygiene practices throughout each organisation have all played an important role in reducing reliance on antimicrobials. It was noted, however, that antibiotic-free production can lead to high moisture droppings if diet is not balanced, leading to wet floors, which in turn leads to footpad lesions, welfare issues, and potentially secondary health problems, highlighting the interdependency of different practices.

Monitoring gut health and identifying solutions to maintain gut health (e.g. essential oils, probiotics, prebiotics) have been adopted by all organisations but results are commercial-in-confidence and

cannot be reported specifically. Some organisations have trialled alternatives to zinc bacitracin and have succeeded in maintaining gut health while reducing overall antimicrobial use. However, it was remarked that ongoing trials of alternatives to antibiotic use are often difficult to evaluate in field scenarios. Live coccidiosis vaccines have been trialled as an alternative to ionophores as had various other replacement products for prevention/control of necrotic enteritis (organic acids, prebiotics, probiotics, secondary plant compounds etc.). Industry accepts, however, that these products will not be better than antibiotics in performance or health outcomes. They are complementary, and are regarded as a tool to improve gut health and reduce overall preventative use (mainly medications for necrotic enteritis prevention, such as zinc bacitracin). Gut health scoring and monitoring at the processing plant is completed to understand efficacy of these alternatives, but otherwise it is difficult to measure their direct benefit.

## **Refine**

All organisations scored a 5 for this category. In one organisation, health monitoring of breeders, detailed history of the vaccination program, and serology were often used to verify infection status. Some diseases that used to be diagnosed by service personnel are now diagnosed by the veterinarian who must confirm the diagnosis with laboratory testing (e.g. spotty liver presents in many different ways, changes in severity are harder to diagnose, and the clinical picture has changed). Organisations reported training service people skilled in identifying common diseases, with the veterinarian on call for support and verification and to investigate cases if needed to authorise treatment. Clinical diagnosis is usually always confirmed by laboratory support. Only the company veterinarian prescribes any use of an antimicrobial. In terms of laboratory diagnostics for bacterial conditions, culture and susceptibility testing is conducted to confirm the causative organism and its susceptibility to available antibiotics (a company-owned laboratory is available in some organisations). Samples are collected and submitted to a laboratory for testing, but antibiotics are still rarely, if ever, needed. Other measures (e.g. management changes) are considered first unless there is a serious disease or poor welfare situation.

If an antimicrobial treatment is needed, the highest label dose rate is usually prescribed because the need to use water tanks for antimicrobial administration means there is always residual that will precipitate out; the higher end of the dose rate is considered more effective. Duration of treatment for most diseases has been reduced from 5 days to 3 days, which is an important aspect of refinement. Response to treatment is carefully monitored. The dose of medications used in feed for necrotic enteritis prevention is only at the recommended label rate. Ongoing improvements include setting and revising goals, monitoring gut health, and making changes based on clearly identified targets. Adopting outcomes of new research such as new vaccines was noted as extremely important.

Veterinarians keep up to date with the latest research on antimicrobial prescribing practices through industry bodies such as ACMF, research and innovation through the AgriFutures Australia Chicken Meat Program, international best practice through attendance at relevant industry conferences, membership of veterinary professional associations, and scientific journal article review. Articles on international poultry health websites and e-journals are also sourced for information to help refine antimicrobial use.

# Implications

The results of the AMS verification process dovetail with the recent pilot AMR surveillance studies that confirmed the low-resistance status of Australian poultry meat (Abraham et al. 2019; 2020; O’Dea et al. 2019). The industry has already adopted many management strategies alleviating the need for antimicrobial treatments and is forging the path towards minimal use. Outbreaks of disease requiring antimicrobial intervention are rare, and in many cases, can be effectively treated and/or prevented through good animal husbandry, environmental stability, genetics, biosecurity, and vaccination. Where antimicrobial intervention is needed, culture and susceptibility testing is almost always used to guide treatment protocols.

Three of the six organisations that produce 90% of Australian chicken meat have implemented formal ASPs that are subjected to regular review and continuous improvement. Current antimicrobial treatments are being reviewed and challenged. They represent minimal interventions with antimicrobial agents, and those that are used are rated as of low importance. For the other three organisations, while they do not have official ASPs in place, they are still operating according to the principles of AMS, particularly for Reduce, Replace, and Refine. All organisations are actively pursuing credible alternatives to further reduce their reliance on antimicrobials, with many advances made in the critical area of gut health. Biosecurity can always be improved, and reuse of litter may become an issue in the future.

In summary, the Australian chicken meat industry’s progressive introduction over many decades of infection prevention and control measures (including vaccination programs and biosecurity initiatives) combined with high standards of husbandry, genetics, nutrition and environmental controls have made the major advancements in antimicrobial stewardship possible. This is buttressed by a conservative regulatory system that has not permitted the use of many antimicrobial agents in meat chickens now considered critically important in human medicine (including colistin, fluoroquinolones and third- and fourth-generation cephalosporins). It is undoubtedly a significant contributor to the low AMR levels now evident in isolates from meat chickens. However, complacency is not an option. Continued vigilance, reinforced by rigorous adoption of AMS programs, will help protect the rare environment of low AMR, enabling early identification of any changes in resistance status as alerts to investigate risk mitigation measures, or assurance of the effectiveness of production practices.

# Recommendations

- 1) It was estimated that the AMS verification tool was delivered to companies that produce about 90% of Australian chicken meat. The biggest antimicrobial usage issues the industry currently faces is the use of preventatives for necrotic enteritis, such as Zinc bacitracin, and managing the differing antibiotic use policies of third parties, including customers. In this context, 99.9% of zinc bacitracin use in humans is topical, so there is no suggestion of any impact of use in chickens on human health. Nevertheless, industry is actively seeking other control methods. It would be ideal for industry to have a formal ASP in place in each company, not just an Animal Health Policy. The recommendation is to extend the project and reissue the AMS verification tool to all companies in the second half of 2020, in particular to capture progress from the three companies that are yet to develop/officially formalise their ASP.
- 2) The importance of the inaugural AVAMS conference was a common theme in answers to questions about how each company has undertaken continuing professional development in relation to AMS. It is recommended that companies attend the next AVAMS conference on the Gold Coast in November 2021.

# Appendix 1: Antimicrobial Stewardship Questionnaire

This self-assessment questionnaire has been developed around the 5R framework of **Responsibility, Review, Reduce, Replace, and Refine**.

Answers to each question will inform the overall score assigned to each R. This will then inform the overall score which will be an average of the 5Rs (rounded to the nearest whole number).

**It is important to note that the answers to the questions (please keep these general) remain strictly confidential to the Antimicrobial Stewardship Verification team (Prof Darren Trott and Dr Stephen Page) for the purpose of assigning an AMS score to the company and no confidential information or intellectual property should need to be provided in completing the self assessment tool. For example, for some questions, the Verification team may only require evidence of procedures being in place rather than detailed examination of the evidence itself. No individual company will be identified in reports to Agrifutures and the material will not be published in its written form without the express written consent of the company and then only after a de-identification process.**

**Please complete answers in RED FONT.**

**Questions pertaining to Responsibility** (Please assign a Score from 1-5 on this section based on your answers to the questions below and the following rubric [circle the appropriate number]):

Score	Status Level	Explanation
1	No capacity	No stewardship framework for this “R” exists
2	Limited capacity	A stewardship framework for this “R” has been discussed but is neither in place nor regularly reviewed
3	Developed capacity	A stewardship framework for this “R” has been put in place but it has not been reviewed
4	Demonstrated capacity	A stewardship framework for this “R” has been put in place and has been reviewed once
5	Sustainable capacity	A stewardship framework for this “R” has been put in place and is regularly reviewed along the lines of good stewardship practice (GSP) using the continuous improvement model.

- 1) Describe the organisation’s hierarchical structure (eg who is in charge and who is involved) in terms of delivery of the ASP along the lines of continuous improvement throughout the production cycle.
- 2) Who in the organisation is responsible for managing the ASP?



- 3) Does the organisation have an antimicrobial stewardship team (AST) in place to deliver the ASP and who comprises this team (this can be one or more people)?
- 4) Does the organisation have an Antimicrobial Stewardship Plan (ASP) in place? Y/N
  - a. *Please ensure that during the face to face interview, a copy of the plan is shown to the verification assessment team*
- 5) If YES, for how long has the ASP been in place?
- 6) Within the organisation, how often are AMS meetings held and who attends?
- 7) Does the organisation have in place a drug or veterinary medicine list and treatment protocol for each of the main bacterial diseases encountered on farm? Y/N
  - a. *Please ensure that during the face to face interview, a copy of the organisation's prescribed drug list and treatment protocol is shown to the verification assessment team*
- 8) If YES, for how long has the prescribed drug list and treatment protocol been in place?

**Questions pertaining to Review** (Please assign a Score from 1-5 on this section based on your answers to the questions below and the following rubric [circle the appropriate number]):

Score	Status Level	Explanation
1	No capacity	No stewardship framework for this "R" exists
2	Limited capacity	A stewardship framework for this "R" has been discussed but is neither in place nor regularly reviewed
3	Developed capacity	A stewardship framework for this "R" has been put in place but it has not been reviewed
4	Demonstrated capacity	A stewardship framework for this "R" has been put in place and has been reviewed once
5	Sustainable capacity	A stewardship framework for this "R" has been put in place and is regularly reviewed along the lines of good stewardship practice (GSP) using the continuous improvement model.

- 1) Has the ASP been revised since inception? (Y/N)
  - a. *How do you decide on changes that are needed?*
  - b. *Describe the process for updating and implementing changes to the ASP*
- 2) If Yes, how often are changes made to the ASP?
  - a. Every three months
  - b. Every six months

- c. Yearly
  - d. >1 year
- 3) Who is responsible for making the changes to the ASP?
  - 4) Has a review of the current status of animal health and wellbeing with respect to antimicrobial use (including use of ASTAG highly important and important antibacterial agents) in the organisation been undertaken? Y/N
  - 5) Does the review include mechanisms to quantify the use of each antimicrobial in the production system (e.g. animal mass x daily dose x duration for in water medication; inclusion rate in feed x kg consumed x duration for in feed)?
  - 6) Does the review include mechanisms to assess optimal quality of use e.g. use audited against the prescribed drug list and treatment protocol (i.e. indication, dosage, duration, route of administration, withholding period is recorded)?
  - 7) How do you keep track of changes in practices that might benefit your organisation?
  - 8) What type of continuing professional development (CPD) is undertaken relevant to AMS?
  - 9) How do you measure progress in meeting AMS aims and goals?
  - 10) What are the most important needs for ongoing AMS aims and goals?
  - 11) Are resources available to support meeting the important needs?

**Questions pertaining to Reduce** (Please assign a Score from 1-5 on this section based on your answers to the questions below and the following rubric [circle the appropriate number]):

Score	Status Level	Explanation
1	No capacity	No stewardship framework for this “R” exists
2	Limited capacity	A stewardship framework for this “R” has been discussed but is neither in place nor regularly reviewed
3	Developed capacity	A stewardship framework for this “R” has been put in place but it has not been reviewed
4	Demonstrated capacity	A stewardship framework for this “R” has been put in place and has been reviewed once
5	Sustainable capacity	A stewardship framework for this “R” has been put in place and is regularly reviewed along the lines of good stewardship practice (GSP) using the continuous improvement model.

- 1) Has the organisation developed and/or adopted prudent use (i.e. prescribing) guidelines for the treatment of bacterial diseases? Y/N

- a. Please ensure that during the face to face interview, a copy is shown to the verification assessment team
- b. During the face to face interview, discuss the main bacterial diseases occurring or being prevented on farm where antimicrobials are indicated. The following Table may be useful in identifying and discussing areas for improvement.

Indication	Antimicrobial Choice	Dose	Route	Duration	Notes on any possible steps taken to reduce usage

- 2) What steps have been taken (if any) to further reduce reliance on these antimicrobials since adoption of the antimicrobial stewardship framework?
- 3) Based on the review of antimicrobial use, do you have a goal to reduce antimicrobial use by a certain amount?
- 4) What is the goal and how will it be achieved?

**Questions pertaining to Replace** (Please assign a Score from 1-5 on this section based on your answers to the questions below and the following rubric [circle the appropriate number]):

Score	Status Level	Explanation
1	No capacity	No stewardship framework for this “R” exists
2	Limited capacity	A stewardship framework for this “R” has been discussed but is neither in place nor regularly reviewed
3	Developed capacity	A stewardship framework for this “R” has been put in place but it has not been reviewed
4	Demonstrated capacity	A stewardship framework for this “R” has been put in place and has been reviewed once
5	Sustainable capacity	A stewardship framework for this “R” has been put in place and is regularly reviewed along the lines of good stewardship practice (GSP) using the continuous improvement model.

- 1) What external biosecurity practices (bioexclusion) are in operation to prevent disease outbreaks requiring antimicrobial treatments (e.g. provision of clean water, feed and air,

exclusion from wild birds, vehicle disinfection protocol, pest exclusion and human access control)?

- 2) What improvements are needed?
- 3) What internal biosecurity practices (biocontainment) are in operation to prevent disease outbreaks requiring antimicrobial treatments? Use specific examples where possible (e.g. hygiene and infection control, all in all out production system, housing design, ventilation and drainage, litter protocols, disease diagnostics)
- 4) What improvements are needed?
- 5) What other practices have been put in place to improve individual animal's adaptive capacity to environmental changes? Use specific examples where possible without disclosing confidential information or IP (e.g. effective vaccines, genetic selection, management, nutrition, housing)
- 6) What improvements are needed?
- 7) What replacements have been introduced and have they lead to improved bird health and reduction in need to use antimicrobials?
- 8) What other measures (efficacious, scientific evidence based) are practiced to reduce or replace the need for antimicrobial treatments? (e.g. gut health, supplements, prebiotics, probiotics)

**Questions pertaining to Refine** (Please assign a Score from 1-5 on this section based on your answers to the questions below and the following rubric [circle the appropriate number]):

Score	Status Level	Explanation
1	No capacity	No stewardship framework for this "R" exists
2	Limited capacity	A stewardship framework for this "R" has been discussed but is neither in place nor regularly reviewed
3	Developed capacity	A stewardship framework for this "R" has been put in place but it has not been reviewed
4	Demonstrated capacity	A stewardship framework for this "R" has been put in place and has been reviewed once
5	Sustainable capacity	A stewardship framework for this "R" has been put in place and is regularly reviewed along the lines of good stewardship practice (GSP) using the continuous improvement model.

- 1) What steps are in place within the organisation to improve the accuracy of disease diagnosis prior to antimicrobial treatment (e.g. point of care diagnostics, regular submissions to veterinary diagnostic laboratories)?

- 2) What changes (if any) have been made to dose and duration of therapy to maximise antimicrobial effectiveness and reduce AMR. Use specific examples where possible.
- 3) How are possible refinements in drug selection and use determined (for example, published literature, conferences, etc)?
- 4) What improvements are needed?

Thank you for completing the AMS verification questionnaire. Please transcribe your scores from each section below to obtain your overall score (round up or down to the nearest whole number).

Stewardship category	Score				
Responsibility	1	2	3	4	5
Review	1	2	3	4	5
Refine	1	2	3	4	5
Reduce	1	2	3	4	5
Replace	1	2	3	4	5
Overall AMS Score					/25

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### **AgriFutures Australia**

Building 007  
Tooma Way  
Charles Sturt University  
Locked Bag 588  
Wagga Wagga NSW 2650

02 6923 6900  
[info@agrifutures.com.au](mailto:info@agrifutures.com.au)

**@AgriFuturesAU**  
**[agrifutures.com.au](http://agrifutures.com.au)**

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