

ANIMAL SCIENCE IN AUSTRALIA



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Association of Animal Sciences

Volume 36

Transforming Animal Management through Sustainable Innovations

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WELCOME TO THE AUSTRALIAN ASSOCIATION OF ANIMAL SCIENCES 2026 CONFERENCE

On behalf of the Australian Association of Animal Sciences (AAAS), we are pleased to welcome you to Adelaide, South Australia, for the 36th AAAS Biennial Conference.

As President and Vice-President of AAAS, it is our privilege to bring together our members, colleagues and partners from across Australia and the broader international animal science community. This conference is a cornerstone event for our Association—providing an important opportunity to share knowledge, strengthen collaborations, and support the continued growth of AAAS and our members.

The 2026 conference theme, “Transforming Animal Management through Sustainable Innovations,” reflects both the challenges and opportunities facing animal industries today. Livestock systems continue to navigate a complex landscape shaped by climate variability, resource constraints, shifting societal expectations, and the imperative to improve animal welfare and environmental outcomes. In this context, innovation—spanning genetics, nutrition, health, digital technologies and management systems—will be central to driving sustainable, resilient and productive animal enterprises.

AAAS has a proud history, having been established in 1954 as the Australian Society of Animal Production. Over time, the Association has evolved into a dynamic and inclusive professional community. We remain committed to fostering diversity, supporting early- and mid-career researchers, and creating pathways for engagement across research, government and industry. The strength of our Association lies in the breadth of expertise and perspectives represented within our membership.

This year’s conference program reflects that diversity. Delegates will engage with a high-quality program of keynote and plenary presentations, technical sessions and workshops spanning critical areas such as methane mitigation, animal nutrition, health, genetics, welfare, sustainability and emerging technologies. Together, these sessions highlight both the depth of scientific inquiry and the practical applications that underpin innovation in animal management.

A defining feature of AAAS conferences is the opportunity to build meaningful professional connections. The 2026 conference has been designed to facilitate engagement across all career stages and sectors, with a range of formal and informal networking opportunities embedded throughout the program.

We encourage you to take full advantage of these opportunities—whether through dedicated networking events, poster sessions, workshops, or the social program—to reconnect with colleagues, establish new collaborations, and share ideas that can shape future research and industry outcomes. For our early- and mid-career members in particular, these interactions are invaluable in building professional networks and identifying new pathways for collaboration and development.

In addition, the post-conference field trips provide a unique setting to continue these conversations while experiencing South Australia’s leading agricultural, research and conservation systems firsthand.

We would like to acknowledge and thank the many volunteers, committee members and contributors whose commitment and efforts have made this conference possible. Their work ensures that AAAS continues to deliver a valuable platform for knowledge exchange, professional development and recognition of excellence across the animal science community.

The breadth of science presented at this conference reflects the diversity of our field—from advances in livestock production systems to research in wildlife, companion animals and sustainability. We trust that you will find this conference both stimulating and rewarding, and that you will enjoy the hospitality and vibrancy of Adelaide. We look forward to the conversations, collaborations and innovations that will emerge over the course of the week.

Matt Bekker
AAAS Federal President

Dr Sue Hatcher
AAAS Vice President

WELCOME FROM THE 2026 AAAS BIENNIAL CONFERENCE CHAIR

On behalf of the Conference Organising Committee, it is my great pleasure to welcome you to Adelaide for the 36th Australian Association of Animal Sciences (AAAS) Biennial Conference.

We are delighted to host you from 13–17 July 2026 at the Hotel Grand Chancellor, where we bring together a vibrant community of researchers, industry professionals, students and partners who are all committed to advancing animal science.

The theme for this year's conference, **“Transforming Animal Management through Sustainable Innovations,”** reflects the collective focus of our community on finding practical, forward-looking solutions to the challenges facing animal industries. From climate variability and resource constraints to evolving societal expectations around animal welfare and sustainability, the need for innovation has never been greater. This conference provides a forum to explore how science and technology can deliver meaningful change across livestock and animal systems.

In developing the 2026 program, the Committee has worked to create a dynamic and engaging experience that reflects both the breadth and depth of contemporary animal science. The program features an outstanding line-up of keynote speakers, plenary sessions, technical streams and interactive workshops, covering areas such as animal nutrition, genetics, health, welfare, sustainability, and emerging technologies. We are confident that delegates will find the program both intellectually stimulating and highly relevant to their work.

Beyond the formal sessions, we have placed a strong emphasis on creating opportunities for connection and collaboration. The conference includes a range of networking events, poster session and informal gatherings designed to encourage meaningful engagement across disciplines, sectors and career stages. These interactions are at the heart of AAAS conferences and often spark the ideas and partnerships that shape future research and industry innovation.

I would like to sincerely thank the members of the Organising Committee, our sponsors and partners, and the many volunteers who have contributed their time and expertise to make this conference possible. Their commitment has been instrumental in bringing together what we hope will be a memorable and impactful event.

Adelaide, located on the traditional Country of the Kaurna people, offers a welcoming and inspiring setting for this year's conference. We acknowledge and pay our respects to Kaurna Elders past and present, and extend that respect to all Aboriginal and Torres Strait Islander peoples.

We encourage you to participate fully in the program, engage with colleagues new and familiar, and take advantage of all that the conference and the city have to offer. We hope you find this experience enriching, enjoyable and inspiring.

We look forward to sharing an excellent week of science, collaboration and connection with you.

Dr Mariana Caetano

Chair, Organising Committee
Adelaide University

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KAM Events, Kate Murphy and Jenny Lawler

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D. S. Wishart	1956–57	Melbourne
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H. N. Turner	1962–64	Sydney
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I. W. McDonald	1972–74	Sydney
C. H. S. Dolling	1974–76	Adelaide
N. M. Tulloh	1976–78	Melbourne
J. H. Shepherd	1978–80	Perth
D. J. Minson	1980–82	Brisbane
J. L. Corbett	1982–84	Armidale
W. J. Pryor	1984–86	Canberra
G. E. Robards	1986–88	Sydney
J. C. Radcliffe	1988–90	Adelaide
A. R. Egan	1990–92	Melbourne
I. P. Barrett-Lennard	1992–94	Perth
J. H. Temouth	1994–96	Brisbane
C. J. Thwaites	1996–98	Armidale
F. W. Nicholas	1998–00	Sydney
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C. M. Oldham	2004–06	Perth
D. P. Poppi	2006–08	Brisbane
R. M. Herd	2008–10	Armidale
R. D. Bush	2010–12	Sydney
R. D. Bush	2012–14	Sydney
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P. I. Hynd	2016–18	Adelaide
M. A. Friend	2018–20	Wagga Wagga
M. A. Campbell	2020–22	Wagga Wagga
D. E. Mayberry	2022–24	Brisbane
M. Bekker	2024–26	Brisbane

FELLOWS OF THE AUSTRALIAN ASSOCIATION OF ANIMAL SCIENCES

Fellowship of the Association shall be awarded to persons who have rendered eminent service to animal science or animal production in general or within Australia in particular.

1956	Charles Euston Young	1986	George Alexander Charles Hoani Scott Dolling Ian Lind Johnstone Dennis John Minson William Henry Southcott
1962	Mervin Clarence Franklin Hedley Ralph Marston		
1964	Philip Gurner Schinckel	1988	John Lovick Corbett Haydn Lloyd Davies Peter Everard Geytenbeek Geoffrey Roger Pearce Laurence Cecil Snook
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		2004	Keith William Entwistle Neil Patrick McMeniman William Anthony Pattie

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2008	David Blair Coates Hugh Dove Peter Thomas Doyle Adrian Roderic Egan Christopher Morris Oldham	2018	Bruce Lipson Hancock Susan Faye Hatcher David Lawrence Hopkins Athol Victor Klieve Christopher Simon McSweeney
2010	Philip Ian Hynd Laurie Robert Piper Dennis Paul Poppi Cyril Richard Stockdale Peter Charles Wynn	2020	Edward Charmley Roger Stephen Hegarty Robert Arthur Hunter Graeme Bruce Martin
2012	Wayne Leslie Bryden Geoffrey Norman Hinch Stuart Ross McLennan Victor Hutton Oddy	2022	Brian Joseph Leury Robyn Dorothy Warner
2014	Frank Rowland Dunshea Robert Maxwell Herd	2024	Eric Nanathan Ponnampalam Philip Edward Vercoe
		2026	Hayley Christine Norman Andrew Nathan Thompson

HONORARY MEMBERS OF THE AUSTRALIAN ASSOCIATION OF ANIMAL SCIENCES

Honorary Members shall be those who, in the opinion of the Federal Council, have rendered eminent service to the Association.

1976	Joseph Phillip Kahler
1980	Clarence James Daley
1982	Ian Neville Southey
1986	John Murray George Andley George Ward
1988	Edward (Ted) Ben Byers John Terrell Williams
1990	Barry Graham Lukins
1994	Christopher John Thwaites Edmund Wyndham
1996	Eric John (Jack) Hilder
1998	Narelle Yvonne Morse Evan Hollinworth Macdonald Barnet
2000	Gordon Terrell Williams
2002	David Macfie Richard Moss
2004	David Hennessey
2006	Anthony (Tony) Charles Schlink
2010	Michael Leo Tierney

THE UNDERWOOD LECTURE

In honour of **Professor E. J. (Eric) Underwood** (1905 – 1980), AO, CBE, BSc(Agric)(Hons)(WA), PhD(Cantab), Hon. DRurSc(UNE), Hon. DSc(Wis), Hon. DSc(Agric)(WA), Hon. DSc(Melb), FRS, FAA, FFA, FAIAS, FASAP, Hon. FACVS. He was Hackett Professor of Agriculture, Dean of the Faculty of Agriculture, and Director of the Institute of Agriculture at the University of Western Australia and a world authority on mineral nutrition.

The Underwood Lecturers have been:

1984	R.J. Moir
1986	H.J. Lee
1988	I.W. McDonald
1990	A.D. Robinson
1992	J. Stocker
1994	K.W. Entwistle
1996	D.E. Beever
1998	H. Dove
2000	N.F. Suttle
2002	J.E. Vercoe
2004	J.C. MacRea
2006	D. Lindsay and B. Paganoni
2008	G. Atwood
2010	D.P. Poppi
2012	R.S. Hegarty
2014	J.L. Jacobs
2016	J.L. Black
2018	D.G. Masters
2020	M. Gill
2022	J.J. Looor
2024	C. Ashworth
2026	E. Kebreab

THE MCCLYMONT LECTURE

The 22nd Federal Council introduced this lecture to honour **Professor G. L. (Bill) McClymont** (1920 - 2000), AO, BVSc(Syd), PhD(Cantab), Hon. DRurSc (UNE), FAIAS, FASAP, Foundation Dean (1955–1976) of Rural Science at the University of New England, and a pioneer in the development and application of ecological principles to the teaching and practice of agriculture.

The McClymont Lecturers have been:

1998	B.E. Norton
2000	A.R. Sykes
2002	G. Grigg
2004	T.G. Reeves
2006	J. Scott, T. Coventry and H. Sutherland
2008	W.H. Winter and P.T. Doyle
2010	P. Morris
2012	W.L. Bryden
2014	A.W. Bell
2016	H. Dove
2018	F.D. Provenza
2020	M.R.F. Lee
2022	C.M. Thornton
2024	L. Majele Sibanda
2026	J. Laporta Sanchis

THE STOBBS LECTURE

To honour **Professor H. (Harry) Stobbs** (1932 – 1978), BSc(Agric), PhD, the Harry Stobbs Memorial Fund established a Lecture that was to be presented at an appropriate conference and if possible published in *Tropical Grasslands*. The 27th Federal Council was invited to include the lecture in its biennial conference and has done so since 2008 with the exception of a lecture presented to the 8th Australian Tropical Pastures Conference in 2009. Harry was recognised internationally for his contributions to our understanding of the plant/animal interaction, particularly his work on grazing behaviour on different sward types in tropical environments.

The Stobbs Lecturers have been:

1980	F.H.W. Morley
1981	R.E. Blaser
1982	V.R. Squires
1984	R.F. Barnes
1985	R.E. Harrison
1987	R.J. Jones
1990	C. Lascano
1993	S. Archer
1994	L. 't Mannetje
1995	J.W. Stuth
1996	F.D. Provenza
1997	J.B. Schiere
2002	W.H. Burrows
2008	G.R. Edwards
2009	M.J. Fisher
2010	D.L. Swain
2012	P. Gregorini
2014	D. Pacheco
2016	A. de Vega
2018	J.M.B Vendramini
2020	H.C. Norman
2022	D.J. Augustine
2024	F. Cowley
2026	E.H. Boughton

THE BARNETT LECTURE

The 28th Federal Council inaugurated this lecture on animal welfare to honour **Associate Professor J. L. (John) Barnett** (1949–2009), BSc (Zool)(Hons)(Sheffield), PhD (Monash). John was internationally recognised for his outstanding contributions to stress physiology and stress-related problems of animal welfare. Over 30 years, his research provided a timely balance on discussions within science on the scientific assessment of animal welfare and its interpretations.

The Barnett Lecturers have been:

2010	P.H. Hemsworth
2012	G.M. Cronin
2014	I. Veissier
2016	A.J. Tilbrook
2018	P.H. Hemsworth
2020	C. Lee
2022	R.E. Doyle
2024	J.L. Rault
2026	L. Hemsworth

FELLOWS ELECTED 2026



Hayley Christine Norman

B.Agr.Sc. (Hons), PhD (University of Western Australia)

Dr Hayley Norman completed a Bachelor of Agricultural Science in 1995 and a PhD (Distinction) in 2002 at the University of Western Australia, working with Prof. Phil Cocks on the reproductive ecology of pasture legumes adapted to dry climates. In 2000 she joined CSIRO, collaborating with Dr David Masters, Dr Robyn Dynes and Dr Ed Barrett-Lennard to develop profitable grazing systems for salinised land within the Salinity and Future Farm CRCs.

Over the past two decades, Hayley has built an internationally recognised research program advancing the role of livestock in Mediterranean and arid farming systems. Her work focuses on optimising the feedbase to meet the year-round nutritional requirements of ruminants while complementing cropping enterprises. She brings together expertise in animal nutrition, agronomy, plant ecology and near-infrared spectroscopy (NIRS).

Hayley has led pioneering research to domesticate salt-tolerant native shrubs, improving their feeding value to enhance profitability, adoption and landscape health. Her team developed innovative methods that incorporate the ‘nutritional wisdom’ of sheep to rapidly identify elite shrub genotypes with higher energy value, an approach that challenges the traditional tendency to consider feeding value late in pasture improvement programs. These approaches have also been applied to pasture legumes, identifying species with higher feeding value, improved livestock safety and suitability for summer utilisation without compromising seed banks. Her team maintains and refines the faecal NIRS methods developed by Dr David Coates and has produced forage NIRS calibrations for more than 150 pasture and shrub species across the Australian feedbase. This expertise now underpins a Global Methane Hub project, developing calibrations to predict intake, selection, diet quality and methane emissions from sheep and cattle faeces. Hayley also manages the CSIRO ruminant nutrition facility at Floreat, supporting livestock and farming systems research across Townsville, Brisbane, Canberra and Adelaide.

Her scientific contributions are both influential and practical. Key publications include *“Halophytes as forages in saline landscapes: Interactions between plant genotype and environment change their feeding value to ruminants”*, the first evidence that red algae reduces methane emissions from sheep and the AAAS Harry Stobbs Memorial Trust Lecture, *“Livestock preference and feeding value as key determinants for forage improvement – why not ask the consumers?”* She has published 66 refereed papers, alongside extensive industry outreach through television, radio and rural media.

Hayley led the commercialisation of Anameka™ oldman saltbush, an Australian native shrub selected for superior growth, nutritional value and palatability. More than eight million Anameka™ plants have now

been established by over 400 producers across Australia. In 2025 she received the W.E. Wood Award for her contribution to salinity and water-management research.

A committed and enthusiastic collaborator, Hayley works with colleagues from CSIRO, Murdoch University, UWA and DPIRD (WA and NSW) on shade and shelter strategies to improve sheep welfare and lamb survival, new feedbase options for meat production in low- and medium-rainfall zones, and the domestication of harvestable annual legumes for mixed farming systems. She has supervised 4 postdoctoral and 20 postgraduate students. Her work has been supported by the Australian meat, wool and grains industries as well as ACIAR, DFAT and DAFF. Hayley has contributed to feedbase research in Afghanistan, Pakistan, Tibet, Iraq and Syria.

Aligned with her research interests, Hayley served as Chair of the WA Soil and Land Conservation Council, is a founding member and Deputy Chair of the WA Livestock Research Council and contributes to the WA Crawford Fund and the UWA Institute of Agriculture Advisory Board. She is an Associate Editor for *Grass and Forage Science* and an Adjunct Associate Professor at Murdoch University. A long-standing supporter of AAAS, she has been a member since 2002, served on the 2006 conference committee and co-edited the 2020 conference proceedings.

In recognition of her contribution to improve saline landscapes and improving the role of livestock in farming systems, the Australian Association of Animal Sciences is pleased to enrol Dr Hayley Norman as a Fellow.



Andrew Nathan Thompson

BAgrSc (Hons) (University of Western Australia), PhD (University of Adelaide)

Dr Andrew Thompson graduated in Agricultural Science from the University of Western Australia in 1989. Andrew grew up on a farm near Lake Varley in the wheat-sheep zone in southern Western Australia. His farm upbringing contributed to his systems thinking and passion for adoption of practical research outcomes. He started his career with the Western Australian Department of Agriculture based in Albany under the leadership of Dr Peter Doyle and played a key role within projects focused on intensive grazing strategies to manage fibre diameter, given huge premiums for finer wool at the time. The concept of using the amount of green feed on offer or FOO as a tool for making more informed pasture and sheep management decisions originated from this early work and these concepts are now embedded in everyday advice and management of sheep across Australia.

He moved to South Australia and completed a PhD at the University of Adelaide in 1996 focussed on genetic and nutritional management strategies to improve staple strength. Following his PhD, Andrew returned to the Western Australian Department of Agriculture based in Katanning and continued working on management of wool quality, before moving to the Victorian Department of Agriculture based in Hamilton in 1999. The time at Hamilton involved Leadership roles within MLA funded R&D programs including Sustainable Grazing Systems and MoreLamb Quality Pastures, plus projects within the Salinity and Future Farm Industries CRCs including Sustainable Grazing of Saline Land and Evergraze. Most notable however was his role in initiating, developing and leading the national \$10M AWI-funded Lifetime Wool project from 2000 to 2007.

Andrew commenced at Murdoch University in 2011, where he is now a Professor in Animal Production Science. Since then, he has developed an internationally recognised research group in sheep reproduction and production. His work has directly informed best-practice management for improving lamb survival and mating ewe lambs and contributed significantly to understanding the roles of fatness on sheep productivity and welfare, genetics for feed efficiency, methane production and feet health, climate resilience and the use of sensor technologies to improve animal welfare and labour efficiency.

Throughout his career, Andrew has remained unwavering in his focus on one goal: improving the productivity, resilience and welfare of sheep enterprises through science that works on real farms. Nationally, he is best known for his leadership in sheep reproduction and lamb survival research. Over more than 25 years, he has been a central figure in transforming how the industry understands and manages ewe nutrition, reproduction and lamb survival. His leadership of the Lifetimewool project in the early 2000s laid the foundation for what has become one of the most influential research and development programs in the Australian sheep industry, Lifetime Ewe Management. This program has since been delivered to more than 5,000 sheep producers in Australia who manage around 40% of the national flock. Independent assessments have estimated the benefits of this program to exceed one billion dollars to the Australian economy – a remarkable example of research translated into lasting, industry-wide change.

Across his career, Andrew has been a principal or co-investigator on more than 60 competitive research grants, attracting about 70 million dollars in funding. Many of the projects have provided the foundation for producer adoption programs. Andrew has contributed to over 120 refereed publications in scientific journals and 90 in conference proceedings. Just as importantly, these projects have been built on collaboration with producers, consultants, research organisations and industry bodies across Australia and New Zealand. Indeed, more than 80% of all his projects have involved interstate partners and or collaboration with multiple project partners. Many of the research models he pioneered, particularly those embedding pre- and post-experimental whole farm systems modelling, on-farm trials and producer participation, are now standard practice across the industry.

Andrew's contribution extends beyond research outputs. He has played a major role in shaping national sheep research priorities through leadership roles with the Salinity CRC, Future Farm Industries CRC and Sheep CRC, Australian Wool Innovation and Meat & Livestock Australia. He is widely regarded as a trusted source of evidence-based advice, regularly invited to speak at industry forums, conferences and producer events, often translating complex science into practical, actionable insights. Andrew's work has been recognised through multiple awards, including a Winston Churchill Fellowship, the inaugural Award for Excellence in Southern Australian Livestock Industries in 2020, the inaugural WA Livestock Research Council Research Award in 2026 and Murdoch University's Vice-Chancellor's Award for Research Impact in Communities.

He has also made a lasting contribution to education and capacity building. At Murdoch University, Andrew has been instrumental in developing undergraduate agricultural science programs, mentoring early- and mid-career researchers, and supervising the next generation of industry-focused scientists. Many of his former students and collaborators are now leaders, both within Australia and internationally.

In recognition of his commitment to combining scientific excellence and practical application of research for the Australian sheep industry and his contribution to research, education and leadership, the Australian Association of Animal Sciences is pleased to enrol Professor Andrew Thompson as a Fellow.

AAAS2026 SESSION CHAIRS

The joint AAAS 2026 Conference Organising Committee continued with the process initiated at the 2024 conference to identify and appoint session chairs for the congress. This approach aimed to broaden the network from which session chairs are drawn, while also creating valuable professional development opportunities for early career animal scientists.

An open Expression of Interest process was conducted in mid-2025 and promoted to AAAS members via email, the conference website, and social media platforms. This transparent and inclusive process resulted in a strong and diverse pool of candidates from across the animal science community.

Following the close of abstract submissions, session chairs were appointed to each concurrent session theme, with a deliberate balance of experienced and early career researchers wherever possible. In sessions with a high volume of submissions, additional co-chairs were engaged to ensure appropriate coverage and support.

Session chairs played a critical role in the development of the scientific program. They coordinated the peer review of submitted papers by assigning abstracts to appropriate subject matter experts or undertaking reviews themselves. During the conference, they will also lead and facilitate their sessions, ensuring a high-quality and engaging experience for presenters and delegates alike.

With more than 150 papers submitted across a diverse range of topics, the contribution of session chairs has been substantial. Their time, expertise and commitment have been instrumental in delivering a strong and balanced scientific program for AAAS 2026.

The Organising Committee extends its sincere thanks to all session chairs for their valued contribution to the success of the conference.

Alan Humphries	Joe Jacobs	Shawn McGrath
Alice Weaver	Kapil Chousalkar	Stephanie Sammes
Amy Bates	Kellie Wenham	Steve Larkin
Apeh Omede	Kieren McCosker	Surinder Chauhan
Bereket Zeleeke Tunkala	Kiro Petrovski	Tom Keogh
Bianca Agenbag	Leah Marett	
Charles Rikard-Bell	Lessa-Joy Dunstan	
Charlotte Adam	Luis Prada e Silva	
Danila Marini	Mariana Caetano	
Dianne Mayberry	Megan Willis	
Dilini Weerathunga	Melindee Hastie	
Elena Dhenavi	Mena Farazi	
Emma Lynch	Michael Rose	
Fazel Almasi	Monique Berkhout	
Hue Do	Renata Tognelli	
Jamee Daly	Sam Franklin	
James Dougherty	Sarah Meale	
James Drouillard	Saranika Talukder	
Joanna Newton	Sean Miller	

REVIEWERS

All contributed one-page papers were subject to peer review by two referees. We acknowledge and thank those listed below for reviewing the one-page papers.

Ajmal Khan	Leesa-Joy Dunstan
Alice Weaver	Luis Prada e Silva
Alyce Lowe	Mandi Carr
Anthea Lam	Mariano Parra
Apeh Omede	Megan Willis
Bereket Zeleke Tunkala	Melindee Hastie
Bianca Agenbag	Michael Rose
Charlotte Adam	Monique Berkhout
Dilini Weerathunga	Renata Tognelli
Elena Dehnavi	Robyn Warner
Emma Lynch	Sarah Meale
Fazel Almasi	Sarankia Talukder
Hue Do	Shawn McGrath
Jamee Daly	Stephanie Sammes
James Dougherty	Sue Hatcher
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Leah Merrett	

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EXHIBITORS



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AWARD SUPPORTERS



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APPENDIX

Conference Program

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UNDERWOOD LECTURE
Innovative Pathways to Low-Emission Livestock

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Abstract Methane (CH₄) from ruminant livestock accounts for approximately 30% of global agricultural greenhouse gas emissions and represents both an environmental challenge and an energy loss. Recent advances have opened new opportunities for mitigation through feed additives, dietary strategies, genetic approaches, and management innovations. This review synthesizes current research on enteric CH₄ reduction strategies, with emphasis on commercially viable and scientifically validated approaches. Meta-analyses and on-farm trials demonstrate that feed additives including 3-nitrooxypropanol (3-NOP), bromoform-containing seaweed (*Asparagopsis* spp.), tannins, and dietary lipids can reduce CH₄ emissions by 10-80% depending on dose and dietary context, while maintaining or improving animal productivity. The feed additive 3-NOP consistently achieves 30-36% reductions across dairy and beef systems, with regulatory approval progressing in multiple countries. Tannin-based products deliver about 10% reductions with no adaptation and ancillary nitrogen management benefits. *Asparagopsis* seaweed shows the highest efficacy (>80% reduction) but long-term and product safety trials are need for regulatory approval. Early-life interventions, such as metabolic programming of calves with CH₄ inhibitors, show promise for sustained long-term reductions through establishment of less methanogenic microbial communities. In parallel, genetic selection for traits such as residual feed intake provides cumulative, heritable gains (1-3% per generation) that complement nutritional strategies. Economic viability is enhanced through carbon market mechanisms, low-carbon fuel standards, and policy incentives, as demonstrated by California's progress toward 40% dairy CH₄ reduction by 2030. Together, these innovations show how integrated approaches linking nutrition, genetics, microbiome manipulation, and farm management can transform livestock production into a driver of both productivity and environmental sustainability, supporting global climate targets including the Global Methane Pledge while maintaining food security. Implementation challenges include measurement and verification systems, regional adaptation, delivery in extensive grazing systems, and ensuring smallholder access to technologies

Precision Nutrition in Poultry Production: Challenges and Successes

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Abstract Chicken meat is one of Australia's most widely consumed and affordable animal proteins, with Australians now eating approximately 55kg of chicken meat per person per year. Chicken meat is a key contributor to food security across income levels. However, the Australian poultry sector faces several unique challenges. Unlike most regions globally that rely on corn-based diets, Australian broiler diets depend on wheat, sorghum and barley, each with distinct anti-nutritional factors and non-starch polysaccharides profiles that can limit growth performance and feed efficiency in birds. Australia also relies on 100% imported soybean meal, the primary global protein source in mono-gastric animal feed. Additionally, many regions in Australia may experience prolonged heat stress, a challenge intensified by the transition toward free-range production. To address these pressures, we collaborate across disciplines from plant breeding to microbiology and immunology, and with industry partners worldwide to develop improved sorghum quality for Australian feed systems, expand utilisation of locally produced canola products and legumes to reduce reliance on soybean meal, use exogenous feed enzymes to optimise feed efficiency and design low-protein diets that maintain growth performance and reduce ammonia emission. Research on the relevance of the net energy system under heat-stressed conditions, as well as work on optimising feed particle size and pellet quality for younger birds, is also underway. This presentation will summarise these recent advances and ongoing challenges in building a more resilient and efficient poultry nutrition framework.

STOBBS LECTURE

In Search of Greener Pastures: Linking long-term research and stakeholder engagement for innovative Water, Carbon, and Biodiversity Pathways from Subtropical Beef Systems

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Abstract Achieving conservation outcomes in working agroecosystems requires integration of long-term ecological research with stakeholder-informed decision-making. However, these domains are often developed independently, limiting their combined effectiveness and the scalability of conservation solutions. This study synthesizes a generalisable research framework that integrates long-term data, stakeholder engagement, and adaptive management, based on nearly four decades of research in subtropical beef systems at the Archbold Biological Station–University of Florida Long-Term Agroecosystem Research (LTAR) site.

The framework was inductively derived from practice and comprises five recurring components: (1) stakeholder-driven research question development, (2) co-produced research design and pilot testing, (3) collaborative data analysis and interpretation, (4) implementation within working landscapes, and (5) adoption, policy integration, and generation of new research questions. Its application is demonstrated through three case studies addressing water, carbon, and biodiversity in subtropical grazing systems.

A watershed-scale water management programme illustrates how co-produced research informed the development of a payment-for-ecosystem-services approach that enables ranchlands to contribute to regional water storage and nutrient management. Carbon research integrating long-term field measurements and modelling demonstrates that subtropical cow–calf systems can function as net greenhouse gas sinks when assessed at the whole-system scale, providing a basis for engagement with emerging carbon markets. Biodiversity research shows that ranch management can support conservation of imperiled grassland birds while maintaining livestock production, highlighting the role of adaptive, multi-stakeholder collaboration.

Across these examples, conservation outcomes are achieved through sustained, trust-based engagement and iterative learning. While ecological outcomes vary in their scalability, the underlying research and engagement process is transferable across contexts. The results highlight the importance of embedding stakeholder engagement within long-term agroecosystem research to enhance relevance, adoption, and impact in animal production systems.

MCCLYMONT LECTURE

Heat stress and Perinatal Programming in Dairy Calves: Biological Responses and Emerging Heat Abatement Strategies

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Abstract Heat stress has traditionally been viewed as a seasonal welfare and production challenge in lactating dairy cattle. However, accumulating evidence demonstrates that thermal stress experienced during prenatal and early postnatal life can alter developmental trajectories with consequences that extend far beyond the period of exposure. Although the developmental consequences of prenatal heat stress have been extensively documented, considerably less attention has been given to the preweaning period. This review highlights early postnatal life as a critical window of developmental plasticity during which environmental heat stress influences thermoregulation, behavior, immune competence, gastrointestinal maturation, endocrine function, mammary gland development, and ultimately lifetime productivity. We summarize current knowledge on the physiological and behavioral responses of calves to increasing environmental heat load, highlighting respiration rate as the most practical and sensitive animal-based indicator for identifying the onset of thermal strain and discussing emerging precision livestock technologies that enable continuous, real-time heat stress detection. Rather than representing only an acute welfare challenge, increasing evidence suggests that postnatal heat stress acts as a developmental stressor that compromises thermoregulatory capacity, alters immune and endocrine development, impairs mammary gland growth, and may have lasting consequences for survival and future productive performance. We also review practical heat-abatement strategies for preweaned dairy calves, including shade provision, mechanical ventilation, and evaporative cooling. Because calf housing systems vary widely among production systems and climates, no single cooling strategy is universally applicable. Instead, effective heat abatement should integrate continuous access to shade with housing-specific approaches that optimize airflow and evaporative heat loss while maintaining a dry resting environment. Across multiple studies, these interventions consistently reduced respiration rate by approximately 10–25 breaths/min, core body temperature by 0.1–0.2°C, and skin temperature by 1–2.5°C, demonstrating immediate improvements in calf welfare and thermoregulatory capacity. Although responses in preweaning growth have been inconsistent, improvements in immune competence, survival, and indicators of future productive potential suggest that mitigating heat stress during early life represents an important investment in long-term herd performance. Collectively, this review supports a shift from reactive seasonal management toward proactive, precision-based heat stress mitigation during early life to improve calf health, resilience, and lifetime productivity under a warming climate.

The Science Behind South Australia's Harmful Algal Bloom: Understanding Karenia and Its Effects on Marine Life

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Abstract In March 2025, South Australia experienced the emergence of an unprecedented harmful algal bloom (HAB) that ultimately affected thousands of kilometres of coastline and had significant ecological, social and economic consequences. Dominated by species of *Karenia*, the bloom resulted in widespread mortality of fish and other marine organisms, disrupted commercial and recreational activities, and prompted one of Australia's largest coordinated marine environmental responses. While harmful algal blooms occur naturally around the world, the scale, duration and impacts of this event highlighted the importance of understanding the biological and environmental processes that drive these increasingly complex marine phenomena.

This presentation examines the science underpinning South Australia's harmful algal bloom, drawing on the multidisciplinary research and operational response undertaken by the South Australian Government in collaboration with universities, national research organisations and industry partners. It explores the biology and ecology of *Karenia*, the mechanisms by which these microscopic algae affect marine life, and the environmental conditions that are understood to have contributed to bloom development and persistence, including nutrient enrichment, oceanographic processes and the prolonged marine heatwave affecting southern Australia.

The presentation also demonstrates how multiple scientific disciplines were integrated to characterise the bloom and inform management responses. Oceanographic observations, satellite remote sensing, water-quality monitoring, molecular diagnostics, ecological surveys and predictive modelling collectively provided an increasingly comprehensive understanding of bloom dynamics and impacts. These approaches supported evidence-based decision making while highlighting the value of coordinated monitoring and adaptive scientific investigation during a rapidly evolving environmental event.

Beyond documenting an extraordinary bloom, the South Australian experience provides valuable insights into building national capability for harmful algal bloom research and preparedness. It demonstrates the importance of sustained environmental observations, emerging monitoring technologies and collaborative research networks in improving our capacity to detect, understand and respond to future marine ecosystem threats, while identifying key scientific questions that remain the focus of ongoing research.

BARNETT LECTURE

Human-animal interactions and positive animal welfare

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Abstract The concept of animal welfare is evolving due to advancement in our scientific understanding of animal biology and changing societal expectations regarding animal use. Animal welfare science has primarily been concerned with minimising negative experiences, but there is growing interest in also promoting positive experiences and positive animal welfare. Indeed, many members of the public conceive animal welfare as not only the absence of suffering, but also the opportunity for positive experiences, which is often referred to as animals having a “good life”. Positive animal welfare focuses on factors that positively impact an animal’s life. Highlighting the importance of providing animals with opportunities for rewarding experiences, beyond alleviating suffering. Positive animal welfare can be defined as the animal flourishing through the experience of predominantly positive mental states and the development of competence and resilience.

Human factors significantly affect farm animal welfare and productivity similarly to that of factors such as housing, nutrition and health. Consequently, human factors are now recognised as a routine component of farm animal husbandry and management. More specifically, human-animal interactions and the subsequent human-animal relationship that develops are important determinants of animal welfare. Human-animal relationships develop from a series of interactions between humans and animals. Where the quality and frequency of interactions between two individuals, as well as the context in which they occur, determine the quality of the relationship. Consequently, farm animals’ responses to humans are affected by the history of their interactions with humans, in particular the nature of human interaction.

A negative human-animal relationship can, largely through fear and stress, compromise the animal’s welfare, health and productivity. Studies particularly in the pig and dairy industries demonstrate a causal link between stockperson attitudes, stockperson behaviour, animal fear and stress and animal welfare. Similarly, a positive human-animal relationship can improve these outcomes for the animal. There is also evidence that a positive human-animal relationship can buffer the aversive nature of husbandry procedures imposed by humans. For example, regular positive human interaction early in life has been shown to have an enduring effect on reducing pigs’ fear of humans and improving their resilience to routine husbandry stressors. Furthermore, it has been suggested that some interactions with humans may actually be a source of environmental enrichment for farm animals, increasing the overall complexity of the animal’s environment. But do positive human-animal interactions provide animals with opportunities for positive experiences, i.e., are they rewarding? In this lecture I will address this question, by considering the concept of positive animal welfare and its scientific assessment, human-animal interactions and their effects on animal welfare, and opportunities for positive human contact to offer positive experiences and positive animal welfare.

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How Rabbits Invaded the World, and What We Can Learn from it

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Abstract How did a species once confined to a small corner of southwestern Europe become one of the most widespread mammals on Earth? Transported by people across the world over the last 2,000 years, rabbits have transformed ecosystems, driven agricultural crises, and become one of the defining examples of invasion biology, especially in Australia, where their impacts are still felt today. Yet paradoxically, rabbits are now declining across parts of their native range in the Iberian Peninsula, where populations are considered threatened. In this talk, I will trace the history of rabbit dispersal from antiquity to the modern era and show how we can reconstruct these movements using archaeology, historical records, museum specimens, ancient DNA, and genomics. Beyond tracing dispersal, I will show how we can use these approaches to observe evolution in action and understand how rabbit populations adapted to new environments, such as the arid landscapes of the Australian outback, and survived devastating disease outbreaks like myxomatosis. The global spread of rabbits is, in many ways, a tragic environmental story. However, it has also become one of the most consequential biological experiments in human history, providing unique insights into the dynamics of invasion, adaptation, and resilience. In a world increasingly shaped by human-driven environmental change, the story of rabbits offers a powerful framework for understanding how species respond, adapt and evolve.

The use of speed and stride data in racehorses to assess limb injury risk.

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Abstract Limb injuries in racehorses develop over time as bone or tendon microdamage accumulates faster than it can be removed. This timeframe means there is the potential for the detection of horses at risk of injury and would enable the modification of the horse's training programme in order to mitigate the risk of future injury. Clinical assessment, including traditional lameness examination is valuable for diagnosis of injuries once they have occurred but is less useful for the identification of horses at risk of developing injuries. The development of wearable technology that can monitor speed and stride characteristics and changes in acceleration may have application in the racing industry for monitoring horses' gait both during races and training gallops. If effective at detecting changes associated with injury risk, wearables have the advantage of being able to non-invasively monitoring large numbers of horses. Initial studies have shown that speed and stride characteristics in races vary substantially between horses and under different conditions such as race distance, track surface qualities and at different stages of a race. Therefore, sophisticated data modelling to allow for these confounders is required to compare stride characteristics between horses and longitudinally in individual horses. Despite this, initial studies have shown some ability to detect horses at risk of limb injury with wearable data from races. Speed and stride length decreases for a mean of five races prior to an injury being recognised, whereas stride frequency does not change. Interestingly this is how we would predict a horse would try to mitigate bone fatigue injury, whereby reducing stride length would have much greater beneficial impact than reducing stride frequency. In human runners, reducing stride length while maintaining speed is recommended for stress fracture mitigation. Changes in acceleration data from wearable sensors have also been investigated with some associations with fracture identified. These findings have encouraged the more widespread collection of wearable data from horses during races and training gallops with the hope that the use of this technology will develop into effective limb injury risk assessment of horses over time.

From Leash to Legislation: Shaping Sustainable Policy for Companion Animal Welfare in a Tech-Driven World

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Abstract Companion animal welfare is undergoing a period of rapid transformation. Advances in animal welfare science, changing public expectations, and the emergence of digital technologies are creating new opportunities, and challenges, for policy makers seeking to promote the wellbeing of animals in human care. Traditional welfare frameworks have largely relied on direct human observation and retrospective assessment of welfare outcomes. However, developments in artificial intelligence, computer vision, wearable sensors and automated behavioural monitoring systems are enabling the continuous collection of animal-based data at an unprecedented scale.

These technologies have the potential to transform animal welfare governance by generating continuous streams of behavioural and physiological data that may influence welfare assessment, compliance activities and policy development. Yet important questions remain regarding the interpretation of welfare data, the ethical use of emerging technologies, and the role of automated systems in shaping future welfare standards.

This presentation explores how technological innovation is influencing the future development of companion animal welfare policy. Drawing on examples from animal welfare science, and legal scholarship, it examines both the opportunities and limitations of technology-driven approaches to welfare assessment. Particular attention is given to the distinction between measuring behaviour and understanding welfare, and to the value judgements that underpin the selection, validation and interpretation of welfare indicators used in AI systems.

As governments and regulators increasingly seek evidence-based approaches to animal welfare, important questions arise regarding the role of automated technologies in shaping policy decisions. Who determines which indicators represent good welfare? How should uncertainty be managed when algorithms are used to inform welfare assessments? And to what extent should legislation rely on continuously generated animal-based data?

The presentation argues that while emerging technologies will play an increasingly important role in informing animal welfare decision-making, technology alone cannot determine what constitutes good welfare. Human oversight remains essential. Sustainable policy development requires the integration of scientific evidence, ethical principles, legal frameworks and community expectations. Since companion animals are intrinsically embedded within society, policy makers need to navigate complex questions surrounding responsibility, transparency, privacy, accountability and animal quality of life.

By examining the intersection of technology, welfare science and public policy, this presentation considers how future legislation might move beyond preventing suffering towards supporting positive welfare outcomes. Ultimately, the future of companion animal welfare will depend not on the technologies we develop, but on how effectively we use them to inform evidence-based, ethical and sustainable policy.

Using Merino Flock Profiling to increase the adoption of ASBVs as a breeding decision tool for commercial Merino producers

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Introduction A modern and viable commercial Merino enterprise must embrace the use of objective genetic measures to ensure they have a continuously improving and resilient flock, that is breeding animals that meet the demands of discerning consumers. It is estimated that 56% of commercial sheep producers use Australian Sheep Breeding Values (ASBVs) in their breeding and selection decisions, and that 50-55% of all Merino rams sold annually in Australia will have ASBVs reported (P. Bradley, personal communication, November 2025). There remains scope to increase the adoption of ASBVs by commercial Merino producers.

Materials and methods Merino Flock Profiling (MFP) involves genotyping 20 animals, selected randomly, from the flock's current drop of lambs. It is an easily conducted and cost-effective tool used to benchmark the genetic potential of a Merino flock against the national flock for a number of key production traits. MFP provides flock average breeding values comparable to all flocks in the Sheep Genetics MERINOSELECT database. The results are also reported as percentiles. The results can be used to track genetic progress and help inform ram purchasing decisions.

In the upper north of South Australia, groups of producers came together to use MFP to increase their understanding of ASBVs and to refine their breeding objectives and ram buying decisions. Group size ranged from 7 to 9 producers. Collection and submission of group member's DNA samples was facilitated, so that all results were received concurrently. All members came together for a workshop, where all individual MFP results were shared and discussed. Training in the use and understanding of ASBVs was provided based on the needs and existing knowledge of the group. All participants left the workshop with the genesis of a breeding objective for their flock and a plan for making better ram buying decisions, having identified the traits they wanted to improve. Three years later, all group members completed another MFP and came together again to discuss the observed changes since their last test.

Resources aimed at stimulating the interest of other commercial Merino producers in MFP were developed. A report was written for one group detailing individual group members results and observations. Additionally, another group contributed to a short video outlining the process and detailing their experiences.

Results Through participating in MFP as a group, producers in the upper north of South Australia have been able to improve their understanding of ASBVs and implement them as a valid and useful breeding decision support tool. They have refined their flock breeding objectives based on their results, and used this to inform their ram buying decisions.

Following the initial workshop, some producers were happy to have it confirmed that they were on the right track with their existing breeding strategy, while some felt they had greater confidence in talking to their ram source and outlining what they are looking for as a client. Some producers were planning to have conversations with their ram source about their potential to start supplying ASBVs with sale rams, while others were considering changing ram sources, so that they could make more informed ram buying decisions.

Producers reported that, with a defined breeding objective and targets for ASBVs when buying rams, they were able to purchase rams of high value to their flock, but which may be toward the bottom end of the sale, and thus avoided competing for the higher priced "good looking" rams. One producer, who had recently been purchasing rams using ASBVs, was unhappy at the prospect that their ram source was going to stop supplying ASBVs, saying he felt he would now be buying rams "blind" without the ASBV information.

With refined breeding objectives and ram buying decisions using ASBVs, group members variously reported: visual improvements in lamb vitality; improved lamb survival; improved scanning percentages; improved lamb numbers; increased fleece weights and improved dressing percentages. By repeating the testing after three years, producers were able to observe the genetic gain their flocks had made and confirm that they were meeting their objectives, or that further changes were required.

A couple of producers defined a breeding objective at the first workshop, but by the second workshop had made no genetic gain toward that objective, principally because their ram source was not providing ASBVs with their rams.

Discussion The methodology adopted has proved to be an excellent approach for wool grower learning and adoption of the use of ASBVs in formulating breeding objectives and in Merino ram buying decisions. Producers were able to improve their understanding of ASBVs and industry indexes; benchmark their flock against the Australian Merino flock; identify individual traits that present opportunities for flock improvement; formulate an individual breeding objective; make ram buying decisions based on these objectives, and observe the impact of these decisions on their flock's genetic potential over a three-year period.

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Bridging the Academic-Industry Divide: Initial Findings of the AAAS ECN Mentor Program

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Introduction Securing a job in the agricultural science industry after studying, whether at an undergraduate, masters or PhD level, can be difficult. The Early Career Network (ECN) within the Australian Association of Animal Scientists (AAAS) identified that there is an untapped wealth of knowledge within their membership base. The majority of which, have successfully navigated the path to employment and continued to excel in their chosen field. A common theme observed within the ECN committee is *'it's who you know, not necessarily what you know'*. The AAAS is uniquely positioned to facilitate connections between those who are seeking mentorship and those who have established a well-worn path. To explore the opportunity to connect those seeking mentorship with experienced professionals, the AAAS ECN committee developed a pilot program consisting of two meetings across a six-month period.

Materials and Methods Guidelines for both the mentees and mentors involved were developed, ensuring this was a mentee led program. The mentee was responsible for setting up meetings, preparing an agenda, outlining goals and objectives, and ensuring they were open to their mentor's advice and suggestions. The mentor's role was to actively listen to the mentee and provide constructive feedback and guidance to help set them on the right path to achieve their career goals. The pilot program was launched in March 2025 via an Expression of Interest (EOI) on the AAAS LinkedIn page seeking those who would be interested in being a mentee, and those interested in mentoring.

Results A total of 88 submissions were received, predominantly those seeking guidance and a mentor. The LinkedIn post was targeted toward AAAS members; however, most respondents were located overseas and were seeking irrelevant information on work or job applications. To ensure appropriate matches in mentees and mentors, respondents were asked to provide information on their chosen fields of interests. From the submissions received relevant to the mentorship program, there was a wide variety across species and areas of interest.

After filtering through these applications, a total of 13 responses were received from Australian based animal scientists, ten of whom were mentees and three mentors. The AAAS ECN committee offered five mentees a mentorship opportunity. The ECN were able to use their existing network to ensure mentees were suitably placed with either mentors who submitted an EOI, or others who were willing to participate from within the AAAS network. Of the five mentees, one did not respond to correspondence from the AAAS ECN committee. A second requested a niche area of mentorship and the committee was unsuccessful in identifying a mentor that the applicant did not already have an existing connection with. The remaining three mentees were successfully linked to mentors and are currently engaged in their programs. These programs are due to conclude in January 2026.

Discussion Anecdotally, the three mentees are finding their mentoring experience valuable and highly recommend the continuation of the program in the future. Mentees will be asked to write a report on their experience, including the organisation, implementation, guidance and overall satisfaction of the pilot program. Building upon the initial successes and lessons learned, the AAAS ECN committee is optimistic about continuing the program in subsequent years. The ultimate objective is to continuously build and expand the network of mentors and mentees to foster stronger connections between students and professionals across academia and industry.

Feedlot TECH: Livestock Health Fundamentals eLearning Course

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Introduction The Australian feedlot industry relies on skilled staff who can recognise, prevent, and respond to livestock health issues. Industry consultation highlighted a clear gap in foundational cattle health skills, particularly for new entrants. The Livestock Health Fundamentals course series on Feedlot TECH was created to address this need by offering practical, accessible training aligned with national standards and modern feedlot practice. This project aimed to close an industry-wide gap in foundational livestock health knowledge by developing an accessible, evidence-based eLearning course that strengthens staff capability, confidence, and consistency in core animal health practices. This paper outlines the development process, evaluation approach, learner outcomes, and early industry impact.

Materials and Methods Australian Lot Feeders Association (ALFA) engaged a feedlot animal health expert and a specialist eLearning developer to ensure technical accuracy and engaging delivery. Content was planned using best-practice adult learning principles, National Feedlot Accreditation Scheme (NFAS) requirements, and current health management protocols. Modules covered induction and acclimation, antimicrobial use, hospital systems, practical procedures, and euthanasia and post-mortem guidelines. Industry representatives, including Ambassador Feedlots, reviewed drafts to confirm relevance. The final course was delivered on Feedlot TECH, supported by optional facilitated sessions and post-course evaluation surveys.

- Knowledge gain was measured through pre- and post-course quizzes.
- Learner satisfaction and relevance were assessed through standardised surveys.
- Engagement, participation, and completion data were extracted from Feedlot TECH analytics.

Results Since launch, Livestock Health Fundamentals has achieved strong uptake and exceeded performance benchmarks. Across five modules:

- Enrolments ranged from 30–83 learners, with consistent national participation.
- Completion rates met or exceeded the 60% target in several modules, with others close behind (47–53%).
- Satisfaction scores averaged >95% across all modules.
- Relevancy ratings ranged from 80–100%, confirming workplace value.
- Knowledge gain showed strong improvement across all modules.

Platform-wide metrics also show strong engagement, with 1,694 registered feedlot staff and 98% satisfaction across fundamental courses. Livestock Health Fundamentals supported continued course uptake and strengthened onsite training programs.

Discussion Findings show the course effectively addressed a long-standing skills gap in core livestock health knowledge. Expert content, practical demonstrations, and scenarios helped ensure relevance and application at all experience levels. High satisfaction and knowledge-gain scores highlight strong instructional design and industry fit.

The course also improved capability in treatment accuracy, early disease detection, animal welfare decision-making, and responsible antimicrobial use—key priorities for feedlots and NFAS compliance.

Conclusion Through structured development, industry collaboration, and evidence-based learning design, the Livestock Health Fundamentals series successfully addressed an identified knowledge gap in feedlot health skills. Now widely adopted and award-winning, it demonstrates the value of accessible, targeted training in building a capable and welfare-focused workforce.

We gratefully acknowledge Meat & Livestock Australia for funding this work and the feedlots and partners that have adopted Feedlot TECH.

Beyond the Feed: Creating value and community through social media

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Introduction Social media can be a powerful tool for adding value for members and fostering community alongside traditional events (Hertel *et al.* 2026). In 2024, the Australian Association of Animal Sciences (AAAS) established a social media working group, which has since evolved into a Communications sub-committee that oversees online communication platforms for AAAS. In mid-2024, a streamlined online submission process via Google Forms was introduced for members and branches to share and promote AAAS opportunities and other information relevant to AAAS members. The aim of this analysis of 12 months of LinkedIn analytics was to get insight into: engagement and growth of the AAAS LinkedIn page as a communication channel, and the content that members most engage with.

Materials and methods LinkedIn analytics data were exported from the AAAS company page for 25/02/2025 to 26/02/2026. Monthly follower data was analysed in Microsoft Excel to quantify net audience growth. Posts were assigned to eight categories based on post type and whether it was an AAAS or an external content (see Table 1). Microsoft Copilot assisted with categorisation. For each category, post frequency, engagement rate ((Total interactions ÷ Total impressions) × 100)) and click-through rate (# of people that clicked on post/ # of post views) were calculated. To inform future strategy, posts with the highest engagement and click-through rates were interpreted as providing the greatest member value and were qualitatively reviewed to identify common features of high-performing content.

Results & Discussion. In the 12 months to 26th Feb 2026, AAAS LinkedIn increased its followers to 2,888, representing a 75% increase over the previous 12 months. As of July 2026, there were now 3350 LinkedIn followers. Table 1 summarises engagement statistics for the 12 months to 26th Feb 2026. A total of 101 posts generated 114,681 impressions, with a median post impression of 916±797 and an average engagement rate of 5.9%. AAAS engagement metrics exceeded LinkedIn averages for both the education and not-for-profit sectors (Mikolajczyk and Hu, 2026), with no advertising spend (i.e. through organic reach). Encouragingly, AAAS specific content generally outperformed external content. Overall, posts advertising AAAS opportunities (i.e. awards, scholarships, mentoring) performed best; however, these posts also had the highest variability in performance.

Overwhelmingly, the best-performing post was the call for expressions of interest to chair at the AAAS conference, achieving a 45.6% engagement rate and reinforcing previous evidence that members value these opportunities (Newton and Bates, 2024). AAAS updates also performed strongly, particularly when highlighting individual member achievements or activities. Tagging members further increased engagement. As AAAS revises its communications strategy, a people-first approach showcasing member achievements and opportunities will continue to add value and strengthen the online community. Overall, AAAS has substantially increased its reach and built an engaged LinkedIn community, providing a valuable channel for sharing information with members and raising AAAS's profile.

Table 1. LinkedIn engagement rates for AAAS posts by post style, *

Post-style	No.	Impressions	Engagement rate	Click-through rate
AAAS event	24	868 (620±529)	4.9% (4.0%±3.4%)	3.0% (2.3%±2.9%)
AAAS opportunity	11	1448 (1302±794)	9.1% (6.6%±12.4%)	7.1% (4.3%±11.5%)
AAAS update	17	1399 (997±1134)	7.5% (7.0%±3.2%)	5.1% (4.3%±3.0%)
External event	12	623 (550±271)	5.2% (4.8%±3.2%)	3.9% (3.1%±2.6%)
External opportunity	8	880 (739±618)	5.5% (5.8%±2.2%)	4.3% (4.7%±2.0%)
Job advert	12	1561 (1197±968)	5.8% (5.8%±2.1%)	4.9% (4.9%±1.9%)
PhD/HDR project	7	1271 (1429±789)	4.9% (5.2%±2.8%)	3.8% (4.2%±2.3%)
Scholarship	10	1199 (1244±543)	4.5% (4.1%±1.9%)	3.4% (3.1%±1.6%)
Total	101	1135 (916±797)	5.9% (5.2%±5.0%)	4.3% (3.7%±4.5%)

* Values are reported as mean (median ± standard deviation) with percentage values indicated where applicable.

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- We acknowledge past and present AAAS Communications Working Group members and all who contribute content for posting on AAAS online platforms.*

Undergraduate and Post-graduate elective livestock consultancy course at Adelaide University

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Introduction The generational gap among those involved in the agricultural and livestock industries, including beef, dairy, goat, and sheep, is widening. This is evident throughout Australia (Mayberry *et al.* 2021), as well as globally, particularly in developed countries (Maró *et al.* 2025). The lack of motivation to be involved with the agricultural and livestock industries, partially due to a lack of understanding of the industry benefits, is one important factor. Additionally, the lack of transfer of scientific knowledge to the field is also evident. Livestock consultants should keep up with the modern trends in the industry and scientific developments, ultimately serving as agents of transfer in extension education of producers (Botha *et al.* 2008). This elective course, through increasing awareness of the industry benefits and improving the technical and non-technical skills of students, should provide a continuous influx of students with interests in the agricultural and livestock industries.

Materials and methods The learning objectives of this elective course, with a maximum of 10 student enrolments a year, include: a) Describe differences between traditional and consultancy (population) practice; b) Create a plan for opening a new livestock consultancy practice; c) Integrate traditional and consultancy (population) practice; d) Prepare a population-level written problem-solving report or a critically appraised topic; e) Demonstrate awareness and basic non-technical competencies essential for livestock consultancy (e.g., communication, facilitation, small group leadership, etc.). The activities in this course include: 1) Tutorials and workshops on livestock consultancy basics, non-technical and technical competencies required by livestock consultants, and integration of livestock consultancy into a holistic livestock management programme; 2) Networking, through industry and social events; and 3) Field trips to commercial livestock properties for introduction to livestock consultancy and the life of a livestock consultant. The course is offered to the Agricultural and Animal Science (undergraduate), as well as the Doctor of Veterinary Medicine (Post-graduate) students. In case there is insufficient student interest, the course can be opened to livestock industry professionals.

Results The course ran for the first time in 2025, as a winter elective course, with 9 enrolled students. Two academics (KRP and MC) and four livestock consultants (EH, BB, NM, and CT) were involved in the delivery. The course content was aligned to the industry needs of attracting and retaining appropriately skilled and educated people into the livestock industry. Activities in 2025 included: 1) Tutorials (9 hours), and workshops (3.5 days), attendance at a livestock farmers' events (1.5 days), and self-study (1.5 days); 2) Networking, through industry (1 day) and social events (a dinner); and 3) Field trips to 3 beef cattle, 1 beef feedlot, 1 laying hens, 3 dairy cattle, and 3 sheep commercial livestock properties. All students successfully met the required learning objectives. The interaction between students from the different degrees demonstrated the power of collaboration in enhancing the ability to solve industry issues through looking at a problem from different perspectives. Course feedback was highly positive, with students reporting that the course was well organised (80%), met their needs (83%), used effective teaching methods (80%), and provided adequate support for learning (91%). Additionally, 94% of students agreed that the course helped them develop new skills and knowledge. The overall learning experience was rated at 89%, with an equal proportion indicating they would recommend the course to a friend or colleague.

Conclusion The livestock consultancy elective course can be used to bridge the gap of skilled professionals, as well as to serve as a stepping stone in the development of future livestock consultants or extension personnel. The development of this university course, tailored to industry needs and delivered in-part by industry professionals will hopefully encourage industry to consider this as a model to help attract university graduates into careers in livestock extension and consultancy. Additionally, having a course that can be delivered across disciplines whilst simultaneously demonstrating a successful co-funding and delivery model will also foster collaborative attitudes towards future industry training and extension programs.

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Student compendium internships build students skills, confidence, network and brand

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Introduction The Student Compendium connects students to primary industries, and primary industry to students (Hancock *et al.* 2022). By bringing together scholarships, internships, graduate programs, work experience opportunities, conferences, and awards into one easily accessible platform, the compendium strengthens student awareness of opportunities. The South Australian (SA) division of the Ag Institute Australia partnered with the Adelaide University Agricultural Students Association to establish the Student Compendium in 2021. The initiative aimed to address the "capacity building" pillar of the SA Agricultural Industry Blueprints, whose objectives are to develop a skilled, inspired, and resilient workforce for the state's primary industries (Grain Producers SA, 2020). Since 2021, 26 students have undertaken internships, with 4-5 interns selected each year to develop annual editions of the Student Compendium. Through the internship, students were encouraged to identify and refine their personal brand by recognising the skills, values and interests that define them as emerging professionals in agriculture. By cultivating their personal brand interns strengthened their individual employability and presented a consistent and credible image aligned with industry expectations. This conscious development of professional identity has proven instrumental in enhancing confidence, guiding career direction, and positioning interns as capable future contributors to SA's primary industries sector.

Materials and methods The internship exposed students to a diverse range of practical, industry-focused tasks, allowing them to develop 15 core competencies and more than 50 specific skills. Interns began with an induction to governance and reporting requirements. Regular meetings allowed interns to collaborate effectively, provide progress updates to supervisors, and develop professionalism through learning meeting procedures. Communication and relationship-building were central elements of the program, with interns initiating contact with industry partners regarding sponsorship and content contributions, thus enabling them to assist in the collation and compilation of the compendium. This was done through cold-calling and emailing, which allowed interns to develop concise and professional pitches that conveyed the value proposition of the compendium. Academic writing and professional engagement were further developed by preparing conference abstracts, presentations, and journal papers. Interns learned to manage their own projects from commencement to completion, applying skills in planning, time management, and accountability.

Results Between 2021 and 2025, 26 interns collectively produced five editions of the South Australian Student Compendium, expanding from 100 to more than 450 entries. Throughout this time, interns presented at 9 state, national and international conferences, co-authored 15 peer-reviewed papers, received 12 industry awards, presented at numerous student career expos and contributed to the establishment of the National Student Compendium. Participants gained extensive practical exposure to the agricultural sector, with many interns subsequently securing employment or leadership roles within the industry. The internship operated under a "learn-by-doing" framework, supported by structured mentoring, reflective reporting, and milestone reviews. This approach ensured that interns developed practical skills while delivering measurable contributions to the agricultural education sector. Through their involvement in national conferences and professional forums, interns gained authentic experience in research communication and industry engagement, further consolidating their readiness for future careers in agriculture.

Conclusion and implications The Student Compendium internship demonstrated the value of a structured, student-led, industry-linked program and showcased the impact it has on building the next generation of agricultural professionals. The implications of this work extend beyond individual student outcomes. By developing industry-ready graduates with strong communication skills, professional networks, and a clear sense of their personal brand this approach demonstrated that students can be powerful contributors to industry development when mentored and given meaningful, real-world responsibilities. The internship's emphasis on visibility, accountability, and communication fostered students' leadership and initiative while reinforcing the importance of professional identity in a competitive job market.

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The On Animal Tracking System (OATS): an affordable, wireless wildlife telemetry system.

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Introduction Animal tracking for both wildlife and livestock research is often expensive and has limitations, primarily related to cost, availability, and customisable functionality (Cypher *et al.* 2014; Hofman *et al.* 2019; Matthews *et al.* 2013). Movement and activity data provide fundamental information for animal science, however, often both the upfront and on-going costs of commercial systems can prevent important research. The aim of this research was to build an affordable and effective system for monitoring the movement and activity of livestock and both native and feral populations of wild animals with a particular focus on small mammals such as the Brush-tailed Rock-wallaby (BTRW).

Methods The On Animal Tracking System (OATS) was designed as a complete open-source animal tracking system including hardware, firmware and cloud-based software. Data (including both Global Navigation Satellite System and accelerometer data) is uploaded from a collar to a field-based DataHub when an animal comes within upload range (figure 1a). Data was subsequently uploaded via cellular networks to a cloud-based database and dashboard to allow syncing of data from multiple DataHubs or sites. The system has been tested and refined on domestic sheep (*Ovis aries*) (Cafe *et al.* 2024), captive dingos (*Canis familiaris*) (Kimber *et al.* In Review) and BTRW.

Results OATS collars, DataHub and cloud-based data pipeline was successfully field tested with 6 BTRW in New South Wales, Australia for a period of up to 60 days (dependent on the soft-release drop-off). This provided researchers with vital information on home-range and inter-colony interactions (figure 1b). Using the latest open-source version, $98.60 \pm 0.14\%$ of accelerometer and $95.26 \pm 0.76\%$ of location possible datapoints were successfully collected based on the expected 10-minute data rate. Further, all data transferred to the DataHub were successfully synced to the cloud database. The mean across four stationary collars had a modal error across the 4 collars of 10.28 ± 0.78 metres. The approximate cost of \$120 AUD per collar and \$1,500 AUD per DataHub along with low operational cost for OATS represents a saving of approximately 70-85% compared to recent commercial quotes for a two-month deployment.

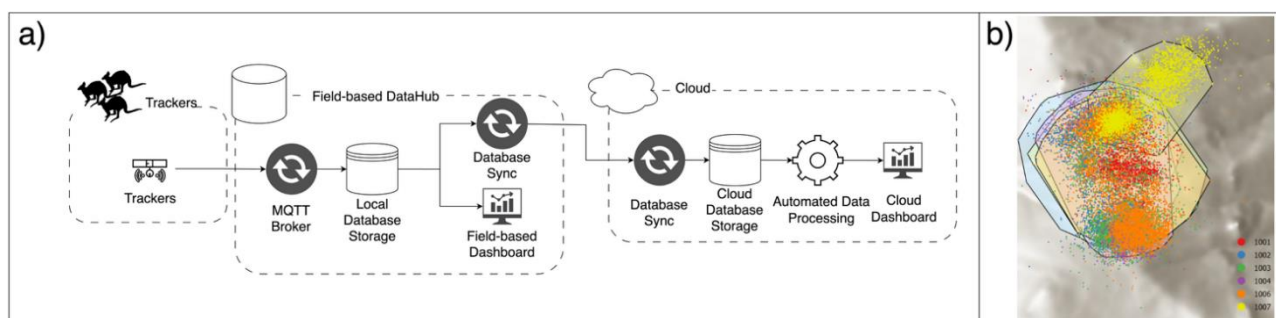


Figure 1. a) A visual representation of the OATS system; and b) 95% minimum convex polygons for 6 collared BTRW.

Discussion The cost, availability and customisability of OATS provide a suitable option compared to commercial solutions for researchers who aim to investigate how animals interact with the landscape and use that knowledge to inform and guide management. With the design being publicly and freely available, it provides the foundation for other researchers to use and adapt the system to suit their research needs, thereby providing the flexibility required for research with a cost that is less prohibitive for carrying out movement and activity research.

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Can Global Navigation Satellite System (GNSS) data alone distinguish between cattle behaviours?

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Introduction Recent studies highlight the advantages of the Global Navigation Satellite System (GNSS) in providing high-accuracy spatial data, which has contributed to the advancement and reliability of Precision Livestock Farming (PLF), enhancing agricultural production while reducing environmental impact in extensive environments (Bailey *et al.* 2021). Additionally, this technology has significantly contributed to understanding animal–environment interactions and physiological states via advanced studies on cattle behaviour monitoring. Many animal behaviour studies have equipped GNSS data with accelerometers and wearable sensors (Hamilton *et al.* 2019) to achieve higher performance in detecting multiple behaviours of cattle. This study aims to answer the question: “Can Global Navigation Satellite System (GNSS) data alone distinguish between cattle behaviours?” by using a machine learning classifier with speed values extracted from consecutive GNSS points.

Material and methods Research activities (GNSS data collection and visual observation) involving ten Angus steers were conducted at the UNE Kirby SMART Farm over 10 days (16–26 May 2023) under the approval of Animal Ethics Authority No: ARA23-031. Each animal was fitted with a UNETracker II collar manufactured by UNE, which was programmed to record multiple 5-minute interval logs called “Bursts”. Each Burst contained five GNSS points recorded at 10-second intervals. Visual observations were annotated using BORIS software for three behaviours: Travelling, Grazing, and Resting. The annotated data were synced with GNSS data based on UNIX timestamps converted from the original data. Three different subsets of data, called Burst B3, B4, and B5 with 3, 4, and 5 GNSS points, respectively, were created from the synced data. Speed values were calculated into eleven statistical features. Four different machine learning algorithms (Random Forest, XGBoost, SVM, and kNN) were used to train behaviour models with 10-fold cross-validation, and the models were evaluated on independent test sets (30%). Performance of the models was based on Accuracy, F1 Score, and Kappa. An oversampling technique, SMOTE, was applied to improve the performance of these models.

Results The four machine learning models showed better performance after applying oversampling, with an increase above 10% in accuracy and F1score. The models performed best in B3 data set. Results showed that XGBoost had the highest classification performance (Accuracy and F1 Score = 0.79; Kappa = 0.68) (Table 1), followed very closely by RF (Accuracy and F1 Score = 0.78; Kappa = 0.67). kNN and SVM showed improvement, with accuracy and F1 Scores ranging from 0.65 to 0.70 and about 35% for Kappa after oversampling, but they still remained the weakest models for multiple classification tasks.

Table 1. Confusion matrix performance of the XGBoost model for Burst 3 (B3)

B3-Before oversampling				B3-After Oversampling			
Prediction	Reference			Prediction	Reference		
	Grazing	Resting	Travelling		Grazing	Resting	Travelling
Grazing	149	57	8	Grazing	123	32	14
Resting	22	57	4	Resting	46	138	9
Travelling	3	4	13	Travelling	5	4	151
Accuracy	0.69			Accuracy	0.79		
F1 Score	0.64			F1 Score	0.79		
Kappa	0.41			Kappa	0.68		

Discussion: This study demonstrated that GNSS itself was able to classify multiple cattle movement behaviours. Applying oversampling improved model performance; however, some misclassification remained at low speeds, typically due to overlap between grazing and resting behaviours. This approach can be confidently applied in further studies where farmers practice free-range grazing in remote areas, helping to quantify cattle movement behaviour to understand grazing distribution and landscape use for improved pasture management and reduced environmental pressure in overgrazed areas.

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Data-driven benchmarking of paddock productivity in Australian beef systems

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Introduction Australian beef production systems operate across diverse landscapes and increasingly variable climatic conditions. These challenges make it difficult for farmers to optimise grazing management and forage utilisation. Advances in precision livestock farming technologies and remote sensing provide new opportunities to link animal performance data with environmental metrics to support paddock-level decision-making (Reeves *et al.*, 2025). In this study, the Paddock Performance Benchmark (PPB) was developed as a data-driven framework that incorporates real-time cattle liveweight (LW) data with readily available pasture biomass, climate, soil, and pasture quality to monitor paddock productivity and inform grazing management strategies.

Material and methods Cattle LW data were collected from commercial beef farms in north-west New South Wales using in-paddock automated weighing systems (Optiweigh). Satellite-derived pasture biomass (Total Standing Dry Matter, TSDM) was obtained from CiboLabs. Weather variables and soil data were sourced from national databases, including the nearest Bureau of Meteorology (BOM) station for each farm and the Sharing and Enabling Environmental Data (SEED) portal. Pasture quality indicators, including crude protein (CP) and metabolisable energy (ME), were measured through quadrat-based pasture sampling and laboratory analysis. Furthermore, ecological surveys provided information on pasture species composition and ground cover at the farm's paddock level. Statistical models were used to estimate cattle average daily gain (ADG) and assess relationships with TSDM, temperature-humidity index (THI), rainfall, soil types, and pasture quality.

Results Cattle ADG varied significantly between paddocks within farms (0.44–1.03 kg/day). The relationship between ADG and TSDM differed among farms (Table 1), with a 1000 kg/ha increase in TSDM associated with changes in ADG ranging from –0.19 to +0.19 kg/day ($P < 0.001$). Forage crops (e.g., oats) showed stronger associations with ADG than perennial pastures, although seasonal effects were also evident. Climate, soil classification, pasture quality, and species composition are being evaluated as explanatory variables to improve predictive capacity.

Table 1. Linear mixed model outputs for paddock-level variability in average daily gain (ADG) and the relationship between ADG and total standing dry matter (TSDM) across three farms.

Farm	Paddock variability				P-value	TSDM effect		
	Variance (kg/day) ²		SD (kg/day)			b**	SE**	P-value
	Estimate	SE	Estimate	SE				
GR	0.314	0.094	0.56	0.084	< 0.001	-0.190	0.023	< 0.001
RG	0.197	0.068	0.44	0.077	< 0.001	-0.182	0.017	< 0.001
TW	1.053	0.411	1.03	0.200	< 0.001	0.191	0.024	< 0.001

b** Regression slope for the effect of TSDM on ADG (g/day per 1,000 kg/ha increase in TSDM); SE** Corresponding standard error for this estimated slope, a measure of accuracy; P-value indicates the significance of the regression slope.

Discussion The substantial variation in ADG among paddocks reinforces the effect of pasture quality and quantity on cattle growth (Pearson *et al.* 2021). However, these results also indicate that paddock productivity was influenced by multiple interacting factors rather than biomass alone. These differences were likely driven by variation in forage composition, pasture quality, seasonal conditions, rainfall, and management, consistent with previous findings on the limits of ground-based productivity estimates (Correa-Luna *et al.* 2024). In this context, ADG may serve as a practical indicator of paddock performance and pasture quality, although this requires further validation across regions. These findings also support the value of the PPB as a framework for integrating real-time LW, pasture, and environmental data to assess paddock productivity (Pringle *et al.* 2021). Future studies should expand the dataset across a broader range of agroclimatic regions and further develop the PPB for integration into routine farm management.

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Customising pasture and animal productivity forecasts using on-farm data and machine learning

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Introduction On-farm data provides valuable insights into past productivity, but its full potential is only realised when combined with projections. Whole-farm system models can forecast pasture conditions and livestock productivity, yet their complexity often limits use to researchers and advisors. Consequently, both farm data and decision-support tools remain underutilised by producers. To address this, a consortium of researchers, consultants and farming groups developed *Farming Forecaster* (Mitchell *et al.* 2022), a producer focussed platform delivering regional forecasts of pasture and livestock production. It uses publicly available weather data to drive simulations of livestock enterprises and provide estimates of soil and pasture conditions, and livestock productivity, over four-month projections. Forecasts are updated twice monthly and are based on either 30 years of historical weather or an ensemble of simulations using Bureau of Meteorology forecasts. While extremely useful and widely adopted, the advancement of machine learning may offer an opportunity to develop a tool that overcomes previous constraints. *Farming Forecaster* relies on a description of a specific farm system, which means users cannot modify inputs such as soil moisture, pasture biomass, or livestock parameters, and projections aren't responsive to recent weather events until the next update. By training surrogate models on simulations with varied inputs, users could interact with a simple interface that allows instant updates and greater customisation, whilst retaining a high level of fidelity to the original simulator. Although limited by their training data, surrogate models are well-suited to exploring key outputs while reducing input complexity. This research aimed to develop a neural network surrogate model capable of producing flexible forecasts of pasture conditions and livestock production. We hypothesised that a surrogate model trained on many simulations could replicate the outputs of the original model with sufficient accuracy.

Materials and methods The AusFarm® model (Hermann *et al.* 2024) was used to run 60,000 simulations of sheep grazing a 100-hectare paddock near Armidale, NSW. Randomised inputs included simulation start date, soil moisture, pasture biomass, soil fertility, animal type (35 kg crossbred lambs or 50 kg Merino wethers), standard reference weight, and stocking rate (via dry sheep equivalents per hectare). The system included a typical regional soil profile and pasture species (phalaris, annual ryegrass and subterranean clover). Daily weather data was downloaded from the SILO repository (<http://www.longpaddock.gld.gov.au/silo/>). The surrogate model was evaluated on its ability to forecast pasture groundcover 90 days ahead using only information available at the simulation start date, without access to future weather information. Forecasts were compared directly with the corresponding AusFarm® outputs, treated as if they were true values. Predictions for each forecasted day were in the form of a predictive probability distribution that was output from the surrogate model. These predictive distributions were used to construct prediction intervals, which define the range the simulated output was expected to fall within a specified proportion of the time. For example, a 95% prediction interval corresponds to the range between the 2.5th and 97.5th percentiles of the predictive distribution.

Results The model produced a mean squared error of 0.03 and a mean absolute error of 0.12 on the 0–1 groundcover scale. Across forecasts, the absolute error exceeded 2% in 52% of cases, 5% in 43% of cases and 10% in 30% of cases. The 50% prediction interval captured 61% of observations and the 95% interval captured 92%, indicating reliable quantification of uncertainty around the predictions. Overall, the model reproduced the general behaviour of the AusFarm® simulations but overestimated groundcover in 58% of forecasts.

Discussion The surrogate model reproduced pasture groundcover with sufficient accuracy for short-term forecasting, capturing key relationships between soil, pasture, animals and stocking-rate. The surrogate model offers clear advantages by providing instant forecasts that can be updated with user-defined conditions. Further improvements are likely achievable through expansion of the training dataset. These results demonstrate that surrogate models are a viable approach for delivering flexible, responsive forecasting tools to producers. Future work will extend this approach to evaluate additional variables, including animal liveweight, supplementary feeding requirements, pasture biomass, and soil moisture content.

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Preliminary results on walk-over weighing system usage and its effect on feedlot cattle performance

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Introduction Feedlot cattle are typically sorted into groups at induction according to breed and liveweight (LW), then fed and marketed on a group level rather than individually. This results in a large variation in carcass characteristics and thus profit achieved on an individual animal basis (Pyatt *et al.* 2006). Monitoring animal performance in-pen using walk-over weighing (WoW) systems could allow for adjustments to feeding (e.g. days on feed) or marketing (e.g. sorting) programs to increase the proportion of animals meeting target carcass specifications. However, this technology has not yet been evaluated for use in a commercial feedlot setting. The objective of the present study was to evaluate the use of an in-pen WoW system under commercial feedlot conditions and assess its effect on feedlot cattle performance.

Materials and methods This study was conducted at a commercial feedlot in Queensland, Australia, and approved by the Animal Ethics Committee of the University of Sydney. Commercial cross-bred steers [20 ± 3 months old (mean $\pm$ SD); 425.73 ± 17.51 kg LW] were allocated at induction into one of two adjacent pens, with every second animal assigned to either the control (n = 170) or WoW (n = 169) pen. At induction, LW, hip height and body condition score (BCS) were recorded. Increments of 0.5 were used to assess BCS on a scale from one (emaciated) to five (overly fat). Steers were fed a commercial grain-based finisher ration, delivered twice daily, with water available *ad libitum*. The WoW pen was divided into two sections using portable fence panels, with one side containing the feed bunk and the other containing the water troughs and most of the resting area. The WoW system was positioned along this fence line. The control pen remained unmodified. Apart from the WoW installation, both pens were managed identically. For the WoW pen, LW was recorded each time an animal crossed the WoW platform and linked to RFID, date and time. Steers were fed for 127 days before slaughter at a commercial abattoir, where carcasses were MSA graded. Total daily records registered by the WoW system were calculated per animal. Induction and endpoint data were analysed in RStudio using linear models with pen (i.e. treatment) as a fixed effect and individual animals as the experimental unit. Endpoint measurements were analysed both with and without induction LW as a covariate.

Results Induction LW of control steers was 5.39 kg lighter than WoW steers ($p = 0.004$; Table 1). No significant differences were observed at induction for hip height or BCS ($p \geq 0.69$). Importantly, average daily gain, hot standard carcass weight, and cold standard carcass weight did not differ between pens, even after adjustment for induction LW ($p \geq 0.33$). The WoW system registered an average of 5.96 records/steer.day, of which 3.81 records/steer.day included a recorded weight > 0 kg (Table 2). After outlier removal, the mean number of records with effective weights was 2.38 records/steer.day.

Table 1. Mean induction and endpoint measurements for feedlot steers in control and WoW pens.

		Control	WoW	SE	P-Value
Induction	Liveweight (kg)	423	428	1.3	0.004
	Hip height (cm)	131.8	132.0	0.32	0.690
	Body condition score (1-5)	2.91	2.91	0.020	0.853
Endpoint	Average daily gain (kg/day)	2.06	2.02	0.032	0.334
	Average daily gain corrected (kg/day)*	2.06	2.03	0.032	0.507
	Hot standard carcass weight (kg)	373	373	2.2	0.972
	Hot standard carcass weight corrected (kg)*	374	372	2.2	0.507
	Cold standard carcass weight (kg)	370	370	2.2	0.857
	Cold standard carcass weight corrected (kg)*	371	369	2.2	0.419

*Corrected variables use liveweight at induction as a covariate ($p < 0.05$). WoW, walk-over weigh.

Table 2. Summary statistics for RFID records of feedlot steers registered by a walk-over weighing system (n = 19,942).

	Mean	SD	Min	Max
Records/steer.day	5.96	5.93	0	150
Records with weight > 0 kg/steer.day	3.81	3.01	0	52
Records with effective weight/steer.day	2.38	2.18	0	35

Discussion The presence of the WoW system was not associated with differences in performance over the 127-day feeding period, even after adjusting for induction LW as a covariate. All animals appeared to adapt well to the WoW system, and none required removal. These findings suggest that in-pen WoW systems can be successfully implemented in Australian commercial feedlots to provide real-time LW data. However, because pen and treatment were confounded, replication across multiple pens and feedlots is needed to confirm these preliminary findings. The outcomes of this study have important implications for the Australian feedlot industry, allowing producers to monitor individual animal performance and make data-driven management decisions.

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Vegetation classification through clustering of drone imagery to investigate livestock-pasture interactions

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Introduction Livestock-pasture interactions are bidirectional and multifold. Remote monitoring of pasture botanical composition from drone imagery can provide insights into the effects of grazing on pastures and reveal causes of grazing patterns when used in combination with location data provided by on-animal sensors. The use of machine-learning (ML) algorithms for image analyses is helping to develop suitable pasture monitoring methodology. In this pilot study, we examined the suitability of an ML-supported clustering methodology developed at Agroscope in Switzerland (Kusch 2025; Cockburn & Kusch 2026) for vegetation monitoring in a temperate Australian grazing system.

Material & Methods The study was conducted at the CSIRO Research Station Chiswick near Armidale, NSW. Fourteen Angus heifers grazed for four weeks in a feature-rich 23-hectare paddock with improved pasture. Drone imagery was collected at the start and end of the grazing period across nine sampling zones of 1 ha, processed into orthomosaics, and clustered using the existing algorithm to classify vegetation. Two clustering methods were applied, a) the original direct RGB based clustering (RGB-Index) and clustering based on a vegetation index (VARI-Index). Both methods were applied with or without use of training datasets. The quality of clustering was assessed by the silhouette coefficient. The results were compared to those of the original study conducted in Switzerland on a 1.5 ha paddock grazed by 4 horses.

Results In the Australian temperate pasture application, the algorithm identified areas of pasture in active growth phase, browned off vegetative state, areas of herbaceous incursion, and areas of low or absent groundcover including bare soil and bodies of water. A comparison of clustering strategies using a range from 2 to 6 clusters revealed higher accuracy for lower number of clusters, while a higher number of clusters offered a higher information content (results not shown). Silhouette scores indicating clustering accuracy are shown in Table 1.

Table 1. Silhouette coefficients in three to six clusters obtained by application of VARI- and RGB-indices on trained and untrained data.

Method of index Number of clusters	Agroscope study paddock				CSIRO study paddock			
	VARI-Index		RGB-Index		VARI-Index		RGB-Index	
	trained	untrained	trained	untrained	trained	untrained	trained	untrained
3	0.453	0.496	0.402	0.424	0.524	0.474	0.459	0.503
4	0.325	0.444	0.384	0.393	0.377	0.403	0.448	0.457
5	0.334	0.412	0.364	0.361	0.317	0.381	0.424	0.429
6	0.229	0.397	0.331	0.330	0.296	0.367	0.403	0.403
Total result	0.372	0.453	0.384	0.394	0.334	0.385	0.426	0.426

Discussion This pilot study demonstrated the feasibility to adapt a clustering method for vegetation monitoring in temperate pastures in Australia. In a Northern temperate climate pasture system, the original RGB-based algorithm was able to identify areas of high, medium and low pasture density and areas of bare soil, and degradation of the pasture area after a four-month grazing period could be detected (Kusch 2025). In the present study, the focus was on botanical composition rather than pasture density. The algorithm achieved a suitable level of accuracy in both applications, despite the differences in vegetation, scale of analysed area, diversity of plant species and physical features, and differing grazing livestock species. These initial results demonstrate the robustness of the methodology across different systems. The clustering method shows promise for the investigation of livestock-pasture interactions.

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We thank Marianne Cockburn from Agroscope, Switzerland, for her expertise and advice in the application of the clustering method.

Exclusion of sheep from an environmentally sensitive area using a commercial virtual fencing system

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Introduction Sustainable livestock management is vital for improving profitability and environmental outcomes in Australian agriculture. Virtual fencing (VF) offers a potential solution, enabling exclusion of livestock from fragile areas while supporting adaptive grazing management. VF uses GPS-enabled collars to communicate virtual boundaries via audio cues followed by mild pulses. Despite being commercially available for cattle, VF for sheep remains underdeveloped. Small-scale studies have shown short-term containment success (Campbell et al, 2023), but its use to exclude sheep from areas across broadacre landscapes, and for longer periods of time, has not been tested. This study evaluated the effectiveness of VF for excluding sheep from an environmentally sensitive area in a low-rainfall, mixed farming system in South Australia.

Materials and methods The trial was conducted in January 2024 at the Minnipa Agricultural Centre, Eyre Peninsula. Fifty merino ewes (approx. three months post-shearing) were fitted with modified Vence CattleRider collars (MSD, San Diego, USA). The ewes were trained to the VF system over seven days in a 7.5ha paddock using Vence's training protocols. The mob was then moved to a 70ha paddock containing barley stubble with some crop regrowth and miscellaneous plant species. A virtual fence was established to exclude access to a sandy, erosion prone area in the paddock (approx. 20% of the total paddock area). The VF remained active for 20 days, collecting GPS, audio, and pulse data. Sheep were weighed and condition scored pre- and post-trial. Temperature (°C) and rainfall (mm) data were collected via a weather station located adjacent to the trial paddock.

Results Sheep were successfully excluded from the protected area for the full 20-day period. Heat-map data showed concentrated grazing pressure near the virtual boundary, yet no incursions occurred. Collar data indicated rapid learning during the training phase, with most signals occurring early in training and a subsequent decline in pulse delivery. Pulse signals remained extremely low for the trial period. However, this could have been influenced by high average daily temperatures. Mean liveweight increased from 74.2 ± 7.4 kg to 80.9 ± 8.1 kg, and body condition score from 3.2 ± 0.4 to 3.7 ± 0.5 , identifying no negative production impacts.

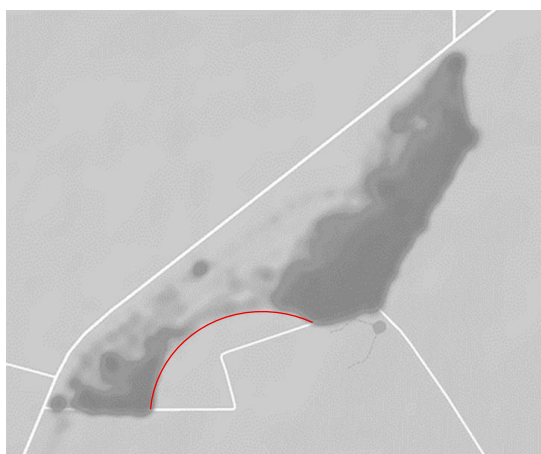


Figure 1. A heat map, generated through the Vence Herd Manager online platform, showing the GPS locations of the fifty sheep throughout the trial period. The red line indicates the approximate location of the virtual fence.

Discussion This trial provides promising preliminary evidence that commercial VF systems can exclude sheep from sensitive zones under real-world conditions. Although the impact of wool insulation was not assessed, learning appeared sufficient to facilitate high levels of exclusion. The findings demonstrate strong potential for VF as a sustainable grazing management tool for sheep enterprises. Progress toward commercialisation will depend on regulatory reform and development of sheep-specific VF hardware.

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The effect of season on the behaviour of sheep around a natural waterway

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Introduction Livestock farming has the potential to negatively affect water quality due to contamination of waterways with sediment, nutrients and the deposition of faecal matter (Monaghan *et al.* 2005). While cattle have been shown to impact the water quality of natural waterways (O’Callaghan *et al.* 2019), little is known about the potential impacts of sheep. It is likely that the behaviour of sheep will be influenced by climatic conditions and pasture quality. In New Zealand (NZ), the motivation for sheep to drink water likely differs between spring and summer due to differences in pasture dry matter and environmental conditions. On many NZ farms water is provided to sheep from reticulated water troughs as well as natural sources such as creeks, streams and dams. The aim of the current studies was to examine ewe behaviour and interaction with a natural waterway during spring (13 to 29 of November 2019) and summer (15 to 28 of February 2020) periods in the Manawatu region.

Materials and methods The study site was a permanently fenced 1.7 ha paddock that contained a discrete natural stream (233m in length, <1 m wide and <30 cm deep; Figure 1). Each study enrolled a different mob of Romney ewes (n = 40) fitted with Global Positioning System (GPS) units and triaxial accelerometers. Ewes were given unrestricted access to a water trough in week one which was then covered to restrict access in week two. Each week was analysed separately to determine the impact of providing access to a water trough.

Results Across the two-week study periods rainfall was recorded on eight days in spring and three days in summer. Daily average air temperatures ranged from 12.0 to 18.7°C in spring and 16.3 to 24.4°C in summer. The stream zone, although accounting for 9% of the study area, in spring contained only 4.3 and 4.6% and in summer 0.7 and 0.3% of the ewe GPS location fixes during the unrestricted and restricted periods, respectively. This indicates that sheep did not show any preference for stream zone and access to the water trough did not influence the time spent near the stream. The hot spot analysis showed that there was a consistent area of low density of location fixes along the stream in both seasons. Areas with a high density of fixes varied between seasons. In both seasons, when access to the water trough was unrestricted there was a hot spot identified near the trough (black dot, Figure 1).

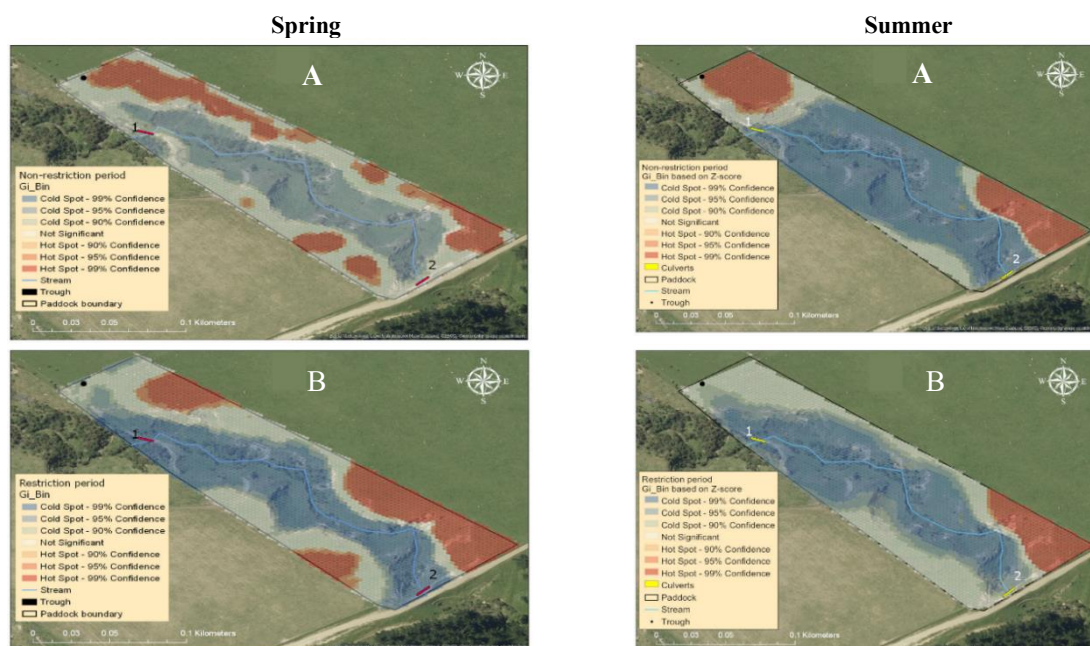


Figure 1. Study site showing the magnitude per unit area of ewe location fixes during spring and summer when provided unrestricted access to a water trough (black dot; A) or restricted access (B). Blue = low density, white = random distribution, red = high density.

Discussion These results suggest that access to the reticulated water trough had no effect on time spent in the stream zone although it influenced the pattern of ewe paddock use. These data suggest that one-wire electric fences could be used to restrict cattle but allow sheep to access waterways to graze.

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Comparing single-trait and multi-trait analyses incorporating breech and body strike records to improve flystrike prediction accuracy in Australian Merino sheep

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Introduction Accurate genetic evaluation of flystrike resistance in Merino sheep is limited by low heritability and recording challenges. Combining information across related traits and time points, such as breech and body strike at early (EBRS and EBDS) and late (LBRS and LBDS) age stages, can improve prediction accuracy by exploiting genetic correlations and increasing the amount of information available for each trait. Therefore, a multi-trait approach is expected to enhance precision in genetic evaluation and support sustainable improvement in strike resistance. This study compares single-trait and multi-trait analyses (EBRS, LBRS, EBDS and LBDS) using flystrike records to assess their impact on prediction accuracy and bias.

Materials and methods Data were sourced from 24 research and industry breeder flocks, comprising animals born between 2006 and 2024, with documented cases of breech and body strike at both early (up to the first shearing, e.g., yearling) and late (above yearling) age stages. Flystrike (breech and body strike) was recorded as a binary trait (1 = struck, 0 = not struck) within defined shearing periods (Dehnavi *et al.*, 2024). Data were grouped by flock, sex, and year of birth to identify unstruck contemporaries, and records were standardised within groups to account for heterogeneity (Dehnavi *et al.*, 2024, 2025). Prediction accuracy was assessed through forward validation, excluding animals born after 2018 from the initial analysis. Predictions were performed separately for each individual trait, using animals with records for that trait in the progeny and their sires. Single-step genomic breeding values (partial ssGEBVs) for animals born from 2018 onwards were compared with ssGEBVs derived from the full dataset. Accuracy (rank Spearman correlation), dispersion (regression slope), and bias (mean difference between partial and full ssGEBVs) were evaluated for progeny and sires.

Results Applying multi-trait analysis increased prediction accuracy (rank correlation) of individual traits (EBRS, EBDS, LBRS and LBDS) in progeny ($\Delta \approx 5\text{--}33\%$) and sires ($\Delta \approx 8\text{--}34\%$), particularly at the late age stage, while also improving dispersion (one is ideal) and reducing bias. It also slightly improves the theoretical accuracy (mixed model equation-derived accuracy) ($\Delta \approx 1\text{--}6\%$). Overall, combining all strike types across stages enhanced accuracy and supported a more reliable genetic selection tool for flystrike resistance in Merino sheep (Figure 1).

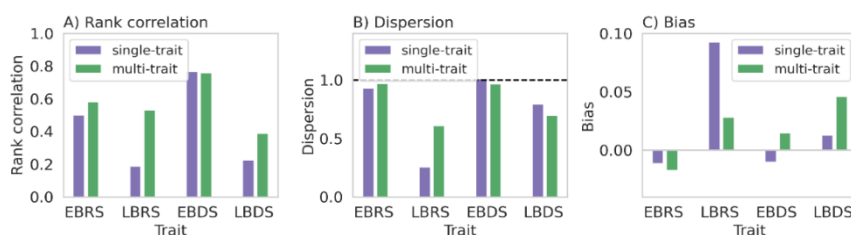


Figure 1. Comparison of single-trait (purple) and multi-trait (green) analyses of flystrike records to evaluate their impact on the prediction accuracy and bias of sire evaluations (ssGEBVs). The figure illustrates: A) rank correlation, B) dispersion, and C) bias. EBRS, early breech strike; LBRS, late breech strike; EBDS, early body strike; and LBDS, late body strike.

Discussion These results demonstrate the benefit of multi-trait analysis in improving prediction accuracy and reducing bias for flystrike resistance. To further enhance accuracy and address gaps in strike records, future analyses will incorporate correlated visual traits, enabling more robust genetic evaluation and selection in Merino sheep.

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We gratefully acknowledge Australian Wool Innovation Ltd for funding this work (Project ON-00775) and the Australian Government for supporting R&D and marketing of Australian wool. We also thank site partners, hosts, and participating breeders for providing data, including INF, MLP, CSIRO, DPIRD, AMSEA, and breeder flocks such as Burbidge Farms.

Brushing for enrichment: Implementing cattle brushes in a commercial feedlot

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Introduction Australian feedlots currently house over 2% of Australian cattle, however, intensive housing systems such as feedlots raise welfare concerns regarding the inability to display natural behaviour. Providing environmental enrichment, such as brushes, in intensive production systems can encourage natural behaviour potentially improving the welfare outcomes of intensively housed cattle. Although there has been research into the use of brushes in dairy systems (McConnachie *et al.* 2018) and in feedlot systems (Meneses *et al.* 2021), there is little evidence regarding the productivity and health outcomes of brush enrichment on feedlot cattle. The study aimed to investigate whether providing feedlot cattle with physical enrichment in the form of brushes influenced animal behaviour, health, and productivity. It was hypothesised that the provision of brushes would facilitate natural behaviour expression and lead to improved welfare and production performance.

Materials and methods Two hundred and fifty-six Angus and Angus cross steers aged 12-18 months old, were randomly assigned to one of two treatment groups in replicate. The groups were Control (standard feedlot pen) and Brush (standard pen allocated two brushes). Ten cattle in each pen were randomly selected as focus animals for observations. Behavioural observations were collected pen-side intensively for 30 min on day 0, 35 and 80 and 15 min and on days 1, 2, 3, 4, 8, 15, 23, 29, 36, 37, 38, 43, 50, 57, 64, 70, 81, 82, 83, 85, and 99 during the morning, midday, and afternoon. Live weight was recorded on day 0, 35, 80 and 121. Average feed consumption was measured daily over the duration of the trial. Mud scores were observed on day 104, 115, 123, 140 and 146 following a rain event. Data was analysed using SPSS and R-Studio to conduct a repeated measures mixed effects model and chi-square test.

Results There was no difference in weight gain ($P = 0.539$) between treatments, with the cattle's average final weight being 637.13 ± 65.19 kg (Control) and 644.74 ± 70.11 kg (Brush). There was also no difference ($P = 0.263$) for feed intake. Treatment had an impact on mud score (Figure 1) with the Brush treatment cattle less likely to be observed with a score of 3 (16%) compared to the Control cattle (31%, $P = 0.031$). Instances of grooming behaviour increased over time in both groups ($P < 0.001$), the same was observed for brush use ($P = 0.002$). Cattle were more likely to groom in the afternoon. Standing, eating and resting behaviours were not impacted by treatment ($P > 0.05$).

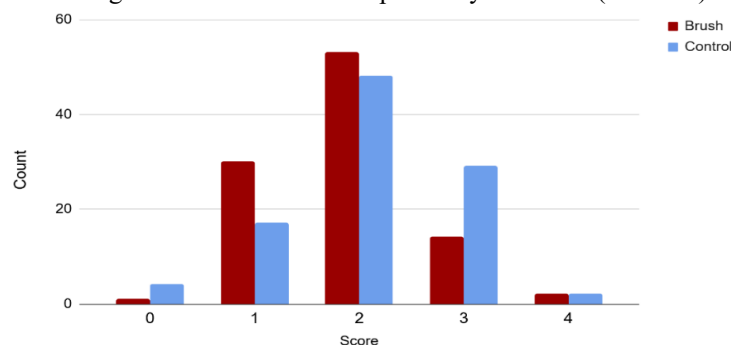


Figure 1. Count of animals observed with mud scores 0 to 4 in the Brush and Control groups. Mud score scale from 0 to 5, where 0 indicates no mud on cow coat and 5 indicates coat of animal is fully covered in mud.

Discussion Providing feedlot cattle with enrichment in the form of brushes had no negative impact on production outcomes, nor impacted normal behaviour, indicating that the addition of brushes and their use does not displace other positive behaviours such as eating, resting and social interaction. Cattle that had access to brushes had differences in coat cleanliness, where the mud score was lower for cattle that were provided the brushes than cattle that were not. Improving coat cleanliness has the potential to improve health and reduce stress associated with increased lairage washing times associated with higher mud scores. Further research needs to be conducted to determine cattle to brush ratio and the implementation of brushes on coat cleanliness and abattoir outcomes. This study highlights the behavioural need for cattle to groom and the functional benefit that brushes can provide.

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Non-steroidal anti-inflammatory drug use in ewes undergoing laparoscopic artificial insemination -a literature review

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Introduction Pain management in livestock is under increasing scrutiny due to ethical concerns around painful husbandry procedures like tail docking. Laparoscopic artificial insemination (AI) is a procedure performed on around 175,000 ewes annually in Australia, using only light sedation and without ongoing pain relief. As consumer expectation for livestock welfare continues to grow, there is pressure to use ethical practices to reduce pain during husbandry. This review examined literature on the use of non-steroidal anti-inflammatory drugs (NSAIDs) in laparoscopic AI of ewes and the potential effect on pregnancy and productivity. We aimed to evaluate the impacts of NSAIDs on livestock pregnancy and productivity and the current registered analgesic products for sheep in Australia and to identify circumstances in which these products could be used to improve animal welfare and reproductive outcomes in sheep.

Materials and methods A scoping review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) framework. The following inclusion criteria were adhered to; the study must be relevant to the topic; the study should be peer reviewed; and the study should be no older than twenty years. The databases used for the review include Web of Science, PubMed, Scopus, University of Adelaide Library. The search term [sheep OR ewe OR ovine AND laparoscopic AI OR artificial insemination AND NSAID OR non-steroidal anti-inflammatory AND pain] was inserted into the databases. Articles were excluded if they were not relevant to sheep, cattle, or other small ruminants. This generated 14,671 articles, with 138 assessed for critical review, from this, 45 were inclusive of the criteria and suitable for the literature review.

Results The use of pain relief is becoming a common practice during routine husbandry interventions that are recognised as painful, most notably lamb marking procedures. Laparoscopic AI is a procedure that is painful or at least stressful, however it is not commonplace to use pain relief beyond muscle relaxants, like Xylazine. The range of licensed and recognised analgesic options for sheep is limited. Research on analgesia in livestock has focused on the acute or immediate pain from a procedure, however, there is evidence that post-procedural pain can persist beyond 1-2 days, and animals may also experience chronic or neuropathic pain. There is conflicting information on the use of NSAIDs during reproductive procedures and the impact on reproductive and productivity outcomes (Table 1).

Table 1 Potential physiological impact of NSAID on prostaglandin and ewe reproductive timeline (Kaczynski et al., 2016; Naitana & Ledda, 2020).

Approximate Timing	Reproductive Stage	Prostaglandin (PG) Function	NSAID Effect	Potential Risk
Day 0 (Laparoscopic AI)	Semen deposited, ovulation approx. 24-30hr after AI	Increased PGE2 & PGF2a trigger follicle rupture	COX inhibition decreases PGE2/PGF2a	Decreased fertilisation success
Day 0-1 (Post-AI)	Sperm move through oviduct toward oocyte	Aid sperm transport	Slower sperm transport or altered fluid environment	Decreased conception as less sperm reach oocyte
Day 1-3	Fertilisation in oviduct	Regulate oviduct tone, ciliary action & fluids	Altered peristalsis & oviductal secretions	Delayed embryo transport
Day 4-6	Early embryo migration into uterus	Prepare endometrium, control uterine tone & timing for entry	Decreased uterine blood flow & secretions	Impaired readiness, reduced implantation rates

Discussion The pain experienced during and following laparoscopic AI in sheep is sufficient to justify a more sustained pain relief and improve the current analgesic protocols. Understanding how pain medication such as NSAIDs will impact pregnancy and the specific timing of administration to reduce any negative impact should be investigated further to ensure animal welfare is optimised and reproductive outcomes are not jeopardised. Currently, there is a limited understanding of adequate dose rate, optimal timing of administration and duration of analgesic efficacy.

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We gratefully acknowledge the University of Adelaide for financial contribution to this project.

Can early-life enrichment shape the learning ability of sheep?

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Introduction Enrichment is an important element in upholding animal welfare standards and reducing stress. In livestock while it has been found to have direct links to production value, the term enrichment has remained vague, and exact causative agents have yet to be solidified in research. The aim of this project is to determine if the added enrichment that bottle-raised sheep experience allows for better development of cognitive processes in adult sheep including memory, learning and resilience. Bottle-raised sheep were therefore compared with Paddock-raised sheep through their performance when put through a y-maze. It was hypothesised that animals with more early life enrichment (Bottle-raised sheep) show fewer indicators of stress and an enhanced ability to learn compared to Paddock-raised sheep who have experienced much less social interaction or added cognitive stimulus.

Materials and methods A total of twenty-eight, twelve-month-old Merino sheep were selected to perform a series of tests in a Y-maze requiring them to remember an exit route (M1, M2) and then learn how to exit when the exit gates were switched (R1, R2). Performance was measured using each sheep's completion time and exit method. On testing days, blood samples were collected before and after each sheep's run to measure plasma cortisol levels using ovine ELISA test kits. Ethics approval was through the University of Adelaide SET Animal Ethics Committee (#S-024-068). Results was analysed using R and R-Studio, count data (side preferences, exit method) were analysed using a chi-square test, for time taken to exit a t-test was conducted. Cortisol is yet to be analysed.

Results Under time parameters, it was found that Bottle-raised sheep completed both memory and learning tasks at a significantly faster rate ($P = 0.003$) than Paddock-raised sheep (20.9 ± 2.91 vs 38.07 ± 4.6 s respectively). During the learning tasks (R1), Paddock-raised sheep failed their learning task more often (total sum failure to exit $n = 21$) than Bottle-raised sheep ($n = 6$). Bottle-raised sheep also improved between testing days more significantly (M1 vs R1, $P = 0.003$) than their Paddock-raised counterparts. There was no difference in blood cortisol levels between the two cohorts prior to testing ($P = 0.6$) or post-testing ($P = 0.8$). Average cortisol concentration after completing the Y-maze was 37.22 ± 3.53 ng/mL for Bottle-raised sheep and 36.28 ± 1.64 ng/mL for Paddock-raised sheep.

Discussion Bottle-raised sheep completed the Y-maze faster than Paddock-raised sheep and exhibited lower failure rates, proposing that early-life enrichment during development positively influences learning and decision-making in sheep. Failure rate and speed of completion in Paddock-raised sheep may be due to fear of humans or lack of understanding of the assigned task. In future sheep could be operantly conditioned to a cue to indicate which side of the maze is open. By providing a cue and assessing their ability to remember the cue and its implications, this test would be a better measure of learning and memory. This method may also reduce human bias and mitigate other factors that may have influenced the outcome of this Y-maze study, such as reducing human involvement to avoid influencing the sheep's behaviour. This factor is particularly important when comparing sheep that have been bottle-raised to sheep that have been paddock-raised. Given the potential for enrichment to improve animal welfare and cognitive performance, further research should be conducted to investigate which types of enrichment produce the greatest improvement in cognitive capacity and flexibility, and a reduction in impulsivity, to achieve optimal animal welfare and production outcomes.

We gratefully acknowledge the University of Adelaide and the Davies Livestock Research Centre for financial contribution to this project.

Sheep remember a spatial maze one year after initial testing

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Introduction Spatial maze tests have been developed and validated to assess spatial learning and memory in sheep (Lee *et al.* 2006). The method has been applied to investigate the cognitive effects of various conditions, including negative stimuli (Doyle *et al.* 2014), parasitic infection (Shamsi *et al.* 2023) and pubertal development (Wojniusz *et al.* 2013). These studies collectively show that sheep can learn to solve the maze and retain task-relevant information over several months. This study aimed to assess the retention of spatial memory over a longer time period of one year.

Materials and methods This study was conducted at the University of New England and was approved by the UNE animal ethics committee (ARA 16-003, 17-015). Ninety-two adult ewes (68 Merino and 24 Maternal breed) underwent maze testing over 3 consecutive days, then repeated the procedure one-year later for a total of 6 repetitions. The maze was an 18.4 × 8.2 m arena with 1.5 m high opaque walls and open internal barriers forming the maze (Fig. 1A). Flock-mates were penned at the end as an attractant. For each trial we recorded completion (yes/no), completion time (maximum 3 min per trial) and total time in error zones. Likelihood of maze completion and of making any error were analysed with binomial generalized linear mixed models; completion time for the completed trials only was analysed with a linear mixed model using log-transformed times. All models included maze repetition, test order and breed as fixed effects and ewe identity as a random intercept. Estimated marginal means for repetition were back-transformed.

Results Maze repetition number significantly affected likelihood of completion ($P = 0.001$), completion time ($P = 0.005$) and error time ($P < 0.001$). The number of sheep completing the maze was stable in Year 1, peaked at repetition 4 and was lowest at repetition 6 (Fig. 1B). Mean completion time declined over repetitions 1–3, was maintained in Year 2 (repetitions 4–5), then increased at repetition 6. The likelihood of making any error showed a similar pattern. Overall probability of completion tended to be lower for Merino than Maternal ewes (0.90 ± 0.02 vs 0.95 ± 0.02 , $P = 0.052$), but breed did not affect completion time among completers ($P = 0.937$) or probability of making an error ($P = 0.997$).

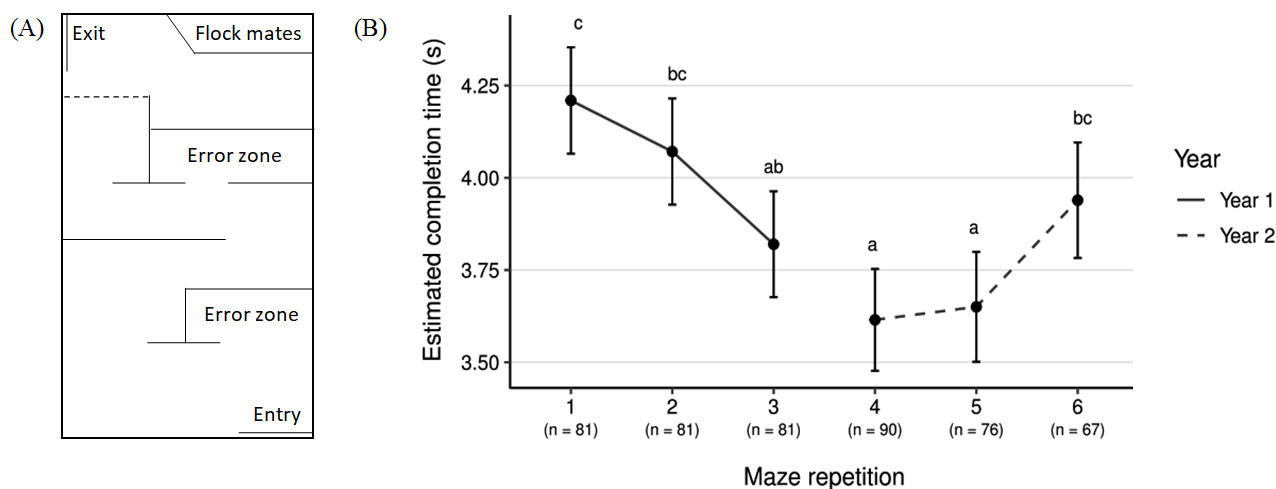


Figure 1. (A) Schematic diagram showing the maze layout, the test was complete when a sheep crossed the dashed line and (B) back-transformed estimated mean completion times across 6 repetitions. The number of sheep that completed the maze in 3 min is indicated below the repetition label. Letters indicate significant differences between repetitions.

Discussion Maze performance was maintained after one year, which is longer than has been demonstrated previously and shows strong retention of spatial memory in sheep. Interestingly, performance then decreased with repeated exposure. This is not likely to reflect a loss of memory retention, but rather a shift in motivation to complete the maze, as sheep became habituated to the test environment. This is an important consideration for future studies using the maze to assess cognitive performance. A limitation of the study was lack of age-matched naive sheep in Year 2 to test for effect of age.

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Flight time in growing rangeland goats was repeatable but not linked to weight gain

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Introduction Rangeland goats represent an underutilised source of meat in Australia, and temperament may be an important determinant of success when adapting to intensive farming conditions (Miller *et al.* 2018). Flight time (FT) is a rapid measure of temperament, whereby calmer animals take longer to traverse a short distance after exiting a crush or weigh crate than flightier animals. In cattle, FT is a repeatable, heritable trait that has favourable correlations with ease of handling, productivity, meat quality and immune function (Burdick *et al.* 2011). This study aimed to quantify the repeatability of FT in growing goats and test its association with average daily gain (ADG). It was hypothesised that FT would be moderately repeatable and that calmer goats would have higher ADG than flightier animals.

Materials and methods This study was approved by the University of New England (UNE) animal ethics committee. Forty-four uncastrated male Boer-cross rangeland goats (average liveweight 18.5 ± 2.2 kg, mean $\pm$ SD) were sourced from an extensively managed commercial property in south-western QLD and transported to an animal house facility at UNE. Goats were individually housed for 8-weeks, during which they were fed a high-quality diet of blended chaff (ME 9.12 MJ/kg, CP 15.6%) and commercial pellets (ME 13.4 MJ/kg, CP 18.3%) that were gradually introduced over the first 2 weeks of the trial. All goats were weighed and FT tested weekly. FT was measured as the time (s) to traverse 1.9 m between two infrared sensors after exiting a weigh crate. Values > 2.4 s indicated a pause (non-continuous flight) and were analysed separately from continuous flight responses. ADG (g/day) was calculated as the slope of a linear regression of liveweight (kg) over time (days) across the 8-weeks. Repeatability (intraclass correlation coefficient, ICC) of FT was estimated with the rptR package in R (Stoffel *et al.* 2017), fitting linear mixed models for log-transformed flight times and a binomial mixed model for the binary outcome of whether FT was censored at 2.4 s, fitting Goat ID as a random effect and date as a fixed effect. The association between FT and ADG was tested using a linear model, with ADG as the response and a single temperament score as the predictor. The temperament score was defined for each goat as its mean log-transformed continuous FT across weeks 2–4. Week 1 was excluded because it was their first exposure to the weighing routine, and weeks 5–8 were excluded as increasing censoring limited interpretation of continuous FT.

Results Across the full 8-week period, repeatability of log-transformed FT was low–moderate ($R = 0.22$, Table 1). Excluding the initial exposure (week 1) slightly increased repeatability ($R = 0.24$). When weeks were grouped into early (2–4) and late (5–8) phases, FT was moderately repeatable in both, but highest in the early phase ($R = 0.50$ vs. 0.36). The probability of exceeding 2.4 s (censored/non-continuous FT) was also moderately repeatable across weeks 2–8 ($R = 0.38$; Table 1). The mean ADG for all goats across the 8-week period was 176 ± 6.1 g/day (mean $\pm$ SE). The linear model showed that mean log-transformed FT across weeks 2–4 was not associated with ADG ($P = 0.413$).

Table 1. Repeatability (intraclass correlation coefficient, ICC) of log-transformed flight time and a binary censoring trait (>2.4 s) across different time windows. Models included date as a fixed effect and Goat ID as a random effect.

Measure	Weeks	Model	n obs	ICC (R)	95% CI for R	P value
Log FT (s)	1-8	LMM (Gaussian)	295	0.219	0.103 – 0.336	<0.001
Log FT (s)	2-8	LMM (Gaussian)	253	0.242	0.105 – 0.368	<0.001
Log FT (s)	2-4	LMM (Gaussian)	119	0.497	0.296 – 0.654	<0.001
Log FT (s)	5-8	LMM (Gaussian)	134	0.364	0.143 – 0.536	<0.001
Censored FT (0/1)	2-8	GLMM (binomial logit)	306	0.377	0.163 – 0.635	<0.001

Discussion Flight time was low to moderately repeatable, supporting its use as a temperament indicator in this species and context. Excluding week 1 resulted in higher ICC estimates, possibly because initial responses may be confounded by novelty and handling rather than reflecting stable temperament. Non-flight behaviours such as stopping became more common in later weeks, leading to a growing proportion of censored observations. This pattern suggests habituation and possibly increased exploratory behaviours that are not strictly “flight” responses, but nonetheless reflect stable individual differences in behaviour. Together, these results indicate that FT-based temperament scores are best derived from early, but not initial, tests (e.g. weeks 2–4). Contrary to our hypothesis and to reports in cattle, we found no evidence that FT was linked to ADG in this group of young goats. This may reflect species differences, the relatively narrow range of growth rates under controlled housing and feeding, or limited statistical power. Nevertheless, the moderate repeatability of FT suggests it represents a stable individual characteristic over several weeks, even if its relationship to growth remains unclear in goats.

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Reimagining Herd Grouping Through a Data-Driven, Multivariate Cow Profiling Approach

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Introduction- Pasture-based dairy systems generally operate under narrow profit margins, making it essential to increase milk yield while optimising feed utilisation. This requires effective management practices, particularly the strategic grouping of cows to meet nutritional requirements and reduce competition within cohorts (Barrientos-Blanco et al., 2022). Existing grouping methods commonly rely on stage of lactation, parity, milk yield or simple nutritional cutoffs (Lee et al., 2020). Such approaches, while useful, can be affected by correlated measurements and may not fully reflect the nutritional demand of individual cows. This study presents a data-driven approach for nutritional grouping of dairy cows by integrating production and physiological parameters to regroup the cows for effective farm management.

Materials and Methods- Data related to nutritional content, milk yield, DIM, BCS, body weight from 120 cows of varying parities were obtained from the DelPro Farm Management Platform at the Ellinbank SmartFarm, Victoria. Missing values in key variables were estimated using a moving average applied per cow, and records with missing critical measurements were excluded. Energy (NEL) and metabolizable protein (MP) requirements were calculated from milk yield, fat, protein, and lactose concentration. Numerical features were standardised using Z-score normalisation, while categorical variables for parity and days in milk (divided into 3 stages) were represented using dummy encoding. Principal Component Analysis (PCA) was then applied to reduce dimensionality and remove redundancy among correlated features. Clustering was performed using the k-means algorithm, with Euclidean distance employed to define cluster membership. Multivariate analysis of variance (MANOVA) was performed to evaluate differences among the final clusters.

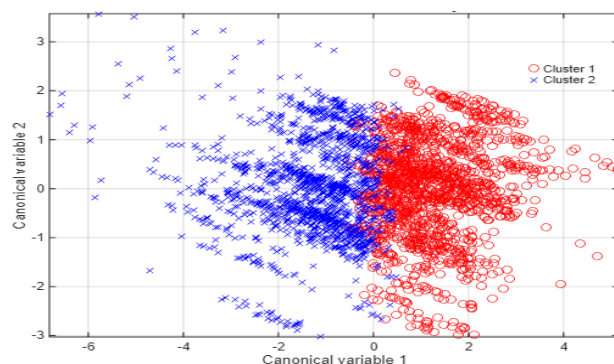


Figure 1- Scatter plot of observations projected onto the first two canonical variables obtained from MANOVA. Canonical variables 1 and 2 are linear combinations of the original variables that best separate the groups.

Results- The MANOVA and subsequent univariate analyses revealed highly significant ($p < 0.05$) differences among the identified clusters for all evaluated variables, including Total milk yield ($p = 2.10 \times 10^{-294}$), concentrations of milk fat ($p = 2.70 \times 10^{-47}$), milk protein ($p = 4.19 \times 10^{-27}$), milk lactose ($p = 8.89 \times 10^{-29}$), Body Condition Score ($p = 2.37 \times 10^{-126}$), and Body Weight ($p = 1.60 \times 10^{-233}$).

Discussion- The observed low p-values demonstrate that the clustering algorithm successfully differentiated cows based on both production and physiological characteristics, indicating strong intra-cluster similarity and clear inter-cluster separation. The consistent statistical significance across multiple variables confirms that the proposed model effectively captures the underlying biological variation among animals and forms nutritionally coherent groups. This multivariate approach produces nutritionally homogeneous clusters, providing a practical framework for targeted specific feeding strategies and improved feed efficiency in dairy herds.

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Investigating the impacts of stocking density on sheep welfare, from controlled conditions to commercial reality

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Introduction Stocking density may be one of the most important determinants of sheep welfare during sea transport from Australia to the Middle East. However, trying to accurately assess the effect of stocking density in commercial conditions is challenging, due to the complexity of the commercial voyage. In addition, published research often confounds stocking density and group size, making it impractical to discern the true effects of each of these factors. Our objective of a collective group of four studies was to provide empirical evidence of how group size, commercially relevant stocking densities, and high heat load conditions impact sheep during livestock export voyages, while controlling for confounding factors in the earlier studies and gradually accumulating environmental complexity to validate findings in a commercial voyage environment.

Materials and methods Four complementary studies utilised 12–24-month-old Merino wethers ($n = 231$ to 750) for experimental periods ranging from 14 to 21 days. The first study examined group size effects (20, 50 or 100 head) on wether behaviour at a constant stocking density (1 m^2 per head) over 5 days and the second study examined the effect of 5 allometric (Petherick and Phillips 2009) stocking densities ($k = 0.027, 0.032, 0.037, 0.042, 0.047$) on the behaviour and biological functioning of wethers over 18 days (Mayes *et al.* 2022). Both the first and second experiments were conducted under ambient environmental conditions. The third study examined the effect of 3 allometric stocking densities ($k = 0.030, 0.033, 0.042$) on the behavioural and biological functioning of wethers in a climate-controlled facility over 21 days, under hot and humid climatic conditions of relevance to Australia's livestock export industry (Mayes *et al.* 2023). The final study further increased environmental complexity and investigated the effects of two allometric stocking densities ($k = 0.033$ and 0.042) on sheep behaviour and biological functioning during a commercial livestock export voyage from Western Australia to Kuwait, during the shoulder period of the northern hemisphere summer. Statistical analyses were all performed in Stata (StataCorp, Release 16. College Station, TX).

Results The first experiment identified that group size had minimal effect on lying synchrony (a key indicator of how restricted space might impact sheep welfare) so smaller groups (approximately 20 head) were considered appropriate for use in subsequent experiments. The second and third experiments found that the effects of stocking density on stress physiology and biological fitness were limited, but reduced pen space did affect the lying positions adopted by the sheep. The final experiment in commercial conditions supported many results from the land-based trials, including that increased stocking density reduced the incidence of lying at some days and timepoints and that the biological implications of restricted pen space appear to be low and may be predominantly achieved through behavioural adjustments alone.

Discussion This collection of four studies provides empirical evidence on the effects of stocking density on sheep welfare by systematically accumulating stressors by increasing environmental complexity. This approach allowed the effects of various factors to be understood, first in isolation and then in combination with other key factors, addressing critical knowledge gaps in livestock transport welfare research. The progressive experimental design enabled results from earlier studies to refine the design of future studies, such as by selecting the most appropriate stocking densities for subsequent experiments and validating that smaller group sizes could represent larger commercial groups. In conclusion, increases in stocking density within the ranges tested had limited effects on stress physiology and biological fitness, but had some effects on sheep behaviour. These conclusions must be interpreted within the context of the specific experimental conditions and environmental parameters investigated.

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Identification and evaluation of pasture legumes adapted to low rainfall environments and climate extremes in southern Australia

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Introduction A resilient feedbase with capacity to survive and recover from climate extremes and underpin livestock production by providing high quality feed is required in the low rainfall environments of southern Australia. Pasture species require specialised adaptations to survive variable climates and prolonged drought conditions that can occur over multiple years, and a variety of survival strategies have evolved in annual and perennial plants. Annual pasture legume cultivars have phenology adapted to climates with specific growing seasons, as well as seed dormancy, which allows for regeneration after three years of cropping or drought. Perennial legumes such as lucerne have deep taproots, which aid their ability to explore subsoil moisture and provide a valuable extension of the growing season. Our objective was to use the newly developed online database tools Genesys-PGR (Crop Trust) to i) identify Australian Pasture Genebank (APG) species and accessions with traits with the potential to aid in climate adaptation for low rainfall environments and future climate scenarios in southern Australia and ii) to evaluate their performance over three low rainfall environments.

Materials and methods Climate-based searches in Genesys-PGR were used to identify *Medicago*, *Ornithopus* and *Trifolium* spp. accessions in international gene banks collected from areas with similar climates to the target environment at Black Rock (Median Annual Rainfall, MAR 233 mm) and Palmer, SA (MAR 329 mm). The APG GRIN-Global database was used to refine the annual legume selections to select plants with local observations for high biomass production and remove *Medicago* spp. accessions with long spines. Climate extremes were used to identify lucerne (*Medicago sativa*) populations collected from low rainfall environments (Humphries *et al.* 2022). Final climate-based selections consisted of 336 annual pasture legumes (291 *Medicago* spp., 45 *Trifolium* spp. and 3 *Ornithopus compressus*) and 12 lucernes evaluated in partially replicated row experiments sown in 2022 at Black Rock and Palmer (with cv. Sultan SU used as a highly replicated control) and a further 67 lucernes evaluated in a third experiment sown at Meningie SA (MAR 404 mm) in 2018 with three replications. Black Rock and Palmer sites were ungrazed and managed to promote seed set in 2022 & 2025 and to eliminate seed set in 2023 & 2024, whilst Meningie was sown and evaluated under a commercial Black Angus grazing system.

Results All experiments successfully established in a season with at least average rainfall (decile growing season rainfall, GSR 5-7), and were monitored through an extreme drought (decile 0.06-0.7 GSR) in 2024. The drought conditions continued into 2025, which had a late break and dry spring. At Black Rock and Palmer, annual *Medicago* accessions of commercially relevant (*M. truncatula*, *M. littoralis*, *M. polymorpha*) and minor (*M. tornata*) species were identified with 20-30% additional biomass compared to control varieties. Accessions of bladder clover (*T. spumosum*) were identified with biomass levels similar to current medic varieties but with earlier flowering and higher seed production in dry conditions. Lucerne survived for three years (2022-2025) under decile 5.4 (215 mm), 1.5 (129 mm) and 0.7 (100 mm) GSR respectively at the Black Rock site, albeit with low final density. At Palmer and Meningie sites, lucerne was very persistent and extended the growing season to provide high quality feed at the beginning and end of season. Lucerne wild relatives survived for eight years at Meningie and outperformed commercial varieties for persistence following two years of drought.

Discussion We demonstrate the successful use of new online database searching tools at Genesys-PGR and the APG to enable the identification of climate-adapted plants with superior performance to local cultivars in low rainfall environments affected by drought in South Australia. The results may also provide insights into what pasture legumes are adapted to current medium rainfall environments under future climate scenarios. The legumes evaluated in this study have high ME >10 (MJ ME/kg DM) and crude protein content of 15-20% to support active liveweight gain in sheep and cattle. For Black Rock, the annual legumes regenerated in 2025 following two low rainfall years where no seed was set, providing a resilient feedbase option compared to the herbaceous perennial legume lucerne, which does not recruit well from seed. At Palmer, both annual pastures and lucerne provide different options for livestock production that can be tailored to meet farming system needs. The 20-30% additional biomass from annual medic provides higher intake for livestock and nitrogen fixation to benefit cereal crops grown in rotation with the pasture. The long-term persistence of lucerne at Meningie under grazing during drought provides evidence for the resilience of perennial lucerne in a low-medium rainfall livestock production system. Lucerne wild relatives outperformed commercial varieties for persistence, showing potential for introgression of climate-adaptation traits into the breeding program to improve drought tolerance and livestock production.

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Association between sheep activity and heat-load related parameters

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Introduction Identifying methods to remotely measure sheep activity in grazing conditions is important for identifying best management practices that support sheep welfare and productivity, particularly during climate extremes where the flock are exposed to more stressors. Animals respond to environmental stressors, such as increased heat exposure, in various ways, for example, by reducing their feed intake (McManus *et al.* 2020) or changing their behaviour such as increased resting (Lovarelli *et al.* 2024). With the innovation of sensor technologies, it is now more practical to continuously monitor animal behaviours – such as sheep activity – in response to heat-load (HL) indices. It was hypothesised that remote sensors can reliably monitor sheep activity and detect changes due to heat exposure.

Materials and methods Twenty 1.5-year-old Merino sheep (51.0 ± 6.2 kg) were equipped with ActiGraph devices to collect overall activity, measured as vector magnitude count (VMC), and three Kestrel devices (5400 Cattle Heat Stress Trackers) were installed across the paddock to monitor weather conditions. The experiment was conducted at CSIRO Chiswick Research Station (Armidale, NSW, Australia). For 14 days experiment, daytime temperatures (Temp; 6 am–8 pm) mostly stayed within the sheep comfort range (12.7 – 25.4 °C) with daily maximum averaging 25.4 ± 2.1 °C (22.6 – 30.3 °C), while relative humidity (RH) exceeded it. Therefore, the Temperature-Humidity Index (THI) and the Heat Load Index (HLI) were used to assess HL based on the definition by Bhatishwar *et al.* 2023, and days were classified into no (NHL), mild (MHL), and moderate to high heat stress (HHL). Daily activity patterns were estimated, and the association with heat-related parameters is then evaluated. A linear mixed-effects model (LMER) was also fitted using the lme4 package in R to assess the effect of HL on activity, with random effect of animal to account for repeated measurements.

Results Two peaks in activity were observed, one in the morning and another in the afternoon, whereas the peak values of HLI and temperature occurred around noon while animals rest (Figure 1A). Activity was negatively correlated with heat-related indices; however, this correlation was not statistically significant across the entire dataset ($P > 0.05$; Figure 1B upper triangular). When considering only the daytime measurements, the correlation became stronger and significant ($P < 0.05$; Figure 1B lower triangular). Results of the LMER also showed a significant decrease ($P < 0.05$) in activity during the afternoon when animals experienced mild or HHS compared to NHL days; however, there were no significant differences between the two levels of HLI (Figure 1C) or across the entire period (data not shown).

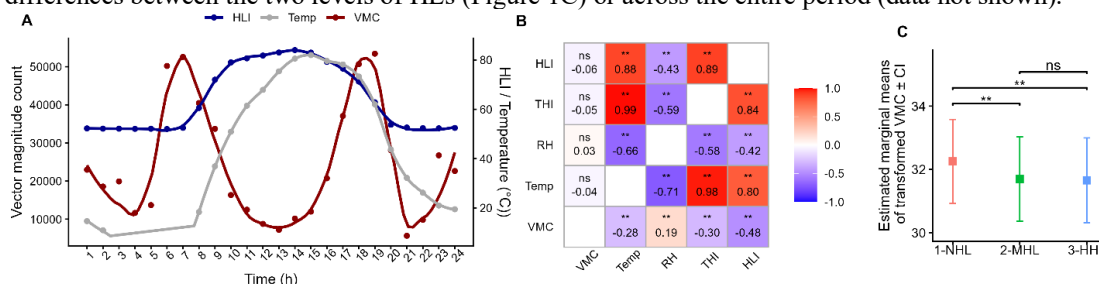


Figure 1. (A) 24-h pattern of sheep activity (group means) and weather parameters (averaged), (B) correlation of VMC and HL indices, and (C) effect of HL levels on VMC (statistical results). Note: Plot A: Temperature scaled to show pattern. Plot B: upper: all data; lower: daytime only. * = significant at $P < 0.05$, ** = significant at $P < 0.01$, ns = not significant, and CI = 95% confidence interval.

Discussion: Although the animals in this study were not exposed to severe heat load, the results indicate that even moderate heat load can negatively affect animal activity, consistent with previous reports on travelled less during hot days (Thomas *et al.* 2008) or change in behaviour in response to heat load (Lovarelli *et al.* 2024). Additionally, changes in sheep activity due to HL can be identified using remote sensors. Sheep may shift their activity from day to night, making circadian patterns helpful for identifying heat-stress impacts. In conclusion, behavioural changes in sheep can be detected even under moderate HL, showing the potential of wearable sensors to monitor small adverse environmental shifts.

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Identifying leverage points for building resilient animal-source food systems in Southern Africa through systems mapping

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Introduction Animal-source food (ASF) systems play a critical role in supporting nutrition, livelihoods, and economic development in Southern Africa (Mapiye *et al.*, 2020). However, they are increasingly challenged by climate variability, market instability, and structural inefficiencies undermining their ability to deliver sustainable nutrition and livelihoods. Understanding these complex and interrelated challenges requires approaches that take a holistic, systems thinking perspective. Systems mapping is one such approach that offers a holistic framework to understanding feedback loops, trade-offs, and cross-sectoral linkages that shape system behaviour (May *et al.*, 2025). This study aimed to apply systems mapping to ASF systems in South Africa (beef), Zimbabwe (poultry), and Malawi (dairy) to identify key leverage points for strengthening resilience. It was hypothesised that vulnerabilities and resilience pathways in ASF systems are shaped by reinforcing feedback loops across production, market, and policy domains, and that targeted interventions at key leverage points can generate system-wide improvements.

Materials and methods A qualitative systems mapping approach was applied across three country case studies. Data were derived from literature review, expert consultations, and iterative team-based synthesis processes. Causal loop diagrams (CLDs) were developed using Vensim PLE software to represent key system variables, interactions, and feedback mechanisms. Variables were categorised across production, environmental, institutional, and market domains. Relationships were defined using causal polarity (+/-) and feedback loops classified as reinforcing or balancing. Cross-case analysis was conducted to identify common system structures, validate relationships through literature triangulation, and detect high-impact leverage points for intervention.

Results Across all case studies, ASF systems exhibited complex, non-linear dynamics characterised by multiple reinforcing and balancing feedback loops. Key reinforcing loops were identified linking input costs, productivity, and income, often exacerbating system vulnerability under stress conditions such as drought or disease outbreaks. Market access, feed availability, and veterinary services emerged as central nodes influencing system performance. Climate variability acted as a cross-cutting driver, intensifying feed constraints and production risks. Despite contextual differences, common leverage points were identified, including improving access to quality inputs, strengthening veterinary and extension services, enhancing market integration, and increasing policy coordination. These leverage points demonstrated potential to shift system behaviour towards improved resilience and stability.

Discussion This study demonstrated the value of systems mapping in uncovering the underlying structures driving ASF system performance and resilience. By identifying feedback loops and leverage points, the approach moves beyond linear problem analysis to reveal opportunities for high-impact, integrated interventions. The findings highlight the importance of coordinated actions across production, market, and policy domains to avoid unintended consequences and maximise system-wide benefits. While the qualitative nature of the analysis limits quantification of intervention impacts, the triangulation of literature and expert knowledge strengthens confidence in the identified system dynamics. Future work should focus on quantifying these relationships and testing intervention scenarios. Overall, systems mapping provides a robust framework to guide evidence-based decision-making for building resilient ASF systems in Southern Africa.

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Understanding accumulated heat load and chill to manage animal welfare, health and productivity under variable climatic conditions.

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Introduction The Northern Australia Climate Program (NACP) develops and delivers practical, timely climate forecast products to support livestock welfare, productivity and informed decision-making in extensive grazing operations across northern Australia. The forecast services provided by NACP aim to enable the proactive management of thermal stress in grazing livestock systems.

Materials and methods Peer-to-peer NACP extension activities that focused on grazing management systems revealed that while acute heat stress is understood, the chronic effects of protracted heat load and chill conditions were not widely recognised or managed. This often compromises recovery and productivity and potentially exacerbates the impacts to animal health and welfare. To better understand chronic thermal load, it is important to understand key drivers that can lead to heat and chill stress, such as minimum temperature, relative humidity, and wind speed. NACP has established that many producers, veterinarians, and livestock handlers are unaware of how minimum temperature influences Accumulated Heat Load Unit (AHLU) and how chronic events can lead to poor welfare, health and productivity implications compared to acute events. Consecutive AHLU events, especially when animals are still recovering from a prior event, can significantly increase risk of morbidity and mortality. Similarly, the combination of cool day-time temperatures, heavy/sustained rainfall, and increased winds can lead to livestock chill, posing additional challenges for animal welfare in northern Australia.

Results To address these challenges, NACP developed prototype forecasts, integrating climatology while considering animal physiology. Research by Cowan et al. (2024) showed that cattle in northern Australia frequently face elevated thermal loads. Analysis of seven cattle mortality events identified key triggers that contribute to thermal stress including high relative humidity, low wind speed and high solar radiation. This led to the development of several Cattle Comfort Index (CCI) forecast products. The AHLU forecast quantifies cumulative thermal burden when the Heat Load Index (HLI) exceeds breed-specific thresholds. The AHLU risk categories are described as Moderate: 21-50, High: 51-100, and Extreme: >100. The Livestock Chill Index (LCI; kJ/m²/hour) estimates potential heat loss in sheep and cattle by factoring in ambient temperature, wind speed and rainfall for unsheltered livestock. Tropical and semi-arid Cattle breeds adapted to tropical and semi-arid conditions (e.g. Brahman and Droughtmaster), are likely to have a thermal chill tolerance similar to shorn sheep and lambs, unlike southern beef breeds with longer hair coats. A key strength of NACP is the integration of research, development, and extension (RD&E). Producer feedback has shaped forecast design, ensuring practical relevance and adoption potential. To support AHLU and LCI adoption, NACP delivered a targeted four-part webinar series, *Thriving Through Change: Manage Livestock Thermal Stress Before It Costs You*, featuring experts from The University of Queensland, University of Southern Queensland, and Feedworks P/L. Topics included drivers of AHLU and LCI, thermoregulation, animal health, genetic resilience, and practical mitigation and adaptation strategies for northern grazing systems. The series attracted 144 registrations from across northern Australia, North America and Indonesia, highlighting the global relevance of livestock thermal stress. Strong attendee engagement illustrated production challenges and clearly demonstrated stakeholder interest. Feedback provided by attendees was consistently positive. Polling captured management strategies that producers may adopt in the future. One family-owned grazing and feedlot operation has now added the webinar recordings to their staff training folder to build internal knowledge, demonstrating practical uptake and value.

Discussion Integrating climate and weather science with animal physiology and embedding it into RD&E improves decision-making and offers a pathway to climate-resilience and adaptation in livestock systems. Future research is required to refine thermal thresholds for grazing livestock, quantify welfare and productivity benefits, and explore multi-species applications, including domestic animals and native fauna. The work undertaken by NACP provides practical decision-support for producers, veterinarians, and industries to manage climate risks, productivity losses, and safeguard animal welfare under variable climatic conditions.

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Assessing climate effects on sheep liveweight using automatic weigh system technology

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Introduction Accurate monitoring of liveweight (LW) for individual animals is imperative for effective management of production, health and welfare within sheep enterprises. Unlike traditional static scales which require yarding and handling, remote and portable automated scales (AS) such as the Optiweigh® (OW), provide a practical solution for continuous monitoring through voluntary animal attendance (Hasan et al., 2024). However, accurate interpretation of automated LW data is challenging due to day-to-day variation in estimates of individual animal weight. Although AS units are designed for diverse climates, no prior studies have comprehensively accounted for rainfall-induced variability in LW trends due to fleece weight in sheep production systems. Addressing this gap is essential for obtaining accurate LW and average daily gain (ADG) data using AS units. This study tested the hypothesis that apparent LW changes in sheep is affected by environmental conditions (temperature, humidity, rainfall), with potential applications to improve the accuracy and utility of AS data.

Materials and methods This experiment was established at The University of Melbourne's Dookie Campus (Dookie; -36.39 °S, 145.72 °E). Average annual rainfall over 30 years (1995 – 2004) is 538 mm, with mean annual minimum and maximum temperatures of 8.7 and 22.4 °C, respectively (SILO Patched Point Data, site 81007). Data utilised in this study were recorded on two different dual purpose wheat paddocks of 0.35 ha each (26/6/25 – 31/7/25). During this period, 11 rising three-year-old Merino wethers (~9 months wool cover) were provided with voluntary access to the OW AS over a duration of eight days, and six of the same age wethers had access to the OW for a duration of 17 days. The OW contained a 1:1:1 ratio of magnesium oxide, salt, and lime, as an attractant. Weather data were from an onsite weather station and LW data were collated post the grazing period. Half hourly weather data were aggregated into two time periods, 'morning' (between 00:00 and 11:59) and 'afternoon' (between 12:00 and 23:59), to match OW data. A Generalized Additive Mixed Model (GAMM) was fitted to investigate the nonlinear effects of total rainfall (R), mean temperature (T), and mean humidity (H) on sheep LW, accounting for repeated measures by including individual wether identity as a random effect.

Results The model identified the predicted mean LW as 53.7 kg and saw a significant non-linear increase with T up to 10°C, then plateaued or declined ($P < 0.001$). High H values ($> 90\%$) were associated with increases in LW ($P = 0.026$), whilst R did not show a significant effect on LW ($P = 0.683$). Random effect variance components revealed considerable individual wether variability in baseline LW (SD = 2.57), which the GAMM incorporated to control for within-subject correlations. Residual variance remained moderate (SD = 1.44), suggesting additional unexplained factors not modelled here affect LW.

Discussion The significant effects of T and H in the model correspond with the sheep chill index, highlighting their role in influencing LW variation. The study period included more cool mornings ($< 10\text{ °C}$) than rainfall events (~13 out of 38 days), as such it is likely that moisture from dew or sustained humidity (potentially exacerbating wet wool conditions) had a greater impact on weight than R alone. Additionally, steady LW gains whilst grazing crops likely obscured acute rainfall effects. While the current modelled data provides valuable insights, limitations include the infrequency of rainfall events recorded, thus constraining current modelling efforts for robust detection of R's short-term impacts on LW gain. Future studies with longer grazing durations and more frequent R events are needed to clarify R influence in variation on wet wool from true LW gain. Frequent LW measurements offer valuable insights into ADG patterns to enable evaluation of individual growth efficiency, allowing for timely management decisions, such as nutritional adjustment, paddock rotations, or culling poor performers (Hasan et al., 2024).

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Evaluation of protein fractionations of two recognised and two novel tropical legumes for the seasonally dry tropics of northern Australia

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Introduction Tropical legumes represent valuable protein sources in ruminant feeding systems, particularly within northern Australian grazing environments. However, variations in the solubility and degradability of legume protein fractions can influence their nutritional efficiency and nitrogen utilisation in the rumen (Tunkala et al., 2023). The aim of this study was to compare the crude protein (CP) characteristics and rumen degradability profiles of two well recognised tropical legumes (*Leucaena leucocephala* cv. Redlands, *Stylosanthes viscosa* cv. JCU Vs1) and two lesser-known tropical legumes (*Cajanus cajan* CG1, *Vigna lanceolata* BL).

Materials and methods The plants were cultivated at James Cook University (JCU) Townsville, north Queensland and harvested in a vegetative early flowering stage of growth. Crude protein was determined using the Dumas combustion method (AOAC 990.03; 2000), while the partitioning of nitrogen fractions followed standardised Australian Feed Industry Association laboratory protocol at the DPI NSW (Wagga Wagga) laboratory. Protein fractions quantified were non-protein nitrogen (NPN), which is immediately available nitrogen not bound as true protein. True soluble protein (TSP) represents rapidly degradable protein that dissolves in buffer. Neutral detergent-insoluble crude protein (NDICP) reflects fibre-bound protein that degrades slowly. Acid detergent-insoluble crude protein (ADICP) represents lignin or heat-damaged protein that is largely indigestible. Buffer-insoluble crude protein (BICP) is resistant to solubilisation and contributes to the undegradable pool. Rumen-degradable protein (RDP), undegradable protein (RUP), and metabolizable and digestible protein values were estimated from those fractions.

Results *Leucaena leucocephala* exhibited the highest CP concentration (20.8%), followed by *Cajanus cajan* (17.2%), *Vigna lanceolata* (13.3%), and *Stylosanthes viscosa* (12.6%) (Table 1). *Leucaena leucocephala* demonstrated greater TSP and a relatively high rumen degradable fraction, suggesting greater ruminal availability. In contrast, *Cajanus cajan* contained negligible soluble protein but highest NDICP and ADICP, indicating a more slowly degradable nitrogen pool. The buffer-insoluble protein proportion was highest in *Cajanus cajan* (14.0%), aligning with its elevated RUP (4.3%). Across species, ADICP (representing the unavailable nitrogen) remained relatively low (1.14–1.61%), implying limited heat damage or lignification of proteins.

Table 1. Crude protein characteristics and rumen degradability profiles of the four tropical legumes analysed.

Legumes	CP (%)	NPN (%)	TSP (%)	NDICP (%)	ADICP (%)	BICP (%)	RDP (%)	RUP (%)	MP (%)	DP (%)
<i>Leucaena leucocephala</i> cv. Redlands	20.8	4.2	4.8	3.5	1.3	11.8	17.2	3.6	19.6	2.3
<i>Stylosanthes viscosa</i> cv. JCU Vs1	12.6	2.2	0.0	2.9	1.2	10.7	9.5	3.2	11.6	2.1
<i>Cajanus cajan</i> CG1	17.2	3.3	0.0	4.1	1.6	14.0	12.9	4.3	15.7	2.6
<i>Vigna lanceolata</i> BL	13.3	3.3	0.9	3.6	1.4	9.2	9.6	3.7	11.9	2.3

CP: Crude protein; NPN: Non-protein nitrogen; TSP: True soluble protein; NDICP: Neutral detergent insoluble CP; ADICP: Acid detergent insoluble CP; BICP: Buffer insoluble CP; ME: Metabolisable protein; DE: Digestible protein

Discussion The results confirm the hypothesis that substantial variation exists in protein fractionation among tropical legumes, with important implications for grazing system design. *Leucaena leucocephala* demonstrated superior protein concentration and ruminal degradability, supporting its established role as a high-quality protein supplement for northern Australian beef production systems. Conversely, *Cajanus cajan* with a greater undegradable protein fraction, may provide a complementary nitrogen source that moderates rapid rumen ammonia release when included in mixed-legume pastures. *Stylosanthes viscosa* and *Vigna lanceolata* were intermediate in CP and degradability. These findings provide practical information for producers seeking to optimise pasture composition to improve nitrogen-use efficiency, reduce urinary nitrogen losses, and enhance animal productivity in seasonally dry tropical environments. Strategic inclusion of legumes with contrasting protein degradation profiles may improve rumen function and overall system performance.

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Effect of melatonin on semen quality in Merino rams under summer heat conditions

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Introduction Heat stress in sheep can occur when the ambient temperature exceeds 25°C. To ensure optimal spermatogenesis the testes need to be 4 – 5 oC cooler than normal body temperature, and scrotal temperature is particularly vulnerable to changes in ambient temperature. An increase in scrotal temperature can result in germ cell apoptosis, DNA damage, and structural abnormalities (Rathore 1969) resulting in reduced sperm quality. Supplementation with melatonin has thought to prevent the damages associated with heat stress due to its strong antioxidant properties (Saarela and Reiter 1994); leading to the hypothesis that an increase in melatonin will protect ram semen from oxidative stress during heat events and therefore improve semen quality parameters. The objective of this trial was to determine the impact of melatonin treatment (0 versus 3 implants) on semen quality in Merino rams during the summer period.

Materials and methods This trial was run at the Roseworthy Campus, University of Adelaide, South Australia, Australia, across 2 consecutive summers (2022/2023 and 2023/2024). In Year 1 (n = 20) and Year 2 (n = 17) rams, aged 2–4 years, were randomly allocated into 1 of 2 treatment groups; control: receiving no treatment, or melatonin: receiving 3 Regulin® (Regulin®, Ceva Animal Health Pty Ltd, Glenorie, New South Wales, Australia) implants behind the ear, as directed by the manufacturer. Over the summer period, semen was collected fortnightly using an artificial vagina starting in December for a total of 8 collections. Ejaculate volume (mL) was measured visually, wave motion was visually assessed under a phase-contrast microscope at 10x magnification, sperm concentration ($\times 10^6$ sperm/mL) was determined using a compact photometer calibrated for ovine semen (SDM 1; Minitube, Germany), live sperm was determined by a eosin-nigrosin stain (Minitube, Germany), and motility assessment analysed using a mobile CASA (mCASA; iSperm, Aidmics Biotechnology Co.). Semen was collected, and analysed, from a 1st and 2nd ejaculate where possible. Data were analysed using SPSS and a general linear model ANOVA test.

Results Supplementation of rams with 3 Regulin® implants significantly improved semen quality when collected during the summer and early autumn months (December through March) across 2 consecutive years (2022/23 and 2023/24). Percentage of live sperm, total motility, and progressive motility, overall ejaculate volume and wave motion were all increased in the rams treated with melatonin ($P < 0.01$; Table 1).

Table 1. Impact of three Melatonin (Regulin®) implants on semen characteristics of rams during summer of 2022 / 2023 and 2023 / 2024.

	Control	Melatonin
Concentration ($\times 10^6$)	4356 $\pm$ 37.05	4442 $\pm$ 37.51
Ejaculate volume, mL	1.25 $\pm$ 0.026a	1.36 $\pm$ 0.026b
Live Sperm (%)	80.98 $\pm$ 1.003a	85.53 $\pm$ 1.027b
Total Motility (%)	66.3 $\pm$ 1.13a	72.2 $\pm$ 1.31b
Progressive Motility (%)	52.88 $\pm$ 1.28a	57.69 $\pm$ 1.16b
Wave motion (0-5)	2.77 $\pm$ 0.06a	3.10 $\pm$ 0.06b

Within row, different superscripts indicate differences; $P < 0.01$

Discussion This study found that there was a significant link between supplementation of rams with melatonin and semen quality. It was concluded that melatonin supplementation in rams can improve a range of semen quality parameters which are linked to an increase in reproductive performance in rams. These results are beneficial to the sheep industry as it offers a method to improve semen quality and therefore reproductive output in rams during times of heat and for mating in the summer period.

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Producer perspectives on buffalo fly management: Insights from an Australian survey.

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Introduction Buffalo fly (BF) (*Haematobia exigua*) is regarded as the most economically significant disease impacting the Australian cattle industry, with annual losses estimated at over \$170 million through reduced productivity, implementation of control measures, and treatment costs (Shephard *et al.* 2022). These small, hematophagous insects can inflict up to 40 bites per animal per day (James *et al.* 2021), concentrating on regions such as the neck, ventral region, shoulders, flanks, and periocular areas (Kettle 1985). The objective of this study was to investigate producer attitudes toward BF infestations, their impact on herd performance, seasonal timing, and available treatments. To address this, a national survey was conducted to capture producer experiences, attitudes, and feedback regarding current control measures. The survey explored key themes including infestation severity, timing of peak fly pressure, preferred treatment methods, estimated cost of treatment, and satisfaction with existing solutions, providing insights into barriers and opportunities for future innovation in BF management.

Materials and methods A questionnaire containing 22 questions using a combination of multiple-choice, Likert-scale and open-ended formats was designed and distributed electronically through SurveyMonkey™. A link to the survey and an introductory message were distributed through multiple channels, including social media, Meat and Livestock Australia promotional material, industry workshops, personal contacts and email distribution by other stakeholder organisations. Questions collected data on location, role in the industry, size of enterprise, impact and effects of BF, timing of BF infestation and changes in timing or severity. The survey also explored the current management strategies and products used, observations of reduced efficacy, utilisation of non-chemical approaches, annual spend and concerns over current practices. The survey remained open for 85 days (July 15th, 2025, to October 8th, 2025), with reminders circulated on the various promotional platforms to encourage participation during that period.

Results A total of 152 responses were received from across three Australian states; the Northern Territory, Queensland and New South Wales, the majority of which were from cattle owners/producers. The impact of BF on production systems was rated as significant or very significant by 65% of respondents, particularly by those in the Northern Territory, and in northern Queensland. Over 70% of producers reported a difference in BF numbers and timing in the past 2 years, with reports of BF emerging earlier, persisting for longer and in greater numbers. The overwhelming majority (94%) had treated cattle for BF in the past 12 months, with most following a pre-determined management strategy. Estimated annual expenditure on BF control varied considerably depending on herd size. For producers managing 0-50 head of cattle, the average cost was \$21.10 per head (range \$1.60-\$60.00), whereas producers running more than 5,000 head reported an average cost of \$3.34 per head (range \$0.20-\$10.00). While per-head costs decreased with increasing herd size, total enterprise-level expenditure remained substantial. The most popular treatment formulations were insecticidal ear tags and backliners, with sprays and back rubbers also frequently used. Other control methods listed included licks, dung beetles, walk through traps and adapting genetics. Over 50% of respondents indicated that they had used non-chemical methods (including: back rubs with repellents, fly traps and dung beetles) in attempts to control BF on their cattle. A total of 52% of producers reported observing reduced efficacy of products over time, reporting that chemical options are not working for the length of time claimed by manufacturers. In response to an open-ended question on key concerns (n=131), shortened duration of efficacy was the most frequently reported frustration, followed by the increasing cost of treatment.

Discussion The results of the survey confirmed that producer attitudes toward BF infestations and satisfaction with current control measures vary across regions and enterprise types, indicating that local conditions influence management practices and perceived efficacy. Reports of earlier emergence, prolonged activity and increased BF numbers suggest climate variability and geographic spread are intensifying the challenge. The deregistration of diazinon has removed a commonly used control option, exacerbating difficulties for producers already facing declining performance of remaining chemical treatments. Reliance on chemical treatments, combined with dissatisfaction over reduced product performance, indicates vulnerability in current management strategies and a strong need for alternative approaches. Encouragingly, the use of non-chemical methods indicates growing interest in diversified management, presenting opportunities for targeted extension and innovation. This was a voluntary survey, and the self-selection bias should be acknowledged, as producers with greater concern regarding BF may be overrepresented in the sample. Nevertheless, the findings emphasise the need for investment and research into resistance monitoring, development of novel control methods, and delivery of regionally tailored extension programs.

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Correlations between IgG and immune-related miRNAs in colostrum and calf blood

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Introduction Colostrum provides essential nutrients and immune protection to neonatal calves, which are born with very low circulating immunoglobulin levels (Godden *et al.* 2019). The transfer of passive immunity from colostrum to newborn calves is crucial for their survival during the first weeks of life (Godden I. 2019; Hue I. 2021). Most colostrum studies investigating calf immunity have focused on immunoglobulin G (IgG), however, little is known about the other immunologically important components, particularly miRNAs. This study investigated the correlations between IgG and immune-related miRNAs in colostrum in calf blood after colostrum ingestion.

Materials and methods A total of 35 Holstein bull calves were fed colostrum from different sources. Each calf had blood samples collected before (day 0) and after colostrum was fed (days 1, 2, 3 and 7). Colostrum (from 12 different cows) and the calf blood ($n = 35$) were analysed for some immune components. Total solids (Brix%) in colostrum was measured by Brix refractometer, total protein in calf blood was measured by serum refractometer, total protein in colostrum was quantified by Bradford assay, IgG was quantified by ELISA, and selected immune-related miRNAs (miR-142-5p, miR-155, and miR-223) were quantified by RT-qPCR using TaqMan assays. The data were analysed using R version 4.4.3 and the correlation and p-value between a pair of parameters calculated using *cor.test* function with “Pearson” or “Spearman” methods.

Results In the colostrum, high correlations were found between total solids, total protein and IgG at days 0 and 1 ($P < 0.05$) (Table 1). In addition, IgG levels in the colostrum were correlated with miR-155 concentrations at both day 0 and day 1 ($P < 0.05$). Some pairs of immune-related miRNAs were also significantly correlated on day 0 (miR-142-5p & miR-155; miR-142-5p & miR-223; and miR-155 & miR-223).

In the calf blood, there was a strong correlation between total protein and IgG at all time-points after feeding colostrum, but there were no correlations between IgG and tested immune-related miRNAs (Table 1). However, some correlations between pairs of tested immune-related miRNAs were found in the calf blood, particularly miR-155 and miR-223 at all time-points.

Table 1. Correlations between components in colostrum and calf blood

Variable 1	Variable 2	Colostrum ($n = 12$)		Calf blood ($n = 35$)				
		Day 0	Day 1	Day 0	Day 1	Day 2	Day 3	Day 7
IgG	Total solids	0.80*	0.60*	-	-	-	-	-
IgG	Total protein	0.69*	0.76*	0.12	0.68*	0.70*	0.86*	0.69*
IgG	miR-142-5p	0.48	0.11	-0.07	-0.02	-0.06	-0.05	0.13
IgG	miR-155	0.68*	0.70*	0.01	-0.09	-0.01	-0.06	-0.24
IgG	miR-223	0.26	0.26	-0.11	0.04	-0.09	-0.18	0.06
miR-142-5p	miR-155	0.76*	0.27	0.08	0.15	0.64*	0.73*	0.66*
miR-142-5p	miR-223	0.80*	0.43	0.21	0.07	0.78*	0.57*	0.64*
miR-155	miR-223	0.66*	0.40	0.81*	0.35*	0.56*	0.47*	0.61*

* $P < 0.05$

Discussion. In the calf blood, IgG was very low at birth (0.3 g/L) but was increased in calf blood after colostrum feeding and was still high level until day 7 (26.5 g/L). IgG and total protein were statistically correlated at all time-points in the calf blood after feeding colostrum, but there was no correlation between IgG level and any tested immune-related miRNAs in the calf blood at any time-point. This indicates that unlike IgG, miRNAs may not be transferred from the colostrum. However, pairs of immune-related miRNAs were significantly correlated in both colostrum and calf blood (e.g. miRNA-155 and miR-223), suggesting they may share a role in the immune function. High correlations between total protein by serum refractometer and IgG in calf blood validates that refractometer is good practical tool to estimate passive transfer in calf blood even 7 days after birth.

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Supplementation with a Specific Yeast Cell Wall Limits Intestinal Damage during a Coccidiosis Challenge

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Introduction Coccidiosis, caused by *Eimeria* spp., is a major challenge in poultry production, leading to gut inflammation, impaired performance, and economic losses (Bafundo, 2025). Subclinical coccidiosis challenges can have significant impacts on commercial broiler performance, especially as use of in-feed antibiotics to limit impact is reducing (Taylor *et al.* 2022). Recent studies on a specific yeast cell wall product have suggested a non-antibiotic, in-feed method for reducing the risk of intestinal damage from coccidiosis. These studies show key mechanistic benefits such as increased goblet cells, spleen weight, monocyte activation and villus height to crypt depth ratio (pers. Comm, 2025). The objective of this study was to evaluate the effect of supplementation with a specific yeast cell wall on gut integrity and parasite excretion in broilers under experimental coccidiosis challenge.

Materials and methods A 20-day trial was conducted at Southern Poultry Feed and Research (USA, 2024) using day-old Cobb 500 male broilers (8 birds/cage; 10 cages/group). Birds were allocated to three treatments: (1) Negative control (uninfected), (2) Positive control (infected), and (3) Yeast Cell Wall (YCW) group (infected + YCW at 1 kg/t feed). On day 14, challenged birds received a mixed oral inoculation of *E. acervulina* (100,000 oocysts), *E. maxima* (50,000), and *E. tenella* (75,000). Performance parameters, lesion scores, and oocyst shedding were assessed.

Results YCW supplementation reduced total oocyst excretion by **27%** compared to positive control, similar to the reduction observed in previous studies with salinomycin (-21%). Species-specific reductions were -83% (*E. maxima*) and -30% (*E. tenella*). Lesion scores decreased by up to **29%** in the middle intestine and ceca. Gut integrity improvements were comparable to those achieved with salinomycin in previous studies. Zootechnical benefits included improved average daily gain (+5.7%), carcass yield (+6.8%), and reduced mortality (-52%).

Discussion Supplementation with the specific YCW mitigated intestinal damage and parasite excretion during a coccidiosis challenge, supporting gut health and performance in broilers. These findings suggest the specific YCW as a valuable nutritional strategy to enhance resilience under enteric stress.

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Effect of CLOSTAT 500 (*Bacillus subtilis* PB6) on performance, carcass characteristics, and health of Australian feedlot cattle

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Introduction Bovine respiratory disease (BRD) remains the leading cause of morbidity and mortality in feedlot cattle, resulting in economic losses to the beef industry. Studies comparing BRD-treated and untreated cattle have reported differences in net returns, primarily due to reduced performance, poorer carcass quality, and increased mortality (Holland *et al.* 2010; Blakebrough-Hall *et al.* 2020). Implementing strategies to reduce BRD morbidity is therefore critical for improving animal health and profitability in feedlots. Previous studies evaluating a commercially available nutraceutical containing a proprietary strain of *Bacillus subtilis* PB6 have reported a 29% reduction in BRD morbidity in supplemented cattle compared with controls (Word *et al.* 2022). The objective of this study was to evaluate the effect of *Bacillus subtilis* PB6 on cattle health, productivity, and carcass characteristics in a commercial Australian feedlot.

Material and methods This study was conducted in a commercial feedlot with a one-time capacity of 50,000 head located in Queensland, Australia. A total of 8,332 Angus cattle were utilised in a randomised complete block design containing 16 replicates. Upon feedlot arrival, cattle (479.56 ± 18.51 kg) were randomised by vendor and assigned to one of two dietary treatments: 1) no supplemental dietary direct-fed microbial (CON), and 2) 0.5 g/animal.day of *Bacillus subtilis* PB6, CLOSTAT 500 (CLO) from d11 to harvest (approximately 105 d).

Results Performance characteristics including final body weight, average daily gain, and feed efficiency were not different between groups, with or without the inclusion of dead and cull cattle in the analyses ($P \geq 0.16$). No significant difference was found in the mortality rate between groups (CON= 0.34% vs. CLO= 0.48%; $P = 0.29$). Overall hospital treatment rate was similar between CON and CLO (12.61 vs. 13.51%, respectively; $P = 0.39$). Across the entirety of the study, there was no significant difference in the overall probability of BRD treatment between groups ($P = 0.23$). However, there was a treatment $\times$ week interaction ($P = 0.0003$) for the probability of BRD treatment, with the CLO exhibiting a lower probability of BRD treatment during week 3 (CLO= 0.57% vs. CON= 1.83%; Figure 1). Carcass traits, including HSCWT (CON = 373.31 kg vs. CLO = 373.85 kg), AUS-marbling (CON = 2.24 vs. CLO = 2.28), P8 fat (CON = 16.03 mm vs. CLO = 16.09 mm), rib fat (CON = 12.03 mm vs. CLO = 11.94 mm), eye muscle area (CON = 79.02 mm vs. CLO = 79.30 mm), and dressing percentage (CON = 55.93% vs. CLO = 55.94%) were similar between treatment groups ($P \geq 0.11$). Regardless of treatment, carcass traits including HSCWT, AUS-marbling, P8 fat, and eye muscle area were significantly affected by BRD treatment ($P \leq 0.04$).

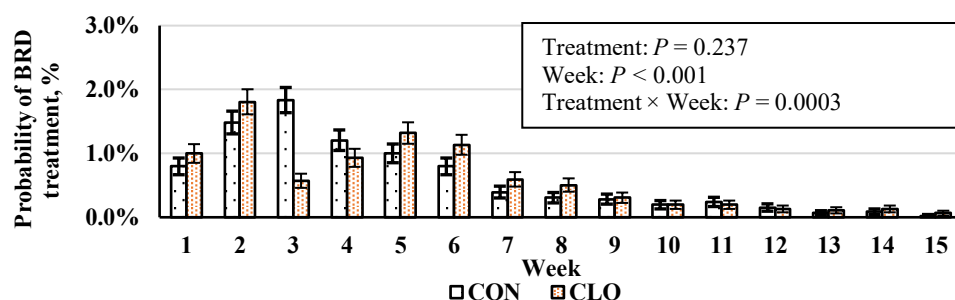


Figure 1. Probability of bovine respiratory disease (BRD) treatment measured weekly throughout the feeding period on a large commercial feedlot in Queensland, Australia. Dietary treatment groups consisted of animals supplemented or not with 0.5g per head per day of *Bacillus subtilis* PB6 (CLOSTAT 500, Kemin Industries, Des Moines, IA) in the finishing ration for approximately 105 d.

Discussion The results of this study indicate that supplementation of feedlot cattle with CLO for approximately 105 d did not affect growth performance, mortality, or carcass characteristics. However, a treatment $\times$ week interaction was found for the probability of BRD treatment, with supplemented cattle showing a lower probability of treatment during week 3 of the feeding period. This period typically corresponds to the early adaptation phase after feedlot induction, when cattle are more susceptible to respiratory disease. These results suggest that *Bacillus subtilis* PB6 supplementation may provide a health benefit during periods of increased BRD risk.

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Bloat Alert: What did we learn from making this app available to Australian producers for four years?

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Introduction Frothy or pasture bloat remains a key disease impacting Australian beef production (Shephard *et al.* 2022). In July 2021 the Bloat Alert app was launched to allow producers to anonymously report cases of bloat on their farm, benefiting industry by notifying other farmers in the district who had subscribed to the free app that cases were occurring locally, and allowing data to be gathered on the circumstances where bloat was occurring for industry to better understand the circumstances and causes (Allworth *et al.* 2022).

Materials and methods In November 2025 the anonymous data input into the app by farmers was downloaded into an Excel spreadsheet. Four entries were removed after being identified as test submissions or duplicates. Descriptive statistics were used to gain insight into the occurrence of bloat during the 4+ years that the app has been available.

Results and discussion There have been 472 subscribers to the app across Apple and Android platforms. Ninety-two reports were submitted from 51 separate reporters (farmers) with the date range of incidents being 5th July 2021 to 29th October 2025. The majority of reports were in NSW (88%; n=81) with 10 in Victoria and a single report from SA. There did appear to be some trends and clusters regarding timing and districts for when bloat occurred and seasonal conditions, although these have not yet been analysed in detail. The two most frequent reporters submitted n=11 and n=7 reports respectively, with both based in southern NSW. The number of animals affected per report ranged from n=1-20 with mob size n=4-3353 head and percentage of mob affected 0.3-28.6%. Of the 92 reports submitted, the majority (74%; n=68) were related to mortalities, involving a total of 112 animals. The remaining 24 reports were of non-fatal bloat, affecting 80 animals. Most farmers reported that the affected animals were young, with 53% (n=49) reporting affected animals were aged 1-2 years and 13% (n=12) less than 1 year old. There were also 27 reports of animals older than 2 years old and 4 reports of mixed age-groups. Steers (n=34) were the most frequently reported category, followed by heifers (n=25), cows (n=20) and bulls (n=4).

The comments provided by producers were insightful, with most sharing information on pasture types and bloat prevention methods used. Most respondents indicated they were quite confident that bloat was the cause of illness or death, with confidence levels using the slide tool ranging from 30% to 100% (median = 90%; N.B. Default was 80%). A high proportion of reporters (45%; n=41) stated they were 100% confident that bloat was the cause. The two lowest confidence reports commented “*Suspect bloat but no evidence. No other animals in mob seem affected. Previously reported non-fatal cases in this mob but had been no sign of bloat for several weeks.*” and the second reported potential clostridial disease. The majority of reports were for cattle grazing a pasture that included clover (74%; n=68), with two listing the pasture as “mixed”, seven reported lucerne as a component of the pasture, seven included medics as a component and 11 as a native pasture or native with other species. There were single reports for cereals (with grain supplementation) and vetch respectively. The majority (57%; n=52) of reports identified they had not provided preventative measures to cattle prior to the case, and another two commented the bloat-prevention product may have run out prior to the case and one said the animals did not appear to be eating much of the preventative product. Preventative measures listed by respondents included hay/roughage, bloat block, Rumensin licks and bloat oil in water troughs. Two respondents who had identified preventative measures were used stated this was a 5in1 vaccination; this would not be effective against bloat but does reduce the likelihood that cause of death was due to a clostridial disease.

Discussions with producers and bloat-prevention product manufacturers and resellers in our network have identified that despite attempts to increase uptake in usage, many producers who are affected by bloat are not subscribing to or submitting incidents on the app.

Conclusion Data reported through the Bloat Alert app confirms that losses to bloat remain a problem for beef producers in Australia, particularly in NSW and Victoria. Not all producers are providing supplements to prevent bloat prior to cases occurring and this may explain some of the incidents that occurred. Efforts to increase market penetration are required to provide the best value to producers using the app.

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Effects of maternal gastrointestinal parasitism on growth of goat kids

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Introduction Goat production is rapidly expanding worldwide. In Australia, the farm-managed goat population increased by with an 82% between 2016 and 2020 (MLA, 2023). However, gastrointestinal nematodes (GINs) remain a major constraint reducing productivity, profitability, and animal welfare (Dey *et al.* 2020), with an annual cost of \$2.54 million in the Australian goat industry (Lane *et al.*, 2015). *Haemonchus contortus* and *Trichostrongylus colubriformis* are the main pathogenic species affecting small ruminants in tropical and subtropical regions (Corrêa *et al.*, 2021). Neonatal survival and early kid growth are key determinants of enterprise profitability, yet maternal parasitism may reduce colostrum quality, milk yield, and potentially impair offspring growth (Dwyer *et al.* 2016). This study investigated the impact of maternal GIN infection on kids' growth during lactation.

Material and methods Twenty twin-bearing two-year-old, Boer × Rangeland does (39.4 ± 1.66 kg BW), were dewormed with Startect® (Zoetis, Australia), and confirmed to have non-detectable faecal egg counts, under the approval from the University of Queensland Animal Ethics Committee (2023/AE000416). Animals were housed in individual pens and received a mixture of Lucerne hay, barley hay, and commercial lactating goat pellets (Riverina, Australia), formulated to meet maintenance requirements, with *ad lib* access to water at all times. Animals were blocked by body weight and randomly assigned to one of two treatment groups: 1) uninfected, or 2) infected. From eight weeks before expected parturition, infected does were trickle-infected orally with 1,500 *Haemonchus contortus* and 600 *Trichostrongylus colubriformis* infective larvae per week; controls received water only. Faecal egg counts were monitored weekly. On day 30 post-kidding, all does were dewormed and moved to pasture. Kids' birth weight (n=40; 17 males, 23 females), weekly weights until day 30, and final body weight at weaning (day 120 post-kidding) were recorded. Data were analysed using the MIXED procedure of SAS software (9.4 version, SAS Institute Inc., Cary, NC), including parasite infection, kid's sex, and their interaction as a fixed effect, and doe BW as a covariate.

Results Doe BW at kidding was not influenced by parasite infection ($P = 0.68$). Kid birth weights were unaffected by infection ($P=0.234$), sex ($P=0.331$), their interaction ($P=0.147$), and doe BW ($P=0.611$). By day 30 post-kidding, kids from infected does were 8.87% lighter ($P = 0.027$), resulting from an 11.1% lower average daily gain (ADG; $P= 0.078$), while kid sex had no effect ($P= 0.941$). A significant sex × infection interaction at day 120 indicated that parasite infection reduced ADG by 14.3% and BW by 15.26 in female kids ($P=0.048$), while males remained unaffected by infection. The effect of sex resulted in male kids having 17.29% higher ADG ($P=0.001$) at d 120. However, maternal infection had no overall impact on kid BW at day 120 post-kidding ($P=0.181$).

Discussion The lower BW of kids from GIN-infected does at day 30 is consistent with previous findings (Houdijk *et al.*, 2017) and may suggest that maternal infection affects kid growth through reduced milk yield or altered nutrient allocation. The significant sex × infection interaction at day 120 indicates that maternal GIN infection affected female and male kids differently: female offspring showed reduced ADG and BW, while males were unaffected, suggesting an early hormonal divergence emerging around 2-3 months (Tani *et al.*, 1992). The lower body condition score of infected does ($P<0.0001$) likely reduced milk production; although initially sufficient, it became inadequate as kid demand increased. Crucially, at day 30, before the postnatal testosterone surge in males, the effect of infection on kid BW was similar between sexes ($P= 0.722$). However, a subsequent androgen surge in males may have promoted muscle growth (Dellal & Polat, 2008), buffering this nutritional deficit after solid feed was consumed, leaving females, who lack this hormonal advantage, more sensitive to the nutritional deficits on day 120.

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Genetic parameters for saliva antibody tests against internal parasites in Merino sheep

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Introduction Parasitic worms in sheep harm their health and reduce meat and wool yields. Breeding for worm resistance offers a durable solution and helps prevent the development of worm resistance resulting from excessive drench use. The worm egg count (WEC) is a well-established trait for selection with low to moderate heritability ranging from 0.16 to 0.22 in Australian Merino sheep (Swan *et al.* 2016). High parasitic specific IgA responses have been consistently identified as a key mechanism in sheep developing natural immunity to worm infections. These animals have reduced number and size of adult worms which then produce less eggs (Hernández *et al.* 2016, Shaw *et al.* 2012, Stear *et al.* 1995). Two tests were developed to measure a mucosal IgA antibody response against parasitic larval stages of *Teladorsagia circumcincta*, *Haemonchus contortus*, and *Trichostrongylus* species using saliva. Test-A used a recombinant protein secreted by the worms as the antigen, while Test-B used a crude extract made from exsheathed stage three larvae (L3). Optimised enzyme-linked immunoassays (ELISA) were used to measure these responses. With the advancement of new technologies for estimating internal parasite load, it is crucial to assess the feasibility of developing breeding values for the industry. The aim of this study was to estimate genetic parameters for the saliva antibody tests against worms.

Materials and methods In total, 1,484 and 857 sheep had records for a recombinant protein internal parasite antibody test (Test-A) and a crude extract protein test (Test-B), respectively. Data management, quality control, normality test and transformations were conducted in Python v3.12. The Shapiro-Wilk test was conducted to assess the normality of the data. To address the right-skewed distribution, data transformation (including logarithmic, cube root, square root, and Box-Cox) and standardisation were performed. The optimal data transformation was assessed by comparing the coefficient of variation (CV) of the transformed means for each dataset and the Log-likelihood model fit from univariate analyses. A linear mixed animal model and Wald F statistic test ($P < 0.05$) were conducted in ASReml V4.2 (Gilmour *et al.* 2021). Various fixed effects were assessed, including birth type (BT), rear type (RT), age*sex interaction, age of dam, and contemporary groups (CG) defined by site, year of birth, sex, and month of measurement. The genetic groups and maternal genetic effects were assessed in the model by fitting them as random effects. The final model for Test-A included only CG, while the BT and age*sex interactions were also fitted for Test-B. The permanent environmental effect was included as a random effect only in Test-A.

Results The best data transformation was the cube root, which resulted in lower CV and higher Log-likelihood. Low to moderate heritabilities were observed in Test-A and Test-B. The highest value, with $h^2 = 0.396$, was observed in Test-A. Low genetic variances were observed for both traits, ranging from 0.014 to 0.019 for Test-A and Test-B, respectively. Genetic (0.96 ± 0.01) and phenotypic (0.83 ± 0.01) correlations between Test-A and Test-B were strong, suggesting that selection for Test-A would result in similar changes for Test-B. Although Test-A and Test-B have different targets, the high correlation between the tests is indicative of the overall measurement of the IgA antibody response against worms.

Table 1. Genetic parameters and heritability for parasite antibody test in Merino sheep

Trait	Vp	Vg	Ve	h ²
Test-A*	0.014(0.001)	0.006(0.001)	0.009(0.001)	0.396(0.045)
Test-B*	0.019(0.001)	0.002(0.001)	0.017(0.001)	0.123(0.058)

* Vp: phenotypic variance; Vg: genetic variance; Ve: error variance; h²: heritabilities

Discussion The low genetic variances reported in this study could indicate a high effect of environmental conditions or could be due to the magnitude of the measurement. Although the genetic variances were low, the moderate heritability indicates that a significant proportion of the observed variation is due to the additive genetic effect, suggesting that selection could be effective. Including additional records for both Test-A and Test-B will be crucial in refining the genetic parameters for these traits and assessing their correlation with other health and production characteristics.

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Rumen Microbiome Composition in Ewes Supplemented with SeaFeed™ Pellets and Rumen Modifiers

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Introduction Feed supplementation with *Asparagopsis* and bromoform (CHBr₃)-containing products, such as SeaFeed™ pellets (SFP), has emerged as a promising strategy to reduce enteric methane (CH₄) emissions in ruminant livestock. Although the anti-methanogenic efficacy of CHBr₃ is well established, comparatively little is known about its effects on rumen microbial community structure, particularly when this additive is supplemented in combination with rumen modifiers. Rumen modifiers, including *Ascophyllum nodosum* (ASCO), grape marc, and biochar, are commonly supplemented in ruminant diets to alter the rumen microbial ecosystem and improve animal health, feed efficiency, and decrease CH₄ production. The composition and function profiles of the enteric microbiome are critical for effective rumen manipulation with low-emissions feed additives. This study hypothesised that SFP would inhibit methanogenic archaea and core methanogenesis pathways, and that rumen modifiers would differentially modulate these responses through additive or antagonistic microbial interactions. Therefore, this study investigated the effects of SFP alone or combined with rumen modifiers on rumen microbial composition and functional pathways in ewes.

Materials and methods Eighteen Merino ewes (n = 3 per treatment) were randomly assigned to six dietary treatments during a 47-d feeding trial: control (no supplement), SFP-only, SFP + ASCO, SFP + grape marc, SFP + biochar, and SFP plus ASCO plus grape marc plus biochar (SFP + all suppl). Ewes had *ad libitum* access to fresh water and a total mixed ration consisting of a 75% forage to 25% concentrate ratio. The supplement components were fed as a loose mix, with the individual inclusion rates of up to 33.12 mg CHBr₃/head/d for SFP, 16 g/head/d ASCO, 140 g/head/d grape marc, and 17 g/head/d biochar, based on estimated daily dry matter intake (1600 g/head/d) observed during the acclimatisation period. At the end of the trial, rumen liquid samples were collected from the ewes and analysed using metagenomic sequencing. Sequencing was performed using the Illumina NovaSeq 6000 platform.

Results Supplementation with SFP and rumen modifiers was associated with shifts in microbial community structure, including reduced relative abundance of methanogenic archaea and increased representation of fibrolytic genera such as *Ruminococcus* and *Prevotella*. While alpha diversity remained stable, beta diversity showed distinct clustering among supplemented groups. Rumen microbial alpha diversity was evaluated using richness- and evenness-based indices, including observed species richness, Shannon diversity, and the Gini–Simpson index. Across all dietary treatments (Control, SFP, SFP + ASCO, SFP + grape marc, SFP + biochar, and SFP + all supplements), no significant differences in alpha diversity were detected, as determined by Kruskal–Wallis tests (Gini–Simpson: $p = 0.494$; observed species richness: $p = 0.260$; Shannon: $p = 0.286$). Principal coordinate analysis (PCoA) based on Bray–Curtis, weighted UniFrac, and unweighted UniFrac distances revealed treatment-dependent differences in microbial community structure that were metric-specific. Bray–Curtis (PCoA1: 24.2%) and weighted UniFrac (PCoA1: 39.1%) ordinations showed substantial overlap among treatments, with PERMANOVA indicating no significant treatment effect (Bray–Curtis: $R^2 = 0.314$, $p = 0.272$; weighted UniFrac: $R^2 = 0.346$, $p = 0.203$), suggesting limited influence of treatments on community composition and abundance-weighted phylogenetic structure. In contrast, unweighted UniFrac analysis demonstrated a clear and significant separation among treatments (PCoA1: 17.9%; $R^2 = 0.369$, $p = 0.007$), indicating that treatments primarily altered the presence or absence of phylogenetically distinct taxa rather than reshaping the relative abundance of dominant lineages. In addition, functional pathway analysis revealed a decreased in the abundance of the hydrogenotrophic methanogenesis pathway in all supplemented groups compared with the control. The strongest suppression occurred with the SFP-only treatment (63% reduction), followed by SFP with all co-supplements (41%), and SFP supplemented with ASCO (32%). In contrast, the SFP + grape marc and SFP + biochar treatments showed increased methanogenesis pathway abundance compared to the other supplemented groups, which coincided with higher methanogenic archaeal levels in these two groups.

Discussion This is the first study to examine rumen microbiome composition in animals fed SFP with rumen modifiers (ASCO, GM, biochar) in a high-forage ration. The alpha- and beta-diversity patterns observed in this study indicate that dietary treatments influenced rumen microbial community membership rather than inducing large-scale restructuring of dominant taxa, as evidenced by the significant separation detected only with unweighted UniFrac. The strongest reduction in the methanogenesis pathway occurred with SFP alone and SFP + all supplements, whereas co-supplementation with grape marc or biochar showed attenuated effects, possibly due to antagonistic interactions between bioactive compounds that may instead stimulate archaeal methanogenesis. These differences highlight the importance of additive interactions in modulating methanogenic activity *in vivo*. These findings suggest that feed additive combinations, such as a CHBr₃-containing CH₄ inhibitor and a rumen modifier, can influence the rumen microbiome through targeted functional or compositional modulation, potentially affecting fermentation outcomes and CH₄ emissions. Overall, these results indicate the potential efficacy of targeted SFP and rumen modifier combinations. However, due to the limited sample size (n = 3 per treatment), the findings should be interpreted with caution and require validation in larger cohorts.

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Effect of bromoform and phytogetic compound on growth performance and greenhouse gas emissions of grassfed Angus steers during the finishing phase

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Introduction Bromoform extracted from red seaweed *Asparagopsis* species has been shown to have potent methane-mitigating potential. Similarly, the phytogetic compound Activo Premium has antimethanogenic and antioxidant properties that can improve rumen function and animal productivity. While several studies have examined the effects of bromoform, understanding of its interactions with phytogetic compounds remains limited. The study aims to evaluate the impact of a combination of bromoform and a phytogetic compound on growth performance and greenhouse gas emissions of grass-fed Angus steers during the finishing phase.

Materials and Methods A total of twenty-one Angus steers were assigned to two treatment groups: a control group (n = 11) and a combined bromoform-phytogetic product group (BPhy; n = 10). The BPhy group received 0.51 mg/kg body weight of bromoform and 3 g of the phytogetic compound. Supplementation was given for 5 weeks, during which body weights were monitored, and greenhouse gas emissions were measured using GreenFeed systems.

Results Methane emissions were reduced by 34 % ($P < 0.001$) and hydrogen emissions were increased by 62 folds when animals were supplemented BPhy compared to the control group ($P < 0.001$). There was no significant difference between the treatment groups for growth performance. These findings indicate that the inclusion of bromoform with Activo Premium was well tolerated and had no detrimental impact on animal productivity.

Table 1. Gas emissions from Angus finishing cattle steers supplemented with Bromoform and phytogetic products.

Parameter	Supplement			Week				
	CON	BPhy	P-value	1	2	3	4	5
Hydrogen (g/day)	0.5 ± 2.6	31.0 ± 2.5	<0.001	19.4 ± 2.2	15.5 ± 2.2	13.4 ± 2.6	15.0 ± 2.2	15.5 ± 2.2
Methane (g/day)	232.6 ± 9.5	153.7 ± 9.3	<0.001	194.9 ± 7.7	194.3 ± 7.7	187.5 ± 8.7	194.4 ± 7.8	194.5 ± 7.0
Carbon dioxide (g/day)	7549.1 ± 166.7	7657.8 ± 170.0	0.654	7608.2 ± 128.0 ^b	7577.7 ± 128.7 ^b	7304.8 ± 138.3 ^a	7642.8 ± 128.9 ^b	7883.7 ± 128

Discussion: Bromoform combined with phytogetic compound reduced methane emissions without any adverse effects on growth performance of grassfed steers. This result is consistent with previous studies showing that moderate bromoform inclusion can reduce methane emissions without compromising feed intake, rumen function, or weight gain (Black et al., 2021). Bromoform exerts its antimethanogenic action by halogenating and inactivating methyl-coenzyme M reductase (Mcr), a key enzyme in the methanogenic pathway of archaea (Glasson et al., 2022).

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The importance of defining methane phenotypes and time windows using Arcoflex sensors in dairy cows

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Introduction Sniffer sensors in milking parlour feed bins allow routine recording of enteric methane (CH₄) emitted in cow breath during milking, but CH₄ concentration changes during a milking visit as cow head position and airflow vary. If phenotypes are not defined carefully, this within-visit noise can mask between-cow differences and reduce the value of the data for genetic evaluation. This study quantified how alternative time windows and peak-based definitions from Arcoflex sensors affect phenotypic variation, heritability (h^2) and repeatability (r) of CH₄ traits, and shows that careful choice of phenotype and time window can turn noisy sniffer records into a reliable breeding tool for lowering methane emissions.

Materials and methods Passive methane sensors (Arcoflex International Pty Ltd) were installed in each feed bin at the Ellinbank SmartFarm (Victoria, Australia) herringbone dairy and recorded CH₄ (ppm) every 10 s during milking from 1 March 2024 to 14 April 2025. After data cleaning (about 10% of the data was removed) and alignment with milking records, visit-level CH₄ time series were retained for 538 Holstein cows with genomic information. We defined ten visit-level phenotypes combining different time windows (full visit, a fixed central window and visit segments) and two summary types (simple averages and peak-based measures). Peaks were defined as numerically high CH₄ observations above its datapoints neighbour. Genetic parameters were estimated using an animal model with fixed effects for milking session (AM/PM), bay number, polynomial age, polynomial days in milk, weight, parity and period (pre- and post-January 2025), and random additive genetic, permanent environmental and residual effects.

Results Across phenotypes, mean CH₄ and coefficients of variation were similar, but h^2 and r differed markedly (Table 1). Full-visit averages gave low h^2 and r , while phenotypes based on the 90–410 s window, especially peak-based traits, showed the highest h^2 and r . Traits defined from the end segment of the visit had near-zero h^2 and very low r .

Table 1. Summary statistics, heritability (h^2) and repeatability (r) for methane phenotypes defined from Arcoflex sniffer data in dairy cows.

Phenotype	Mean (ppm)	SD	CV	Min-Max	h^2	r
Average	496	283	0.63	103-3497	0.08	0.14
Average of peaks	720	451	0.62	101-4929	0.11	0.18
Average of 90-410	419	261	0.72	107-4214	0.19	0.26
Average of peaks 90-410sec	606	434	0.62	108-4743	0.23	0.29
Average of first segment	338	210	0.74	100-4492	0.09	0.15
Average of peaks of first segment	518	387	0.63	101-4850	0.11	0.18
Average of middle segment	508	323	0.70	100-4644	0.06	0.13
Average of peaks of middle segment	730	512	0.70	101-4993	0.06	0.14
Average of end segment	573	381	0.66	100-4427	0.01	0.06
Average of peaks of end segment	843	599	0.71	101-4935	0.0	0.06

Discussion These results show that phenotype definition and time window selection have a large impact on the estimated genetic parameters for CH₄ measured by passive methane sensors. Focusing on a biologically stable period of the visit (90–410 s after gate opening) and using peak information improved both heritability and repeatability compared with simple full-visit averages, suggesting better separation of between-cow differences from short-term behavioural and technical noise. In contrast, end-of-visit traits appeared dominated by non-genetic sources of variation, possibly related to the cow completing consumption of grain, exiting behaviour and variable distance from the sensor. For breeding programmes aiming to use methane sensor data, Defining methane phenotypes using a biologically stable time window and peak-based measures improves the genetic signal and appears to reduce noise in sniffer-based methane records.

Can forage conservation be used as a method to lower methane emissions on farms?

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Introduction As increased emphasis is being placed on reducing methane emissions from livestock on farm, many strategies are being investigated ranging from supplements to genetic selection of animals and pastures, however these can be costly and may take years before results are realised. Forage conservation has become a commonplace practice on Australian farms as a method to cover shortages in feed during times of drought or feed deficit, as well as being used as a source of high-quality forage during production feeding, with recent research indicating that it may also provide methane abatement opportunities to farmers (Sun *et al.* 2023). Therefore, the objective of this study was to see if different forms of forage conservation reduced methane emissions across a selected range of forage types.

Materials and methods Samples used in this study were sourced and tested as part of the Livestock Productivity Partnership project ‘Developing NIR calibrations to screen for methane production’. Samples were obtained from a variety of sources including research trials, farmers and samples submitted for routine testing through the Feed Quality Service at Wagga Wagga. Total gas production was determined using the Ankom RF Gas Production SystemTM. Briefly, 1g of freeze-dried ground forage was added to 120ml of buffered rumen fluid solution, the headspace in the jars purged with nitrogen and incubated in a shaking water bath at 39°C for 48 hours. The pressure (psi) of each bottle was recorded every 10 min for 48 h and cumulative gas production calculated (mL gas/g DM incubated). At the end of the 48-h incubation period, a gas sample was collected from the headspace of each module and stored until analysis by gas chromatography (GC). Once analysed, methane and CO₂ percentages of the samples were determined and methane and CO₂ production then calculated.

Results The range of forage types and methane gas production can be seen Table and Figure 1. A total of 12 forages were selected that had observations for fresh forage and at least hay, silage or both. While there was a significant ($P < 0.05$) difference between parent forage and the same conserved forage for half of the forage types trialled, all showed a substantial drop in methane gas production with one or both forms of forage conservation.

Table 1. Mean methane gas production (mL/g DM)

Sample type	Forage	Hay	Silage
Barley	35.88 ^a	26.16 ^b	*
Canola	26.43 ^a	21.13 ^a	13.55 ^b
Digit grass	37.75 ^a	29.89 ^b	*
Lucerne	31.49	28.98	*
Lucerne/ryegrass	32.99	30.66	*
Millet	29.84 ^a	28.17 ^a	22.65 ^b
Oats/Vetch	35.73 ^a	36.86 ^a	23.21 ^b
Rhodes grass	38.25	34.8	*
Ryegrass	34.8	*	29.9
Ryegrass/Clover	36.8 ^a	*	29.85 ^b
Ryegrass/Lucerne/Clover	39.59	*	36.22
Sorghum	35.37	32.21	*

*Values are least-square means, row-wise superscripts indicate different treatment means ($P < 0.05$). * Indicates missing samples

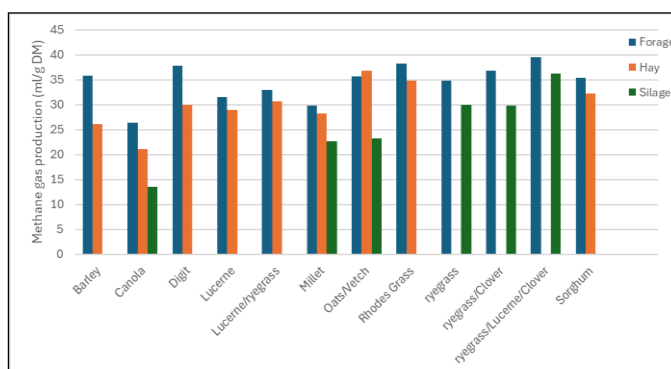


Figure 2. Impact of forage conservation on the methane content of a variety of forage types

Discussion The results from this current study indicate that there may be significant advantages to utilizing forages conservation practices as a means for producers to maximise production while limiting greenhouse gas emissions. While the numbers and forage types collated for this study remain small, results highlight the potential of using both hay and silage as a means of methane mitigation. It is hoped that funding may be able to be secured to undertake further research in this field, incorporating significantly more conserved forage samples and covering a greater diversity of forage types.

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Australian government program to reduce methane emissions in livestock

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Introduction Methane from ruminant livestock accounts for about 71% of Australia's agricultural emissions and 13% of national emissions (National Inventory Report 2023). The Australian Government is investing \$29 million through the Methane Emissions Reduction in Livestock (MERiL) program in research to help cut livestock emissions. MERiL covers all cattle and sheep production systems, especially extensive grazing systems where 95% of livestock are raised. The program runs until 2027. It aligns with the Government's Net Zero Plan and Agriculture and Land Sectoral Plan, and the Global Methane Pledge.

Materials and methods MERiL is a three-stage competitive grants program aligned with Technology Readiness Levels (TRLs):

- Stage 1 (TRL 2–3): Research on abatement potential, safety, and productivity benefits of methane-reducing livestock feed additives and forage species.
- Stage 2 (TRL 3–5): Assessing feasibility of delivery technologies for feed additives to grazing animals.
- Stage 3 (TRL 5–8): Large-scale validation and demonstration trials of the most prospective feed additives and delivery solutions for grazing animals.

The program also generates data for updating the National Greenhouse Accounts.

Results Projects supported under the MERiL program have demonstrated substantial methane reductions and some productivity benefits and have explored innovative delivery systems.

Methane mitigation:

- 3-NOP (Bovaer®) reduced methane emissions by up to 70% in cattle and 20% in sheep.
- Asparagopsis-based products achieved emission reductions of up to 98% in cattle under ideal conditions (Kinley et al., 2024), 88% in sheep pen trials, and 30% in lactating dairy cows under grazing conditions.
- Polygain™ (sugarcane extract with polyphenols and amino acids) reduced emissions by 24% (Bai et al. 2025) in lactating dairy cows and 34% in beef cattle, both under grazing conditions.
- Agolin Ruminant® (essential oils formulation) achieved 20–22% reductions in beef cattle and sheep.
- Probiotics (MYLO®) lowered methane emissions by 10%.
- A pasture containing 30% *Desmanthus* legume reduced methane emissions by 9% during the wet season in beef cattle.
- Brassica forage reduced methane by 37% in sheep.

Productivity benefits:

- Asparagopsis-infused oil improved feed conversion efficiency by 7.4% (Kinley et al. 2024) and increased beef carcass weight by 19.7 kg (George et al. 2024).
- Probiotics enhanced lamb growth by 24%.
- Polygain™ and Agolin Ruminant® showed some improvement in meat quality in sheep.
- Desmanthus pasture resulted in about 20 kg/head liveweight gain in beef cattle.
- Other additives had little or no effect on productivity or quality.

Delivery technologies:

Smart feeders and RFID systems, lick blocks, molasses licks, loose licks, pellets, fodder cubes, injection into drinking water, and a sustained-release bolus have been developed and are being field-tested under grazing conditions.

Discussion MERiL projects have demonstrated significant potential for methane mitigation. Wide adoption of methane-reducing feed additives and forage species faces barriers such as cost, inconsistent productivity gains, and logistical challenges in extensive grazing systems. Areas for further investigation include: scaling up delivery technologies for extensive grazing; health and safety; cost-effective additives and formulations; and integrating multiple long-term mitigation strategies such as low-emission pastures, vaccines, and animal genetic improvements, which are still under development.

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Synergistic effects of pyromellitic diimide, rhubarb, fumarate, and monensin on methane reduction, hydrogen utilization, and fermentation profile in sheep fed lucerne pellets

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Introduction Pyromellitic diimide (PD) has been shown to reduce enteric methane (CH₄) emissions and results in increased hydrogen levels when tested in vitro, but no research to date has yet quantified CH₄ reduction potential of PD in vivo. Furthermore, it is proposed that a combination of CH₄ inhibitors (commonly referred to as ‘stacking’), such as PD, unrefined rhubarb extract (R), or monensin (M), and hydrogen acceptors, such as fumarate (F), could improve the mitigation of CH₄ as well as redirect hydrogen to other sinks.

Materials and methods Forty-eight Merino-Cross sheep with an average body weight (BW) of 23.8 ± 2.21 kg were housed in an individual pen and randomly allocated in a complete block design with 8 dietary treatments for a 35-day feeding period. The experimental diets were based on lucerne pellet mixed with 1.0% canola-oil, alone (Control) or with addition of 50 mg/kg dry matter (DM) of PD, 250 mg/kg DM of R, 30 mg/kg DM of M, or 2000 mg/kg DM of F, and the combined mixtures of PD+R, PD+R+F or PD+R+F+M. Enteric CH₄ emissions were measured weekly in open-circuit respiration chambers for 5 weeks. Rumen contents were collected 3 h post-feeding on the day following each CH₄ measurement and analysed for dissolved gas composition by gas chromatography.

Results Dietary additives did not alter the DM intake, average daily gain, feed efficiency, or body condition score of the sheep. Supplementation of PD reduced ($P < 0.01$) CH₄ production, yield, and intensity by 74 to 79% compared to the Control. However, other additives did not reduce CH₄ emissions, and we did not observe further improvement in CH₄ reduction when PD was combined with other additives. Compared to the Control, the concentration of dissolved CH₄ (dCH₄) in rumen fluid was reduced ($P < 0.01$), and dissolved hydrogen (dH₂) was increased ($P < 0.01$) by 8-fold in sheep when PD was added to the lucerne diet. This rise in dissolved H₂ from PD was reduced by half with the addition of R alone or in combination with F or M to the PD diet. The addition of R to the PD diet also increased ($P < 0.01$) rumen fluid butyrate concentration, while the combined supplementation of all additives (PD+R+F+M) increased ($P < 0.01$) the molar proportion of propionate and decreased the proportions of acetate, butyrate, and the acetate-to-propionate ratio. The count of total protozoa was reduced ($P = 0.02$) in sheep fed M.

Table 1. Least-squared means of enteric methane (CH₄) emissions and gasses dissolved in rumen fluid of Merino wethers fed a lucerne pellet basal diet supplemented with 50 mg pyromellitic diimide/kg DM (PD), 250 mg rhubarb extract/kg DM (R), 2000 mg fumarate/kg DM (F), and 30 mg monensin/kg DM (M) alone or in combinations, during 5 weekly, 23-h open-circuit respiration chamber measurement periods.

	Diet								SEM	P
	Control	PD	R	F	M	PD+R	PD+R+F	PD+R+F+M		
CH ₄ emissions (g/d)	11.8 ^a	2.49 ^b	11.9 ^a	11.6 ^a	10.3 ^a	3.35 ^b	3.68 ^b	2.15 ^b	0.597	<0.01
CH ₄ emissions (g/kg DMI)	12.5 ^a	2.50 ^b	12.5 ^a	12.2 ^a	11.0 ^a	3.41 ^b	3.88 ^b	2.28 ^b	0.603	<0.01
Total dissolved gas (v/v, %)	2.77	2.53	2.92	2.70	3.37	2.73	2.77	2.68	0.644	0.98
Dissolved H ₂ (μM)	5.49 ^{ab}	44.3 ^a	3.77 ^{ab}	1.72 ^b	1.63 ^b	21.9 ^{ab}	25.3 ^{ab}	20.9 ^{ab}	9.286	<0.01
Dissolved CH ₄ (mM)	0.12 ^a	0.00 ^c	0.10 ^{ab}	0.06 ^{abc}	0.07 ^{abc}	0.01 ^{bc}	0.04 ^{abc}	0.00 ^c	0.018	<0.01

Discussion In sheep fed lucerne-based diets, PD alone or in combination with rhubarb extract, fumarate or monensin reduced concentration and emitted CH₄ production and yield by 78 to 80% compared with the Control, although the precise mechanism of CH₄ inhibition by PD is currently unknown. R appears to act as a hydrogen sink, but only when CH₄ is already inhibited, in this case by PD. As an unrefined product, more work is needed to understand the mechanism by which rhubarb extract reduces H₂ emissions. The lack of further reductions in dH₂ or increase in propionate concentration (data not shown) with the inclusion of fumarate in PD+R+F suggests that fumarate has no benefits in terms of hydrogen utilization when hydrogen is already being partially redirected with rhubarb (PD+R). In conclusion, the supplementation of PD alone or combined with R+M+F can reduce CH₄ emissions, and when combined with rhubarb extract, can redirect hydrogen to other sinks in sheep without compromising intake or performance.

Effect of Antimethanogenic additive (3NOP: Bovaer®) feed frequency on methane emission reduction in Merino grazing ewes in South Australia

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Introduction As livestock industries contribute between 16.5 and 21% of total anthropogenic greenhouse gas (GHG) emissions making it the largest contributor to the food system emissions (Sinke *et al.*, 2023), there is a need to reduce GHG emissions. 3-nitrooxypropanol (3-NOP), commercially available as Bovaer® is an enzyme inhibitor, stopping the production of methyl-coenzyme M reductase (MCR) the rumen for at least one hour. As production of methane is only reduced for a designated period post feed, it is important to understand if feed frequency influences long-term methane inhibition. Therefore, this trial was conducted within South Australia, to determine the optimal feed frequency of 3-NOP for sustained methane reduction in grazing sheep.

Materials and methods Beginning in autumn 2024, 252 ewes were selected based on liveweight (LW) range: ≥ 60 and ≤ 80 kg, and body condition scored (BCS): ≥ 2.75 and ≤ 4.0 then stratified into one of four treatment groups ($n = 63$ per group). The 3-NOP was prepared as a pelleted ration at delivery rate of 100 ppm/hd/day, fed either once per day (150 g /ewe/day; 3-NOP 1), twice a day (75 g / ewe / drop /day; 3-NOP 2) or three times a day (50 g / ewe / drop /day; 3-NOP 3) compared to a control pellet fed once per day (150 g /ewe/day; CTL). Methane (CH₄) was measured using a small ruminant GreenFeed Machine (C-Lock, USA) where animals were trained to access grain, which was rotated between each of the four paddocks every three weeks. CH₄ intensity (g / kg LW) and CH₄ mass flow (g/day) data were analysed in SPSS using a generalised linear mixed model, with treatment as a fixed factor and ewe included as a random effect. Differences between treatment groups were considered significant at $P \leq 0.050$.

Results Both 3-NOP 1 and 3-NOP 2 had lower CH₄ mass flow compared to both 3-NOP 3 and CTL ($P < 0.001$). Similarly, when accounting for LW, 3-NOP 1 and 3-NOP 2 had lower CH₄ intensity compared to both 3-NOP 3 and CTL ($P < 0.001$).

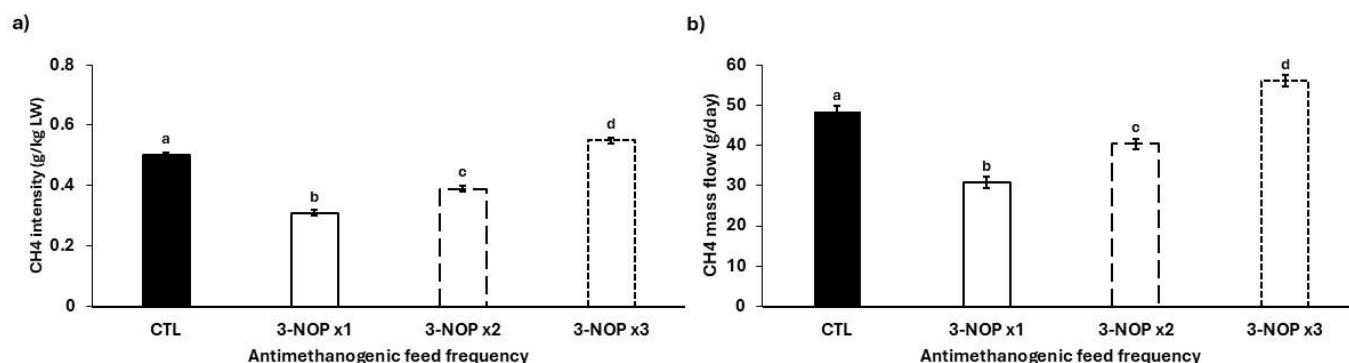


Figure 1. Graphs depicting **a)** the difference in CH₄ intensity (g/kg LW) between feeding frequency of Bovaer® to merino grazing sheep over 24 months, and **b)** the difference in CH₄ mass flow (g/day) between feeding frequency of Bovaer® to Merino grazing sheep over 24 months.

Discussion These results indicate that feeding Bovaer® either once (150 g/feed) or twice (75 g/feed) per day was the most effective in reducing methane production in Merino grazing sheep in South Australia. It is likely that the active concentration in the pellets at just 50 g/feed of Bovaer® three times a day was not high enough to elicit a reduction in enteric CH₄ emissions. Whilst time of CH₄ measurement post-feed was accounted for, it is possible too few animals visited within the active time to accurately assess CH₄ mitigation potential. Neither long-term access to Bovaer®, or feed frequency negatively impacted production traits, or health parameters. Further research is about to begin to investigate alternative methods of additive delivery, for multiple antimethanogenic compounds.

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Annual methane emissions profile for Angus cows grazing the South-West coastal pastures of Western Australia

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Introduction In southern Australia, cattle enteric methane emission—despite significant variation across regions and rainfall zones—are calculated using generic national conditions and emission factors. Measuring locally relevant emissions in diverse grazing systems offers two key benefits: (1) enhancing the accuracy of Australia's enteric emission inventory, and (2) providing data to support tailored, region-specific mitigation strategies. We undertook a full-year baseline study. As this was an observational study, we did not evaluate a specific hypothesis.

Materials and Methods We measured enteric methane, hydrogen, and carbon dioxide emissions using GreenFeed technology (C-Lock Inc., Rapid City, SD, USA) in 61 Angus beef cows for 1 year. We conducted the study on a commercial farm 20 km north of Albany in Western Australia with the cows managed under the farmer's standard annual system. There were no experimental treatments or interference beyond access to the GreenFeed unit, which provided <10 % of the total diet. We divided the year into five periods based on predominant feed types (Fig. 1). We calculated the daily mean emissions for each cow, averaged across animals to obtain herd daily values, and then summarised for each period. In addition to direct methane measurements, we estimated methane emissions using Australian emission factors.

Results The average annual methane was 210 g/day. Methane was higher during the green period (March–October) than during the dry period (November–February) ($P < 0.05$) (Fig. 1), and higher during periods of hay supplementation. The methane models underestimated emissions when cows were supplemented with hay/silage and overestimated when grazing un-supplemented pastures (Fig. 1).

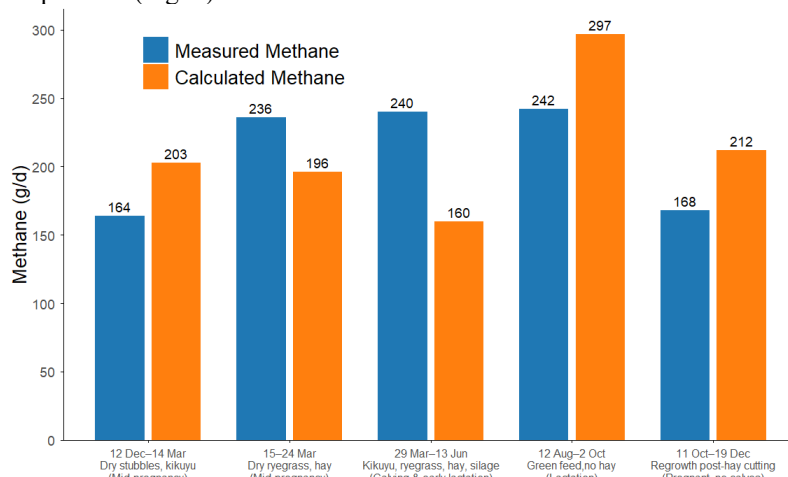


Figure 1. Actual (Blue) vs modelled (Orange) methane for each period. X label includes dates, feed type and pregnancy status.

Discussion Enteric methane production was driven not only by feed intake but also by pasture quality, growth stage, overgrazing, and hay supplementation. The highest methane and hydrogen emissions occurred during spring, coinciding with green feed and active rumen fermentation. Hydrogen increased nearly tenfold during this period, indicating an intensification of the methanogenesis process. Overgrazing (defined as feed on offer <1500 kg/ha dry matter) coincided with reduced methane output, likely due to reduced feed intake, altered rumination patterns and fermentation dynamics. Hay supplementation further elevated methane compared to un-supplemented grazing. These findings suggest that pasture type and condition are critical drivers of enteric methane output. Comparison of measured and modelled emissions revealed notable discrepancies. The modelled results underestimated emissions when cows were supplemented with hay or silage and overestimated emissions when cows grazed un-supplemented pastures. This suggests that current national or global prediction models which rely predominantly on intake and cattle weight, do not accurately account for all the factors driving methane. Therefore, the models do not accurately represent all Western Australian grazing systems, where seasonal feed variability and supplementation practices differ from generic assumptions. Adjusting these models for local conditions could improve the accuracy of Australia's methane inventory and support region-specific mitigation strategies. This study provides the first full-year, direct measurements of methane emissions from beef cows in a Western Australian grazing system, revealing higher emissions during green feed periods and discrepancies with modelled data. These locally relevant data enhance the accuracy of Australia's enteric emission inventory, enabling targeted, region-specific mitigation strategies.

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Towards low-emission grazing systems: preliminary methanogenic potential screening of northern Australia forage plants

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Introduction Almost two-thirds of Australia's beef cattle are produced in extensive systems across northern Australia (Queensland, Western Australia, and the Northern Territory), where they graze on native and naturalised vegetation. Their enteric methane emissions account for approximately 62.5% of the national total, yet current methane mitigation technologies based on additive supplementation are not readily applicable to these northern systems. Preliminary *in vitro* screening of native plants in Western Australia revealed some potential antimethanogenic species that can reduce enteric methane production by 20–90% (Durmik *et al.* 2010; 2017). These species offer potential for reducing methane emissions across northern grazing systems, but data on their distribution across the region are limited. To address this challenge, this work focused on developing practical and cost-effective mitigation strategies that can be implemented across extensively grazed regions of northern Australia. A key first step is identifying plant species with low methanogenic potential from within the existing feedbase. It was hypothesised that forage plant species present in the various agro-ecological zones of northern Australia will differ in their capacity to reduce enteric methane production.

Materials and methods For an initial baseline, plant material included seven native grass species collected from field plots growing at the University of WA Shenton Park Research Station (Perth, WA). Plant samples were predominantly taken at senescence, with two species also sampled at an early vegetative stage. In addition, leaf samples of several varieties of leucaena (*Leucaena leucocephala*) were sourced from the UWA Shenton Park Research Station (Perth, WA), DPIRD Kununurra (Kununurra, WA), and DPI QLD (Redlands, QLD). Collected plant material was either freeze-dried or oven dried prior to being milled through a 1 mm screen. The plants were tested *in vitro* for methanogenic potential following procedures described by Durmik *et al.* (2010), with testing conducted in WA and Qld-based laboratories using sheep and cattle rumen fluids, respectively. Briefly, 0.1 g of each plant sample was weighed in triplicate into anaerobic culture tubes (Anaerobic Tube, Cat. No. 2048-00150; Bellco Glass, Vineland, NJ, USA). Rumen fluid was collected from three animals, and mixed with McDougall's buffer (McDougall, 1948) at a ratio of 1:1.5. For sheep-derived rumen fluid, if required the pH was adjusted to <7.0. Under anaerobic conditions, 10 mL of the buffered rumen inoculum was added to each tube. Oaten chaff (positive control) and a no-substrate treatment (negative control) were included. Tubes were incubated at 39 °C for 24 h, after which gas pressure was measured, and gas volume (mL/g dry matter (DM)) calculated as an indicator of plant fermentability. Headspace gas was collected for methane determination by gas chromatography (450GC, Bruker Technologie, Australia). Methanogenic potential was expressed as total methane produced (mL) per gram of dry matter incubated.

Results Preliminary results suggest that methanogenic potential is influenced sample preparation method (oven vs freeze-dry). Among the grasses tested, plant material from *Dichanthium sericeum* (senescing, oven-dried) produced the lowest methane (9 mL/g dry matter), followed by *Astrelia pectinata* (15 mL/g dry matter) and *Panicum decompositum* (16 mL/g dry matter). Vegetative, freeze-dried plant material from *Leucaena leucocephala* exhibited variable methanogenic potential depending on cultivar and sample origin but consistently reduced methane without negatively affecting the overall rumen fermentation. In contrast, *Panicum decompositum*, was found to reduce methane but also negatively affected the fermentation, reducing the total gas volume produced after 24 h incubation. Our preliminary plant screening results showed some differences in methanogenic potential occurring between the use of sheep and cattle rumen fluid probably due to differences in microbial composition. Further analysis will be conducted to verify these results.

Discussion The *in vitro* screening assay demonstrated the ability to identify differences in methanogenic potential between cultivars of the same species, and across different growth stages of a plant species. These preliminary results suggest that variability exists among some rangeland grass species and between different *Leucaena* samples. Differences were also observed between vegetative and senescing stages of grasses, as well as among field replicates. Further analyses are underway to provide more detailed insights into these interactions and to confirm the observed trends.

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Water-based delivery of bromoform formulations to mitigate methane in cattle

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Introduction Bromoform, due to its ability to reduce methane emissions from ruminant livestock by inhibiting the final steps of methanogenesis ((Wood and Wolfe, 1966, Wood *et al.* 1966), is a potential feed additive for that purpose. The use of synthetic bromoform as a feed additive allows scaling up without impacting the marine environment, while eliminating the cost of harvesting and transportation involved in harvesting seaweed as a source of bromoform (Gyeltshen *et al.*, 2025). While inclusion of bromoform as a feed additive under feedlot conditions can be effective, its implementation in grazing conditions can be challenging. This challenge could possibly be met using bromoform formulations designed to readily disperse in drinking water. This experiment had the aim of quantifying the methane mitigation achieved with such a formulation.

Materials and methods Forty Angus steers (approx. age = 12-15 m, mean weight (SD) = 342 ± 35.7 kg) were allocated to four liveweight blocks in a randomized block design that tested multiple bromoform-based formulations with 5 replications for each formulation in two testing periods after baseline measurements. The bromoform formulations were mixed either in feed or in drinking water. This paper only describes the effect on methane emission reduction from inclusion of bromoform-based formulations added to drinking water. Five water treatments (T1, T2, T3, T4, T5) (with bromoform intakes of 114, 174, 263, 247 and 426 mg/hd/d, respectively, plus a control (T0) were included. Treatment formulations were added into a 20-L drinking water in a floppy tub provided at the time of feeding. An additional tub of 20 L plain water was provided 2 h later as an alternative drinking water. Water intakes were visually checked at 2-h intervals and the last check carried out at 4:00 PM every day. When water in the tub was less than 5 L, additional 20 L was added. The steers were adapted to the treatment formulations for 10 days in the pens followed by two sessions of 23-h (consecutive days) methane measurement period in the respiration chambers. The effects of the treatments on methane emissions were compared with baseline and control emission data using linear mixed model effects. Volatile fatty acids and protozoa in rumen fluid were compared between treatments.

Results Methane production per day (g/d, $P = 0.015$) and methane yield (g/kg DMI, $P = 0.025$) were significantly reduced by inclusion of treatments in a bromoform-dose dependent manner with highest methane yield reduction of 79% from T5 (426 mg bromoform/hd/d). Dry matter intake ($P = 0.312$) and Total Water Intake ($P = 0.231$) were not affected by the Treatment. The total volatile fatty acids concentration and the composition of the VFA were not affected by the Treatment ($P > 0.05$).

Table 1. Estimated marginal means of enteric methane (CH₄) emissions, dry matter intake and water intake of Angus steers fed with a total mixed ration and supplemented with synthetic bromoform formulation in 20 L drinking water to achieve a target bromoform dose of 0 (T0), 114 mg/hd/d (T1), 174 mg/hd/d (T2), 247 mg/hd/d (T3), 263 mg/hd/d (T4) and 426 mg/hd/d (T5). Additional water in separate drinking water was provided two hours after feeding and topped up twice thereafter.

	Period	T0	T1	Treatment				T5	TRT	Period	T × P
				T2	T3	T4					
CH ₄ emissions (g/d)	BL	99.9 ^a	76.1 ^a	84.3 ^a	93.1 ^a	79.4 ^a	102.0 ^a		0.015	0.002	< 0.001
	TRT	130.5 ^c	67.2 ^{bc}	63.7 ^{ab}	67.9 ^{ab}	97.7 ^{ab}	29.6 ^a				
CH ₄ emissions (g/kg DMI)	BL	14.2 ^a	11.6 ^a	11.8 ^a	13.0 ^a	11.8 ^a	13.3 ^a		0.025	<0.001	<0.001
	TRT	14.6 ^c	10.0 ^{bc}	6.9 ^{ab}	7.2 ^{ab}	6.7 ^{ab}	3.1 ^a				
Methane abatement (% of control)			32%	53%	51%	54%	79%				
DMI (Chamber, kg/day)	TRT	9.2 ^a	9.9 ^a	9.3 ^a	9.6 ^a	9.8 ^a	9.9 ^a	0.312	-	-	-
Total Water Intake (L/day)	TRT	18.3 ^a	19.8 ^a	24.5 ^a	23.8 ^a	18.3 ^a	26.2 ^a	0.231	-	-	-
Water Intake with Treatment * (L/day)	TRT	16.5 ^a	15.2 ^a	11.6 ^a	11.7 ^a	16.5 ^a	14.2 ^a	0.160	-	-	-
Total VFA (mM)	TRT	59.4 ^a	79.9 ^a	56.7 ^a	58.6 ^a	59.3 ^a	65.4 ^a	0.638	-	-	-
Acetate, % Total VFA	TRT	58.8 ^b	53.6 ^{ab}	52.0 ^{ab}	56.7 ^{ab}	49.3 ^a	50.5 ^{ab}	0.015	-	-	-
Propionate, % Total VFA	TRT	24.6 ^a	26.1 ^a	32.0 ^a	27.2 ^a	29.9 ^a	34.1 ^a	0.037	-	-	-
Butyrate, % Total VFA	TRT	12.1 ^a	16.0 ^a	11.9 ^a	10.7 ^a	15.5 ^a	10.5 ^a	0.35 ^a	-	-	-
Acetate: Propionate	TRT	2.50 ^a	2.07 ^a	1.65 ^a	2.28 ^a	1.68 ^a	1.51 ^a	0.058	-	-	-

*The Treatment product was added in 20 L water to achieve the target dose rate for individual treatment formulations. BL = Baseline; TRT = Treatment

Discussion This study demonstrated that methane emissions can be reduced by incorporating formulated bromoform carriers that are readily dispersible in drinking water. These additives, added to achieve target doses of 114 to 426 mg bromoform per head per day, showed between 32 and 79% reduction in methane yield when compared with the control group. This study serves as a proof of concept that methane mitigants can be delivered through drinking water when suitably formulated for use in water.

Methane Emissions and Carbon Abatement

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Enteric methane emissions from Wagyu heifers fed a grower and finisher diet with varying doses of 3-nitrooxypropanol

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Introduction The addition of 3-nitrooxypropanol (3-NOP) to ruminant diets reduces enteric methane production by inhibiting an enzyme critical to methanogenesis in the rumen (methyl-coenzyme M reductase). A recent meta-analysis of 17 beef studies found that 3-NOP supplementation, ranging from 32 to 338 mg/kg of dry matter (DM) across studies, reduced methane production (CH_4 g/d) by $36.2 \pm 24.43\%$ and CH_4 yield (CH_4 g/kg DM intake) by $33.2 \pm 25.54\%$ (de Oliveira *et al.* 2026). In Australia, Angus steers fed a tempered barley-based feedlot diet had a quadratic response to 3-NOP dose (50 to 125 mg/kg DM) with up to 90% abatement of methane production and yield (Almeida *et al.* 2023). However, 3-NOP has reduced mitigation efficacy as dietary neutral detergent fibre increases (de Oliveira *et al.* 2026), which is particularly relevant for Australia's Wagyu beef feedlot diets that have higher forage content to accommodate feeding programs from 350 to 600 d. Therefore, this project was designed to evaluate the efficacy of 3-NOP to abate enteric methane production at three different doses in a Wagyu grower and finisher diet fed to growing Wagyu cattle. In addition, an oil-based 3-NOP product was evaluated to compare with a powdered 3-NOP. It was hypothesised that a linear increase in the relative abatement of methane production and yield would be observed with increasing dose of 3-NOP in the diet, that greater abatement will be achieved when feeding a higher-grain finisher diet compared to the grower diet, and that methane abatement in the oil-based treatment would be equal to or greater than the powder.

Materials and methods Thirty purebred Wagyu heifers (initial liveweight 233 ± 2.6 kg; mean $\pm$ SE) were blocked on liveweight (3 blocks of 10 heifers) and randomly allocated to one of five treatments. The heifers were housed in individual pens for 94 d, consisting of 14 d transition (no treatments), 38 d grower phase, a 4-d transition, and 38 d finisher phase, with the start for each block of 10 heifers staggered by 2 days. During the grower phase, heifers were fed a typical Wagyu grower total mixed ration (TMR; 64% tempered barley) *ad libitum* by adjusting individual daily feed offered once per week to target approximately 5% feed refusals (as-fed). Each morning five treatment mixes (CON, BOV-50, BOV-100, BOV-150 and OIL-100) were prepared by mixing 29.5 g/kg DM of canola oil and 30.0 g/kg DM of dry mineral supplement into the base TMR within 2 h of feeding. The mineral supplement and canola oil for the control (CON) treatment did not contain 3-NOP. The BOV-50, BOV-100 and BOV-150 treatment mixes included 3-NOP powder (Bovaer-10; dsm-firmenich, Switzerland) in the mineral supplement to achieve 50, 100 and 150 mg 3-NOP/kg DM in the final TMR, respectively, and all received control canola oil. The OIL-100 treatment received control mineral supplement but the canola oil was prepared with the inclusion of a proprietary oil-based 3-NOP product (dsm-firmenich, Switzerland) to achieve 100 mg 3-NOP/kg DM of the final TMR. This was repeated for the finisher phase using a Wagyu finisher TMR with 76% tempered barley. During both 38-d phases (grower and finisher), each block of heifers entered individual open-circuit respiration chambers ($n = 10$) on d 14, 21, 28 and 35 for two consecutive 23-h sample periods to determine the production of methane and hydrogen. Daily feed offered and refused were measured and samples collected for DM and 3-NOP concentration analysis, and control TMR samples were bulked weekly for nutritive analysis. Rumen fluid was collected via oro-gastric intubation from each heifer 3 h post-feeding on the days they exited chambers and immediately tested for pH and redox potential. Sub-samples of rumen fluid were collected for volatile fatty acid and rumen $\text{NH}_3\text{-N}$ concentration and for dissolved gas (CH_4 and H_2) composition analysis using gas chromatography. Liveweights were measured immediately prior to rumen fluid sampling to determine average daily (kg/day).

Results This experiment is ongoing at the time of writing, and final data will be presented in person. The expected results will include mean DM intake and average daily gain, mean daily production and yield of methane and hydrogen measured in respiration chambers, as well as VFA profile, rumen $\text{NH}_3\text{-N}$ concentration, and composition of dissolved CH_4 and H_2 gases. This experiment was designed with the following contrasts that will statistically compare 1) the overall effect of dose across the 4 levels of 3-NOP inclusion (0, 50, 100 and 150 mg/kg DM), 2) the overall effect of base TMR (grower vs finisher) and 3) the effect of 3-NOP delivery method between the powder (BOV-100) and oil-based (OIL-100) treatment, at the same level of inclusion (100 mg 3-NOP/kg DM).

Discussion The results of this experiment will be a valuable contribution to evaluating the efficacy of 3-NOP inclusion in Australian Wagyu feedlot programs. An oil-based alternative may improve the stability of the 3-NOP in the mixed feed and provide a practical alternative to feeding powder-based feed additives in feedlot conditions.

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Annual Methane Emissions Profile for Sheep Grazing Pasture in Southern Western Australia

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Introduction Enteric methane (CH₄) from livestock rumen fermentation is a critical global agricultural greenhouse gas (GHG) source, accounting for approximately 80% of Australian agricultural emissions (Hegarty & Kennedy, 2011). Developing scalable mitigation strategies whether nutritional, genetic, or management based require robust baseline data for accurate national carbon accounting. However, quantifying emissions in free range grazing systems is challenging due to high seasonal variability in forage quality and composition, which significantly alters rumen fermentation pathways (e.g., volatile fatty acid ratio) and makes static pen feeding models inadequate. This study aimed to address this knowledge gap by establishing a continuous, year round CH₄ emission profile for Merino sheep under dynamic grazing conditions typical of Southern Western Australia (WA) using non-invasive GreenFeed (GF) technology. Specifically, we aimed to 1) quantify individual daily CH₄ emissions across distinct seasonal phases, 2) relate emission rates to changes in pasture type, and 3) generate a robust, region specific dataset to inform future mitigation research and enhance carbon accounting frameworks.

Materials and Methods This ~13 month longitudinal study was conducted at the Katanning Research Station (KRS) in Western Australia, utilizing a cohort of 58 young Merino sheep (43 ± 0.3 kg average liveweight at start plus standard error) managed under typical grazing practices (average stocking rate 4.0 dry sheep equivalents per hectare) throughout the trial period. The study was strategically divided into seven, ~60 day phases to capture regional shifts in feed quality and quantity: Phase1; cereal oat stubble/supplementation, Phase2; early start of green mixed pasture, Phase3; green mixed pasture, rye grass, sub clover and cape weed, Phase4; start of dry mixed pasture including rye grass, sub clover and cape weed, Phase5; dry pasture including barley with anameka, Phase 6; anameka saltbush and Phase7; oat stubbles as additional short period (~30 days). Individual animal emissions of CH₄ and CO₂ were measured across all phases using non-invasive GF units (C-Lock, USA; which trains sheep for voluntary visits). A small feed reward of lupins (~10g per visit with 4 to 5 visits/day) representing approximately 4% of estimated intake. Liveweights (LW) and condition scores (CS) were measured at the start and end of each Phase. Overall 38 sheep (65%) visited the GF frequently enough for inclusion in the analyses. Mean daily CH₄ emissions across the six seasonal grazing phases were analysed using a General Linear Model for repeated measures, with daily CH₄ fitted as the response variable and Phase as a fixed effect, and LW and CS included as covariates. LW and CS were analysed separately using the same model.

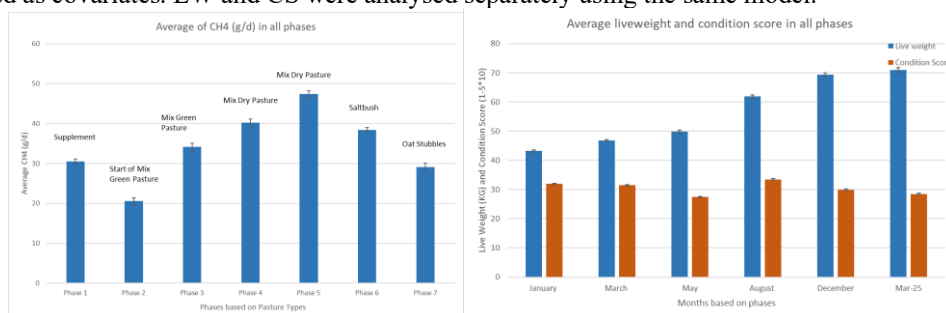


Figure 1. The average CH₄ g/d within each pasture phase detailed in material and methods (left) and liveweights (kg) and condition score for all phases (right).

Results and Discussion The study area consisted of a stable, mixed pasture composition throughout the year. Significant differences ($P < 0.005$) in mean daily CH₄ emissions were observed across the six grazing phases. CH₄ was significantly lower (28.4 ± 0.51 g/d) during the green pasture phases (2&3; April–August) compared to the dry pasture phases (4-6; 41.9 ± 0.52 g/d, September–March), which is likely due to higher digestibility and lower fibre content of green forage altering rumen fermentation pathways. These seasonal fluctuations in mean daily CH₄ production provide new information for establishing reliable regional emission factors. Anameka saltbush showed potential as a supplementary feed during dry conditions over the 60-day dry-feeding phase with only minor supplementation from the greenfeed (approx. 40-50 g/hd/day of lupins) achieving LW and CS maintenance. These seasonal shifts directly reflect changes in pasture quality; the highly digestible green mixed pasture (Phases 2-3) supported lower emissions than the more fibrous, mature dry pastures (Phases 4-6). Therefore, the methane profile is driven by the specific nutritional composition and fibre content of the available forage rather than just the time of year. Overall, the continuous increase in LW and maintenance of CS throughout the year studied suggests that CH₄ variability was influenced by dietary factors and not constrained entirely by productive potential. This project delivers the first continuous, individual animal dataset of methane emissions for grazing sheep in Western Australia, providing a crucial baseline for refinement at KRS and guiding the design of future mitigation experiments, and targeting feed and genetic based strategies for the WA sheep industry.

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Methane mitigation of beef steers via a molasses lick block containing an anti-methanogenic compound

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Introduction Mitigation of enteric CH₄ emissions has become a global priority for sustainable livestock production. Recent developments have occurred with different anti-methanogenic ingredients with varying success, including diet supplements with natural plant extracts (Nikoloric *et al.* 2025). Cattle are produced in diverse environments, and there is a need to develop effective methods of delivering these anti-methanogenic ingredients in both feedlot and grazing systems. Molasses lick blocks (MLB) have high palatability and can be implemented in extensive grazing systems to deliver key nutrients to improve cattle growth rate (Löest *et al.* 2001). The present study hypothesised that steers supplemented with MLB containing anti-methanogenic ingredients based on natural plant parts would decrease CH₄ emissions with no negative impact on total feed intake.

Materials and methods This study was approved by University of Sydney Ethics Committee (AEA 2023/2293). A total of forty, 12–20-month-old steers [320 ± 40 kg (mean ± SD)] were randomly assigned to either a control or MLB pen (4 Seasons Pty Ltd and AgCoTech Pty Ltd., Crestmead, Queensland, Australia) in a crossover design with 2 experimental periods of 56 days with an initial adaption of 14 days. Gas exchange data was collected using a Greenfeed system (C-Lock Inc., South Dakota, USA) delivering lucerne pellets. Animals were fed the same diet of 50:50 oaten-vetch hay in electronic feeders. The MLB group was freely offered MLB containing a proprietary mix of natural products and essential oils sourced from *Myrtaceae*, *Rutaceae*, *Poaceae*, *Amaryllidaceae*, and *Lamiaceae* (Nikoloric *et al.*, 2025), while the control group was not provided a molasses lick block. To allow for ad libitum intake and a maximum of 1 kg/d of lucerne pellets delivered via the Greenfeed for both groups. Total dry matter intake (DMI) and total metabolisable energy intake (MEI) was estimated for each steer. Daily summary values were calculated for each variable and animal, then averaged for each experimental period and animal. A mixed effects linear regression model was used with treatment as fixed effect and animal within treatment as random effect. With emmeans and standard error of the mean presented.

Results Animals with access to the MLB consumed 0.552 kg/head per day in period 1 and 0.628 kg/head per day in period 2. There was no effect of treatment on CH₄ ($P = 0.918$), CO₂ ($P = 0.303$) and total DMI ($P = 0.934$; Table 1). In contrast, H₂ was lower ($P = 0.001$) and O₂ was greater in MLB compared to control steers ($P = 0.004$). The CH₄ yield (g/kg DMI and g/kg MEI) showed no difference between MLB and control steers ($P = 0.183$; $P = 0.319$). The average daily gain was 5.8 % greater ($P = 0.030$) in the animals supplemented with MLB than the control steers.

Table 1. Mean gas exchange and performance of steers fed a molasses lick block (MLB) with anti-methanogenic ingredients or a control group with no MLB.

	Control	MLB	SEM	P value
Total Dry Matter Intake (DMI) kg/d	10.18	9.77	0.357	0.079
CH ₄ , g/d	279.5	279.1	5.58	0.918
CO ₂ , g/d	7204	7422	150.3	0.303
H ₂ , g/d	0.83	0.61	0.046	0.001
O ₂ , g/d	5196	5679	117.4	0.004
Average daily gain (kg/d)	1.12	1.28	0.052	0.030
CH ₄ yield, g/kg DMI	28.30	29.40	0.726	0.183
CH ₄ yield, g/kg Metabolisable Energy Intake	3.285	3.397	0.087	0.319

Discussion The MLB animals consumed the MLB containing anti-methanogenic ingredients, however there was no effect on methane production, in contrast to a decrease of 10.3 % in CH₄ (g/d) previously observed with this supplement in a pellet (Nikoloric *et al.* 2025). In addition, Nikoloric *et al.* (2025) found a decrease in CH₄ yield (g/kg/d) of 7.5–11.7 %. The significant reduction in CH₄ yield (DMI and MEI) indicates improved methane efficiency, suggesting that animals produced less methane per unit of feed consumed or energy intake, however this current study did not observe any differences in methane production, indicating the product can work but currently the developed MLB was not successful at reducing methane emissions. This may be due to the active ingredient becoming deactivated during production, or issues arising in decay of active ingredients over time postproduction. Of note, MLB animals had higher average daily gain than the control steers, with no differences in total DMI, indicating the MLB steers were more efficient in converting available dry matter into body mass. The lack of significant differences in DMI indicates that the molasses lick block was well tolerated and did not suppress appetite, which is essential for practical adoption. In conclusion CH₄ (g/d) and total DMI was not affected by MLB supplementation, but MLB steers gained 14.3 % more compared to control steers.

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 We gratefully acknowledge Meat and Livestock Australia Donor Company, 4 Seasons Company Pty Ltd and Agcotech Pty Ltd for funding this work.

***Medicago* spp. reduce methane when measured *in vitro* using abattoir derived ovine rumen fluid**A. M. Lowe^A, B. Agenbag^A, D.M. Peck^{A,B}, and A. Humphries^{A,B,D}^ASouth Australian Research and Development Institute (SARDI), ^BThe University of Adelaide, ^CAustralian Wine Research Institute, Waite Campus SA 5064 Australia.^DCorresponding author. Email: alyce.lowe@sa.gov.au

Introduction Enteric methane production accounts for *c.* 65% of greenhouse gas emissions from the Australian agricultural sector. Practical ways to reduce methane production from grazing ruminants are needed and may include the manipulation of the feedbase toward greater proportions of species with plant secondary compounds such as saponins, which can inhibit enteric fermentation (Eckard *et al.* 2010, Ku-Vera *et al.* 2020, Badgery *et al.* 2023). *Medicago* species, including annual medics and lucerne, are valuable legume components of southern Australian pastures. They are also rich in saponins (Kozłowska *et al.* 2020), suggesting a role for *Medicago* spp. in addressing methane emissions. We hypothesized that *Medicago* accessions with differing saponin compositions would vary in their ability to reduce methane *in vitro*. We explored if there is a relationship between anti-methanogenic effect and saponins content.

Materials and methods Dried herbage from 32 *Medicago* samples; 20 annual medic accessions from six species, and 12 lucerne populations with diverse saponins profiles, were evaluated using an ANKOM *in vitro* gas production system. Up to 30 samples were tested per run using buffered, fresh abattoir derived ovine rumen fluid with herbage samples included at either 30% or 100% compared to a control substrate diet. All samples were run in triplicate fermentation vessels. Methane concentrations in total gas were quantified using GC-MS, and saponins were characterised via UHPLC-MS, representing a wide chemical spectrum. Methane production was analysed by one-way ANOVA, with principal component analysis (PCA) used to examine the relationships with saponin profiles.

Results Across all samples, both annual medics and lucerne showed potential to reduce methane *in vitro*, although the magnitude of reduction varied amongst species. The greatest reduction was observed in a *M. arabica* (Fig. 1); however, no consistent association was detected between total saponin concentration or specific saponin groups and methane in the PCA direct association between saponin composition or total saponin content of the dried herbage and methane reduction was not evident.

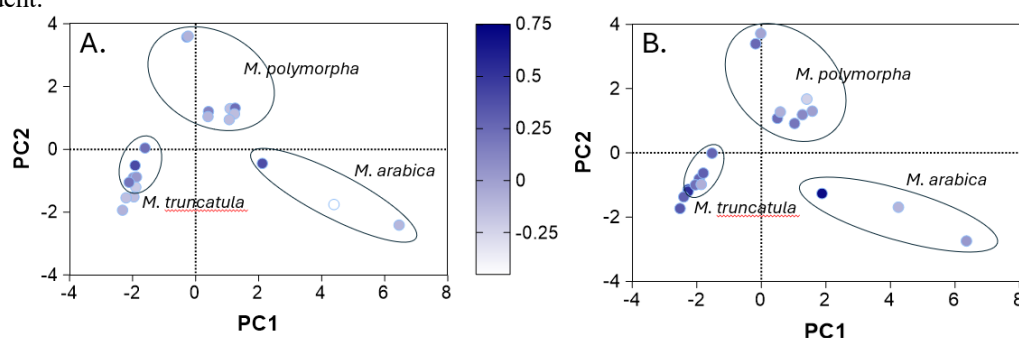


Figure 1. Principal component analysis (PCA) of saponins and percentage methane reduction from *in vitro* gas production testing for 20 annual medics at feed inclusion rates of (A.) 30% and (B.) 100%. Accessions separated along the first two axes based on saponins profiles, with the different *Medicago* spp. clustering together. Colour scale reflects the relative reduction of methane production (darker colour indicates greater effect) compared to a positive control feed sample and shows no trends in the PCA.

Discussion Our *in vitro* evaluation demonstrates that several *Medicago* accessions; both annual medics and lucerne, can reduce methane production compared to a substrate control diet. The most effective accession reduced methane substantially, highlighting the potential for genotype-based differences within the genus. Importantly, methane reduction did not correspond with total saponin class, indicating that saponins alone do not explain antimethanogenic response within the chemical diversity assessed. These findings emphasise the value of further biochemical and genomic characterisations. Overall, our results confirm that *Medicago* spp. contain accessions capable of reducing methane *in vitro*. Future work will include animal studies and expanded screening across the *Medicago* gene pool to validate these *in vitro* outcomes to identify mechanisms underpinning methane reduction.

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Water delivery and efficacy of antimethanogenic additives in grazing sheep in South AustraliaA.M. Lowe^{1*}, J. A. Hebron¹, E. Winslow², P. J. Verma¹, R. Quinlan³, P. Avarez-Hess³, S. Jacques³, Z. Durmic⁴, and A.C. Weaver¹¹South Australian Research and Development Institute, Livestock Welfare and Innovation, Turretfield Research Centre, SA, Australia. 5350.²Department of Primary Industry and Regions South Australia, Major Programs, Drought Resilience, Struan, South Australia³Rumin8 PTY, LTD, West Perth, WA, Australia. 6005.⁴University of Western Australia, School of Agriculture and Environment, Rumen Methane Group, AgGHG Research Hub, WA, Australia. 6009.

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Introduction This project investigated two classes of antimethanogenic additives, Agolin®Ruminant (AR, Feedworks) and water soluble stabilized bromoform (WSSB: Rumin8), delivered via drinking water under extensive grazing research conditions in South Australia. It was hypothesised that; (1) AR and WSSB could be effectively delivered via an automatic water delivery system; (2) neither additive would have an adverse effect on ewe health or productivity; and (3) both additives would reduce methane production under grazing conditions.

Methods and Materials During summer/autumn 2024, six-year-old, non-pregnant, non-lactating ewes ($n = 119$) accessed additives delivered via an intermediate bulk container (IBC) fitted to a concrete trough and a TruTest electronic ear tag reader. AR was delivered at a rate of 0.1 g/hd/day, and WSSB at 7.7 mg bromoform/head/day. IBC water levels were recorded daily and troughs flushed, cleaned and refilled twice weekly. Data regarding the daily additive (water) intake, effect on health (blood biochemistry), productivity (LW, BCS, wool growth) and methane production were collected. Ewes were stratified into one of three treatment groups and further divided into two replicates: $n = 6$ paddocks: no additive (control): $n = 39$; AR: $n = 40$ and WSSB: $n = 40$. Methane was measured using a small ruminant GreenFeed unit (C-Lock, USA) rotated between paddocks every three weeks with methane intensity calculated as g/d divided by animal LW. Data was analysed using a generalised linear mixed model, with water intake/consumption production and biochemistry analysed as repeated measures. Differences between treatment groups were considered significant at $P \leq 0.050$.

Results Both additives were successfully delivered via water, and there were no differences in the daily water intake measured between mobs or estimated for individuals (Table 1). While ~40% of animals visited the Greenfeed unit for methane measures, all animals accessed the water with the frequency of trough visits being greater for AR and WSSB animals compared with control ewes (Table 1). LW, BCS were unaffected by treatment ($P > 0.05$), creatinine kinase was reduced in WSSB animals ($P = 0.018$); however still within a healthy range, and wool length from AR ewes was 2.2 mm shorter than WSSB and Control ewes ($P = 0.001$).

Table 1. Drinking behaviour and methane intensity from ewes receiving either no antimethanogenic additive (Control), Agolin®Ruminant (AR) or Water Stabilised Soluble Bromoform (WSSB) through a closed water delivery system. Data presented as mean $\pm$ standard error mean

	Control	AR	WSSB	P
Ewes (n)	39	40	40	
Water Intake mob, L/d	83.96 $\pm$ 3.03	84.10 $\pm$ 3.05	82.44 $\pm$ 3.03	0.912
Water Intake ewe, L/d	4.27 $\pm$ 0.15	4.18 $\pm$ 0.15	4.04 $\pm$ 0.15	0.551
Trough Visits, n/d	4.03 $\pm$ 0.09 ^a	5.39 $\pm$ 0.06 ^b	5.66 $\pm$ 0.09 ^c	0.001
Methane, g/d	47.16 $\pm$ 2.56 ^a	28.95 $\pm$ 3.25 ^b	38.24 $\pm$ 2.95 ^c	0.001
Methane, g/d. LW	0.571 $\pm$ 0.14 ^a	0.388 $\pm$ 0.24 ^b	0.504 $\pm$ 0.15 ^a	< 0.001

^{abc}Superscripts indicate significant differences ($P < 0.05$) between treatment groups.

Discussion Both AR and WSSB were successfully delivered to sheep via drinking water without negatively impacting the health parameters. Additionally, both AR and WSSB reduced methane production in ewes, with AR having a greater reduction in methane intensity compared to both control and WSSB ewes. Further research investigating the long-term effects of AR and WSSB is warranted to determine optimum delivery and impacts on productivity and health while reducing methane output.

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Engaging Key Producer Influencers to Influence Knowledge, Skills and Attitudes Toward Reducing Emissions in Agriculture

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Introduction Ag Ex plays a pivotal leadership role in enabling South Australian broadacre grower groups to operate as an influential, interconnected network. These grower groups serve as “innovation brokers,” bringing together advisers, researchers, NRM organisations, resellers and farmers. They form the soft infrastructure that underpins on-ground practice change, providing trusted, locally relevant information and extension support (Nettle, 2017).

In 2022, Ag Excellence Alliance (Ag Ex) reviewed its strategic priorities and identified a significant gap in the preparedness of South Australia’s farming systems groups to address the challenges posed by climate change. To respond to this gap, Ag Ex appointed a Climate Smart Facilitator to build capability, foster collaboration, and develop practical initiatives to support emissions management across the State.

Recognising that change on farms is strongly influenced by the people and organisations farmers trust, Ag Ex adopted a strategy focused on engaging key influencers across the sector. Industry leaders, advisers, grower groups, government and independent organisations were brought together to build shared understanding, deepen their emissions-related capability, and extend this knowledge through their networks to producers.

Background Ag Ex was a key delivery partner with the Grower Group Alliance (WA) in the Australian Government’s Carbon Farming Outreach Program. Through this work, and by leveraging its strong ~~grower group and industry~~ networks across South Australia, Ag Ex gained detailed insights into current attitudes, capability and readiness relating to emissions management. The result of this project is a valuable baseline for shaping extension approaches and identifying emerging needs.

Materials and methods Baseline and exit survey of trainers involved, workshop participant evaluation, workshop summary reports provide quantitative data around learning outcomes. Consultants (29) from around the state (agronomists and livestock consultants) were contracted to the project which set out to increase farmer understanding of emission management and carbon farming. The model was to remunerate independent advisers to participate in training and subsequent workshop delivery with farmers, typically that they have a trusted and enduring relationship with. This approach factors local and deep insight into the audience needs to transfer information on a complex topic.

Network Engagement Findings Across all engagement activities, one message was dominant initially: market expectations for credible emissions data are increasing, however at conclusion there are no clear pathways for value capture from emissions reporting, and that farmers who start preparing now may be best positioned as the landscape evolves.

Mandatory Climate Related Disclosures combined with supply-chain initiatives from companies such as Cargill and PepsiCo, are signalling a shift where sustainability performance is becoming integral to doing business. New demand streams such as Sustainable Aviation Fuel feedstocks reinforce this trend. Banks alone have been identified by growers as asking for data. The carbon accounting tools with their limits to estimates, can currently be verified for higher confidence or used as planning guides.

Participants noted that many growers already collect much of the data required for emissions calculations, but current processes remain time-consuming and fragmented. There is strong demand for simple, integrated systems to streamline data capture. Among existing tools, G-GAF is considered the most accurate (where good data exists), while AIA offers greater usability, and several other calculators provide simple interfaces. The prevailing advice was pragmatic: start managing data, test the tools, and build familiarity over time.

From a management perspective, productivity was consistently identified as the most effective lever for reducing emissions intensity. Key contributors such as methane and nitrous oxide can be influenced through improved grazing practices and better nitrogen efficiency, while carbon storage typically requires actions ~~attention~~ outside the immediate farming operations. Farmers respond most strongly where sustainability actions align with profitability, efficiency gains, and emerging market opportunities for low-emission grain.

Industry-wide, participants highlighted the need for stronger grower advocacy supported by credible data, increased digital adoption, and targeted capability building from advisers, consultants and universities. Importantly, many growers are already implementing practices that align with sustainable and regenerative agriculture principles, even if they do not identify with the labelling.

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Methane inhibition alters carbon isotope ratios of wool in Merino sheep

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Introduction The measurement of enteric methane emissions poses a significant bottleneck in the development of strategies to reduce enteric methane. This study explored carbon isotope ratios of animal-derived products as a potential biomarker for measuring enteric methane emission. Methanogenesis in the rumen preferentially uses the light isotope of carbon, ^{12}C , concentrating the heavy isotope, ^{13}C , in the animal (Fig 1a) leading to the hypothesis that reducing enteric methane changes the carbon isotope ratios ($\delta^{13}\text{C}$) of the animal-derived products relative to the diet $\delta^{13}\text{C}$.

Materials and methods To test this hypothesis, a controlled feeding trial was conducted on Merino sheep with different levels of methane inhibition with the methane inhibitor 3-NOP (Bovaer®) (CSIRO Livestock Animal Ethics Committee Approval no. 24-06). The trial involved a ten-week baseline phase (no inhibitor) and a ten-week experimental phase (with inhibitor) and wool was collected at the end of each phase. The baseline and control diets were lucerne and oaten hay fodder cubes (Multicube). The methane inhibited groups received the same fodder cubes but with 3-NOP incorporated into them at levels of 55 (low), 130 (mid) and 256 (high) mg/kg DM, ensuring a constant ratio of 3-NOP to feed intake. Carbon isotope ratios of the wool and the feed were measured, and the difference was calculated as the wool-diet offset (Δ_{wool}) (Fig 1a). Methane yields during both periods were measured using respiration chambers. Differences among groups were assessed using ANOVA and Tukey's post-hoc test of pairwise comparisons.

Results Methane yields decreased by 22%, 34% and 53% for low, mid and high groups, respectively. The Δ_{wool} values did not differ among groups for the baseline phase (p -value = 0.08) but did differ during the experimental phase (p -value = $2\text{E-}5$) with all inhibited groups having significantly smaller Δ_{wool} than the control (p -values < 0.01; Fig 1b). Paired comparisons of the same animal's Δ_{wool} values from the baseline and the experimental phases showed no differences within the control group, but significant differences in the all methane-inhibited groups (p -value < 0.05).

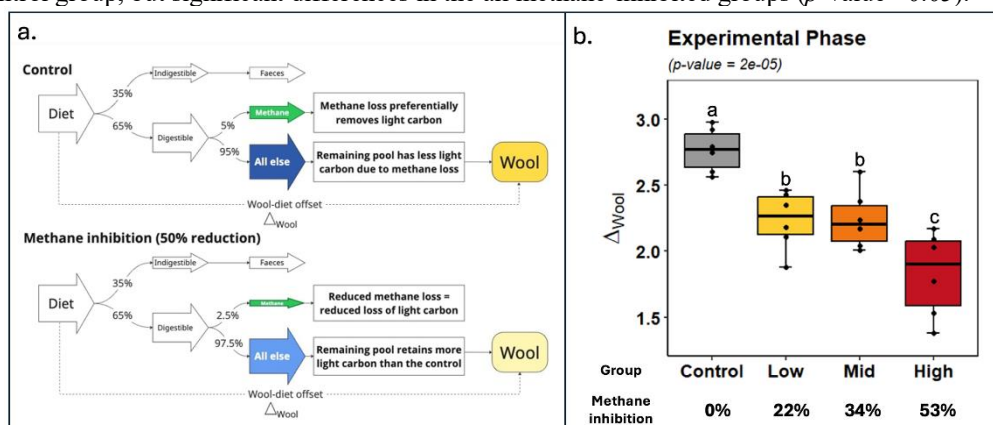


Figure 1. a) Schematic illustration of the hypothesised relationship between methane inhibition and carbon isotope offset between wool and diet (D_{wool}) b) Measured D_{wool} by group for the experimental period with significant differences indicated with letters.

Discussion The results of this feeding trial demonstrated that methane inhibition is associated with smaller carbon isotope offsets between wool and diet (Δ_{wool}). These results support the hypothesis that reduced enteric methane production reduces carbon isotope offsets in animal-derived products. The likely underlying mechanism for the observed isotopic shifts is the inherent fractionation (selective partitioning) of carbon isotopes during methane production by archaea (McInerney et al., In Review) that should also affect carbon isotope ratios in other materials biosynthesized by the animal. Furthermore, the same process should occur during methane formation in all ruminants. Therefore, carbon isotope offsets from diet have the potential to offer a widely applicable biomarker for enteric methane emissions. Future research should address the effect of diets, seasonality, species and production conditions and increase the number of animals studied to better account for individual differences.

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McInerney FA et al. (In Review). *Scientific Reports*. <https://doi.org/10.21203/rs.3.rs-8168311/v1>

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Assessment of methane reduction efficacy of 3-NOP delivered to cattle through drinking water

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Introduction Technologies that significantly reduce enteric methane (CH₄) emissions from ruminants need to be developed for livestock operations to reach a carbon neutral position. 3-nitrooxypropanol (3-NOP, commercial name Bovaer[®]) acts as a greenhouse gas mitigant by inhibiting methane production in the rumen. Novel ways of delivering the compound to grazing cattle, such as through drinking water, are being investigated, but high-resolution methane measurements and monitoring of drinking behaviour are required to understand its efficacy. The project studied the delivery of 3-NOP through drinking water to cattle under control feeding conditions using high-resolution technology (respiration chambers and water flow devices) to understand how drinking behaviour impacted 3-NOP effectiveness. It was hypothesised that the use of 3-NOP as an additive in drinking water will still reduce rumen methane emissions in cattle, although perhaps not to the same degree as when included in feed.

Materials and methods This study was conducted at CSIRO Lansdown Research Station, (Woodstock, QLD). A group of 16 Droughtmasters heifers (478 ± 28 kg) were selected and placed in a randomised complete block design, blocked by weight and randomly assigned to one of the treatments. Animals were allocated to two groups with eight animals per experimental group: Control (without 3-NOP in drinking water); or 3-NOP in drinking water. The trial followed a cross-over design with animals in Period 1 receiving: 30 mg 3-NOP/L of water and in Period 2: 60 mg 3-NOP/L of water. The animals were fed with a tropical Rhodes grass hay and were housed in each period in individual pens for 10 days before they entered for 48 h into the open circuit-respiration chambers for enteric methane and H₂ measurements. At the end of each period rumen fluid samples were collected via a stomach tube at 3 h post feeding. Water consumed by the animals was measured using electronic sensors through the day and treatment was provided through water using Smartdosing+ D25+ units. Data were analysed as a univariate model using the GLM procedure of SPSS, with the animal as the experimental unit and the treatment as the fixed effect.

Results Methane and H₂ production from animals receiving the treatment through drinking water were significantly different to control animals ($P \leq 0.05$). Methane production was reduced by 7% and 14% with 30 mg and 60 mg of 3-NOP per L of water respectively, while H₂ emissions increased when methane was inhibited in treated animals (Figure 1). The average daily water intake in chambers was 28.9 L and 28.2 L for control and 3-NOP respectively. Further observations indicated that a minimum intake of 0.4 uM of 3-NOP is required to get a methane inhibition response. Methanogen abundance was reduced, and metagenomic sequencing revealed significant differences in both microbial community composition and functional profiles between treated and control animals. A significant ($P \leq 0.05$) increase in formate, butyrate and propionate with a subsequent decrease in acetate were also observed in the treated animals.

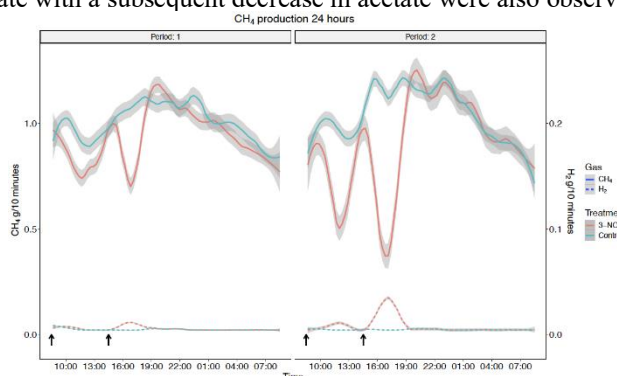


Figure 1. The average CH₄ (left axis, solid lines) and H₂ (right axis, dashed lines) production (g/ 10 minutes) profile for cattle treated with 3-NOP in water at 30 mg/L (Period 1) and 60 mg/L (Period 2) and respective controls. Arrow indicates when feed was offered.

Discussion This study demonstrated that Bovaer[®], can be administered via drinking water to cattle, detecting a decrease in methane production within the predicted range for the dose and diet used. The results confirm that when cattle consumed enough 3-NOP in water to reach a minimum intake of 0.4 uM of 3-NOP per event, significant reductions in enteric methane emissions can be achieved. The observed variability in methane reduction was associated with natural fluctuations in water intake leading to variations in 3-NOP ingestion by the animals. In addition, volume and frequency of intake of water with 3-NOP affected the extent of the inhibition with most drinking occurring after eating. Further research could focus on how to improve water delivery systems and how grazing behaviour, season and diet may influence overall effectiveness of this anti-methanogenic compound.

We gratefully acknowledge dsm-firmenich and Meat Livestock Australia for funding this work.

The Effect of Bromoform Supplementation on Microbial Communities of Pregnant Beef Cattle

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Introduction Bromoform extracted from Seaweed, primarily from *Asparagopsis* species, is reported as one of the most effective natural inhibitors of enteric methanogenesis in ruminants. While bromoform consistently suppresses methane production, its broader effects on rumen microbial ecology and functional metabolism remain poorly understood. Understanding these microbial responses is essential for predicting long-term efficacy, safety, and sustainability of seaweed-based methane-mitigation strategies.

Materials and Methods A total of 42 cows, aged between 3 and 12 years, with an average weight of 706 ± 71 kg, were randomly assigned to either a control group or a bromoform group over an average of 43 days. The cow individually received a daily supplement of 250 g of a customised concentrate blend containing canola oil, with or without the addition of bromoform extracted (487 mg/day) from *Asparagopsis armata* (SEAFEED; Sea Forest, Triabunna, Tasmania, Australia). Rumen fluid and rectal faecal samples were collected for metagenomic shotgun sequencing to evaluate taxonomic composition using Kraken2.

Results In the rectal faecal samples, the relative abundance of Euryarchaeota, which are the leading group of methane-producing archaea, reduced significantly from $96.4 \pm 2.42\%$ in the control group to $90.16 \pm 5.97\%$ in the bromoform-supplemented group (FDR = 0.000). In contrast, the Thermoproteota group showed a significant increase of $7.36 \pm 4.76\%$ in the supplemented animals compared to $2.52 \pm 1.65\%$ in the control group (FDR = 0.001). At the genus level, the relative abundance of *Methanobrevibacter* reduced from $82.01 \pm 7.84\%$ in the control group to $62.17 \pm 19.33\%$ in the bromoform-supplemented group (FDR = 0.001).

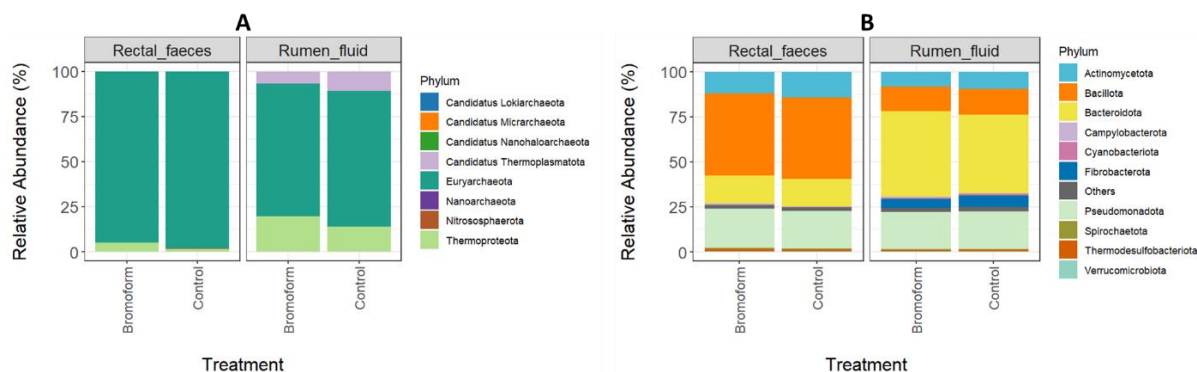


Figure 1. Phylum-level composition of the rumen microbiome analysed using whole-metagenome sequencing of rumen fluid and rectal faeces. (A) Archaea and (B) Bacteria.

Discussion: This study found that bromoform extracted from *Asparagopsis armata* selectively impacts specific archaeal groups, particularly those involved in methane production, while preserving the overall composition and functional balance of bacterial communities. Previous seaweed supplementation studies confirm this selective effect, with *Asparagopsis taxiformis* consistently suppressing *Methanobrevibacter* and *Methanosphaera*, accompanied by a relative increase in *Methanomethylophilaceae*, a group known for methylotrophic methanogenesis (Roque et al., 2019). These results indicate selective inhibition and community restructuring within the archaeome.

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Nutritional and anti-methanogenic potential of edible shrubs from central NSW

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Introduction Forage selection and manipulation have the potential to lower methane emissions in livestock production. Shrubs and browse species can comprise a significant portion of the diet for ruminant livestock for meat and wool production across many areas in Australia, especially in rangeland and more arid environments (Durmic, 2010). Shrubs often contain high levels of plant secondary compounds (PSCs) including polyphenols, tannins, and saponins, which have demonstrated inhibition effects on rumen archaea (Durmic, 2010). Shrubs can also offer additional benefits such as shelter, erosion protection and wind breaks. The objective of this study was to determine the fermentability and methane abatement potential of a range of shrubs foraged in NSW.

Materials and methods Shrub species were identified and sampled following confirmation of consumption by sheep foraging on them in adjacent pastures. Twenty-four shrub species were selected from locations in the central west area of NSW between May and October 2025. Samples were freeze dried and ground to 1mm at NSW DPIRD in Wagga Wagga. Total polyphenols (TP), total tannins (TT) and condensed tannins (CT) were analysed by spectrophotometry using FAO protocols. Rumen fluid fermentations over 48hrs were conducted using the Ankom RF Gas Production System as described by Kite (2025). Total gas volumes (TGV) were calculated using cumulative gas pressures, and the gas composition including methane production (MP) was determined by gas chromatograph (GC) and expressed as mL/g sample. Volatile fatty acids (VFAs) were also measured by GC in the fermented fluid (Kite, 2025). Pepsin cellulase digestibility (AFIA 1.7R) and crude fat (Method AOCS Am 5-04) analysis were conducted on all samples and metabolisable energy calculated using AFIA Method 2.2R (PC-ME).

Results Figure 1 plots the results of the analysis sorted for increasing MP (mL/g/MJ). There was a strong positive correlation with MP and TGV ($R^2 = 0.65$) that increased to ($R^2 = 0.91$) with removal of two outliers. MP also showed a relationship with VFAs ($R^2 = 0.57$) and to a lesser extent the ratio of acetate to propionate ($R^2 = 0.39$). There was a range of lipid content (1.9-11.0%) and MP was also influenced by the lipid content ($R^2 = 0.19$). *In vitro* methane values did show weak negative correlations with TP ($R^2 = 0.22$) and TT ($R^2 = 0.22$) but no correlation with CT ($R^2 = 0.02$). Protein values ranged between 7.2-23.3%, PC-ME values ranged between 5.4-10.2 MJ/kg.

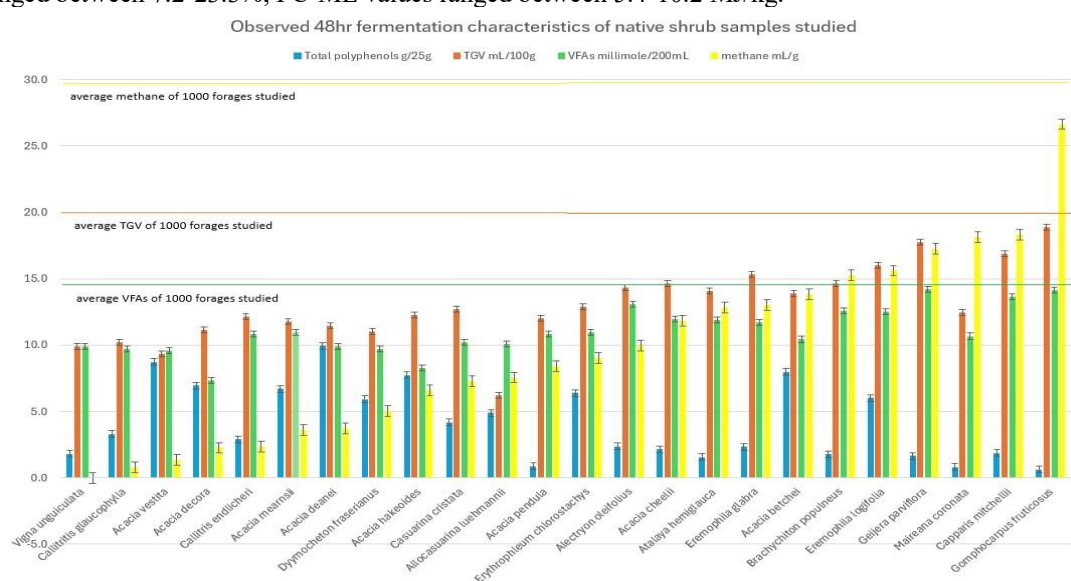


Figure 1 Total polyphenols, Total gas volume (TGV), Volatile fatty acids (VFAs) and methane mL/g

Discussion. All shrub samples gave MP values lower than the average observed for a diverse range of forage samples (n=1013) measured in a recent study. TGV values and VFAs for all shrub samples were also lower than the average of these measurands for the same set. A review of the MP, TGV and VFA results indicate many of these samples have significant potential for methane mitigation according to the guidelines discussed by Durmic (2010). Further *invitro* and *in vivo* studies will help determine if results translate to native shrub/pasture mixes and animal-based models, and if they can offer mitigation potential when used as a supplement to conventional forages and feeds.

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Geometric dose-response of *Lactobacillus* spp. on milk yield and enteric methane emissions in late-lactation dairy cows

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Introduction *Lactobacillus* spp. (LAB) based direct fed microbials (DFM) are widely used in ruminant nutrition to enhance productivity without leaving detectable residues in animal products (Lambo *et al.* 2021). However, the optimal dose required to improve performance while simultaneously reducing enteric methane emissions in pasture-fed dairy cows remains unclear. The objective of our experiment was to evaluate the effects of a geometric progression of doses of LAB supplementation on milk yield, composition, and enteric methane emissions in late-lactation dairy cows.

Materials and methods Fifty-five spring-calving Holstein-Friesian cows (mean $\pm$ standard deviation: 20.1 $\pm$ 1.86 kg milk/day; parity 3.2 $\pm$ 1.38; 209.4 $\pm$ 19.95 days in milk; body weight 637.5 $\pm$ 44.53 kg) were allocated to one of the five treatments: 1) Control (CON): basal diet only; 2) DFM1: basal diet + LAB (1×10^{10} CFU/day); 3) DFM2: basal diet + LAB (1×10^{11} CFU/day); 4) DFM3: basal diet + LAB (1×10^{12} CFU/day); 5) DFM4: basal diet + LAB (1×10^{13} CFU/day). Treatments were administered once daily in the morning at milking for 42 days. Basal diet comprised 5.3 kg DM/d grain mix offered in two equal amounts at milking and *ad libitum* vetch (*Vicia sativa* L.) hay. Individual dry matter intake, and milk yield were recorded for each cow. Methane emissions from individual cows were estimated using the modified SF₆ tracer technique (Deighton *et al.* 2014) over the last 5 days of the experiment. Data were analysed using CRD-based ANCOVA in Genstat 24 (VSN International, Hemel Hempstead, UK).

Results There were no linear or quadratic effects of the DFM dose for any parameters (Table 1). Total DMI, milk yield and energy-corrected milk were not affected by treatment ($P > 0.485$). Methane production, yield and intensity did not differ significantly among the treatments ($P > 0.365$), although, numerical reductions in methane yield were observed in DFM1 (8%), DFM2 (10%), and DFM3 (4%) compared to the control.

Table 1. Effects of LAB dose on dry matter intake (DMI, kg/d), milk yield (kg/d), energy corrected milk (ECM, kg/d), methane production (MeP, g/d), intensity (MI, g/kg ECM) and yield (MY, g/kg DMI) measured on days 38 to 42 of the experiment.

	Treatments					SED ¹	P value		
	CON	DFM1	DFM2	DFM3	DFM4		Treatment	Linear	Quadratic
n	11	11	11	11	11				
Total DMI	21.6	23.1	24.0	22.7	22.6	1.32	0.486	0.828	0.983
Milk yield	16.3	16.1	15.7	15.7	16.2	0.66	0.808	0.646	0.438
ECM	19.5	19.1	18.6	18.9	19.8	0.72	0.509	0.230	0.582
MeP	531	525	522	532	543	16.5	0.743	0.223	0.775
MI	27.7	27.2	27.2	27.8	27.9	0.91	0.876	0.514	0.608
MY	24.8	22.9	22.3	23.9	24.2	1.42	0.366	0.479	0.813

¹ SED = standard error of the difference between treatments

Discussion: Once daily supplementation with graded doses of LAB over 42 days did not significantly affect methane production, yield, or intensity in late-lactation dairy cows fed a predominantly forage-based diet. However, numerical reductions in methane yield of up to 10% were observed in some treatment groups, suggesting potential for modest mitigation effects. A continuous supply of DFM may be necessary to achieve significant impacts under forage-based feeding systems.

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Faecal NIRS to predict methane yield of cattle offered diverse subtropical foragesH. C. Norman^{A,B}, E. Hulm^A, M. G. Wilmot^A, J. K. Hendry^A, P. Young^A and E. Charmley^A^ACSIRO Agriculture and Food, WA 6014 Australia.^BCorresponding author. Email: hayley.norman@csiro.au

Introduction Near infrared reflectance spectroscopy (NIRS) is a rapid and inexpensive technology that is used to assess the nutritive value of feeds consumed by ruminant livestock. It is also used to predict information about the diets of cattle grazing in extensive systems (Coates and Dixon 2011). The Coates calibrations were commercialised by MLA and CSIRO to predict traits such as faecal nitrogen, dietary nitrogen, dietary dry matter digestibility, faecal ash and faecal carbon isotopes (proportion of C3 and C4 plants in the diet). The ‘master’ machine and associated data for this technology are maintained by CSIRO at the Floreat site. Our aim is to update these calibrations to improve predictions of diet quality and to include new traits such as intake, methane and methane yield.

Materials and methods This study utilised faecal samples and data from three pen feeding experiments conducted at CSIRO’s Lansdowne Research Station in Townsville between 2018 and 2020 (Suybeng et al 2021; Stifkens et al 2022). Diets included subtropical grasses, desmanthus, leucaena and lucerne. Daily dry matter intake (DDMI) was recorded, and methane emissions were measured using open circuit respiration chambers. Dried and ground cattle faecal samples (n=160) were scanned with a desktop machine (Unity Spectrastar 2600XTR; utilising wavelengths from 700 – 2500 nm) and partial least squares methods were used to develop statistical relationships between measured traits and absorbance.

Results Methane yield varied from 13.2 to 2.64 g methane/kg of dry matter intake. Figure 1 presents a regression of measured and predicted data for all animals. The calibration offered an R^2 of 0.78 and the mean error of prediction was 1.13 g/kg dry matter intake (DMI).

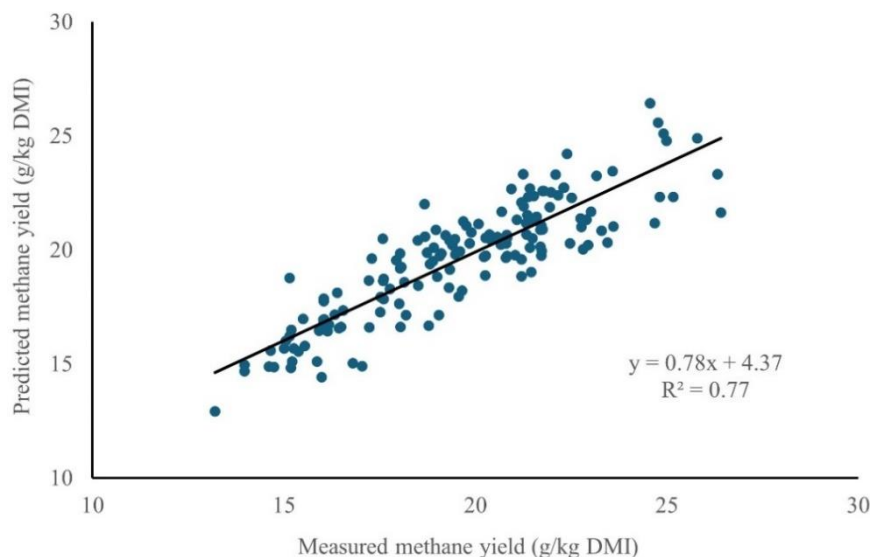


Figure 1. NIRS predicted and actual methane yield (g/kg dry matter intake) of cattle grazing northern forage systems.

Discussion This study demonstrated a significant opportunity to develop NIRS calibrations to predict methane yield from cattle grazing a range of diverse diets. Measurement of intake and methane emissions are laborious and require the use of metabolism crates and respiration chambers. This involves significant expense associated with forage harvest, feeding penned animals and maintenance of facilities as well as downsides associated with animal confinement and staff safety risks. Development of an NIRS-based methodology will enable preliminary field-based screening for low-methane forages and capture critical information regarding voluntary feed intake in extensive systems. Moving from dry and ground samples in a laboratory, to wet unground samples in the field remains a challenge due to errors generated by moisture, sample heterogeneity and ambient light. Future research aims to expand the commercial faecal NIRS commercial calibrations to include new traits and to broaden them to encompass southern cattle and sheep. We are working with the Global Methane Hub to develop methane and intake calibrations for dairy cattle in developing countries.

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Performance of Nellore cattle receiving a bromoform-based additive during the feedlot finishing phase

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Introduction Bromoform is a halogenated compound with strong inhibitory effects on ruminal methanogenesis and has emerged as a promising methane-inhibiting feed additive for cattle. While its efficacy in reducing methane emissions has been consistently demonstrated, limited information is available regarding its effects on growth performance and feed efficiency in feedlot systems, particularly in *Bos indicus* cattle. We hypothesised that supplementation with a bromoform-based antimetagenic additive would improve growth performance and feed efficiency in finishing Nellore bulls. Our objective was to determine whether a bromoform-based antimetagenic additive improves animal performance in a high-grain finishing system. Understanding these responses is essential to assess whether methane-mitigating strategies can enhance productivity in tropical feedlot systems.

Materials and Methods Eighty Nellore bulls (initial body weight 313 ± 19 kg) were housed in individual pens and assigned to control (n = 40) or additive (n = 40) in a randomized complete block design, using initial body weight as the blocking criterion. The 118-day finishing period included 21 days of adaptation to concentrate inclusion, and the additive was supplied to the additive group for 97 days following gradual adaptation (60, 80 and 100% of the recommended dose). The additive consisted of synthetic bromoform diluted in canola oil (Investigational Veterinary Product; Rumin8 Pty Ltd, Australia) and was provided at 30 mg/kg DM. Live weight was recorded periodically and dry matter intake (DMI) was measured daily. Performance variables included average daily gain (ADG), feed efficiency (FE = ADG/DMI), and residual feed intake (RFI), calculated as the residual from the regression of DMI on ADG and metabolic weight (BW^{0.75}). Data was analyzed using PROC GLIMMIX (SAS 9.4), with treatment as fixed effect and block as random effect (P ≤ 0.05).

Results

Table 1. Effect of a bromoform-based additive on intake, growth performance, and feed efficiency in finishing Nellore bulls.

Variable	ADDITIVE	CONTROL	P-value
Average daily gain (ADG, kg/day)	1.33 ± 0.04	1.34 ± 0.04	0.081
Dry matter intake (DMI, kg DM/head/day)	8.63 ± 0.19	8.35± 0.19	0.267
Feed efficiency (ADG:DMI)	0.160 ± 0.003	0.152 ± 0.003	0.043
Residual feed intake (RFI, kg DM/head/day)	-0.171 ± 0.123	0.176 ± 0.124	0.050

This table shows the values mean ± standard error of the mean (SEM).

Discussion Although ADG and DMI did not differ between treatments, the bromoform-based additive improved feed efficiency and reduced RFI, indicating enhanced metabolic efficiency. The improvement in feed efficiency is likely associated with reduced ruminal methane production and, consequently, lower energy losses, allowing more dietary energy to be directed toward growth without increasing feed intake. These findings are consistent with previous studies evaluating bromoform-based additives, which reported substantial methane mitigation without detrimental effects on feed intake or growth performance (George et al., 2024; Gyeltshed et al., 2025). In the broader project dataset, a 55% reduction in methane was observed, further supporting the potential of bromoform-based additives to enhance feed efficiency while maintaining growth performance in finishing Nellore bulls fed a high-grain diet.

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Gross and histopathological observations of the rumen after brominated compounds fed to sheep for 60 days

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Introduction Tribromomethane (TBM, bromoform) is the main antimethanogenic compound in *Asparagopsis taxiformis*, known for its effect on enteric methane. However, there are questions around the safety of feeding brominated compounds to ruminants (Glasson *et al.* (2022). Related effects, in particular on rumen wall integrity have been documented in sheep (Li *et al.* 2018) and cattle (Muizelaar *et al.* 2021). The objective of this study was to examine, describe and document pathological changes that occurred in the rumen of sheep when fed TBM or tribromoethanol (TBE).

Materials and methods This study was part of a larger trial designed to measure the effects of the 2 additives on feed efficiency and methane emissions, and postmortem examinations were conducted at the conclusion of the trial to assess rumen health. Sixty Merino wethers (housed in individual pens) were divided into 3 groups (Control, Treatment A, Treatment B) and fed a pelleted diet (ME 11%, DMD 90%, CP 12%, NDF 43%) for 60 days: Control pellet, pellet A with a 0.10 (w/w) TBM/ α -cyclodextrin mix added at 0.03% DM, or pellet B with a 0.10 (w/w) TBE/ α -cyclodextrin mix at the same concentration. Twice per week the animals were offered small amounts (≤ 300 g/h) of oaten hay for dietary and environmental enrichment. At the end of the experiment, 4 animals per group (n=12) were randomly selected for necropsy, with gross examinations of the rumen within 1 h of euthanasia. Representative 5×5 cm rumen sections from each animal (except for Treatment A where samples from only 3 animals were collected) were excised from the most severely affected areas in addition to unaffected areas. Sections were fixed in 0.10 (v/v) formalin solution. All samples were submitted to the VetPath laboratory (Jandakot, WA) for histology, where inflammation of the rumen was scored on a scale 0–3 (0=none; 1=mild, 0–25% of a 0.237 mm² circle; 2=moderate, 25–50% of a 0.237 mm² circle; 3= severe, >50% of a 0.237 mm² circle) and additional parameters including ulceration (% affected), microabscesses and fibrosis (present or absent) were assessed by a veterinary pathologist. These observations have not been statistically analysed.

Results All groups had some degrees of change of the rumen wall - in the Control group these were mild to moderate. In both treatment groups there were moderate to severe changes with large patches of marked parakeratosis with a cauliflower-like appearance (Fig 1a), nodular hyperplasia, bruising, haemorrhages, erosion, ulceration, and significant papillary loss. Microscopically, Controls showed mostly mild changes (score 1), with 1 case of mild to moderate inflammation. Treatment animals consistently scored ≥ 2 , including 2 severe cases (score 3) with neutrophilic infiltration and rumen epithelium necrosis. In Treatment A, 2 animals had ruminal ulceration affecting approximately 10% of the specimen surface examined, and 1 animal had 25% of the specimen area affected. All treatment animals had fibrosis and 6 had microabscesses, whereas only 1 Control animal had fibrosis. Submucosal lymphangiectasia was also observed in 6 out of 7 animals examined in treatment groups, present in 0–25% (n=2), 60–70% (n=2) and 80–90% (n=2) of the examined specimen. One Control animal had submucosal lymphangiectasia present in 70% of the examined specimens.

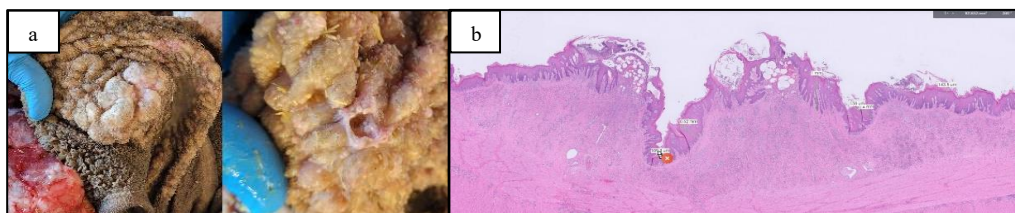


Figure 1. a) Parakeratosis and ulceration of rumen **b)** Loss of papillae, mucosal hyperplasia with rete pegs, areas of erosion, mucosal necrosis, sloughing, vacuolation of submucosa and grade 3 inflammation.

Discussion While animals fed pelleted feed can exhibit some degree of parakeratosis (Radostits *et al.* 2007), in this observational study, those fed brominated compounds TBM and TBE had more pronounced gross and histological pathological lesions in the rumen than those fed the Control pellet. Similar findings have been reported by Muizelaar *et al.* (2021) when supplementation with *Asparagopsis taxiformis* lead to ruminal epithelial disruption and inflammatory changes alongside methane reduction in cattle. Antimethanogenic feed additives can play an integral part in reducing greenhouse gas emission from ruminant agriculture, however these observations highlight the need for assessing animal health alongside other objectives, to ensure development of additives that are effective and safe.

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Long term supplementation of grazing sheep with an essential oil blend – effects on methane, reproduction, productivity and health

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Introduction Enteric methane emissions from ruminants are the main source of agricultural greenhouse gases in Australia where most ruminants are raised in grazing systems but mitigation strategies remain underexplored (Badgery *et al.* 2023). A potential solution is delivery of plant-based, low-cost methane mitigation strategies which could also offer co-benefits, such as improved animal health, rumen efficiency and productivity. A blend of essential oils, Agolin Ruminant® (AR), originally developed to promote animal production has shown a modest effect in reducing methane in cattle, but recent reports demonstrated up to 33% reduction in sheep (Prathap *et al.* 2023, Subedi *et al.* 2024). The objective of this study was to evaluate AR in grazing ewes, quantifying methane mitigation and effects on reproduction, productivity, and health under extended supplementation.

Materials and methods Merino ewes (n=225, age 3 yrs, 60 ± 0.4 kg liveweight, LW) were allocated to 9 paddocks (3 ha, 3 paddock replicates per treatment, n=25). Over 16 months (Apr 2024-Aug 2025), custom-made supplementary pellets (ME 13%, DMD 84%, CP 21%, NDF 28%) were delivered via lickfeeders, and included a pellet without AR (Control), or AR at 100 mg/ewe.d (Low AR) or 300 mg/ewe.d (High AR). Methane was measured using 3 GreenFeed® units (GF; C-Lock Inc., Rapid City, USA) between Nov 24-Jun 25, with each paddock having 2 measurement blocks of approx. 1 month duration. Methane measurements lasting >2 min were analysed. Ewe LW was measured monthly and body condition score (BCS) every 2 months. Ewes lambed twice during the study (Yr 1 and Yr 2). Fleece weights were measured at shearing in Jan 25. Volatile fatty acids (VFA) and ammonia (NH₃) concentrations were measured in rumen fluid samples collected at the beginning, middle and end of the study and used as health indices. Data were analysed using linear mixed effects model fitted by REML in R (methane only; R Core Team, 2023) or JMP Student Edition 18 (SAS Institute, Cary, USA) with least squares means compared using the Tukey-Kramer HSD test.

Results Compared to Control, in the period Nov 24-Feb 25 methane production (MP; g/d) was numerically reduced (p>0.05) by 18.5% and 25.5% in the Low AR and High AR groups, respectively, but in the period Mar 25-Jun 25, the Low AR group had only 7% lower MP, whereas the High AR group had greater MP than Control (Table 1). Ewe LW and BCS were not affected by the treatments, nor were fleece weights, reproduction parameters, VFA or NH₃.

Table 1 Average (LS mean ± SE) methane production (MP; g/d), reproduction rate (%; Yr 2), average daily weight gain (kg/d), body condition score (BCS; endpoint), greasy fleece weight (kg), total volatile fatty acids (VFA; mmol/L; endpoint) and ammonia (NH₃; mg/L; endpoint) across the three treatment groups.

	Control	Low Agolin	High Agolin
<i>Methane</i>			
MP (Nov24-Feb25)	43.1 ± 2.4	35.1 ± 2.4	32.1 ± 3.2
MP (Mar25-Jun25)	27.5 ± 2.3	25.5 ± 2.2	32.7 ± 2.6
<i>Reproduction</i>			
Reproduction rate	139 ± 4.06	146 ± 1.10	131 ± 5.81
<i>Productivity</i>			
ADWG	0.71 ± 0.05	0.72 ± 0.03	0.80 ± 0.04
BCS	3.7 ± 0.06	3.4 ± 0.04	3.5 ± 0.05
Greasy fleece weight	4.46 ± 0.09	4.32 ± 0.08	4.47 ± 0.07
<i>Health</i>			
Total VFA	83.24 ± 7.45	69.6 ± 7.48	72.8 ± 7.50
NH ₃	143.4 ± 24.87	138.5 ± 24.92	98.1 ± 24.96

Discussion Supplementation with AR numerically reduced MP of grazing ewes by 18.5% (Low AR) and 25.5% (High AR), however this was not observed consistently across 7 months of GF measurements. This inconsistency may be due to a changing feedbase over seasons, while the lack of significance in the effect was most likely due to low visits to the GF units resulting in high variance within animal and between animals. There were no effects of AR supplementation on reproduction, productivity and health. This is the first evaluation of AR in a long-term grazing trial with sheep, and observations of methane mitigation are promising. However, this study also highlighted the challenge of measuring methane with GFs under grazing conditions, and future work is needed to understand how the seasonal variables present in a grazing system change the efficacy of AR.

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A Techno-Economic Assessment of the Potential to Reduce Enteric Methane from Australian Livestock Systems

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Introduction In 2023, 45% of national methane emissions were from enteric fermentation (DCCEEW 2025). Several technologies and approaches are either currently available or being developed to reduce enteric methane emissions. However, their efficacy, cost and likelihood of adoption vary between production systems. The aim of this project was to assess the cost and mitigation potential of interventions at the national scale whilst accounting for regional variation in production system attributes.

Materials and methods Production systems were clustered into five typologies (Table 1) based on farm area, herd size, stocking density and proportion of farm cropped (ABARES 2025). For each production system, the practical feasibility of different intervention options and how they could be implemented as part of existing management systems was reviewed. For example, additives would be easy to include as part of a total mixed ration in feedlot and dairy systems, whereas in extensive grazing systems, they could be incorporated into a dry-season loose mineral mix or water delivery system. While the consumption of additives in the intensive systems would be tightly regulated, consumption of mineral mixes and water varies between animals and across seasons, so the efficiency of emissions abatement would be less in extensive systems. Emissions abatement cost was quantified using a recursive farm systems economic model developed for representative farms in each system. The model simulates herd dynamics, pasture development, supplementary feeding under stochastic cattle price and cost pathways. Adoption likelihoods for key technologies were incorporated using the ADOPT framework (CSIRO 2025). Adoption profiles were then integrated with farm-level abatement outcomes to estimate both technically and financially achievable emissions reductions. Results were aggregated using bottom-up scaling that transferred results from farm scale to regional level using regional cattle head counts. National marginal abatement cost curves (MACCs) were constructed that reflect regional system dynamics.

Results and discussion The results will be used to frame government abatement policy and guide future research. Modelling analysis is still on-going, and results will be presented at the AAAS conference in July.

The literature review highlights the need for a diversity of mitigation options to overcome the challenges posed by diverse production systems. Emphasis is placed on the difficulty and cost of reducing emissions from extensive grazing systems, which is where most emissions of enteric methane originate (Table 1). It is easier to implement emissions reduction technologies in feedlot and dairy systems where animals are intensively managed. However, these systems are already operating at close to maximum efficiency and contribute only 11% of national enteric methane.

Table 1. Indicative reductions (%) in enteric methane for systems × technologies based on review of literature and conversations with experts in emissions abatement. These estimates are being refined through farm system modelling.

	Feedlot beef	Intensive beef, sheep & dairy	Mixed crop- livestock	Extensive beef	Very extensive grazing
Share of national emissions	Small				Large
Ease of intervention	Easy				Hard
Additives	80	40	30	20	20
Dietary improvement	0	5	10	10	15
Genetics		1% reduction per year for all species & systems			
Herd management	0	5	5	5	5
Rumen modification			Unknown.		
Vaccination	Researchers are targeting a 30% reduction. Applicable to all species & systems				

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The effect of bromoform combined with a probiotic on greenhouse gas emissions in Angus weaners

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Introduction Livestock production is responsible for 70% of Australia's greenhouse gas emissions. Bromoform, a compound that inhibits methane (CH₄) production in the rumen, has been shown to reduce emissions between 30 to 98% have been reported to date when supplemented in cattle, but the effects on performance are conflicting (Glasson et al., 2022). Probiotic supplementation has shown methane abatement properties but is more known for boosts in productivity via rumen modulation (Kelsey and Colpoys, 2018). Hence, combining the two products could achieve a synergistic effect with large improvements in performance and methane abatement. This study assessed the combination of feeding bromoform and a probiotic supplement on dry matter intake (DMI) and enteric CH₄ emissions in roughage-fed Angus weaners.

Materials and methods Sixty Angus weaners were blocked into two treatment groups: control (Con = 30) and bromoform combined with a probiotic (BPro = 30) based on initial body weight (322 ± 50 kg, mean $\pm$ s.d.). Both groups received 250g of soybean meal homogenised with 47.7mL of oil with or without (Con) the inclusion of bromoform (BPro; 0.69 mg of bromoform/ kg BW + 30 g of a probiotic pellet per head. GreenFeed units were used to quantify CH₄ emissions throughout the trial, and a baseline measurement was collected before experimental supplementation started (day 0). Metabolisable energy intake (MEI) was quantified as per Caetano et al. (2017), and subsequently, DMI was estimated. Data was analysed via a mixed model within R Studio, where treatment (T; BPro vs Con), day of supplementation (D; 0 to 42) and the interaction (T $\times$ D) were fitted as fixed effects and animal ID was fitted as a random effect to account for variability within animals across days. A probability of < 0.05 was considered significant.

Results There were no differences in MEI ($P = 0.853$; BPro - 81.70 ± 2.74 MJ/ day and Con - 80.77 ± 2.69 MJ/ day) or DMI ($P = 0.86$; BPro - 7.76 ± 0.26 kg/ day and Con - 7.68 ± 0.25 kg/ day) between the treatment groups over the trial period. There was, however, a significant interaction between day of supplementation and treatment for CH₄ emissions (Figure 1; $P < 0.001$), where the BPro group had 49.7% lower emissions than the control group in the first 14 days. The difference in mitigation observed was lower in the following 28 days, with 30% day 21, 39.7% by day 28, 30.5% by day 35 and 38.8% by day 42.

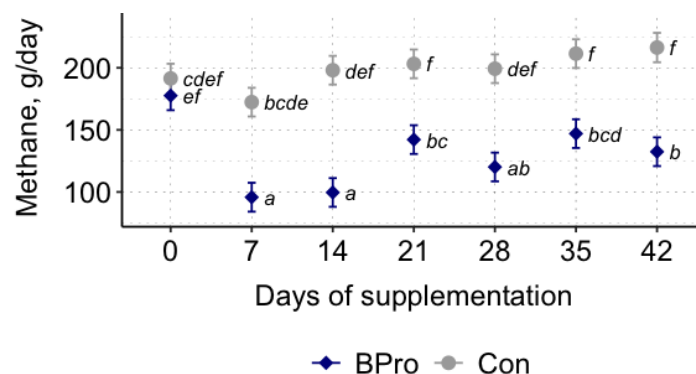


Figure 1. The interaction between the day of supplementation and treatment ($P < 0.001$) and its effect on methane emissions (g/day) when Angus weaners were fed a control supplement or the combination of Bromoform and probiotics over 42 days. a, b, c, d, e, f Differing superscripts depict significance.

Discussion The combination of bromoform and a probiotic was successful in reducing methane emissions in Angus weaners in an extensive system. Although mitigation was achieved, the level of abatement was lower than that observed with bromoform independently in other studies at similar dosage rates (Glasson et al., 2022). Additionally, DMI was not impacted, which raises questions about the economic viability of using the products in combination when considering the costs per head per day. Further research is required to evaluate dosage rates and strains of probiotics to establish whether a synergistic relationship is possible between these products to achieve boosts in performance and supersede the products' performances when used independently.

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Commercial-scale evaluation of a low-methane ration for reducing enteric methane emissions in sheep

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Introduction Enteric methane emissions from sheep are a major greenhouse gas source from livestock. Effective mitigation requires integrated strategies combining nutritional interventions, animal management, genetic selection, and biotechnologies to deliver reductions at commercial scale without compromising productivity (Almeida *et al.* 2021). Dietary approaches are attractive because they can be implemented rapidly through existing feed chains and operate synergistically with other measures (Beauchemin *et al.* 2020). Milne Feeds has adopted a holistic approach coupling innovation in feed formulation with on-farm adaptation and measurement technology to reduce emissions while enhancing animal performance, profitability, and environmental outcomes. This study evaluated the methane mitigation efficacy of a low-methane ration (MAG-LM) under commercial conditions following extensive *in vitro* screening. It was hypothesised that sheep fed MAG-LM would have lower enteric methane emissions and emission intensity than those receiving a conventional farmer-formulated homemix ration, while maintaining growth and carcass performance.

Materials and methods A commercial time-series feeding trial involving 1,600 crossbred lambs compared MAG-LM with a conventional homemix ration. MAG-LM was formulated using a single-batch artificial rumen system to identify diets with reduced methane production potential while maintaining nutritional adequacy. Lambs were managed under standard commercial conditions. Methane emissions were continuously monitored on-farm using open-path Fourier transform infrared spectroscopy (OP-FTIR), a non-intrusive micrometeorological method providing repeated, path-integrated measurements without disturbing normal animal behaviour (Tomkins *et al.* 2011). OP-FTIR systems have been successfully applied in grazing and feedlot environments and can provide near-continuous estimates of methane flux when combined with dispersion modelling (McGinn *et al.* 2019). Animal performance was assessed through average daily gain (ADG) and feed conversion ratio (FCR), with feed intake and liveweight recorded at regular intervals. On reaching market weight, lambs were processed under standard commercial conditions and carcass traits obtained. Methane yield (g CH₄/kg dry matter intake), emission intensity (kg CH₄/kg liveweight gain), and total emissions per cohort until slaughter were derived from OP-FTIR measurements combined with intake and growth data. Data were analysed using time-series models with ANOVA.

Results MAG-LM reduced methane production by 84% relative to the control diet ($P < 0.01$) in *in vitro* screening. When fed to two cohorts of 400 lambs, MAG-LM resulted in a methane yield of 14.36 g CH₄/kg dry matter intake, emission intensity of 0.09 kg CH₄/kg liveweight gain, and total emission of 574.75 kg CH₄ until slaughter. Methane fluxes showed a consistent diurnal pattern, with lower emissions overnight until early morning and higher emissions later in the day, consistent with feeding behaviour and previously reported cycles (Hristov *et al.* 2013). Overall, MAG-LM reduced methane emissions by 72.83% compared with conventional homemix ration. Lamb growth performance as indicated by ADG, FCR and carcass yield remained within commercial expectations, suggesting that the large reduction in methane was not achieved at the expense of productivity.

Discussion The marked reductions in methane yield and emission intensity with MAG-LM under commercial conditions demonstrate the potential of targeted nutritional strategies to deliver substantial, practical enteric methane abatement in sheep systems. These findings support holistic ration formulation integrating multiple nutritional levers (e.g. fermentable carbohydrate balance, lipid inclusion, and fibre digestibility) and feed processing technology rather than single additives (Beauchemin *et al.* 2020). The close agreement between *in vitro* screening and *in vivo* response highlights artificial rumen systems as cost-effective tools to prioritise formulations prior to field validation (Bekele *et al.* 2025). Maintaining ADG, FCR and carcass yield while lowering methane emission intensity improves both environmental and feed-use efficiency outcomes and can help the lamb sector progress towards greenhouse gas reduction targets without compromising market specifications. The results are consistent with previous work showing ration composition and processing can substantially influence methane yield in lambs with minimal impact on growth when diets remain nutritionally balanced (Maweu *et al.* 2024). Overall, MAG-LM demonstrates that significant, sustained reductions in enteric methane emissions at commercial scale are achievable through targeted ration design informed by *in vitro* screening and supported by continuous OP-FTIR monitoring, providing a scalable, feed-based pathway for the sheep industry to lower emissions intensity while maintaining animal performance and carcass value.

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Efficacy of Tribromomethane Rumen Boluses on Methane Emissions in Beef Steers

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Introduction Enteric methane (CH₄) emissions from beef cattle contribute to global greenhouse gas emissions and efforts to address these are essential for mitigating climate change. Tribromomethane (TBM) reduces CH₄ production by inhibiting the methyl-coenzyme M reductase (MCR), a key catalyst in methanogenesis (Glasson et al., 2022). TBM is naturally derived from red seaweed (*Asparagopsis* spp.) and it can also be manufactured synthetically (Glasson et al., 2022). The objective of this study was to evaluate the effect of a rumen bolus with slow-release TBM on CH₄ production in beef steers. It was hypothesised that animals that received rumen boluses with TBM would reduce CH₄ emissions compared to those receiving placebo boluses.

Materials and Methods Sixty Hereford steers [396 ± 21.5 kg (mean $\pm$ SD)] were randomly allocated to one of two pens (30 animals/pen) and then each steer randomly received two control (placebo) or two TBM boluses (15 animals/pen/treatment; Ruminant BioTech Corp Ltd, Auckland, New Zealand). Gas exchange data was collected using a GreenFeed unit (C-Lock Inc., South Dakota, USA) that delivered 1 kg/animal/day of lucerne pellets. A basal diet of 66:33 lucerne: oaten chopped hay was delivered in electronic feeders (Intergado®, Betim, Minas Gerais, Brazil). Daily summary values were calculated for each variable and then averaged for each animal throughout the 90-d experimental period. Calculation of total dry matter intake (DMI) included both pellet and hay DMI. A linear regression model with treatment and pen as the fixed effects was analysed in RStudio, but pen ($P > 0.05$) was dropped.

Results. Steers in TBM showed a reduction of 29% in CH₄ production ($P < 0.001$) and 24% in CH₄ yield ($P < 0.001$) compared to the placebo group. In contrast, TBM showed higher H₂ production compared to control steers ($P < 0.001$). The TBM steers also showed lower CO₂ production and O₂ consumption compared to placebo steers ($P < 0.05$). Total DMI was not significantly impacted by treatment ($P > 0.05$) but tended to be lower in TBM compared to placebo animals.

Table 1. Gas exchange and total dry matter intake and of steers administered placebo or tribromomethane (TBM) slow-release rumen boluses to growing steers.

Variable	Placebo	SE	TBM	SE	P-value
CH ₄ , g/d	254.2	11.96	181.2	11.70	<0.001
CH ₄ yield, g/kg DMI	28.43	1.303	21.51	1.270	<0.001
CO ₂ , g/d	6986	200.1	6341	196.0	0.026
H ₂ , g/d	0.57	0.221	1.74	0.22	<0.001
O ₂ , g/d	4640	125.0	4235	122.5	0.025
Total DMI, kg/d	9.05	0.310	8.24	0.310	0.069

Discussion The present study used slow-release TBM rumen boluses for a period of three months and seems to be the first study published with boluses containing TBM in cattle. Sun et al (2025) demonstrated that a high dose of TBM dietary supplementation reduced CH₄ production and yield as in the present study, but increased DMI in steers fed a forage diet (Sun et al., 2025). In contrast a meta-analysis by Kebreab et al. (2025) found that DMI was decreased alongside CH₄ production and yield decreases with dietary supplementation of TBM. Both Sun et al (2025) and Kebreab et al (2025) determined the same result for CH₄ production and yield as observed here, though provide different results for DMI impacts. Comparing this to the trend observed with the current study indicates that further work is required to articulate potential impacts here. The increase in H₂ production of the present study suggests that hydrogen was diverted from CH₄ to H₂ when MCR was inhibited by TBM (Glasson et al 2022; Kebreab et al., 2025). In conclusion, the present study demonstrated that a slow-releasing rumen bolus containing TBM is a promising and practical tool to reduce CH₄ production in beef cattle fed high forage diets with broad applications to different production systems including extensive grazing enterprises. Further research in different production systems and animals is required to support broad adoption of this novel technology.

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Assessing the effect of feeding *Asparagopsis*-based feed additives on bromoform, dibromomethane and bromomethane residues in milk during a whole lactation

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Introduction *Asparagopsis*-based formulations have proven highly effective in reducing enteric methane emissions from ruminants, with their antimethanogenic effect largely attributed to the halogenated compound bromoform (Machado *et al.* 2016). However, little research has investigated the cumulative effects of continuous exposure to halogenated compounds on bromoform excretion in milk from dairy cows. Our study aimed i) to determine the effect of naturally-derived bromoform from *Asparagopsis* on bromoform concentrations in milk when fed twice daily at milking over a full lactation; ii) to evaluate changes in bromoform concentrations in milk when cows were fed increasing concentrations of *Asparagopsis* formulation during the introductory period, and after the cessation of *Asparagopsis* formulation in the diet.

Materials and methods Sixty lactating, multiparous, Holstein-Friesian cows were allocated to one of two treatments: CON (0 bromoform/d) and BR (270 ± 27 mg bromoform/d). The treatment formulations were provided by GrainCorp (GrainCorp Feeds, Hamilton, Queensland, Australia) and mixed with the cow's grain offered twice daily during milking. The basal diet consisted of perennial ryegrass (*Lolium perenne* L.) *ad libitum* with supplemental pasture silage offered during summer. Milk samples were collected in the introductory period, as cows were introduced to their full treatment allocation (on experiment days 6, 12 and 18, corresponding to 46, 138 and 229 mg of bromoform fed per day respectively), and on experiment days 35 to 39 (early lactation, EL), 109 to 113 (mid-lactation, ML), 235 to 239 (late-lactation, LL) and every three days during the washout period (experiment days 241, 244, and 247) for analysis of bromoform, dibromomethane and bromomethane by GCMC. Introductory period data were analysed using ANCOVA with polynomial regression. EL, ML and LL data were subjected to RCBD-based repeated measures split-plot ANOVA.

Results Bromoform, dibromomethane and bromomethane were not detected in milk from control cows. During the introductory period, bromoform concentration in milk increased linearly ($P < 0.001$) with increasing bromoform concentration offered in the BR treatment (Figure 1). Neither dibromomethane nor bromomethane was detected in milk at any stage of the experiment. Bromoform concentrations in milk were greater in late lactation than in early lactation, with a maximum bromoform concentration in milk of 7.62 µg/L. During the washout period, bromoform concentration in milk fell below the detection threshold within three days of cessation of the BR treatment.

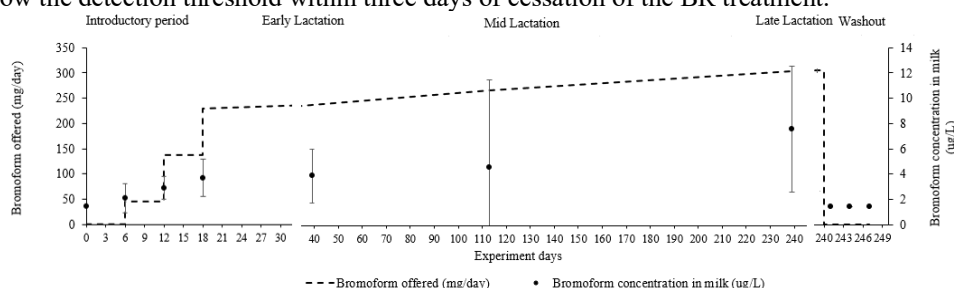


Figure 1. Bromoform offered (mg/day) and bromoform concentration in milk (µg/L) as measured during the introductory period; early, mid and late lactation; and washout period.

Discussion Continuous feeding of *Asparagopsis*-based formulations over a full lactation resulted in detectable but low bromoform concentrations in milk, with the maximum concentration detected being one twelfth of the World Health Organisation guideline value for safe drinking water (100 µg/L; WHO, 2017). The greater concentrations of bromoform in late lactation were likely due to a combination of greater bromoform intake and lower milk yield rather than cumulative accumulation. In conclusion, twice-daily feeding of *Asparagopsis*-based formulations to dairy cows over a full lactation resulted in bromoform concentrations in milk well below international safety thresholds, and rapid elimination from milk after feeding ceased, indicating no evidence of long-term accumulation. These findings support the safe use of *Asparagopsis*-based feed additives in dairy production systems when managed under controlled feeding conditions.

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Combining Bromoform with a Phytogenic Compound Enhances Tissue Cellular Integrity in Beef Cattle

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Introduction The red macroalgae *Asparagopsis taxiformis* and *Asparagopsis armata*, which contain bromoform, have emerged as promising strategies for mitigating rumen microbial methanogenesis (Gyeltshen et al., 2025). Activo Premium, a phytogenic feed additive containing a blend of plant-derived bioactive compounds, including essential oils and secondary metabolites with antioxidant properties, is formulated to modulate rumen fermentation, reduce methane emissions, and enhance ruminant performance (Soltan et al., 2018). Although both supplements have been evaluated individually for their effects on rumen fermentation and methane mitigation, their combined impact on animal health remains poorly understood. This study aimed to assess the effects of supplementing bromoform combined with a phytogenic compound on histopathological lesions in the kidney, liver, and rumen. It was hypothesized that this combination, due to the antioxidant properties of the phytogenic compound, would confer cellular protection and attenuate tissue damage.

Material and Methods Twenty-one Angus steers (572.3 ± 6.2 kg; 20 ± 0.01 months; mean ± s.d.) were allocated to either a control group (n = 11) or a treatment group (BPhy; n = 10) fed bromoform (SeaFeed; Sea Forest Ltd., Triabunna, Tasmania, Australia) combined with a phytogenic compound (Activo Premium; EW Nutrition GmbH, Hogenbögen, Visbek, Germany) for 42 days under grazing conditions. The BPhy group received canola oil containing 291 mg bromoform/head/day for the first six days, and from day seven onwards, the same dose of bromoform was provided together with a phytogenic compound (3 g/head/day). Kidney, liver, and rumen tissues were collected at slaughter for histopathological assessment. All data was analysed in RStudio using packages biometryassist and ASReml-R.

Results The BPhy group exhibited a significantly lower proportion of abnormal kidneys compared to the control group (P = 0.026), suggesting a protective effect of the bromoform-phytogenic combination on renal tissue (Table 1). In contrast, no significant differences were observed between the groups for liver and rumen tissues, indicating that these organs were largely unaffected under the conditions of this study.

Table 1. The effect of treatment and the proportion of cellular morphological abnormalities in various tissues of grassfed Angus cattle at finishing stage.

	Control (n = 11)	BPhy* (n = 10)	P-value
Kidney	0.727	0.100	0.026
Liver	0.182	0.100	0.603
Rumen	0.364	0.400	0.866

* Bromoform (291 mg/head/day) combined with a phytogenic compound (3 g/head/day).

Discussion These results indicate that a moderate dose of oil-stabilized bromoform, when combined with a phytogenic compound, can enhance cellular integrity and overall tissue health in beef cattle. The combination appeared to reduce histopathological lesions in kidney, suggesting a protective effect at the cellular level. This finding highlights the potential of integrating bromoform with phytogenic additives as a strategy to support animal health. Future studies should evaluate each product independently and in combination to clarify their individual and synergistic effects.

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Methane yield of dairy cows is correlated with the ratio of methane and carbon dioxide in their breathS.R.O. Williams^{A,C}, S. Chandra^A and L.C. Maret^{A,B}^AAgriculture Science & Technology, Department of Energy Environment and Climate Action, VIC 3821 Australia^BSchool of Applied Systems Biology, La Trobe University, Bundoora, VIC 3803, Australia^CCorresponding author. Email: richard.williams@agriculture.vic.gov.au

Introduction Measuring enteric methane emissions from ruminants is time consuming and expensive. The use of proxy measures that predict methane emissions could overcome these constraints. It has been shown that the mass ratio of methane and carbon dioxide emitted by dairy cows in respiration chambers is strongly correlated to both methane production (MeP, g/day) and methane yield (MeY, g/kg dry matter intake, DMI) (Moate et al., 2018a). However, it is not known if these correlations hold when expired gases are measured using a different technique to obtain representative daily samples, or if the ratio of gas concentration is correlated to MeY. We hypothesised that 1) the ratio of CH₄ to CO₂ exhaled by dairy cows over a day would be correlated with MeY regardless of measurement technique, and 2) the ratio of gas concentrations would be correlated with MeY.

Materials and methods Previously cleaned data were collated from 10 experiments (372 records) where gases were measured using respiration chambers (Grainger et al., 2007, Moate et al., 2018b) and 9 experiments (10 measurement periods, 379 cow mean records, 1788 daily concentration records) where daily representative breath samples were captured using the modified SF₆ technique (Deighton et al., 2014). Concentration ratios were calculated as the raw ratio (gases in cow sample) and the corrected (cow – background) ratio. Concentration ratios were averaged within cow within experiment to enable matching to MeY data. A regression with groups analysis (Cave and Baird 2023) was done using Genstat 24 (VSN International, Hemel Hempstead, UK).

Results The Chamber and SF₆ regressions with methane yield had different intercepts but the same slopes (Figure 1a, $r^2 = 0.475$). The raw and corrected regressions with methane yield also had different intercepts but the same slope with methane yield (Figure 1b, $r^2 = 0.376$).

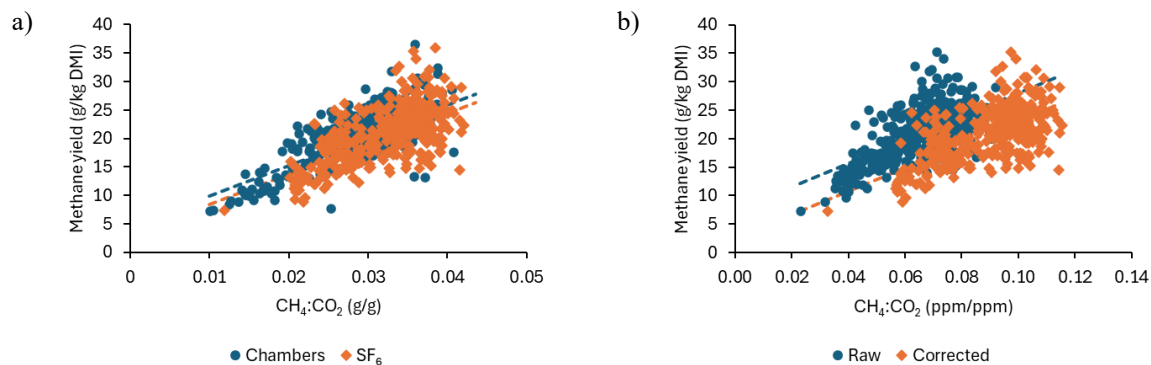


Figure 1. Methane yield (g/kg DMI) versus a) the ratio of CH₄ to CO₂ on a mass basis and b) the ratio of CH₄ to CO₂ on a concentration basis, without and with correction for background gas concentrations.

Discussion. The regression slope between MeY and the mass ratio of CH₄ to CO₂ was not affected by technique of measuring expired gases. However, the difference in intercepts indicates there is a systematic difference between breath sampling using Chambers and SF₆. The concentration ratio of CH₄ to CO₂ in cow breath was correlated with MeY, but not correcting for background concentrations would result in a greater estimate of MeY. We propose that with further work it may be possible to predict the methane yield of dairy cows from the ratio of gases exhaled in their breath.

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Comparison of extraction techniques of ruminal fluid: impact on pH, protozoa, ammonia-N and volatile fatty acid profiles of dairy cows

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Introduction There are different methods to extract ruminal fluid from dairy cows. Among these are extraction through an oro-ruminal sampling probe (per os) or through a cannula (per fistula). Previous work has compared ruminal fluid sampling techniques in sheep (Geishauser and Gitzel, 1996) and dairy cows fed total-mixed rations (de Assis Lage et al., 2020), which showed inconsistent correlations between methods. Further, the different methods have not yet been compared in pasture-fed dairy cows. We hypothesised that the technique used for ruminal fluid sampling would have no effect on measured ruminal fermentation parameters.

Materials and methods The study was conducted at the Ellinbank Smart Farm, Victoria, Australia (38°14'S, 145°56'E). Six multiparous rumen cannulated Holstein-Friesian cows were used in this experiment with a mean ($\pm$ standard deviation) milk yield of 36 ± 4.9 L/d, 8 ± 2.0 years old, 54 ± 6.8 days in milk and with a liveweight of 589 ± 43.7 kg. Cows had access to *ad libitum* perennial ryegrass (*Lolium perenne* L.) and 7 kg DM/cow per d of grain mix offered in two equal portions per day. On day 3 of the experiment, cows were sampled for ruminal fluid 4 h after morning milking. Ruminal fluid was sampled using two methods: 1) per os (Adam et al., 2025) or 2) per fistula using a copper pipe and a 100 mL syringe inserted into the opened cannula of each cow (Russo et al., 2017). Total protozoa count, ammonia-N concentration, total volatile fatty acids (VFA) concentration and individual VFA proportions were determined using methods described by Adam et al. (2025). Data were analysed by ANOVA in R studio (R Core Team, 2026) with a $P < 0.05$ considered significant.

Results The method of sampling affected ruminal fluid pH and total VFA concentration (Table 1). There was no difference in protozoa count, ammonia-N concentration or proportion of acetate, propionate, total butyrate and total valerate due to sampling technique.

Table 1. Mean ($\pm$ standard deviation, SD) of ruminal fermentation parameters from fluid collected per os or per fistula.

	Per os	Per fistula	P-value
pH	6.6 ($\pm$ 0.07)	6.1 ($\pm$ 0.17)	< 0.001
Ammonia-N (mg/L)	138 ($\pm$ 85)	179 ($\pm$ 87)	0.423
Protozoa Log ₁₀ (count+1000))	5.4 ($\pm$ 0.20)	5.6 ($\pm$ 0.28)	0.094
Total VFA (mM)	39.4 ($\pm$ 4.43)	29.2 ($\pm$ 7.00)	0.013
Individual VFA (mM/100mM)			
Acetate	60.0 ($\pm$ 2.69)	59.9 ($\pm$ 2.83)	0.937
Propionate	3.6 ($\pm$ 0.30)	3.6 ($\pm$ 0.32)	0.812
Butyrate, total	32.1 ($\pm$ 2.30)	32.3 ($\pm$ 2.51)	0.872
Valerate, total	4.2 ($\pm$ 0.39)	4.1 ($\pm$ 0.60)	0.849

Discussion Our results demonstrate that the ruminal fluid sampling method influenced pH and total VFA concentration, consistent with results reported by Pathak et al. (2025). It has previously been reported that saliva content can influence pH (Geishauser et al., 2012) and total VFA (Palma-Hidalgo et al., 2021), which may explain the differences observed. In conclusion, our results show that ruminal fluid sampling technique had no significant effect on protozoa count, ammonia-N concentration or proportions of individual VFA in pasture-fed dairy cows. We therefore partially accept our hypothesis. We recommend that either method can be used to indicate the ruminal fluid characteristics of protozoa count, ammonia-N concentration or proportions of individual VFA. However, the per fistula technique should be used for measurements of pH and total VFA.

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Growth rate drives intramuscular fat deposition in lambs

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Introduction Intramuscular fat (IMF%) is a key determinant of lamb meat eating quality, influencing tenderness, juiciness, and flavour. IMF% is shaped by genetic, environmental, and production factors, including the pattern and timing of growth throughout the animal's life. Different growth phases may affect IMF% in distinct ways because muscle and fat tissues develop at different rates. This study compares overall growth rate from birth to slaughter (GR1) with early-life growth rate from birth to weaning (GR7) to determine which period is more strongly associated with IMF%. It was hypothesised that faster early-life growth (GR7) would show a stronger negative association with IMF% than growth over the full production period (GR1). This expectation was based on the biological premise that early postnatal growth prioritises lean tissue accretion, particularly muscle fibre development, whereas intramuscular fat deposition occurs later in development and may be constrained when early growth is rapid.

Materials and methods A total of 12,139 lambs were analysed from eight research sites across Australia over 13 years (2007–2019) as part of a large study. Lambs represented Merino, Maternal and Terminal sire types and were raised under grazing systems. Live weights were recorded at birth, weaning and post-weaning until slaughter. Growth rates were calculated (kg/day), where GR1 represented birth to slaughter, and GR7 represented birth to weaning. Carcass traits, including hot carcass weight (HCWT), rib fat depth and eye muscle depth (EMD), were measured and included in the analysis model. IMF% was determined using near-infrared spectroscopy. Statistical analysis used linear mixed-effects models in R (Pinheiro *et al.* 2018).

Results Both GR1 and GR7 had significant curvilinear relationships with IMF% (Figure 1; $P < 0.01$). GR1 showed a positive effect ($F = 257$), increasing IMF% up to a plateau. GR7 showed a negative effect where faster early-life growth reduced IMF%. When compared in the same model, GR7 had the largest influence on IMF% ($F = 580$), while GR1 remained a consistent predictor.

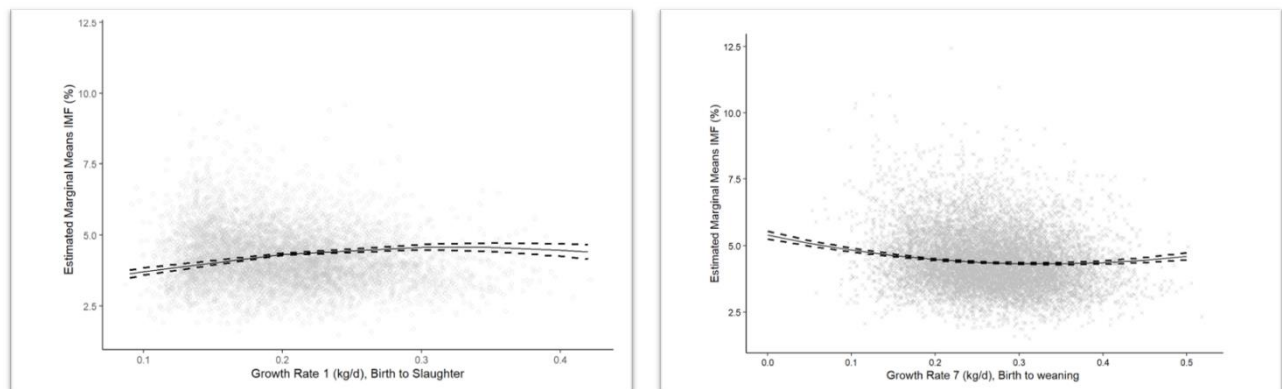


Figure 1. Estimated marginal means for intramuscular fat (IMF%) from the base models when corrected for growth rates GR1 and GR7.

Discussion Growth rate during different phases of life plays a critical role in IMF% deposition. The negative relationship between GR7 and IMF% suggests early growth promotes muscle deposition over fat. In contrast, GR1 reflects lifetime growth where fat deposition increases closer to maturity (Gardner *et al.*, 2010). The stronger influence of GR7 highlights the importance of early-life management. Balancing growth efficiency with meat quality is essential. In conclusion, the mechanisms underlying the differing effects of growth rate during pre- and post-weaning periods are not fully understood; however, several explanations can be proposed. Animals exhibiting high growth rates during the pre-weaning phase are likely to have greater lean meat yield and are more efficient at converting nutrients into body weight, primarily through muscle deposition with minimal fat accumulation. In contrast, higher growth rates during the post-weaning period may reflect increased dietary energy intake, which supports both continued growth and enhanced fat deposition, including intramuscular fat. Additional research is required to quantify the impact of genetics and environment on the expression of IMF%, in order to meet the increasing demand for highly marbled lamb meat.

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Optimising grain mixes to balance herd nutrient intake when dairy cows have differential access time to pasture

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Introduction Managers of pasture-based dairy systems face challenges in providing optimal nutrition for their cows. To further complicate feed allocation, consistency in milking order results in cows returning to the paddock last arriving to 65% less available pasture than cows that return first; subsequent milk yield declined by up to 6.1 kg/cow.d (Douglas et al., 2025; Wright et al., 2025). Nutritive characteristics of the pasture change throughout a grazing session, specifically a reduction in ME and CP and an increase in NDF, which also contributes to the milk yield decline (Wright et al. 2025). Previous research investigated reallocating the amount of grain offered to grazing dairy cows based on milking order, but none has investigated complementing the nutrients from pasture later in a grazing session. It was hypothesised that offering a grain mix that complemented the pasture available to cows that return to the paddock last would increase herd average milk yield.

Materials and methods The 19-day experiment was conducted at the Ellinbank SmartFarm in Victoria, Australia, with AEC approval (project code 2024-12). Sixty spring-calving, Holstein-Friesian cows [51 ± 13 days in milk (mean $\pm$ SD)] were randomly allocated to one of four treatments. These treatments (CON and GRN) were fed a combination of two grain mixes (GM1 and GM2; fed at 7.6 kg DM/cow.d (including minerals); Table 1) and cows returned at one of two time-intervals (T0; cows returning to the paddock first, and T3; cows returning to the paddock 3 hr later). Daily pasture allowance was 25 kg DM/cow.d (to ground level). While GM1 consisted of only barley grain, GM2 consisted of wheat and barley grains, plus canola meal. There was no difference in ME between GM1 and GM2, but higher CP was observed for the GM2 (12.6% vs 9.4%). During the 6-d measurement period, the n-alkane technique (Mayes et al., 1986) was used to estimate pasture intake and milk yield was recorded twice daily. All data were statistically analysed using an ANCOVA model within GenStat (GenStat 24, 2025).

Results Herd average milk yield for the GRN cows increased compared with the CON cows (35.0 vs. 33.8 kg, respectively; $P = 0.012$). Milk yield of the T0 and T3 cows differed significantly. The GRN T0 and GRN T3 treatments consumed similar amounts of pasture (22.6 vs. 21.2 kg DM/cow.d, respectively), compared with the CON treatment (23.4 vs. 18.9 kg DM/cow per d, for T0 and T3 respectively).

Table 1. Mean milk yield (kg/cow.d) and dry matter intake (DMI) of pasture (kg of DM/cow.d) for cows in each of the treatments during the 6-d measurement period.

	Group		Time-interval		Interaction				SED			P-value		
	CON	GRN	T0	T3	CON T0	CON T3	GRN T0	GRN T3	Group	Time	Int	Group	Time	Int
Grain mix	-	-	-	-	GM1	GM1	GM1	GM2	-	-	-	-	-	-
Milk yield	33.8 ^a	35.0 ^b	36.1 ^b	32.7 ^a	35.6	32.1	36.6	33.3	0.42	0.41	0.59	0.012	<0.001	0.853
Pasture DMI	21.1	21.9	23.0 ^b	20.0 ^a	23.4 ^c	18.9 ^a	22.6 ^{bc}	21.2 ^b	0.67	0.66	0.95	0.272	<0.001	0.020

*SED = standard error of the difference; superscripts indicate statistical significance ($P < 0.05$).

Discussion. This experiment investigated feeding cows that returned to the paddock last a grain mix that complemented the nutrients of the pasture they returned to. Herd average milk production increased when cows that arrived later were offered an optimised grain mix, supporting our hypothesis. This increase in milk yield may be partially due to improved nutrient intake and increased pasture intake. Pasture DMI of the GRN T3 cows increased, possibly due to the inclusion of canola meal, driving pasture DMI even when pasture mass had depleted (Huhtanen et al., 2011; Douglas et al. unpublished). There is potential to increase herd average milk yield by matching the nutrients of the grain offered in the dairy with the nutrients found in the paddock, highlighting the potential use of real-time measurements of pasture nutritive characteristics for optimising nutrient intake.

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Supplementation of Rhodes grass hay with whole cottonseed improves average daily gain of Brahman cross steers in tropical Western Australia

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Introduction. Cattle in Australia's northern pastoral regions are typically weaned onto native pasture and backgrounded until they reach sufficient weight (~280-350 kg) to be sold for live export or to a feedlot. This is hindered by the low energy and protein content of native forages during the dry season, reducing weight gain and increasing days needed to reach market weight. The recent expansion of cotton production in the Kimberley region of Western Australia (WA) has led to increased availability of whole cottonseed as a source of energy and protein for cattle production. Cottonseed has been fed to improve cattle performance in other systems in Australia (Andrews 2025), although there is limited information on the potential benefits for northern cattle genotypes with tropical forages. This study hypothesised that supplementation of Rhodes grass (*Chloris gayana*) hay with whole cottonseed would improve the liveweight gain of Brahman cross cattle in northern production systems.

Materials and methods. The trial was conducted at the DPIRD Research Station in Kununurra, WA. Seventy-two Brahman cross steers (initial liveweight 277 ± 13.4 kg) were randomly assigned to one of two groups: Control (*ad libitum* Rhodes grass hay + mineral mix) or Treatment (Control + 0.5% pen average liveweight whole cottonseed) for 75 days. The level of cottonseed provided was determined based on literature data regarding safe feeding rates for maximising performance (Andrews 2025). Each pen had 12 steers, and there were 3 pens/treatment. Intake and refusals were recorded daily by pen, and the cottonseed fed was adjusted weekly. Animal growth was analysed via mixed models in R, with initial liveweight and treatment as fixed effects, and pen as a random effect; ANOVA was used for intake data.

Results. Despite consuming 4% less feed on average than Control steers, Treatment steers had a 25% higher energy intake due to the additional energy provided by the cottonseed (Table 1). This resulted in a higher average daily liveweight gain for the Treatment steers and ultimately a higher final liveweight and hot carcass weight along with an improved feed conversion ratio.

Table 1. Effect of feeding cottonseed on cattle performance (Mean $\pm$ SD)

	Control	Treatment	P-Value
Average Total Dry Matter Intake, kg/steer.day	7.62 $\pm$ 0.09	7.29 $\pm$ 0.17	0.037
Average Metabolisable Energy Intake, MJ/steer.day	45.9 $\pm$ 0.54	57.7 $\pm$ 1.32	<0.001
Final Live Weight, kg	323 $\pm$ 17.2	332 $\pm$ 17.1	0.011
Hot Carcass Weight, kg	153 $\pm$ 8.91	158 $\pm$ 8.68	<.0001
Average Daily Gain, kg live weight/steer.day	0.58 $\pm$ 0.15	0.77 $\pm$ 0.19	0.011
Feed Conversion Ratio, kg dry matter intake/kg liveweight gain	13.4 $\pm$ 1.29	9.43 $\pm$ 0.47	0.007

Discussion. These preliminary results suggest that supplementation of Rhodes grass hay with whole cottonseed is a viable option to improve liveweight gain for cattle production systems in tropical northern Australia. Further research will explore how cottonseed and other local crop by-products could be used to help Northern cattle reach market specifications more efficiently.

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Bagasse as a Prebiotic for *Bacillus* Probiotics in Broiler Diets

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Introduction Prebiotics, a source of fermentable fibre, have been shown to provide a substrate for beneficial gastrointestinal microbes when added to poultry diets. Many bacteria present in the monogastric small intestine are capable of utilising these indigestible carbohydrate as sources for energy. In this way the prebiotic stimulates the growth of beneficial bacteria, such as *Bifidobacterium* and *Lactobacillus*, thus restricting the growth and colonisation by pathogenic bacteria (Ricke 2018). Sugarcane bagasse (SCB) is an indigestible fibre in monogastric diets and may be suitable as a prebiotic for poultry as it enhances intestinal *Bacillus* proliferation (Kheravii *et al.* 2017). Thus, the objective of this study was to provide a synbiotic diet containing SCB as a prebiotic along with *Bacillus* probiotics that were isolated from SCB to promote the growth of beneficial bacteria, enhance broiler intestinal health and growth performance.

Materials and methods For this bioassay 320-day old Male Ross 308 broiler chicks were individually weighed and allocated to groups by random stratification. The dietary treatment groups (DTGs) were fed from days 1 to 21 with 5 replicate cages per DTG. The control diet (DTG1) consisted of a balanced 54% wheat-based diet. DTG2 included the novel *Bacillus subtilis* (*B. subtilis*) at approximately 5×10^9 spores/kg of feed. Sugarcane bagasse (SCB) was incorporated either untreated (natural/raw) at 2% in DTG3, or alkaline treated (TSCB) at 2% in DTG4 and 4% in DTG5. Additionally, *B. subtilis* was combined with 2% untreated SCB in DTG6, with 2% TSCB in DTG7, and with 4% TSCB in DTG8. SCB was included at 2% and 4% based on levels previously reported in the literature and to ensure acceptable diet palatability. The mash diets and water were provided *ad libitum*. Chicken body weight and cage feed consumption was determined weekly to calculate daily weight gain (DWG), daily feed intake (DFI) and feed conversion ratio (FCR). For the final 3 days of the experimental period apparent metabolisable energy (AME) was determined by total excreta collection. The excreta was weighed daily after removal of debris, pooled and subsampled from each pen. On day 21, digesta from birds within a cage were pooled for measurement of ileal viscosity and pH. IMB SPSS Statistics 25 statistical software was used to perform a one-way analysis of variance (ANOVA) with each cage considered an experimental unit (replicate). A Tukey's *post hoc* multiple comparisons test was applied to determine significant differences among treatments.

Results The FCR results displayed in table 1 demonstrate that *B. subtilis* (DTG 2) resulted in a significant ($P < 0.05$) increase in body weight compared to the addition of 4% TSCB (DTGs 5 and 8). A similar but non-significant trend was observed with AME values. The mean ileal pH was uniform across all diets ranging from 7.5 to 7.8 ($P = 0.387$). The mean ileal viscosity showed a significant ($P = 0.041$) difference between treatment groups with the addition of the probiotic (DTG 2) and 2% SCB (DTG 3) having the lowest values. The highest viscosity value was recorded when the probiotic was fed with 4% TSCB (DTG 8).

Table 1. Effects of a *Bacillus* probiotic on both untreated (SCB) and treated (TSCB) sugar cane bagasse on the performance of broiler chickens fed a wheat-based diet *ad libitum* from days 1-21 of age.

Parameters measured	Days of age	Dietary Treatment Groups (DTGs)								SEM	P-value
		1	2	3	4	5	6	7	8		
FCR	21	1.2 ^a	1.2 ^a	1.3 ^{ab}	1.2 ^a	1.4 ^b	1.3 ^{ab}	1.3 ^{ab}	1.4 ^b	± 0.029	0.022
Ileal pH	22	7.7	7.8	7.6	7.5	7.7	7.7	7.6	7.7	± 0.033	0.387
Ileal viscosity (cp)	22	4.0 ^{ab}	3.2 ^b	3.1 ^b	3.5 ^{ab}	3.5 ^{ab}	4.4 ^a	3.8 ^{ab}	4.7 ^a	± 0.199	0.034
AME (MJ/kg DM)	22	13.5	13.6	13.5	13.6	13.4	13.3	13.4	13.2	± 0.094	0.072

^{a,b} Values in the same row with different superscript letters are significantly different ($P < 0.05$) (i.e., values with at least one common superscript are not significantly different).

Discussion To unravel the interactions of probiotics and indigestible fibre (prebiotics), detailed intestinal microbiome analysis is required. Although the results of the bioassay showed mild positive interactive effects, additional bioassays including ileal digestibility, and measurements of short chain fatty acids (SCFAs) are required to indicate if bagasse is a potential poultry prebiotic. Such studies would also help determine the suitability of SCB as a prebiotic for poultry, and how the origin of the *Bacillus* isolation influences the probiotic's success. The novelty of this bioassay was that the probiotic bacteria used in the studies were isolated from bagasse. To conclude, little interaction was observed, and this raises another question of how does the origin of *Bacillus* isolation influence probiotic success?

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Efficacy of Single and Combined *Bacillus* Probiotic Supplementation in Broiler Diets

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Introduction There is ongoing debate about whether probiotics are more effective when administered individually or in combination (Shini & Bryden, 2021). For poultry, both mono-strain and multi-strain probiotic microbes of the same species, or genus, have been administered, showing positive results. A number of authors have reported the use of multi-microbe probiotics being effective in enhancing the growth performance, apparent nutrient digestibility, and intestinal morphology of broilers, when included at the dosage of 10^8 and 10^9 cfu/kg of the diet. The efficacy of probiotics is dependent on many factors including the selection of the species or strain, combination of several strains, administration level, application methods, and ability of the selected strain to survive in the complex poultry gastrointestinal environment (Kim *et al.* 2012). Thus, the objective of this study was to address this knowledge gap by investigating the probiotic effects of *B. amyloliquefaciens* and *B. subtilis* fed to broilers as singular preparations or in combination in a high wheat diet. Examining these 2 *Bacillus* species under both scenarios will provide further understanding of the probiotic mechanisms of action.

Materials and Methods Male Ross 308 broilers were randomly allocated into pens at 28 days post-hatch and offered a wheat (920 g/kg) based digestibility bioassay diet that contained celite (20 g/kg), a source of acid-insoluble ash (AIA), which was used as an indigestible marker. Four dietary treatment groups (DTG) were used in this study. DTG1 being the control diet with no probiotic added, DTG2 included *B. subtilis*, DTG3 included *B. amyloliquefaciens* and DTG4 included a combination of *B. subtilis* and *B. amyloliquefaciens*. DTGs with the *Bacillus* probiotics were included at approximately 5×10^9 spores /kg feed. The mash diets and water were provided *ad libitum*. For the final 3 days of the experimental period apparent metabolisable energy (AME) was determined by total excreta collection. The excreta was weighed daily after removal of debris, pooled and subsampled from each pen. On day 7, digesta from birds within a pen were pooled for measurement of ileal viscosity, pH, and starch digestibility. IMB SPSS Statistics 25 statistical software was used to perform a one-way analysis of variance (ANOVA) with each pen considered an experimental unit, and five pens per replicate treatment group. A Tukey's *post hoc* multiple comparisons test was applied to determine significant differences among treatments.

Results Table 1 displays the results for ileal pH, viscosity, and starch digestibility along with AME. With the exception of the viscosity results, no significant ($P > 0.05$) differences between treatments were observed in the other parameters measured. The mean ileal pH was uniform across all diets ranging from 7.3 to 7.6. A similar but non-significant trend was observed with the AME values, with the lowest value being the control group without the supplementation of *Bacillus*. The starch digestibility percentages were lowest in DTG3 and highest in DTGs 1 and 2 with similar values of 84.6% starch digestibility.

Table 1. Ileal starch digestibility, pH and viscosity, and AME measurements for dietary treatment groups (DTG) 1 to 4.

Parameters measured	Dietary Treatment Groups				SEM	P-value
	1	2	3	4		
Ileal pH	7.5	7.5	7.6	7.3	± 0.062	0.416
Ileal viscosity (cp)	20.9 ^a	14.0 ^b	23.3 ^a	14.2 ^b	± 2.371	0.017
Ileal starch digestibility (%)	84.6	84.6	78.2	81.3	± 1.546	0.753
AME (MJ/kg DM)	11.9	12.5	12.8	12.6	± 0.198	0.269

^{a,b,c} Values in the same row with different superscript letters are significantly different ($P < 0.05$) (i.e., values with at least one common superscript are not significantly different).

Discussion The data from this study demonstrated that *B. subtilis* significantly reduced digesta viscosity compared to *B. amyloliquefaciens*. Interestingly when the two probiotics were fed together digesta viscosity was reduced to the same extent as feeding *B. subtilis* alone. This reduction may be attributed to the ability of *B. subtilis* to produce enzymes that break down anti-nutritional components in a high-wheat diet or to stimulate bacteria that degrade these compounds. Overall, the *Bacillus* species differed in their effects, with *B. subtilis* consistently reducing intestinal viscosity and improving AME more effectively than *B. amyloliquefaciens*. These outcomes suggest that *B. subtilis* is primarily responsible for the observed improvements, thereby providing clearer insight into the functional differences between the two probiotic species and their mechanisms of action.

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Backgrounding cattle reveal potential for sorghum utilization in confinement feeding systems

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Introduction Corn generally is regarded as being superior to grain sorghum as an energy source for cattle, but its continued use in the High Plains region of the United States poses a threat to groundwater resources due to its high water demand. Sorghum is characterized by drought tolerance and decreased water requirements compared to corn. Experiments summarized herein focused on identifying sorghum varieties that could compete with corn as energy sources for cattle, while offering a means of conserving irrigation water.

Materials and Methods An *in vitro* system was utilized to characterize dry-processed grains with respect to rate and extent of disappearance. Selected varieties were then compared to corn in a feeding study with backgrounding steers. Crossbred steers (n=120; initial BW = 273.1 kg ± 2.94) were stratified by BW and randomly allocated to three treatments at arrival; 341x120 sorghum hybrid (< 1000 micron; n = 40 steers), waxy sorghum (< 1000 micron; n = 40 steers), or dry rolled corn (~4000 micron; n = 39 steers). Steers were equipped with RFID ear tags and fed once daily *ad libitum* in an Insentec feeding system (Hokofarm Group; Emmeloord, The Netherlands). Diets consisted (DM basis) of 26% corn silage, 30% alfalfa hay, 40% of the respective grain, and 4% supplement. Body weights were collected on days 0, 30, and 60 and feed samples were collected weekly to determine DM, CP, NDF, ADF, starch, Ca, P, and K concentrations. Animal performance measures were analyzed using the MIXED procedure of SAS 9.4 (SAS Inst. Inc., Cary, NC).

Results Final BW was greater for steers fed waxy sorghum compared to corn ($P < 0.003$), and the 341x12 hybrid was intermediate but not different from other treatments ($P > 0.10$). Steers fed sorghum-based diets had greater DMI and ADG compared to those fed corn ($P < 0.01$), but G:F was unaffected by grain type ($P < 0.30$).

Table 1. Impact of grain types on animal performance during feeding trial.

Item	Grain Source			SEM	P value
	Corn	341x120 sorghum	Waxy sorghum		
DMI, kg/d	8.79 ^a	9.48 ^b	9.30 ^{ab}	0.245	0.04
ADG, kg	1.37 ^a	1.52 ^b	1.55 ^b	0.041	<0.01
Gain:feed	0.1589 ^a	0.1626 ^a	0.1701 ^a	0.0059	0.36

^{ab}Means within a row without a common superscript letter are different ($P < 0.05$).

Discussion The preliminary *in vitro* experiment provided useful insight to identify sorghum cultivars that were inferior, equivalent, or superior to corn with respect to both rate and extent of dry matter disappearance. When used in the subsequent feeding experiment, superior sorghum cultivars yielded performance that was comparable to that achieved by feeding a corn-based diet. We conclude that grain sorghum can replace corn in backgrounding diets without compromising performance, while also providing a means of decreasing demand for limited water resources.

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Multi-omics analysis of milk and plasma reveals differences in dairy goats divergent for feed efficiency

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Introduction Improving feed efficiency (FE) in dairy production systems is important for reducing input costs and improving sustainability. Commonly measured FE traits are feed conversion ratio (FCR; the ratio between feed intake and milk production) and residual feed intake (RFI; the difference between actual and predicted feed intake for a given production level). Measuring FE on a large scale is costly and time consuming, as it requires individual feed intake and production data. Thus, developing tools to screen animals without requiring intake data is attractive. Metabolomics (analysis of small metabolites) and lipidomics (profiling of lipid species) together provide complementary biochemical insights into the physiological mechanisms underlying FE traits. Our objective was to investigate differences in ‘omic profiles between early lactation goats divergent for FE (FCR vs. RFI).

Materials and methods 54 early-lactation (13 ± 6 days in milk) Saanen does (12 mo old) were selected based on parental pedigree for milk production (High, n = 27; Low, n = 24), housed individually, and fed a total mixed ration diet (twice/d). Feed intake (daily), body weight (3 times/wk), milk yield (daily), and milk components (twice/wk) were recorded for 49 d. The FCR was calculated using dry matter intake (DMI) and energy corrected milk (ECM; FCR = DMI/ECM). The RFI equation is outlined in Kirkham et al. (2025) based on the model by Koch et al. (1963). Blood and milk samples for the goats most divergent for RFI (n = 32 total) were collected before feeding on day 46 and stored at -80°C until metabolomic (GC-MS; Shimadzu 2030 and TQ8050NX systems) and lipidomic (LC-MS; Agilent 1290/6490 QQQ platform) analysis. Focused comparisons of the most extreme high (H-RFI) and low (L-RFI) RFI animals (n = 7/group) and the most extreme FCR (H-FCR and L-FCR; n = 7/group) to investigate pathway differences between RFI and FCR. Phenotypic data was subject to REML analysis using GenStat (22nd ed.). The ‘omics data was analysed based on peak intensities (normalised by median, log₁₀-transformed) using MetaboAnalyst 6.0 (<https://new.metaboanalyst.ca>). Pathways with $P < 0.05$ and false discovery rate (FDR) 0.20 were considered significant.

Results Six goats overlapped between efficiency classifications: 4 were H-RFI and H-FCR, 1 was L-RFI and L-FCR, and 1 H-RFI but L-FCR. The fitted means for efficiency and production characteristics are presented in **Table 1**. The oPLS-DA models explained a greater portion of variation for RFI compared to FCR across all datasets in both milk and plasma (RFI: 14–32%; FCR: 15–23%). Metabolomic pathway analysis identified 6 pathways differing between H-FCR and L-FCR (e.g. galactose metabolism) and 2 for H-RFI and L-RFI (e.g. biosynthesis of unsaturated fatty acids) in milk and plasma. Glutathione metabolism was of significance in both RFI and FCR ($P < 0.02$; FDR < 0.20). Across milk and plasma, 59 candidate biomarkers were identified for FCR and 75 for RFI (AUC > 0.8; $P < 0.05$).

Table 1. Fitted means for goats divergent for residual feed intake (RFI) or feed conversion ratio (FCR). High-RFI and High-FCR groups (n = 7 each) represent the most efficient goats, and Low-RFI and Low-FCR groups (n = 7 each) represent the least efficient.

Item	High-RFI	Low-RFI	SED	P-value	High-FCR	Low-FCR	SED	P-Value
Body weight (kg)	49.7	46.8	3.34	0.40	43.5	51.9	2.92	0.014
Dry matter intake (kg DM/d)	2.4	2.8	0.11	0.004	2.4	2.7	0.13	0.08
Energy corrected milk (kg/d)	3.4	3.3	0.35	0.81	3.7	2.6	0.25	<0.001
FCR	0.79	0.89	0.122	0.43	0.67	1.11	0.077	<0.001
RFI (kg of DM/d)	-0.22	0.25	0.056	<0.001	-0.16	0.08	0.065	0.003

Discussion. Distinct metabolic and lipidomics patterns were identified between RFI and FCR extreme goats, and between the two FE traits. Comparisons showed no association between RFI and ECM or BW, supporting the premise that RFI estimates FE without confounding effects of production level or body reserves (Herd & Arthur, 2009). In contrast, goats classified as H- or L-FCR differed in BW and ECM, suggesting that selection based on FCR could unintentionally alter production traits. The ‘omics revealed differences in glutathione and galactose metabolism pathways, which may indicate that L-RFI and L-FCR goats are more susceptible to oxidative stress. Galactose is a key substrate for lactose synthesis and has been highlighted as a biomarker for metabolic status, energy balance and FE in cows and sheep (Marina et al., 2024). In our experiment it was concluded that distinct metabolic profiles were evident between FCR and RFI in early lactation dairy goats, attributed to differences in amino acid and energy metabolism.

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Effects of Silage Additives on Chemical Composition, Fermentation, and Aerobic Stability of Whole-Crop Maize Silage under Tropical Conditions

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Introduction Ensiling high-quality maize is essential for profitable dairy production; however, achieving optimal fermentation becomes increasingly challenging under hot tropical conditions. Whole-crop maize is widely used for silage because of its high biomass yield and favorable energy density. Under tropical climates, elevated temperatures and variable dry matter (DM) at harvest may impair fermentation efficiency. Poor post-harvest handling can further reduce nutrient retention and aerobic stability. Lactic acid-producing inoculants and molasses are commonly applied to enhance fermentation, yet their efficacy under high ambient temperatures remains insufficiently documented. This study hypothesized that silage additives (homo- and hetero-fermentative inoculants, molasses, and their combinations) would improve fermentation quality, nutrient preservation, and aerobic stability of maize silage under tropical conditions.

Materials and methods Corn hybrids Dk6789 and P30K08 were cultivated under irrigated conditions at the University of Agriculture Peshawar, Pakistan. The experiment followed a $2 \times 5 \times 4$ factorial arrangement in a completely randomized design, comprising two maize hybrids, five additive treatments (water control, CCS; homofermentative LAB, HomLAB; heterofermentative LAB, HetLAB; molasses; and MIX), and four ensiling durations (3, 7, 21, and 150 days), with three replicates per treatment. Maize was harvested at 33.1% DM, chopped to 1.3–1.5 cm, and ensiled in 3-L laboratory silos. Each sample was treated with the respective inoculant (homLAB, hetLAB, molasses or MIX) or deionized water in case of control corn silage (CCS) and then ensiled in 3 L laboratory silos. Each of the inoculants/deionized water was sprayed on thin layers of chopped corn crops and properly mixed. For each genotype, four subsamples of the control and each of the four inoculated silages were collected and processed as day-0 samples. Silos were stored at ambient tropical temperature (30–38°C). Chemical composition, protein fractions, Cornell Net Carbohydrate and Protein System carbohydrate subfractions, and in vitro DM digestibility (DMD) were determined using standard AOAC procedures. Fermentation characteristics were analyzed by HPLC. Data were analyzed using repeated-measures ANOVA (PROC MIXED, SAS), and means were separated using Tukey–Kramer tests ($P < 0.05$).

Results Silage additives significantly influenced chemical composition and fermentation characteristics ($P < 0.05$). Compared with the control (CCS), HomLAB and MIX increased crude protein (7.13% and 7.06% vs. 6.52% DM), non-fiber carbohydrates (49.8% and 49.4% vs. 46.7% DM), and DMD (66.4% and 65.8% vs. 62.1%). Soluble crude protein was reduced relative to CCS. Ensiling duration affected nutrient dynamics, as DM, crude protein, neutral detergent insoluble crude protein, acid detergent insoluble crude protein, and non-fiber carbohydrates declined over 150 days, whereas soluble crude protein and DMD increased. Hybrid P30K08 exhibited higher non-fiber carbohydrates, starch, and DMD than Dk6789 ($P < 0.05$). HomLAB produced the highest lactic acid concentration (9.20% DM) and lowest acetic acid (1.16% DM), ammonia-N (3.46% of total N), and pH (3.66), achieving stable pH within three days. HetLAB and MIX enhanced aerobic stability (>72 h) compared with CCS (25 h). Inoculated silages showed increased lactic acid bacteria counts and improved DM recovery (up to 97.3%), with reduced yeast and mold populations.

Discussion Rapid lactic acid production and early pH decline observed in HomLAB and MIX treatments enhanced silage stabilization and nutrient preservation under tropical conditions. The heterofermentative inoculant increased acetic acid concentration, contributing to superior aerobic stability. Improvements in carbohydrate fractions and DMD indicate enhanced rumen-available energy despite prolonged ensiling. Differences between hybrids demonstrate the importance of genotype selection in optimizing silage nutritive value under high-temperature environments. Additives application can improve fermentation quality, nutritional value, DM recovery and aerobic stability of whole crop corn silage under hot summer conditions of the tropics. The MIX inoculant showed potential to improve in-silo fermentation, and aerobic stability at the same time, however, further investigation are required, particularly with respect to dose rate.

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***Moringa oleifera* Leaf Meal, Probiotics, and Organic Acids as Alternatives to Antibiotic Growth Promoters for Improving Bone Strength in Broilers**

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Introduction Genetic selection for rapid growth in broiler chickens has improved production efficiency but created unintended physiological challenges. Rapid muscle accretion often outpaces skeletal development, leading to mineral deficiencies and metabolic imbalances that increase the risk of leg weakness, bone deformities, osteoporosis, and other skeletal disorders, thereby compromising growth, welfare, and profitability. Antibiotic growth promoters (AGPs) enhance nutrient utilisation and the absorption (Ca, P, Mg), thereby supporting skeletal health. Following the 2006 EU ban on AGPs due to concerns about antimicrobial resistance, natural alternatives are being explored. Plant-based additives, probiotics, and organic acids enhance gut health, nutrient bioavailability, and growth performance, but their relative effectiveness for skeletal development and bone mineralisation in broilers remains unclear. This study therefore evaluated the efficacy of *Moringa oleifera* leaf meal (MOLM), a three-strain *Bacillus* probiotic (PRO), and coated butyric acid (ORG) as alternatives to AGPs in broiler nutrition. It was hypothesised that dietary inclusion of these additives would improve tibia bone strength, morphology, and mineral composition relative to the control (basal diet without additives), with performance comparable to or exceeding that of a conventional antibiotic growth promoter.

Materials and methods A total of 600 day-old mixed-sex Cobb 500 chicks were randomly allocated to five dietary treatments: AGP (300 g/ton zinc bacitracin + 500 g/ton salinomycin), MOLM (1000 g/ton MOLM), PRO (500 g/ton Enviva Pro), ORG (1000 g/ton Novyrate C), and the CON (Control diet with no additive inclusion). At 35 days of age, 12 birds per treatment were randomly selected for assessment of tibia bone breaking strength, morphology, and mineral composition. Tibia breaking strength was measured using an LRX-Plus (5 kN; Lloyd Instruments, AMETEK Inc.) with a 10 mm circular specimen at 50 mm/min. A vertical load was applied at the midpoint of the tibia shaft and the maximum force (N) at fracture was recorded. Tibia morphology (length and weight) and mineral composition (ash, calcium, and phosphorus) were determined using standard laboratory and AOAC procedures. Data were analysed using the Generalised Linear Model (GLM) procedure of SAS/STAT® software 9.4 (SAS Institute Inc. 2013).

Results Significant differences were observed in LTBW, with MOLM and control birds showing higher values than ORG ($P < 0.05$). This 'loss' in tibia weight reflects lower mineral deposition and bone density, not bone shrinkage, as skeletal growth continues despite rapid body weight gain. The birds in the control group (CON) had a higher tibia weight-to-length ratio (TW/TL) ($P < 0.05$), while ORG birds had the lowest. The TW/TL ratio reflects bone robustness relative to length, so a higher value indicates a denser, stronger tibia, whereas a lower ratio suggests lighter, less mineralised bones. A higher Ca: P ratio ($P < 0.05$) was observed in MOLM, PRO, and ORG birds, where CON birds had the lowest ratio.

Table 1. Least square means ($\pm$ SE) of tibia characteristics and mineral composition of broilers fed diets containing *Moringa oleifera* leaf meal, probiotic, or organic acid as alternatives to antibiotic growth promoters

Attributes	Dietary treatments				
	AGP	MOLM	PRO	ORG	CON
TL (cm)	8.89 $\pm$ 0.095	8.73 $\pm$ 0.095	8.97 $\pm$ 0.095	8.87 $\pm$ 0.095	8.70 $\pm$ 0.095
TW (g)	9.75 $\pm$ 0.365	9.75 $\pm$ 0.365	10.25 $\pm$ 0.365	9.33 $\pm$ 0.365	10.33 $\pm$ 0.365
LTBW (g)	5.54 ^{ab} $\pm$ 0.547	6.11 ^a $\pm$ 0.547	5.51 ^{ab} $\pm$ 0.547	4.45 ^b $\pm$ 0.547	6.12 ^a $\pm$ 0.547
TW/TL (g/cm)	1.09 ^{ab} $\pm$ 0.035	1.11 ^{ab} $\pm$ 0.035	1.14 ^{ab} $\pm$ 0.035	1.05 ^b $\pm$ 0.035	1.19 ^a $\pm$ 0.035
TBBS (N)	350.25 $\pm$ 19.526	339.08 $\pm$ 19.526	339.00 $\pm$ 19.526	310.67 $\pm$ 19.526	329.83 $\pm$ 19.53
Ash (%)	47.76 $\pm$ 0.241	48.09 $\pm$ 0.241	45.96 $\pm$ 0.241	45.95 $\pm$ 0.241	47.86 $\pm$ 0.241
TAI	5.40 $\pm$ 0.177	5.54 $\pm$ 0.177	5.14 $\pm$ 0.177	5.11 $\pm$ 0.177	5.60 $\pm$ 0.177
Ca (%)	8.33 $\pm$ 0.391	8.60 $\pm$ 0.391	8.57 $\pm$ 0.391	8.34 $\pm$ 0.391	8.03 $\pm$ 0.391
P (%)	3.90 $\pm$ 0.133	3.96 $\pm$ 0.133	3.85 $\pm$ 0.133	3.85 $\pm$ 0.133	3.99 $\pm$ 0.133
Ca: P (%)	2.14 ^{ab} $\pm$ 0.053	2.16 ^a $\pm$ 0.053	2.22 ^a $\pm$ 0.053	2.17 ^a $\pm$ 0.053	2.00 ^b $\pm$ 0.053

^{a,b} Means within a row with no common superscript differ significantly ($P < 0.05$); AGP = 300 g/ton zinc bacitracin and 500 g/ton salinomycin; MOLM = 1000 g/ton *Moringa oleifera* Leaf Meal; PRO = 500 g/ton three-strain *Bacillus* probiotic; ORG = 1000 g/ton coated butyric acid; CON = no additives; TL = tibia bone length, TW = tibia bone weight, LTBW = loss in tibia bone weight, TW/TL = tibia weight-to-length ratio, TBBS = tibia bone breaking strength, TAI = tibia ash index, Ca = calcium; P = phosphorus.

Discussion While no significant effects were observed on tibia ash content or tibia bone breaking strength, the numerically superior tibia mineral values in MOLM-fed birds, along with the significantly higher Ca:P ratios in birds fed the alternative additives, suggest positive trends in mineral utilisation and balance. These findings, coupled with the overall comparable performance to AGP-fed birds, reinforce the potential of MOLM, probiotics, and organic acids as functional alternatives to conventional growth promoters, especially in promoting sufficient bone mineralisation and mineral homeostasis in broiler production.

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Effects of de-fatted Pongamia (*Millettia pinnata*) seed cake on intake and digestibility in cattleM. Ni^A, A.V. Chaves^B, and S.J. Meale^{AC}^A School of Agriculture and Food Sustainability, The University of Queensland, Gatton, QLD 4343, Australia^B School of Life and Environmental Sciences, Faculty of Science, The University of Sydney, NSW 2006, Australia^CCorresponding author: Sarah J. Meale, E-mail: s.meale@uq.edu.au

Introduction Pongamia (*Millettia pinnata*) is a leguminous tree native to Asia and Australia (Kamde, 2018; Naik *et al.* 2008). Pongamia seed cake, produced after oil extraction, has the potential to be used as a protein supplement in feedlot diets as it contains about 30% crude protein (Dutta *et al.* 2012). With the cost of traditional protein supplements, such as cottonseed meal and soybean meal increasing, use of Pongamia seed cake may alleviate economic pressures (Soren and Sastry, 2009). However, traditionally, pongamia contains high concentrations of furanoflavonoids, particularly karanjin (~3,700 ppm) and pongamol (~1,674 ppm; (Housman *et al.* 2020)). These compounds impart a bitter taste and negatively affect feed intake and rumen fermentation (Dutta *et al.* 2012; Gupta *et al.* 1981). The novel processing methods used for Pongamia seed cake in this study reduced these concentrations to 67 ppm total, a level hypothesised to be below the threshold for adverse effects on animal intake or digestibility. Therefore, this study evaluated the effect of increasing inclusions rates of novel Pongamia seed cake, with reduced karanjin and pongamol content, on cattle intake and diet digestibility.

Materials and methods Steers used in this study were cared for under the approval and guidance of The University of the Queensland Production Animal Ethics Committee (Approval Number 2023/AE000318). Four cannulated Jersey-cross steers were used in a 4 × 4 Latin square design across four periods of 14 d adaptation and 7 d experimental measurements (84 d total) in a metabolism crate, such that one animal received one of the dietary treatments in each period. Animals were randomly assigned to a square and treatment sequence. Experimental treatments consisted of the basal diet (46.5% rolled barley, 42% cereal hay, 8% cottonseed, 2% feedlot supplement, 0.7% vegetable oil, and 0.3% lime) where Pongamia seed cake replaced cottonseed at 1) 0%, CONT; 2) 2%, Low Pongamia; 3) 4%, Medium Pongamia; or 4) 6%, High Pongamia (DM-basis). Feed offered and refused was quantified daily, with sub-samples collected and dried at 60°C for 48 h for determination of DM content. From day 19–21, total faeces were quantified and sub-sampled for determination of DM content, and to facilitate determination of diet digestibility.

Results Replacement of cottonseed with increasing levels of Pongamia seed cake did not affect dry matter intake (DMI; $P = 0.429$), averaging 13.6 kg/day. Similarly, the dry matter digestibility (DMD) also showed no difference with the increasing levels of pongamia in cottonseeds replacement ($p = 0.403$), which the average is 60.8%.

Discussion Housman *et al.* (2020) reported that supplementing high levels of Pongamia seed cake mixed with wheat middlings reduced feed palatability, primarily due to elevated concentrations of karanjin and pongamol (5667 ppm and 2554 ppm, respectively). Feed intake did not differ significantly between the control and PSC-supplemented groups, indicating that PSC can effectively replace cottonseed without compromising palatability. Similarly, dry matter digestibility (DMD) was unaffected across treatments, consistent with the low concentrations of karanjin and pongamol. These results support previous findings that reduced levels of these secondary metabolites enhance the suitability of PSC as a protein source in cattle diets.

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Functional Anti-Allergic Pet Yogurt Enriched with Fermented Herbal Extracts: Development, Bioactivity Validation, and Product Feasibility

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Introduction Canine allergic dermatitis involves complex immune dysregulation and barrier dysfunction; dietary interventions are commonly used alongside pharmacologic management. Increasing evidence supports a functional “gut–skin axis,” where gut microbial composition and microbially derived metabolites influence systemic and skin inflammation (Felton, 2025). Fermenting botanicals with lactic acid bacteria can biotransform polyphenols and related compounds, potentially enhancing bioavailability and generating new bioactive metabolites. We therefore investigated a yogurt-based delivery system incorporating FHE as a practical functional pet food format.

Maternalns and methods In this study, fermented herbal extracts (FHE) were first prepared by extracting selected botanicals with a food-grade solvent, followed by inoculation with lactic acid bacteria and fermentation under controlled conditions (Weatherly, 2013). The fermentation process was monitored by measuring pH and titratable acidity. Subsequently, the FHE were incorporated into a pet yogurt matrix at various concentrations, and formulation parameters such as stabilizer strategies and fermentation conditions were optimized to assess physicochemical properties (viscosity, water-holding capacity, syneresis) and microbial viability during storage (Ozturk, 2024). LC–MS-based metabolite profiling confirmed distinct changes in the metabolic profile following fermentation, indicating increased diversity and bioavailability of bioactive compounds compared to non-fermented extracts (Zhao, 2023).

Results The optimized pet yogurt prototype incorporating fermented herbal extracts (FHE) demonstrated stable physicochemical properties, including desirable acidity, viscosity, texture, and controlled syneresis, while maintaining microbial viability throughout refrigerated storage, thereby supporting its manufacturability as a functional pet product. LC–MS metabolite profiling confirmed that fermentation enhanced the recovery and diversification of bioactive compounds compared to non-fermented extracts, consistent with increased phenolic content and improved antioxidant/anti-inflammatory potential. Furthermore, FHE exhibited significant anti-allergic activity in mast-cell models by suppressing IgE/antigen-triggered degranulation (measured via β -hexosaminidase release) without cytotoxicity, accompanied by immunomodulatory cytokine trends indicative of reduced allergic inflammation. These findings collectively suggest that fermentation-derived metabolites (postbiotic fraction) confer functional bioactivity beyond the base yogurt matrix, supporting the potential of FHE-fortified pet yogurt as a novel functional food for managing allergic responses.

DPPH

Table 5. Analysis of DPPH free radical scavenging rate of fermentation extracts by different fermentation strains.

DPPH(%)	Before fermentation	<i>Lactococcus</i>
	28.64±0.01 b	35.23±0.01 a

^{a,b} Different superscript letters in the same antioxidant assay signify significant differences ($p < 0.05$). Data are presented as mean $\pm$ standard deviation of triplicate experiments.

Reducing power

Table 6. Analysis of reducing power of fermentation extracts by different fermentation strains.

Reducing power assay (L-Cysteine, $\mu\text{g/mL}$)	Before fermentation	<i>Lactococcus</i>
	535.07±5.03 c	601.73±8.08 a

^{a,b} Different superscript letters in the same antioxidant assay signify significant differences ($p < 0.05$). Data are presented as mean $\pm$ standard deviation of triplicate experiments.

Total Phenol Content

Table 7. Analysis of total phenolic content of fermentation extracts by different fermentation strains.

Total phenol content (μg of GAE / mL)	Before fermentation	<i>Lactococcus</i>
	551.83±16.05 b	579.60±6.41 a

^{a,b} Different superscripts in the identical parameters signify significant differences ($p < 0.05$). All values are mean $\pm$ standard deviation of triplicate analysis and analyzed using ANOVA.

Code	Curd time (h)	pH	Syneresis (%)	Titratable acidity (%)	Lactose (%)
SB	31 $\pm$ 1.41 ^a	4.87 $\pm$ 0.08 ^a	8.214 $\pm$ 1.515 ^a	0.055 $\pm$ 0.007 ^a	2.315 $\pm$ 0.304
SBP	23.5 $\pm$ 0.707 ^c	5.15 $\pm$ 0.014 ^a	6.071 $\pm$ 0.505 ^a	0.047 $\pm$ 0.006 ^a	N.D.
SBL	39 $\pm$ 1.414 ^a	4.59 $\pm$ 0.056 ^b	7.857 $\pm$ 1.010 ^{ab}	0.739 $\pm$ 0.011 ^b	N.D.
SBLP	25 $\pm$ 1.414 ^c	4.79 $\pm$ 0.014 ^c	4.571 $\pm$ 0.404 ^b	0.743 $\pm$ 0.005 ^b	3.265 $\pm$ 0.714

The results were expressed as mean $\pm$ SD ($n=2$). Values with different letters indicate significant differences ($P < 0.05$) by Duncan's multiple range test. N.D; no data. %; 10000ppm.

Figure 1. Comparative Analysis of the Physicochemical Properties and Antioxidant Capacity of Yogurt Prepared with Mixed Probiotic Strains.

Discussion A fermented-herbal-enriched pet yogurt can be formulated with acceptable physicochemical quality and refrigerated stability while delivering fermentation-derived metabolites that demonstrate in vitro anti-allergic activity in IgE-mediated mast-cell assays. Given the relevance of microbiota-linked modulation to allergic skin disease in dogs, the concept warrants next-stage work: pilot-scale processing, palatability/acceptance testing, dose-ranging, and controlled in vivo validation in dogs with pruritus or allergic dermatitis.

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Validation and Commercialization of an Eggshell Powder–Based Composite Feed Additive for Improving Growth and Robustness in Pre-Weaning Hanwoo Calves

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Introduction Pre-weaning calves are susceptible to enteric disease and unstable gut function, and interventions that stabilize mineral nutrition and gut ecology can improve robustness and productivity. ESP is predominantly calcium carbonate with trace minerals and has been widely investigated as an inexpensive calcium source with good digestibility/bioavailability (Schaafsma, 1999, Chang, 2003). We hypothesized that an ESP-based composite additive can (i) improve mineral status and growth and (ii) reduce diarrhea risk by supporting a more stable gut environment, detectable via microbiome and metabolome shifts.

Maternal and methods A total of 24 Hanwoo calves (60 days old) were randomly assigned to control or ESP-composite additive groups (n=12/group) and followed until 120 days of age (pre-weaning period). The additive was mixed into the basal diet (milk replacer/creep feed) at a fixed rate, with intake recorded where feasible. Growth was assessed via serial body weights to calculate average daily gain, alongside daily health monitoring (diarrhea scoring, morbidity). Blood samples were analyzed for biochemistry (total protein, glucose, calcium, phosphorus, magnesium) and endocrine markers (cortisol, insulin). Fecal samples underwent shotgun metagenomic sequencing and untargeted LC–MS metabolomics to identify taxonomic/functional shifts and metabolic signatures linked to supplementation and gut health, enabling mechanistic interpretation of diarrhea resilience during early-life microbiome development (Arshad, 2021).

Results Over the 60-day supplementation period, the ESP-composite group showed improved growth performance (higher ADG, favorable body weight) compared to controls. Blood profiling revealed enhanced mineral status (increased Ca, P, Mg) without metabolic disturbance, along with reduced cortisol and improved glucose-insulin homeostasis. Also, supplementation reduced diarrhea incidence and morbidity, corresponding with fecal metagenomic shifts toward a more stable, beneficial microbial profile. LC–MS metabolomics further identified functional signatures consistent with improved nutrient utilization and gut health. These integrated findings suggest that ESP enhances performance partly through highly bioavailable eggshell-derived calcium, while simultaneously promoting gastrointestinal stability via microbial and metabolic modulation—a systems-level effect beyond single-endpoint improvements (Zhang, 2025).

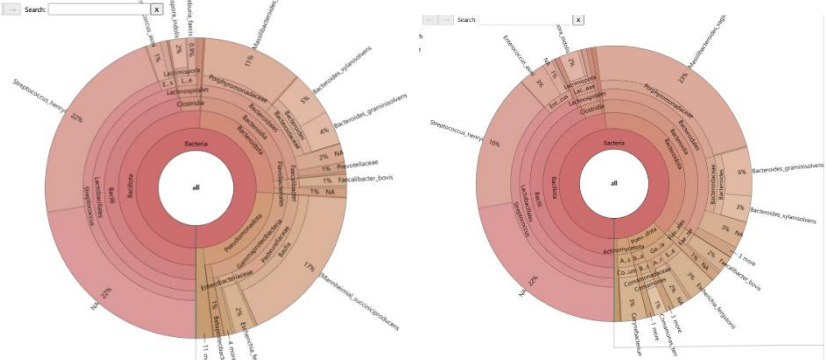


Figure 1. Microbiome Taxonomic Profiles by Treatment Group Across the Pre-Weaning Period.

Discussion An eggshell powder–based composite additive demonstrated growth, mineral-status, stress-physiology, and gut-health advantages in pre-weaning Hanwoo calves, supported by clinical monitoring plus fecal metagenomics and LC–MS metabolomics. These integrated outcomes provide a commercialization-relevant evidence package for prototype optimization, on-farm demonstration, and product positioning as an upcycled mineral-plus-gut-stability solution for Hanwoo calf rearing (Gao, 2025).

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Breeding pasture legumes for improved livestock health and welfare

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Introduction Pasture legumes provide high quality and protein feed to livestock and enhance total pasture biomass in mixed swards with grasses via nitrogen fixation. Breeding efforts usually focus on increased production and persistence, which increases livestock production. Here we describe three pasture breeding initiatives that prioritise livestock health and welfare; 1. Annual medics bred with resistance to powdery mildew (PM), a disease that causes increased plant coumestrol levels that reduce fertility and cause lambing difficulties (Reed 2016), 2. Novel subterranean clover (*Trifolium subterraneum*) cultivars with new herbicide resistance that allow older problem phytoestrogenic clovers to be removed, which also reduce fertility and cause lambing difficulties, and 3. new lucerne (*M. sativa*) cultivars tolerant to cowpea aphid (CPA, *Aphis craccivora*), which have photodynamic pigments that when ingested cause photosensitisation in livestock, leading to swelling of the face, muzzle, and ears (fatal in lambs), which can result in blindness, difficulty grazing, and secondary infections like mastitis. The breeding targets for annual medics and clover respond to long-term fertility related issues that are well defined (Reed 2016, Nichols *et al.* 2013) and known to be widespread in South and Western Australia (Bennet *et al.* 2019, Foster *et al.* 2021), whereas CPA in lucerne is only recently reported (Powells *et al.* 2022) as a new and emerging threat.

Materials and methods Medic: Resistance to PM was identified in a strand medic (*Medicago littoralis*) accession, crossed with cv. Angel and the PM resistant cv. Seraph released. PM resistance was backcrossed into barrel medic (*M. truncatula*) using speed breeding and cv Emperor released. Subterranean clover: Seed of four sub clover cultivars were mutated and planted in 1 ha. Herbicide was applied to regenerating plants at the label rate to control subterranean clover. Plants without herbicide damage were selected, developed using speed breeding methods, and entered in regional trials in 2025. Lucerne: CPA populations collected from lucerne fields in the upper southeast of SA in October 2025 were reared in a glasshouse and used to screen a diverse collection of lucerne genotypes for tolerance against control cultivars with historic levels of CPA tolerance.



Figure 1 Subterranean clover sprayed with herbicide at 0, 1 & 2x label rate (L to R). Top is tolerant lines and bottom is cultivar.

Results A naturally occurring PM infection resulted in older cultivars having coumestrol level of 383 mg/kg while Seraph had 37 mg/kg. In 2022 with a wet spring, the PM resistant cultivars stayed free of PM when the older cultivars were covered with PM. Herbicide tolerant clover lines express high tolerance (Fig. 1) but require further evaluation before cultivars are released. Initial screening of lucerne genotypes has found variation in tolerance levels.

Discussion Coumestrol increase with fungal disease and cause infertility in livestock (Reed 2016). The new PM resistant cultivars maintain low coumestrol levels when older cultivars developed high levels when PM is present. The lower coumestrol levels in Seraph and Emperor is expected to improve fertility. Several subterranean clover cultivars with unsafe phytoestrogenic levels were released before 1982 (Nichols *et al.* 2013) that are still widespread in many areas (Bennet *et al.* 2019, Foster *et al.* 2021). Subterranean clovers with new herbicide tolerance are tolerant of 2x the label rate whereas older cultivars are not (Fig 1). The new herbicide tolerant clover cultivars will provide a new way of controlling old oestrogenic cultivars and thus improve fertility. They will also provide new ways of dealing with problem weeds such as stemless thistles (*Onopordum* spp.) and capeweed (*Arctotheca calendula*). Whilst identification of new sources of tolerance for CPA has only just begun, we are hopeful that CPA resistant cultivars can reduce incidences of photosensitisation as well as increasing animal production. In conclusion, breeding pasture cultivars for specific traits has the potential to improve livestock fertility, health and welfare as well as production.

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Pre-calving nutrition improves calf growth in northern beef herds

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Introduction In northern beef herds, the nutrition of pregnant breeders has a major influence on both calf growth and the ability of cows to recover after calving. First-lactation cows are particularly vulnerable, as they must partition energy between finishing their own growth, building body reserves, and producing milk. When nutrition before calving is limited, milk production can suffer, and calf growth slows. The Calf Alive project was established to quantify how improving nutrition before calving influences calf performance and cow condition under commercial conditions. This study reports results from three intensively monitored properties where precise calving dates and birth-to-weaning growth could be measured. We hypothesised that providing a targeted protein–energy supplement before calving would increase milk production, translating into increased calf average daily gain (ADG) to weaning.

Materials and methods Pre-calving supplementation was implemented for 6–8 weeks before the expected start of calving at three commercial properties during the 2023/24 season: one herd of mature cows (Site A) and two herds of first-calf heifers (Sites B and C). A total of 418 calves with complete birth-to-weaning records were analysed (Site A: 81; Site B: 186; Site C: 151). Pregnant cows were stratified by liveweight and estimated calving date (from foetal ageing) and randomly allocated to treatment or control groups. The treatment group received a targeted protein–energy supplement supplying approximately 300–400 g CP/day, while controls grazed the same paddocks without additional supplementation. At Sites A and B, walk-over-weighing units at the only watering point recorded daily liveweight, allowing calving dates to be identified from sustained weight drops supported by weekly visual checks. At Site C, calving was observed daily, and calves were weighed within 24 hours of birth. These systems enabled accurate estimation of calf average daily gain (ADG) from birth to weaning. Site A comprised mature Brahman cows (Katherine, NT), Site B Angus-cross heifers (Camooweal, QLD), and Site C Belmont Red heifers (Western Downs, QLD). Cow weight class (light, medium, heavy) was defined within each herd from pre-supplementation liveweight distributions (mean $\pm$ 0.43 $\times$ SD). Calf growth was analysed separately for each property using linear mixed-effects models (PROC MIXED), with treatment, calf sex, weight class and parity as fixed effects and cow as a random effect. Results are presented as least-squares means ($\pm$ SEM).

Results Site A achieved a lower supplement intake (17 kg/cow) compared with the two heifer sites (32 and 42 kg/heifer at Sites B and C, respectively). Storm activity in November and the presence of surface water likely reduced yard visitation and disrupted supplement access at Site A. Providing extra nutrition before calving improved calf growth at two of the three properties, with responses strongest in first-calf heifers. At Site B, supplementation increased calf ADG by 32 g/d ($P = 0.04$), while at Site C the benefit was 56 g/d ($P = 0.02$). At Site A, where supplement intake was lowest, and cows were mature, the difference was not statistically significant (+52 g/d; $P = 0.13$). Across all sites, male calves grew faster than females. Dam weight class influenced calf growth only at Site B, where calves from heavier heifers outperformed those from lighter heifers ($P < 0.01$).

Table 1. Effect of pre-calving supplementation on calf average daily gain (g/d) from birth to weaning.

Factor	Level	Site A (Cows) (g/d $\pm$ SEM)	P-value	Site B (Heifers) (g/d $\pm$ SEM)	P-value	Site C (Heifers) (g/d $\pm$ SEM)	P-value
Treatment	Control	759 $\pm$ 24	0.13	861 $\pm$ 13	0.04	821 $\pm$ 17	0.02
	Treatment	811 $\pm$ 24		893 $\pm$ 12		877 $\pm$ 16	
Sex of Weaner	Female	732 $\pm$ 25	<0.01	852 $\pm$ 12	<0.01	814 $\pm$ 17	<0.01
	Male	838 $\pm$ 23		901 $\pm$ 11		883 $\pm$ 17	
Dam Weight Class	Light	767 $\pm$ 30	0.75	840 $\pm$ 15	<0.01	836 $\pm$ 19	0.50
	Medium	780 $\pm$ 31		887 $\pm$ 14		842 $\pm$ 21	
	Heavy	799 $\pm$ 30		904 $\pm$ 15		869 $\pm$ 21	

Discussion Pre-calving supplementation improved calf growth in first-calf heifers but had limited impact on calves from mature cows, indicating that heifers are more sensitive to nutritional constraints in late gestation. Across properties, the observed improvements in ADG translate to an additional 7–12 kg of weaning weight. It was concluded that pre-calving protein–energy supplementation increased calf average daily gain in first-calf heifers, supporting the hypothesis that improved maternal nutrition before calving enhances milk-mediated calf growth.

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Adaptive growth responses of indigenous goats to water restriction

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Introduction Water scarcity is an increasing constraint to livestock production in arid and semi-arid regions under climate change (Akinmoladun et al., 2019). Limited water availability negatively affects growth performance in livestock. Goats, especially indigenous breeds, are generally more tolerant to water scarcity than many other livestock species due to physiological and behavioural adaptations that support survival in harsh environments. However, comparative evidence on the growth responses of indigenous goat breeds under varying levels of water restriction remains limited. The Nguni goat and Xhosa goat are indigenous to South Africa and are widely raised in semi-arid regions where seasonal water shortages occur (Donnenfeld et al., 2018). We hypothesized that water restriction would reduce growth performance and feed intake in both breeds, but that differences would exist between breeds in their ability to cope with water stress. This study therefore evaluated the effects of different levels of water restriction on growth performance of Nguni and Xhosa goats.

Materials and Methods Eighteen female goats per breed (Nguni: 19.43 ± 0.26 kg; Xhosa: 15.92 ± 1.12 kg) were assigned to three watering treatments: ad libitum water intake (W0), 70% of ad libitum intake (W70), and 50% of ad libitum intake (W50). Each treatment group consisted of six animals per breed. Goats were housed individually in pens and fed a total mixed ration containing 70% lucerne hay and 30% concentrate at 4% of body weight (BW) on a dry matter basis. The experiment consisted of a 14-day adaptation period followed by a 75-day data collection phase. Growth performance parameters measured included final body weight (FW), total weight gain (TWG), average daily gain (ADG), and total dry matter intake (TDMI). Data was analysed using a two-way analysis of covariance (ANCOVA) with breed and water restriction level as fixed effects and initial body weight included as a covariate. Statistical significance was declared at $P < 0.05$.

Results FW declined as water availability decreased across treatments. Under moderate water restriction (W70), Nguni goats maintained a higher ($P < 0.05$) FW (16.76 kg) than Xhosa goats (15.74 kg). A similar pattern was observed under severe water restriction (W50), where Nguni goats maintained a FW ($P < 0.05$) of 16.60 kg compared with 15.03 kg in Xhosa goats. TWG and ADG were also significantly reduced with increasing water restriction. At W70, Nguni goats lost less ($P < 0.05$) BW (-0.87 kg) compared with Xhosa goats (-1.89 kg). Under severe restriction (W50), the weight loss ($P < 0.05$) was -1.02 kg in Nguni goats and -2.61 kg in Xhosa goats. ADG followed a similar pattern, declining from positive values under full water supply to negative values under water restriction. Xhosa goats experienced a larger reduction ($P < 0.05$) (-34.75 g/day) compared with Nguni goats (-13.68 g/day) under W50. Water restriction also significantly reduced total dry matter intake ($P < 0.05$). However, Nguni goats consistently consumed more feed ($P < 0.05$) than Xhosa goats across all treatments.

Discussion Water restrictions reduced growth performance, highlighting the importance of adequate water supply for productivity in small ruminants. Limited water intake impairs digestion, metabolism, and feed consumption, leading to weight loss (Sejian et al., 2021). The observed decline in body weight gain and average daily gain confirms that water scarcity negatively affects growth in goats (Mpendulo et al., 2020). Despite this, Nguni goat showed greater tolerance to water stress than Xhosa goat, with smaller reductions in body weight, ADG, and feed intake. This suggests better physiological adaptation to dehydration and metabolic stress. Indigenous goats adapted to arid environments typically exhibit efficient water use and lower metabolic demands. These findings emphasise the value of indigenous goat genetic resources in climate-resilient livestock production, particularly in drought-prone regions

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Producer perspectives on goat pain management

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Introduction The Australian Industry Welfare Standards and Guidelines for Goats state that appropriate pain relief should be used during and after routine husbandry procedures such as disbudding and castration (Animal Health Australia 2020). However, compared with cattle and sheep, goats have limited access to registered analgesic products in Australia, due to regulatory requirements and economic constraints associated with minor species registration (Meibusch and Cain 2025). While non-steroidal anti-inflammatory drugs such as meloxicam and local anaesthetics such as lignocaine are registered for use in cattle and sheep, they are often used off-label in goats, due to the lack of goat-specific label claims. Consequently, there is little information regarding current producer practices or attitudes towards pain mitigation. The objective of this study was to investigate current producer use and future potential of pain relief products in the Australian goat industry. To achieve this, a national survey was conducted to capture producer experiences, attitudes towards pain relief, and better characterise the relationship goat producers have with veterinarians.

Materials and Methods A survey was designed and distributed electronically through Survey MonkeyTM, targeted at goat producers across the three sectors (meat, milk and fibre). A link to the survey was distributed through multiple channels, including social media, LinkedIn, email distribution channels from the Goat Industry Council of Australia and other stakeholders. The survey consisted of 14 open or closed questions to collect data on location, primary enterprise focus, size of enterprise, the importance of pain management during husbandry procedures, regularity of husbandry procedures, pain relief use, product choice, access to veterinary prescription and opinions surrounding access to pain relief if it were more readily available. The survey remained open for 14 days (March 18th, 2024, to April 1st, 2024) with reminders published twice during that period.

Results A total of 277 responses were received; over 100 of these were in the first 24 hours of the survey. Producers responded from all eight Australian states and territories, representing meat, dairy and fibre sectors, as well as hobby farmers. The overwhelming majority (93%) of respondents felt that management of pain is very or critically important during all husbandry procedures such as disbudding or castration. Over half (73%) of the responses indicated they had used a pain relief product prior to or at the point of the husbandry process, with the vast majority accessing products through veterinarians under the off-label provisions. The most popular choice of pain-relief product was meloxicam (81%), most likely on the recommendation provided by their veterinarian. Additional comments (n=128) were provided at the end of the survey, the major themes throughout these comments were issues with vet accessibility, product accessibility and concerns for the welfare of the goats. On a positive note, the majority of respondents indicated they would use a pain relief product for most, if not all husbandry procedures if it were available from resellers.

Discussion The survey captured perspectives from producers already engaged with pain management, revealing that among the group, there is a strong recognition of pain management importance and willingness to use products during husbandry procedures. The current reliance on off-label veterinary prescriptions demonstrates that motivated producers are navigating existing regulatory pathways, though this approach has limitations in scale and accessibility. The lack of published goat-specific data creates challenges for prescribing veterinarians to recommend accurate dose rates and withholding periods to mitigate legal liability for residue issues. While survey respondents indicated interest in reseller access, the most realistic pathway forward is registration of on-label products for veterinary prescription, which would formalise current practices and provide clearer guidance for practitioners. However, the regulatory process for product registration is lengthy and costly, requiring substantial pharmacokinetic and efficacy studies that represent a significant investment. Without progress toward registered pain relief options for goats, whether through industry, government, or collaborative funding of required studies, the gap between welfare standards expectations and practical implementation will persist. This has implications not only for animal welfare but also for the industry's social license to operate and potentially for international trade requirements.

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Contactless Machine--Loaded-Enabled Microwave Sensing for Grass Seed Detection in Sheep

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Introduction Grass seed infestation (GSI) is a major issue for the Australian sheep industry, impacting meat and wool quality, sheep welfare and productivity (Kelly *et al.* 2018). Seeds picked up during grazing can rapidly penetrate fleece, skin and underlying tissues, making early, contactless detection valuable for mitigation. Our previous work shows that using terahertz signals (0.3-0.5 THz) and Convolutional Neural Networks has shown over 95% accuracy for identifying seeds beneath 1 cm of wool (Wang Q *et al.* 2025). However, terahertz systems are complex and expensive. Microwave systems are significantly cost-effective, simpler, and more robust for detecting materials than complex terahertz systems. Their mature technology allows for portable, on-site deployment and their longer wavelengths offer better penetration through wool, ensuring efficient, high-accuracy seeds detection.

Materials and methods The experimental setup utilized a Keysight P5008A USB Vector Network Analyzer (VNA) and a 1-18 GHz horn antenna in a normal reflection mode (Fig. 1 (a)) to measure the reflected signal (S_{11}). The antenna was positioned 10-40 cm from the sample, which consisted of lamb shoulder muscle tissue (15 cm × 30 cm). Five causal species including barley grass (*Hordeum* spp.), rat tail fescue (*Vulpia* spp.), brome grass (*Bromus* spp.), Chilean needle grass (*Nasella neesiana*), and barley seed (*Hordeum vulgare*), were placed on the top of the tissue sample, and covered by wool at a thickness of 7-9cm. We developed a seed identification machine learning (ML) system using a Support Vector Machine (SVM) classifier. The S_{11} amplitude data, measured across 950 frequency points, was grouped and labeled as “no seed” or “with seed”. The SVM was trained using S_{11} amplitudes from a selected subset of frequency points as input features. Our primary objective was to identify the optimal, narrow frequency range that achieves robust seed detection while minimizing the impact of varying wool thickness.

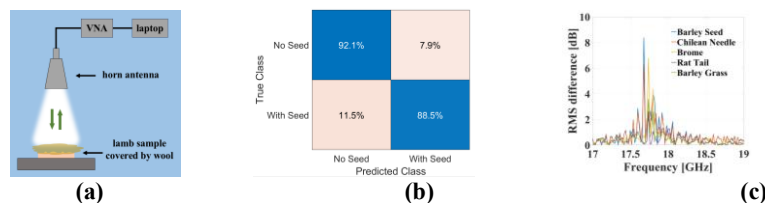


Figure 1. (a) Schematic of the experimental setup for identifying seeds embedded in lamb tissue covered by wool. (b) Confusion matrix for the identification performance with trained SVM using features from 18.919-19.399 GHz.

The SVM model was trained using a portion of the data while reserving the remaining, unseen data for validation to ensure robustness. In particular, the SVM was trained with measurements from wool lengths containing both ‘with seed’ and ‘no seed’ samples. It was then validated using data from a different wool thickness to assess robustness and generalization capability. For example, model training utilised 7 cm and 8 cm wool length data, whilst validation used the 9 cm data. This procedure was repeated three times. Each of the 7 cm, 8 cm, and 9 cm datasets served once as the validation set, while the remaining two were used for training. The classification accuracies from the three trials were then averaged to determine the optimal narrow frequency range providing best performance with strong robustness.

Results The averaged result is shown in the confusion matrix in Fig. 1 (b), where the optimal frequency range within the confusion matrix was found to be between 18.919 and 19.399 GHz. Seeds were detected with an average accuracy of 88.5%. Figure 1 (c) shows RMS S_{11} differences versus frequency between with and without seeds covered by 8 cm thick wool. Notable peaks are observed near 17.5-18 GHz, which are slightly lower than the optimal range from SVM because this variable region is less repeatable. The SVM selects frequencies with the most stable, consistent separation.

Discussion This study demonstrates the use of a VNA to measure the S_{11} response of lamb samples covered with wool to determine grass seed presence. We employed an SVM model to detect seeds by training on one dataset, validating on another unseen dataset. The trained SVM model achieved an overall detection accuracy of 90.3%. These preliminary findings highlight the practical potential of this approach for early detection of grass seeds before impacting sheep welfare and productivity.

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The influence of secondary Improvac vaccination timing on pork quality

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Introduction ImprovacTM vaccination is commonly used to immunocastrate male pigs for the control of boar taint. Boar taint is caused by the presence of androstenone, indole and skatole in the meat and fat of entire males and is linked to consumer rejection of boar meat products (Panella-Riera *et al.* 2016). The Improvac vaccination protocol involves two injections; one at ~10 weeks, followed by another ~4-5 weeks before slaughter. There is flexibility in the timing of the second vaccination and an opportunity to select the timing to improve growth performance and carcass quality (Lealiifano *et al.* 2011). There are some questions around the influence of the pig end liveweight and whether there is an interaction of pig weight with secondary vaccination timing affecting pork quality. This study investigated the effect of secondary Improvac vaccination timing, pig weight and their interaction on pork quality.

Materials and methods. Commercial slaughter pigs (Large White x Landrace x Duroc, n = 1,056), born in the same week, were sorted at 17 weeks of age into 48 pens (22 pigs per pen) based on an individual weights, with 16 pens each of light (mean weight = 61.3 kg), medium (74.5 kg) and heavy (86.5 kg) pigs. Within each weight group, four secondary vaccination treatments were applied (2, 3, 4 or 5 weeks before slaughter), with four pens assigned to each vaccination treatment. To emulate commercial slaughter weights, sampling was staggered over three weeks, with heavy pigs sampled first (at 22 weeks) followed by medium pigs (at 23 weeks) and small (at 24 weeks). For each pen, two pigs from the pen's highest weight quartile and two from the lowest weight quartile were selected for pork quality, providing 64 animals per weight group and 48 animals per vaccination treatment. Hot standard carcass weight (HSCW) and P2 fat depth data were collected at the processor. After processing, short loins (including *longissimus*) from one side were vacuum packed, transferred to the University of Melbourne and aged for seven days under refrigeration. *Longissimus* quality attributes: pH, colour (CIE L* lightness, a* redness, b* yellowness), purge (% loss in weight), cook loss (% loss by weight), and Warner Bratzler shear force (WBSF) were measured after ageing as described in Huang *et al.* (2023) and Gu *et al.* (2023). Mixed linear modelling was conducted on quality attributes using GenStat. (22nd edition), and initial fixed models included Improvac vaccination timing, weight group and their interaction as fixed factors, and pen as random factor. Final fixed model included Improvac vaccination timing and weight group.

Results There was no interaction of Improvac vaccination timing and weight group ($P > 0.05$ for all quality attributes, data not reported). Main effects models showed weight group influenced all quality attributes ($P < 0.05$ for all, Table 1) and there was no influence of timing of Improvac vaccination for all quality attributes ($P > 0.05$ for all).

Table 1. The effect of 2nd Improvac vaccination timing, and weight class on pork carcass and *longissimus* quality.

Quality attribute	Weeks before slaughter				Weeks SED	Weeks P-value	Weight groups			Weight SED	Weight P-value
	2	3	4	5			Light	Medium	Heavy		
HSCW (kg)	84.3	87.5	88.2	89.3	2.44	0.22	80.1 ^a	88.9 ^b	92.1 ^b	2.14	<0.01
P2 (mm)	10.9	11.5	11.6	11.5	0.53	0.49	10.5 ^a	11.2 ^a	12.3 ^b	0.46	<0.01
pH	5.42	5.42	5.40	5.42	0.011	0.21	5.44 ^a	5.43 ^a	5.37 ^b	0.010	<0.01
L*	54.4	54.8	54.7	54.4	0.67	0.92	56.0 ^a	53.8 ^b	53.9 ^b	0.58	<0.01
a*	7.91	7.66	7.58	7.38	0.291	0.36	8.06 ^a	7.53 ^b	7.31 ^b	0.252	0.02
b*	6.74	6.92	6.66	6.45	0.451	0.77	7.38 ^a	6.41 ^b	6.28 ^b	0.391	0.02
Purge (%)	2.15	2.01	2.46	1.92	0.398	0.57	1.83 ^a	2.65 ^b	1.92 ^a	0.345	0.04
Cook loss (%)	22.4	22.1	20.2	22.2	1.41	0.40	20.0 ^a	21.0 ^a	24.1 ^b	1.22	<0.01
WBSF (N)	22.0	22.9	21.9	22.7	0.65	0.31	22.5 ^a	21.4 ^b	23.2 ^c	0.56	<0.01

Different superscript letters indicate statistical significance.

Discussion Pork quality was not affected by the timing of the secondary Improvac vaccination, or by the interaction between secondary Improvac vaccination timing and pig weight. This is a positive outcome for industry, indicating from a meat quality perspective there are no quality trade-offs associated with the timing of secondary Improvac vaccinations. However, weight group affected pork quality. While the higher WBSF, and higher cook loss in the heavy pigs is possibly due to their lower pH (Channon *et al.* 2000), we cannot confirm the reason for this lower pH.

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Preliminary study on the effect of breeding objectives on muscle fibre composition and meat quality

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Introduction The Australian pork industry has been selecting pigs for production traits such as efficiency of lean growth for decades. This selection may contribute to the inconsistency in pork quality in Australia (Channon et al., 2017). Selection for muscling (usually associated with reduced fat depth) is generally associated with an increase in the proportion of glycolytic fibres, which likely contributes to pork quality variation (Fiedler et al., 2004). This study aimed to investigate the impact of maternal and terminal lines, which have distinctively different breeding objectives, on the proportion of glycolytic fibres, ultimate pH, paleness and drip loss.

Materials and methods In total 20 pig carcasses were sampled from terminal (Ter; breeding focus on growth rate, leanness, feed conversion efficiency) and maternal (Mat; breeding focus on reproduction/piglet performance) lines from suppliers 1 and 2. At 3 hrs post-mortem, samples were collected from *Biceps femoris* (BF), *Longissimus thoracis et lumborum* (LTL), and *Triceps brachii* (TB), snap-frozen then stored at -80°C for muscle fibre characterisation. At 48 hrs postmortem, muscle ultimate pH, colour and drip loss were assessed as described in Huang et al. (2023). Muscle fibre characteristics was determined by SDS-page using the method of Scheffler et al. (2018). Statistical analysis was performed using GenStat, 22nd ed (VSN International, Hemel Hempstead, UK) with Restricted Maximum Likelihood (REML) analysis [Fixed model = muscle*line; Random model = carcass number].

Results Ter-1 had a higher proportion of glycolytic fibres, and higher paleness in LTL than Mat-1. There was no effect of breeding objectives on muscle fibre composition and meat quality traits for the other muscles. For BF and LTL muscles, the proportion of glycolytic fibres was higher, which was likely related to the lower ultimate pH, higher paleness and higher drip loss, relative to the TB muscle.

Table 1. Effect of genetic lines on the muscle fibre composition and meat quality traits across three pork muscles.

Muscle	Line	Line				SED	P value		
		Mat-1 (n=5)	Mat-2 (n=5)	Ter-1 (n=5)	Ter-2 (n=5)		Muscle	Line	Muscle × Line
Glycolytic fibre (%)	LTL	63.4	60.7	69.9	61.3	3.41	< 0.001	< 0.001	< 0.05
	BF	63.0	54.7	63.0	60.6				
	TB	53.1	33.7	51.5	36.4				
Ultimate pH	LTL	5.53	5.43	5.53	5.41	0.034	< 0.001	< 0.001	< 0.001
	BF	5.57	5.55	5.58	5.54				
	TB	5.81	5.63	5.90	5.65				
L*	LTL	47.3	46.4	49.2	45.8	0.98	< 0.001	0.22	< 0.01
	BF	43.6	41.2	42.2	40.9				
	TB	39.2	39.7	38.4	39.7				
EZ drip loss (%)	LTL	2.87	3.60	3.12	4.78	0.517	< 0.001	< 0.05	< 0.05
	BF	3.10	3.93	2.96	4.24				
	TB	0.74	1.39	0.90	0.66				

Discussion The terminal line, which was selected for production traits, such as fast lean growth, had higher glycolytic fibres and paler colour in the muscle LTL only. The negative impact on LTL is likely associated with the heavy selection on loin parameters such as loin eye area for the terminal line. The paleness and drip loss, which are important traits that influences consumer perception, are generally affected by the muscle fibre characteristics such as proportion of glycolytic fibres in the muscles, hence having an impact the appearance of meat products.

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BREEDPLAN 200 day weight and milk EBV's predict weaning weight differences in Brahmans

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Introduction BREEDPLAN estimated breeding values (EBV's) are statistical predictions of an animal's genetic merit for a specific trait compared to others in the same breed. EBVs for weaning weight (WT) account for both direct genetic effect (i.e. 200 day WT EBV) and the maternal genetic component (200d WT maternal, commonly referred to as the Milk EBV). These two EBVs are used to predict a young animal's growth potential and the mother's genetic maternal contribution to the weaning weight of a calf. The dam's milk EBV is an estimate of her genetic contribution to the calf's weaning weight beyond her own genetics for growth rate. This study aimed to determine if the 200d WT EBV and the dam's Milk EBV were significantly associated with the weaning weight of Brahman calves.

Materials and methods Weaning weights were collected at Brian Pastures (BP) and Spyglass (SG) research stations as part of the Repronomics project. A total of 280 records from the 2025 Brahman cohorts were used. Importantly, these weaning weight records had not been submitted to BREEDPLAN and therefore are not contributing to the BREEDPLAN Milk or 200 day WT EBV's. BREEDPLAN establishes 200 day WT EBV's for these calves based on genomic relationship information through single step evaluation. Liveweight of the calf at weaning in kg's (WW) was modelled using R studio, initially including fixed effects for location (LOC), calf sex (CS), weaner age in days (Age) (as covariate), and age of dam in years (DA) (cows eight and older were grouped). The model also included the 200 day WT EBV of each calf and the milk EBV of its dam. Linear mixed models were stepped down, removing terms in order of non-significance to produce the final model for WW ($P < 0.05$) to determine if the EBV terms were significant. The expectation was that the regression coefficient of the calf's weaning weight on each of the EBVs would be equal to one (i.e. 1 kg WW/1 kg EBV).

Results Effects LOC, CS, DA, Age and both the Milk EBV and 200 day WT EBV were significant (Table 1). There were no significant interactions between the EBVs and the other fixed effects. The model had an R^2 value of 0.72. The regression coefficient for the Milk EBV was 1.43kg/kg and 200 day WT had a regression coefficient of 1.06 kg/kg.

Table 1. Mean, standard deviation (SD), Minimum, and Maximum of the 2025 weaners and their dam traits, the P values of fixed effects in the final model and the regression coefficients and standard error (SE) of the two EBV's

	Mean	SD	Minimum	Maximum	P<0.05	Regression coefficient	SE
Weaning weight (kg)	211	33	132	305			
Age of calf (days)	194	23	131	242	< 2.2e-16		
Dam Age (years)	5	2	3	8	< 2.2e-16		
200 day WT EBV (kg)	18	7	-1	40	5.141e-11	1.06	0.16
Dam's Milk EBV (kg)	-1	3	-8	5	0.000191	1.43	0.38
Location					3.240e-06		
Calf sex					1.716e-05		

Discussion By using animals where the weaning weight data was not yet included in BREEDPLAN, this study showed that both 200 day WT and Dam's Milk EBV (prior to including weaning weight records) were highly significant in predicting weaning weight and were close to their expectations of one. The Milk EBV regression coefficient was higher than one (albeit with a larger standard error), indicating slightly more weaning weight was observed per unit of Milk EBVs. Due to the much lower spread in the Milk EBV in this dataset it was estimated with lower precision. 200 day WT EBV had a regression coefficient close to one, indicating that one unit change in 200 day WT EBV did equal a 1kg change in weaning weight. The lack of significant interactions between either EBV and the fixed effects, such as sex and location, demonstrates that the impact of EBVs on weaning weight was not different across locations or calf sex. These results suggest that producers can be confident that by selecting on these EBV's they can influence the weaning weight of their calves through this selection.

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Shedding scores across lifetime for Wiltshire-cross ewes

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Introduction With a long-term trend of decreasing coarse wool prices (> 30µm) in New Zealand and increased shearing costs, there is an increasing demand for research into sheep that do not require annual shearing (Beef + Lamb NZ 2022). One strategy which can be employed to help reduce shearing costs is to transition the flock from a full woolled breed, such as Romney, to a fully shedding breed, such as a Wiltshire (Farrell *et al.* 2020). However, there is a lack of long-term data during the transition period and specifically the impact of the various crosses on shedding score. It was hypothesised that shedding score would be greater in animals with a greater percentage of Wiltshire genetics but it would not increase with age.

Materials and methods A long-term breeding study was started at Riverside Farm, Massey University (40°50'31"S 175°37'04"E) the autumn of 2020 at breeding. The starting population were Romney ewes bred to Wiltshire rams, with resulting ewe progeny bred back to Wiltshire rams. Wiltshire crosses born in 2020 (50% Wiltshire) and in 2021 (50% and 75% Wiltshire) were utilised in the present study. These animals were then followed with their individual shedding scores (0 – no shedding, 5 – full shed, 0.5 score increments, Johnson *et al.* 2007) as yearlings, 2-tooth and as a 4-tooth. These data were analysed in SAS 9.4 using Proc GLM with the fixed effect of proportion of Wiltshire genetics, animal fitted as a random effect and age at scoring fitted as a covariate. Rankings of shedding scores were calculated using Proc RANK in SAS 9.4 and then correlation between rank was calculated using Proc CORR

Results At yearling shed scoring (around 520 days of age) the weights of both groups did not differ ($P>0.05$, data not shown). Average weight was greater for the 50% Wiltshire cohort at the 4-tooth scoring event, but these were a smaller number of animals which had been selected to be retained due to their greater shedding.

Table 1. Age, shedding (shed) score and number of records for Wiltshire cross animals born in 2020 and 2021 followed through to Dec 2023.

Proportion Wiltshire	Yearling shed (n)	Yearling shed score	Yearling shed age (days)	2-tooth (n)	2-tooth shed score	2-tooth shed age (days)	4-tooth Shed (n)	4-tooth shed score	4-tooth shed age (days)
50.0%	230	1.27 ^b	524 ^a	189	1.19 ^b	818 ^a	43	1.24 ^b	1189 ^a
75.0%	51	3.90 ^a	521 ^b	43	2.91 ^a	788 ^b	22	3.54 ^a	1170 ^a

^{a,b} rows within the same column with different superscript are significantly different ($P<0.05$)

Shedding scores increased as proportion of Wiltshire increased (Table 1), but not by age at scoring. There was decrease in shedding score observed between yearling and 2-tooth shedding scores in the 75% animals which can mostly be attributed to timing of measurement, with animals scored in the October as 2-tooth following the February score they had as yearlings, however, the score was still greater for the 75% animals (2.91 vs 1.19). The rank shedding score correlations between age categories were 80.4%, 63.4 % and 65.3% between yearling and 2-tooth, yearling and 4-tooth and 2-tooth and 4-tooth respectively.

Discussion Favourable correlations in both breed proportions across age categories indicate that the yearling shedding score can provide a robust measure for determining the animal's ability to shed its fleece at older ages (Johnson *et al.* 2007; O'Connell *et al.* 2012; Vargas Jurado *et al.* 2020; Sneddon *et al.* 2023). Increased shedding at the 4-tooth stage compared with 2-tooth can be in part attributed to a selection step, whereby the lowest shedding animals within a breed cohort were removed. A score of 1 to 1.5 means that the sheep will have a bare belly during summer, by 3 the sheep will have only 40% of the fleece that an animal at 0 would have (Johnson *et al.* 2007). The data shows that as the proportion of Wiltshire genetics increases the shedding score increases also. Therefore, farmers can have confidence that within a couple of generations of crossbreeding, the proportion of ewe needing crutching and/or full shearing should decrease.

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Carcass characteristics and meat quality of Australian goat breeds and their crosses

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Introduction Australia is the world's largest exporter of goatmeat, exporting approximately 90% of its production overseas valued at \$364 million, while only a small proportion is consumed domestically (MLA, 2025). Despite the scale of the industry, there is limited information on carcass characteristics across goat breeds and on the genetic tools required to produce a uniform product (Abhijith *et al.* 2023). The dataset produced from this study will enhance the understanding of the genetic variation within various breed types and support the development of estimated breeding values for key meat quality traits. Therefore, the objective of this project was to investigate phenotypic data for carcass and meat quality traits of Rangeland, Kalahari and Boer goats and their crosses in Australia.

Materials and methods This project used 765 wether goats (exit liveweight 45.37 kg ($\pm$ 8.45, Table 1) produced from NSW Department of Primary Industries and Regional Development's 'Measured Goats' project described by Granleese *et al.* (2023). Breeds included Rangeland (RR), Kalahari (KK) and Boer (BB) goats and their crosses. Breed nomenclature is expressed as the sire followed by dam (for example, RB, Rangeland sire and Boer dam). All goats were born together (Condobolin Research Station), raised together and slaughtered together. Goats were weighed day of exit and transported to an export abattoir and held in lairage for 15 hours prior to slaughter. All goats were slaughtered in a single run, eviscerated, dressed, HSCW recorded and inspected in accordance with standard industry practice. The carcasses were chilled at 1°C for 22 hours prior to boning. After the carcasses were chilled, the loin saddles (*longissimus lumborum*, LL) were boned out and retained at 1°C for further laboratory analysis. The LL was denuded, silver skin was removed and samples processed to determine intramuscular fat (IMF %), shear force (SF) at 5 and 10 day ageing from left and right LL. The ultimate pH (pHu) was measured at 48-72 h post-mortem. The effect of breeds was analysed as a fixed term using the statistical analysis program R x 64 3.5.0 (R-Core Team, 2023, Austria) by running linear model using the lme4 package. HCWT was included as a covariate for some traits.

Results Exit liveweight and HCWT differed significantly across breeds, with BB and KK goats significantly heavier than the RR, whereas there was no difference between the crossbred goats. The pHu was higher in the KK compared to BB ($P < 0.05$), however, the pHu did not differ to all other breeds. All other meat quality parameters did not differ significantly between the goat breeds or their crosses.

Table 1. Estimated marginal means ($\pm$ standard error) for carcass characteristics and meat quality parameters for Australian goat breeds.

Variable	BB	BK	BR	KB	KK	KR	RB	RK	RR	P-value
LW (kg)	48.0 (0.74) ^c	45.7 (1.28) ^{abc}	45.3 (1.14) ^{abc}	47.2 (1.26) ^{bc}	48.2 (0.73) ^c	44.5 (1.13) ^{abc}	45.2 (1.13) ^{abc}	42.9 (1.07) ^{ab}	41.9 (0.62) ^a	***
HCWT (kg)	21.8 (0.33) ^c	20.9 (0.57) ^{bc}	20.8 (0.50) ^{bc}	21.3 (0.55) ^{bc}	21.7 (0.32) ^c	20.1 (0.49) ^{abc}	20.2 (0.49) ^{abc}	19.4 (0.47) ^{ab}	18.9 (0.27) ^a	***
pHu	5.86 (0.01) ^a	5.87 (0.03) ^{ab}	5.90 (0.01) ^{ab}	5.90 (0.02) ^{ab}	5.91 (0.02) ^b	5.91 (0.02) ^{ab}	5.92 (0.02) ^{ab}	5.92 (0.02) ^{ab}	5.94 (0.01) ^{ab}	*
IMF (%)	3.61 (0.08)	3.44 (0.14)	3.60 (0.13)	3.62 (0.14)	3.68 (0.08)	3.70 (0.13)	3.75 (0.12)	3.88 (0.12)	3.86 (0.07)	NS
SF5 (kg)	79.0 (2.02)	80.7 (3.54)	74.0 (3.04)	76.1 (3.34)	76.8 (1.96)	74.8 (2.98)	84.1 (2.98)	77.1 (2.86)	73.9 (1.72)	NS
SF10(kg)	72.2 (1.86)	74.0 (3.11)	67.7 (2.77)	69.9 (3.04)	70.0 (1.79)	70.4 (2.79)	75.5 (2.69)	68.5 (2.63)	69.6 (1.56)	NS

*LW; exit liveweight, HCWT; Hot carcass weight, IMF; intramuscular fat, pHu; ultimate pH, SF5; shear force at 5 days ageing, SF10; shear force at 10 days ageing. Significant levels are; 0 **** 0.001 *** 0.01 ** 0.05 ' 0.1 ' ' 1, NS; not significant.

Discussion The variation in exit liveweight and HCWT among the goat breeds highlights the impact of breed on yield and the potential to enhance production efficiency through genetic selection and breeding programs. Although there were no differences observed in meat quality parameters between breeds, the values are consistent with previously published studies for goats (Abhijith *et al.* 2023, Goetsch *et al.* 2011). However, the SF values are much higher than lamb (Hopkins *et al.* 2011) suggesting the goats may have cold shortened. These results provide a foundation for advancing the Australian goat meat industry by improving the understanding of how breed composition affects meat quality and by capturing variation within and between breeds and their crosses. Additional cohorts are required to enhance this dataset before making further recommendations.

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Factors influencing sale of village chickens in resource-limited communities in South Africa

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Introduction Village chickens are common in resource-limited communities reared mostly by households living below the poverty line (Tenza *et al.* 2024). Chickens are mainly used for meat and eggs. Yet their genetic potential to generate income is overlooked. High transaction costs and informal marketing channels constrain the contribution of chickens to generate income. It is pertinent to integrate village chickens into formal value chains and provide empirical evidence that guides policies and interventions to enhance productivity and income for resource-limited communities. The objective of the study was to identify the factors that influence selling of village chickens in resource-limited communities.

Materials and methods The study was conducted in Musina Local Municipality (22° 22' 0" S, 29° 45' 0" E), in Vhembe District Municipality, Limpopo Province, South Africa. The study area has a comparative advantage in production of village chickens and is predominantly rural. Households rely on field crops, vegetables, extensive livestock rearing, and social grants. The study adopted a cross-sectional quantitative research design. Purposive sampling was applied to identify 150 households that kept village chickens to provide information about factors that influence selling of village chickens in resource-limited communities. The sample size was determined using Yamene's formula at a 95 % confidence level. Adults of either gender represented households. Data was collected through interviews using a pre-tested structured questionnaire. Data were analysed using Statistical Package for Social Sciences (version 28). Ordinal logistic regression was used to predict the odds ratios of the socio-demographic factors that influence chicken sales.

Results The probability of a household selling chickens was not influenced by gender or whether the farmer belonged to a farmer association (Table 1). Households where farmers had not received training were 2.71 times more likely to sell chickens compared with those who had received training, and unemployed farmers were 1.63 times more likely to sell chickens compared with employed farmers. Farmers with large flocks were 4.52 times more likely to sell chickens.

Table 1. Odds ratio estimates for socio-economic factors influencing chicken selling

Predictor	Odds ratio	Lower CI	Upper CI	Significance
Gender (male vs female)	1.156	0.600	2.228	NS
Farmer association (yes vs no)	1.074	0.485	2.378	NS
Livestock training (yes vs no)	0.369	0.150	0.909	**
Employment status (employed vs unemployed)	0.615	0.266	1.420	*
Flock size (small vs large)	0.221	0.107	0.456	***

Higher odds ratio estimates indicate a greater difference in occurrence between levels of predictors

* P < 0.05; ** P < 0.01; NS = Not different (P > 0.05).

Discussion Conclusion and implications Gender did not influence chicken sales in this study. It has previously been found that there are different gender roles in the management of chickens, with women primarily owning and managing chickens and men involved in chicken production and sales (Alemayehu *et al.*, 2018). It is unsurprising that unemployed farmers are more likely to sell chickens given resource scarcity. Yusuf & Popoola (2022) supports that untrained farmers sell chickens more than trained farmers. However, this does not guarantee marketing opportunities due to lack of reliable buyers and unorganized marketing channels. Training, employment, and flock size were the major factors that influenced village chicken selling in resource-limited communities. Prioritising capacity building on chicken production and marketing strategies promotes innovation and sustainable village chicken production for income generation.

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Optimum productive life in pasture-based dairy systems

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Introduction Optimum productive life is influenced by numerous factors including input and output costs, genetic gain, cost and availability of herd replacements, animal health and welfare (De Vries & Marcondes 2020). The average productive life in Australian dairy herds is currently ~4 lactations (Khansefid *et al.* 2023), which may differ from the optimum across different feeding systems. Our aim was to test if optimum productive life varies between pasture-based and intensive dairy systems.

Materials and methods We modelled a 400-cow dairy herd across 10 lactations in Microsoft Excel. Changes to income and costs associated with changing herd voluntary culling rate were calculated separately for each lactation and then summed with Earnings Before Interest and Tax (EBIT, \$/cow/year). The model accounted for reduced profit in first and second lactation, reduced profit and higher costs in lactations 6+, genetic opportunity cost of keeping older cows and the favourable impact of voluntary culling on older animals, herd replacement costs and changes to calf pathways. To test if optimum productive life differed between pasture-based and intensive dairy systems, five-year average farm financial data (FY20–24) were obtained from Dairy Farm Monitor Project via DairyBase for 129 high-grazed feed/low-grain and 329 low-grazed feed/high-grain herd-years, respectively. Pasture and intensive herds differed in grazed feed, fodder and concentrate intake (3.95, 0.62, 0.99 vs 1.79, 3.78, 3.07 tDM/cow), milk production (417 vs 585 kgMS/cow), milk price (\$8.21 vs \$9.52/kgMS) and feed costs (\$1027 vs \$2879/cow). Genetic gain of \$40/cow/year, cull cow value of \$1268, and heifer rearing cost of \$1682/head was assumed.

Results. In both pasture-based and intensive herds, optimum productive life was 3.6 lactations, equivalent to 27% replacement rate and 16% voluntary culling (Fig 1). However, the curve was quite flat near the optimum. Overall, shorter productive life reduced EBIT, more than longer productive life. A 1 lactation decrease from optimum productive life reduced EBIT by \$43 and \$61/cow/year in pasture-based vs intensive herds, respectively, compared with \$10 and \$15/cow/year for a 1-lactation increase. Although shorter productive life reduced costs of genetic lag and older cows, this did not offset lower milk income from more lactation 1 and 2 cows. Similar trends were seen in pasture and intensive herds, however higher milk income in intensive herds increased the magnitude of changes to voluntary culling rate.

Discussion While the optimum productive life reported here agrees with literature (De Vries & Marcondes 2020), the slope suggests that there may be a range over which productive life is nearly optimal. As optimum productive life is sensitive to milk income and costs (De Vries & Marcondes 2020) an important next step in expanding this work will be sensitivity analyses of key assumptions as well as modelling other feeding systems.

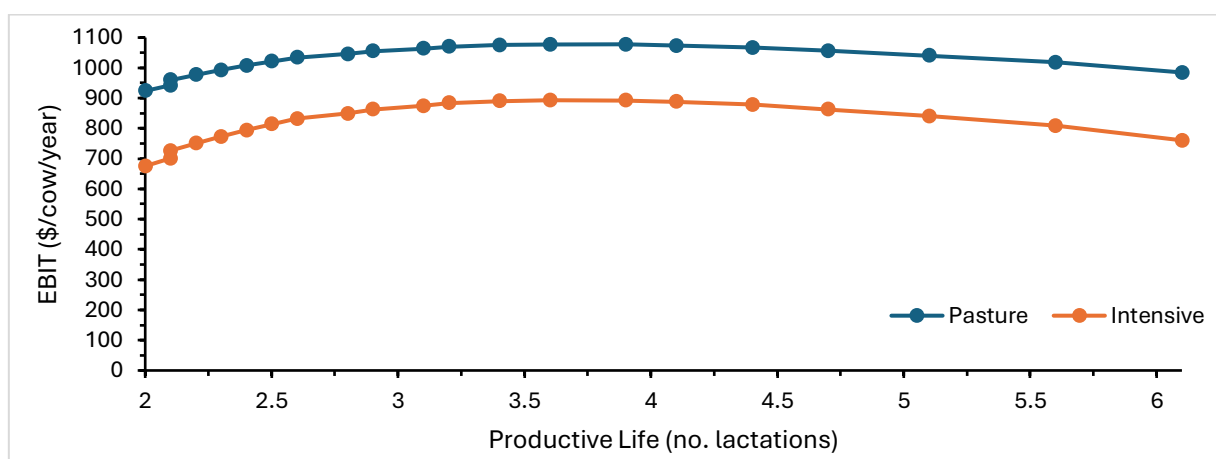


Figure 1. Effect of voluntary culling rate on Earnings Before interest and tax (EBIT, \$/cow/year) in pasture-based and intensive dairy systems

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Do cooking methods influence sensory properties of premium beef cuts?

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Introduction Eating quality is central to consumer acceptance of beef, with tenderness, juiciness, flavour and overall liking evaluated collectively rather than as isolated traits. Eating quality is shaped by animal factors, production practices and post-mortem handling, and understanding these influences has informed grading systems including Meat Standards Australia (MSA). Within the MSA framework, muscle-type differences, connective tissue content and intramuscular fat (IMF) are key contributors to palatability, though breed effects on sensory attributes remain inconsistent. Cooking method further modulates flavour development, texture and juiciness, yet research often emphasises tenderness at the expense of a broader sensory assessment. Given beef's variability and the limited guidance available to consumers, greater clarity on the drivers of eating quality is needed. Therefore, this study aimed to evaluate how muscle type, cooking method, breed and their interactions affect the sensory attributes of Australian premium beef.

Materials and methods A group of 200 steers, mixed breeds of crossed Wagyu x Angus (WA) and purebred Angus (AA), were obtained from a feedlot after around 200 days-on-feed and were slaughtered under MSA protocols in a commercial abattoir in Warwick, QLD. A cohort of 18 WA and 18 AA carcasses was selected for consumer sensory testing balancing marbling and ossification between breeds. At 20 h post-mortem, chuck roll, outside flat and striploin primals were collected, chilled, transported to the UNE Meat Science Laboratory, trimmed and dissected into *serratus ventralis* (SV), *biceps femoris* (BF) and *longissimus lumborum* (LL) muscles. Meat sensory samples were prepared according to MSA protocols, as outlined by Watson *et al.* (2008) for grill, shabu shabu and yakiniku cooking. All samples were aged to 14 days, frozen, then thawed for testing. Sensory evaluation involved 1080 consumers across six sessions per cook method, using standardised MSA procedures, 100-mm line scales and MQ4 calculations, with quality grades assigned to assess tenderness, juiciness, flavour and overall liking. Additionally, consumers selected one of four MSA quality grades to best represent their satisfaction level: unsatisfactory (2 stars), good everyday (3 stars), better than everyday (4 stars), or premium (5 stars) (Thompson *et al.* 2008). A three-way analysis of variance model in R (R Core Team, 2023) was used to evaluate consumer sensory scores and satisfaction levels with the fixed effects of breed, muscle type, cooking method, and their interactions plus marbling score as a covariate. The level of significance set at $P < 0.05$.

Results and discussion Muscle type significantly influenced sensory characteristics ($P < 0.05$, Table 1). The SV and LL muscles were notably more tender (60.4 and 63.9) than the BF muscle (43.6). SV recorded the highest juiciness (67.4), while BF had the lowest (54.9). Flavour, overall liking, MQ4 and consumer satisfaction were greatest in the LL muscle, intermediate in SV and lowest in BF. Cooking method affected all sensory traits except tenderness; yakiniku produced markedly higher juiciness (67.5) than shabu shabu (60.6), with grill samples not differing statistically from either. Breed influenced only flavour, with WA steers scoring higher than AA steers by 3.1 points. Significant impacts of muscle type and cooking method interactions on the sensory quality were observed.

Table 1 - Sensory properties of *serratus ventralis* (SV), *biceps femoris* (BF) and *longissimus lumborum* (LL) muscles from crossed Wagyu x Angus (WA) and purebred Angus (AA) steers cooked various methods

	Muscle (M)			Cooking method (C)			Breed (B)		SEM	P value			
	SV	BF	LL	Grill	Shabu shabu	Yakiniku	WA	AA		M	C	B	MxC
Tenderness	60.4 ^a	43.6 ^b	63.9 ^a	56.5	56.2	60.7	59.4	54.5	0.89	<0.001	0.505	0.066	0.022
Juiciness	67.4 ^a	54.9 ^c	63.0 ^b	63.1 ^{ab}	60.6 ^b	67.5 ^a	64.0	61.1	0.71	<0.001	0.013	0.150	0.008
Flavour	60.2 ^b	54.5 ^c	65.7 ^a	64.0 ^a	55.7 ^b	65.8 ^a	61.9 ^a	58.8 ^b	0.67	<0.001	<0.001	0.042	<0.001
Overall liking	61.2 ^b	50.7 ^c	65.3 ^a	61.3 ^a	56.6 ^b	65.2 ^a	61.5	57.8	0.71	<0.001	0.019	0.054	0.003
MQ4	60.9 ^b	49.9 ^c	64.6 ^a	60.5 ^a	56.3 ^b	64.2 ^a	60.9	57.2	0.69	<0.001	0.020	0.065	0.004
Satisfaction (star)	3.3 ^b	3.0 ^c	3.5 ^a	3.4 ^a	3.2 ^b	3.4 ^a	3.3	3.2	0.03	<0.001	0.021	0.259	0.008

Means within the same row in each factor with differing superscripts are significantly different ($P < 0.05$).

Conclusion It was concluded that muscle type was the main determinant of beef sensory performance. The LL muscle consistently showed the highest flavour, overall liking, MQ4 and satisfaction scores, while the BF muscle had the lowest across attributes. Cooking method influenced all traits except tenderness: grilling and yakiniku generally enhanced eating quality for tender muscles such as SV and LL, whereas shabu shabu was better suited to tougher muscles like BF. The strong interactions between muscle type and cooking method emphasise the importance of considering both factors when predicting eating quality. Breed affected only flavour, and this limited effect indicates that carcass phenotype traits are more reliable predictors of sensory variation than breed alone.

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A network of mixed farming long-term experiments in Southern Australia

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Introduction Increasingly variable rainfall presents a major challenge to global agriculture, demanding greater system resilience to sustain productivity. Empirical data on resilience and performance trade-offs between specialised and integrated systems remains limited (Baker et al., 2023). This paper describes results for the first of a multi-year, cross regional project that investigates different mixed farming systems (combined grain crop and sheep grazing enterprises) in New South Wales (NSW), Victoria (VIC), and Tasmania (TAS) to test the overarching hypothesis that integrated crop-livestock systems are inherently more resilient under variable climates. Here we present preliminary results on sheep grazing days achieved by systems including livestock during the 2025 grazing season (324 days).

Materials and methods Experiments were established at three sites with distinct climate characteristics, Wagga Wagga, NSW (Animal Ethics Approval Number (AEAN) A24120), Dookie, VIC (AEAN 29816), and Evandale, TAS (AEAN 31268). At Wagga Wagga, three systems (Traditional, High-intensity mixed, and Ley) with composite ewes (1–4 years, 65–80 kg) were implemented in phased, replicated ($n = 3$) 2.4 ha farmlets (0.2 ha sub-paddocks). At Dookie, two systems (mixed farming with annual pastures (MFAP), and mixed farming with ley pastures (MFLP)) using merino wethers (2–3 years, 40–50 kg) were established in phased, replicated ($n = 3$) 1.08 and 1.44 ha farmlets (0.36 ha sub-paddocks). At Evandale, a set stocking grazing treatment with merino ewes (2–3 years, 30–40 kg) was applied to ryegrass and cocksfoot-based pastures ($n = 3$; 0.6–0.7 ha). Time spent on the various feed types was evaluated over 324 days (1st January – 21st November).

Results Across sites, the proportion of time spent on different crops or pastures varied between systems. In the Wagga Wagga Ley system (Fig 1a), grazing time was spread relatively evenly among stubble, confinement feeding off trial, dual purpose canola, and grass/clover pastures (15–25%). The traditional and high-intensity systems grazed lucerne/sub-clover for nearly 50% of grazing days, with remaining time split between hand feeding on plots, stubble and minor forages. At Dookie, MFAP (Fig 1d) relied heavily on vetch-based pastures (71%), whereas MFLP focused on clover-dominant pastures (38%, Fig 1e). At Evandale, set-stocked sheep grazed grass/clover pastures continuously (Fig 1f).

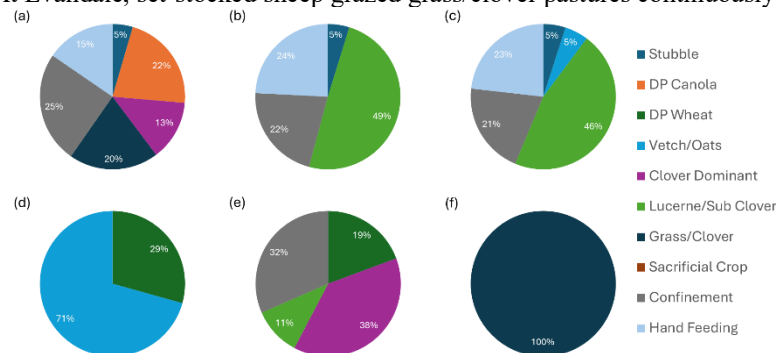


Figure 1. Average ($n = 3$) grazing days between 1st Jan – 21st Nov 2025 on each of the feed types, expressed as a proportion of total days grazed for Wagga (a) Ley (266 days), (b) Traditional (306 days), (c) High intensity (323 days), Dookie (d) MFAP (~106 days) (e) MFLP (~140 days), and Evandale (f) Set stocking (98 days).

Discussion Mixed farming systems with various grazing and forage management options experienced diverse results in this season. These grazing patterns illustrate how contrasting mixed-farming designs distribute livestock across feed types through the year, and how the drought conditions impacted length of grazing periods on each feed base, with the dry Autumn increasing days in confinement or hand feeding in paddocks at Wagga Wagga and Dookie. Both class and liveweight of sheep contributed to the observed range in grazing days as well. Together, these results describe a spectrum of grazing allocations that can be used to compare how different mixed farming systems organise feed supply and may inform future evaluation of drought resilience and system performance.

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Pre-calving nutrition improves calf growth in northern beef herds

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Introduction In northern beef herds, the nutrition of pregnant breeders has a major influence on both calf growth and the ability of cows to recover after calving. First-lactation cows are particularly vulnerable, as they must partition energy between finishing their own growth, building body reserves, and producing milk. When nutrition before calving is limited, milk production can suffer, and calf growth slows. The Calf Alive project was established to quantify how improving nutrition before calving influences calf performance and cow condition under commercial conditions. This study reports results from three intensively monitored properties where precise calving dates and birth-to-weaning growth could be measured. We hypothesised that providing a targeted protein–energy supplement before calving would increase milk production, translating into increased calf average daily gain (ADG) to weaning.

Materials and methods Pre-calving supplementation was implemented for 6–8 weeks before the expected start of calving at three commercial properties during the 2023/24 season: one herd of mature cows (Site A) and two herds of first-calf heifers (Sites B and C). A total of 418 calves with complete birth-to-weaning records were analysed (Site A: 81; Site B: 186; Site C: 151). Pregnant cows were stratified by liveweight and estimated calving date (from foetal ageing) and randomly allocated to treatment or control groups. The treatment group received a targeted protein–energy supplement supplying approximately 300–400 g CP/day, while controls grazed the same paddocks without additional supplementation. At Sites A and B, walk-over-weighing units at the only watering point recorded daily liveweight, allowing calving dates to be identified from sustained weight drops supported by weekly visual checks. At Site C, calving was observed daily, and calves were weighed within 24 hours of birth. These systems enabled accurate estimation of calf average daily gain (ADG) from birth to weaning. Site A comprised mature Brahman cows (Katherine, NT), Site B Angus-cross heifers (Camooweal, QLD), and Site C Belmont Red heifers (Western Downs, QLD). Cow weight class (light, medium, heavy) was defined within each herd from pre-supplementation liveweight distributions (mean $\pm$ 0.43 $\times$ SD). Calf growth was analysed separately for each property using linear mixed-effects models (PROC MIXED), with treatment, calf sex, weight class and parity as fixed effects and cow as a random effect. Results are presented as least-squares means ($\pm$ SEM).

Results Site A achieved a lower supplement intake (17 kg/cow) compared with the two heifer sites (32 and 42 kg/heifer at Sites B and C, respectively). Storm activity in November and the presence of surface water likely reduced yard visitation and disrupted supplement access at Site A. Providing extra nutrition before calving improved calf growth at two of the three properties, with responses strongest in first-calf heifers. At Site B, supplementation increased calf ADG by 32 g/d ($P = 0.04$), while at Site C the benefit was 56 g/d ($P = 0.02$). At Site A, where supplement intake was lowest, and cows were mature, the difference was not statistically significant (+52 g/d; $P = 0.13$). Across all sites, male calves grew faster than females. Dam weight class influenced calf growth only at Site B, where calves from heavier heifers outperformed those from lighter heifers ($P < 0.01$).

Table 1. Effect of pre-calving supplementation on calf average daily gain (g/d) from birth to weaning.

Factor	Level	Site A (Cows) (g/d $\pm$ SEM)	P-value	Site B (Heifers) (g/d $\pm$ SEM)	P-value	Site C (Heifers) (g/d $\pm$ SEM)	P-value
Treatment	Control	759 $\pm$ 24	0.13	861 $\pm$ 13	0.04	821 $\pm$ 17	0.02
	Treatment	811 $\pm$ 24		893 $\pm$ 12		877 $\pm$ 16	
Sex of Weaner	Female	732 $\pm$ 25	<0.01	852 $\pm$ 12	<0.01	814 $\pm$ 17	<0.01
	Male	838 $\pm$ 23		901 $\pm$ 11		883 $\pm$ 17	
Dam Weight Class	Light	767 $\pm$ 30	0.75	840 $\pm$ 15	<0.01	836 $\pm$ 19	0.50
	Medium	780 $\pm$ 31		887 $\pm$ 14		842 $\pm$ 21	
	Heavy	799 $\pm$ 30		904 $\pm$ 15		869 $\pm$ 21	

Discussion Pre-calving supplementation improved calf growth in first-calf heifers but had limited impact on calves from mature cows, indicating that heifers are more sensitive to nutritional constraints in late gestation. Across properties, the observed improvements in ADG translate to an additional 7–12 kg of weaning weight. It was concluded that pre-calving protein–energy supplementation increased calf average daily gain in first-calf heifers, supporting the hypothesis that improved maternal nutrition before calving enhances milk-mediated calf growth.

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Dual energy x-ray absorptiometry data can predict commercial cut weight with good precision

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Introduction Several pre-chill dual energy x-ray absorptiometry (DXA) systems have recently been installed in Australian lamb processors, providing considerable advances in the assessment of carcase composition over traditional methods (Gardner *et al.* 2018). These improvements in precision extend to the estimation of cut weight, with predictions using DXA estimates explaining 85% of the variation and thus exceeding predictions using GR for most cuts (Gardner *et al.* 2021). This superiority in precision and accuracy of estimates using DXA combined with tools such as the Lamb Value Calculator (LVC) and Carcase Optimisation Tool present significant opportunity for carcase sortation pre-fabrication to optimised cutting plans, resulting in maximised profit. The LVC uses HSCW and carcase composition, assessed by palpation, GR knife, or DXA, to estimate the weight of primal cuts through prediction equations developed from data on 200 carcasses boned out to commercial specification in a research environment. A potential limitation of the opportunity to maximise profit through improved carcase sortation is the ability of the LVC equations to predict cut weight under commercial conditions. The aim of this study was to determine the precision with which the LVC equations can predict cut weight using DXA estimates for cuts produced in a commercial environment at chain speed.

Materials and methods Lamb carcasses were processed following standard slaughter floor practices. Following manual fat palpation at the hot scale, carcasses were DXA scanned (Scott Automation and Robotics) and electrically stimulated prior to entry into the chiller where they remained overnight (~18-24hrs). Carcasses ($n=141$) from a large phenotypic range based on HSCW [24.34 ± 2.73 kg (mean $\pm$ SD)] and DXA lean (53.8 ± 2.4 %) were selected on entry to the boning room and tracked through fabrication. The weights of both the right and left side for bone-in and boneless cuts from the forequarter, saddle, and hindquarter regions were collected for a range of commonly produced commercial cuts. Data were analysed in R by linear models with the *lm* function (R Core Team, 2020). Regression was used to analyse the amount of variation in cut weight described by: a carcasses own HSCW, the left side cut weight (for predicting the right side cut weight), and the LVC prediction using DXA lean estimates. Prediction precision was described by R-square (R^2) and Residual Standard Deviation (RSD).

Results Over 70% of the variation in weight was accounted for by the LVC prediction using DXA lean in most cuts. The residual variation between left and right side weight for each cut was below 30% for 12 of the 15 cuts sampled; cuts in the saddle region had the least residual variation (12-16%), followed by the hindquarter (6-41%), then forequarter (10-79%). The variation in the right cut weight accounted for by the left cut weight was considered the maximum precision attainable, and LVC predictions using DXA lean fell within an average 13% of this value (range 0-21%). The predicted value using DXA lean described an average 25% more variation in cut weight than HSCW alone for 10 of the 15 cuts. This trend where the side weight accounted for the greatest variation, followed by LVC predictions using DXA, and then HSCW, was observed in 7 of the 15 cuts recorded.

Discussion This study demonstrated the capacity for the LVC equations to predict the weight of commercial cuts produced at chain speed using DXA lean estimates. The LVC predicted cut weight using DXA lean estimates with precision as high as 93%; prediction precision below 70% was only reported for five cuts. Previous work, where cuts were prepared under research conditions, reported piece weight can be predicted using DXA inputs with R^2 ranging from 0.64-0.95 (Gardner *et al.* 2021) and 0.51 - 0.95 (López-Campos *et al.* 2018). For cuts with lower precision such as those in the forequarter, the amount of variation explained by the HSCW and side predictions were similarly low. The results of our study are similar to those reported by López-Campos *et al.* (2018), in that the ability of models using DXA estimates to predict cut weight were less precise for cuts from the forequarter region. The 5 cuts where HSCW described more variation was unexpected given the ability for the LVC equations to use DXA composition estimates and account for varying degrees in fatness at the same carcase weight. The greater precision seen in the HSCW prediction over DXA for these cuts is likely because the carcase's own HSCW was used to explore the relationship with cut weight, rather than taking LVC prediction equations using HSCW and applying them to a different data set, as is the case for the DXA prediction values. The results of our study have demonstrated the ability to predict cut weight using DXA estimates under commercial conditions with good precision. Future work utilising advancements in carcase composition assessment provided by DXA alongside site-specific adjustments to prediction models can further increase the precision of cut weight prediction to maximise profitability through optimised carcase allocation to fabrication plans.

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Production of Composite lambs in mixed-farming systems in Southern New South Wales

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Introduction The increasing frequency of drought presents a significant challenge to agricultural systems and reinforces the need for resilient management strategies to maintain long-term productivity. A long-term research trial was established in 2024 at Charles Sturt University, as part of the Southern NSW Drought Resilient Mixed Farming System Long-term Field Trials Project. The project aims to identify which farming system, and components within farming systems, improve drought resilience and long-term profitability in mixed farming enterprises. To assess how livestock integration contributes to system resilience, the productivity and profitability of a terminal lamb production system is being compared between the three farming systems; traditional mixed (five years of lucerne and seven years cropping), high intensity mixed (five years lucerne and seven years of cropping with more forage options available from vetch and dual-purpose crops), and ley (two years cropping and two years annual clover pasture).

Materials and methods Fifty-four Composite ewes (1-4 years) were joined in January over a 6-week joining period, and allocated to farmlets representing the traditional, high intensity or ley systems. Each system was fully phased and replicated ($n = 3$). Stocking rates reflected the available forage with ewes stocked at 5.3 ewes/ha of lucerne (traditional), 7.3 ewes/ha of lucerne (high intensity) and 6.1 ewes/ha of arrowleaf clover available. Stocking rates were adjusted to 1.2 lambs per ewe at lamb marking. Ewes and lambs were weighed at key production stages, and lambs were weighed every 30 days post-weaning for three months. Production costs, including pregnancy scanning, vaccination, and drenching were analysed across systems. After weaning, lambs received coarse salt as a low-cost supplement to support live weight gain. Ewes and lambs had access to 0.8 ha (traditional) 1 ha (high intensity) and 1.8 ha (ley) of grazing area. Lambs exited the systems once 70% of lambs within a replicate exceeded 50 kg liveweight or earlier if forage availability became limiting. A multivariate analysis of variance compared management costs from the three farming systems using IBM SPSS Statistics.

Results Management costs for ewes and lambs averaged \$9.20 per ewe and \$6.81 per lamb. Feeding costs averaged \$0.23/hd/day for joining and \$0.64/hd/day for lambing. Feeding costs between systems (**Table 1**) did not vary significantly ($P < 0.05$) due to limited feed availability and subsequent set stocking of all farming systems. The lambs in the ley and high intensity systems exited at the same time, whilst the lambs from traditional system exited 1.5 weeks after. Intake of coarse salt provided to the weaned lambs differed, reflected in the supplementation cost. Lamb sale value at exit weight exceeded an average of \$250/hd across all systems.

Table 1. Average production cost (\$) per head per farming system for ewes and lambs in 2025 and value of lambs (\$/hd) and \$/ha at time of exiting the system.

	Traditional	Ley	High Intensity
Management Costs			
Ewes	\$9.20 ± 0.0	\$9.20 ± 0.0	\$9.20 ± 0.0
Lambs	\$6.81 ± 0.0	\$6.81 ± 0.0	\$6.81 ± 0.0
Feeding Cost			
Confinement Joining ¹	\$9.25 ± 0.0	\$12.94 ± 0.0	\$12.94 ± 0.0
Lambing ²	\$25.83 ± 2.0	\$26.93 ± 0.0	\$27.34 ± 0.0
Weaner Supplement ³	\$2.95 ± 2.5	\$1.81 ± 6.8	\$2.33 ± 3.8
Lamb Value \$/hd	\$294.33 ± 9.5	\$311.30 ± 13.5	\$277.44 ± 11.7
Lamb Value \$/ha⁴	\$2,207.50 ± 70.9	\$1,444.06 ± 164.2	\$2,307.99 ± 81.0

¹ 66-day confinement feeding. Includes adaptation period to grain prior to the 6-week joining period. ² 41-day hand feeding.

³ Supplement provided for the weaned lambs for 43 days in the high intensity and ley farming systems, and 55 days in the traditional farming system. ⁴ Gross value of lambs \$/hectare grazed

Discussion The preliminary results from the 2025 season demonstrate the high contribution of lamb production in mixed-farming systems in 2025, driven by high lamb growth rates and lamb values when sold in November. As drought frequency and rainfall variability continue to increase, systems that minimise supplementary feeding requirements while still supporting strong lamb growth are likely to offer greater resilience and profitability. The ongoing multi-year dataset will allow assessment of how these systems perform under different seasonal conditions and identify management strategies that best support long-term productivity.

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Influence of body weight at calving on subsequent milk production of dairy heifers

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Introduction The age and body weight at calving (BWC) of replacement dairy heifers are considered as important metrics for management in a dairy farm as it can affect subsequent first lactation performance (Sejrsen & Purup, 1997). However, the recommendations for optimum BWC varies widely between publications due to variations in the farm feeding system, genetics, nutrition, herd management and environment. For example, in Holsteins' high concentrate intensive feeding BWC ranges from 550 kg to 650 kg, while pasture-based system ranges from 450 kg to 550 kg (Holmes et al., 2002). While Dairy Australia published the recommended BWC (510 kg with an optimal mature weight of 600 kg) for Australian farms in 2013, no recent studies evaluate heifer performance. Therefore, this experiment aimed to evaluate the influence of BWC on milk production of Holstein Friesian heifers.

Materials and methods The experiment was conducted at The University of Melbourne Dookie Dairy (Aug - Dec 2024). Holstein Friesian dairy heifers (n=24) were enrolled at calving (day 0) until day 120 post-calving and grouped as either BWC1 (<530 kg, n=8) or BWC2 (>530 kg, n=16) for analysis. Daily body weight, milk yield (MY), milk somatic cell count (SCC) and milk composition (fat, protein and fat/protein ratio) were automatically collected at each milking via the automatic milking system (AMS; Lely Astronaut; Lely, The Netherlands). Body condition score (BCS) was assessed on days 0, 7, 14, 21, 70 and 120 post-calving. The diet consisted of concentrates, pasture, and silage and/or hay fed when grazing and concentrates were insufficient to meet the herd's nutritional requirements. All data were analysed for repeated measures using the MIXED procedure of SAS.

Results The BWC2 heifers were heavier than BWC1 across all timepoints (480 kg and 516 kg for BWC1 vs. 551 kg and 549 kg for BWC2 for day 0 and day 120 respectively). The BCS differed across lactation for BWC1 compared to BWC2 (4 and 4.5 for BWC1 vs. 4.5 and 4.5 for BWC2 at day 0 and day 120 respectively). Based on Table 1, MY differed across days and between groups but showed no interaction. Milk fat and fat/protein ratio were not different between groups and there was no interaction between group and lactation days. Milk protein differed between group and lactation days, but no interaction was observed. There was no difference in milk SCC between groups, although SCC varied across lactation days where the highest was at day 7 and lowest at day 120 for both BWC1 and BWC2.

Table 1. Milk production of heifers with varied body weight at calving (BWC) across lactation*

Milk composition	Group	Lactation days					G	P-value	
		7	14	21	70	120		L	G*L
Milk yield (litres)	BWC1	9.1 ±1.56	12.3	16.9	21.7	19.1	0.001	<.0001	0.08
	BWC2	12.5 ±1.21	17.9	22.2	25.0	21.0			
Fat (%)	BWC1	4.4 ±0.18	4.6	4.2	3.7	3.9	0.08	<.0001	0.16
	BWC2	4.7 ±0.14	4.2	3.9	3.6	3.7			
Protein (%)	BWC1	4.34 ±0.97	4.2	4.1	3.5	3.4	0.004	<.0001	0.65
	BWC2	4.2 ±0.07	4.0	3.8	3.3	3.3			
Fat/protein ratio	BWC1	1.00 ±0.44	1.10	1.02	1.06	1.16	0.81	<.0001	0.19
	BWC2	1.10 ±0.35	1.04	1.00	1.08	1.12			
SCC (10 ³ cells/mL)	BWC1	739 ±153.2	580	43	34	29	0.07	<.0001	0.006
	BWC2	167 ±119.9	78	65	71	54			

*Values are least-square means and a pooled standard error in the first column. BWC1: Body weight at calving <530 kg (n=8), BWC2: Body weight at calving >530 kg (n=16), G: Group, L: Lactation days.

Discussion These results suggest that BWC influences the first lactation performance of Holstein Friesian heifers from calving until early lactation (day 120). Heifers with a greater BWC (>530 kg) had a greater MY than those with a lower BWC (<530 kg). However, no difference in milk composition was observed. This is likely due to heavier heifers having greater fat mobilization of body reserves compared to lighter heifers at calving. While this experiment utilized a low number of animals, these findings contribute beneficial knowledge for farmers to use when making management decisions in Australian grazing systems.

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An Economic Comparison of Fixed-time Artificial Insemination and Natural Mate in Commercial Angus Beef Heifers

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Introduction Reproductive efficiency is a key driver of the biological and economic sustainability of beef production systems. In southern Australian pasture-based systems, profitability is largely determined by the number of calves weaned per cow joined and calf weaning weight (Walmsley *et al.* 2016). Natural mating remains the most common reproductive strategy in commercial beef systems, although, fixed-time artificial insemination (FTAI) is increasingly popular in heifers due to the opportunity to increase the number of early conceptions, access to sires of greater genetic merit and improved labour efficiency at the time of calving. However, adoption of FTAI in commercial beef herds is limited due to perceived cost (Lardner *et al.* 2020). The objective of this study was to determine the value of FTAI relative to herd profitability.

Materials and methods The study was conducted on a commercial Angus breeding enterprise on King Island, Tasmania. A total of 1,696 heifers were allocated to one of three treatment groups using stratified randomisation based on pre-joining weight and body condition score: 1) natural mate (NM; n=403), 2) single 250-µg injection of prostaglandin F2α, prior to natural mate (SNM; n=443) or 3) FTAI + oestrus detection protocol (FTAI; n=850). Pregnancy status was determined via ultrasonography with fetal aging used to assign conception cycle (1st cycle; conceived to insemination or within the first 21-days, 2nd cycle; conceived between day 22 and 42 or 3rd cycle; conceived after day 42). Data collected included weight, body condition score, calving date, dystocia, calf survival, weaning weight and rebreeding performance. Economic analyses incorporated treatment costs (hormones, semen and labour) and bull costs (purchase or homebred developmental costs). These costs together with production outputs were used to calculate gross margin per calf weaned allowing a comparison of the profitability of reproductive strategies. The potential genetic merit of progeny born to FTAI sires was estimated by the difference in the Angus Breeding Index between the FTAI and natural mate sires.

Results Conception rate and cycle did not differ between treatments ($P>0.05$), conception rates within three weeks were 50.6%, 52.0%, and 56.1% for NM, SNM, and FTAI heifers respectively, and overall conception rates within nine-weeks were 92.3%, 90.1%, and 93.5%. Heavier heifers were more likely to conceive early (within six-weeks) across all treatments ($P<0.01$). FTAI heifers conceived an average of 11 days earlier ($P<0.001$) and weaned heavier calves (6 kg; $P<0.001$). Calving rate, dystocia, and rebreeding success did not differ between treatments ($P>0.05$). Total costs (treatment + bull costs) per pregnancy were \$66, \$71, and \$144 for NM, SNM, and FTAI groups respectively. Despite heavier, higher value calves at weaning, gross margin per calf weaned was lowest for FTAI. Calves sired by FTAI bulls had a potential genetic advantage of \$39.50, of which half is inherited (\$19.75), and considering only calves from the 56.1% of FTAI heifers that conceived would retain this, the weighted average potential genetic gain per calf was \$11.06.

Table 1 Calf weaning weight, income per calf, income per pregnancy, cost per pregnancy and gross margin per pregnancy.

	NM	SNM	FTAI
Income			
Calf wwt (kg)	165	167	172
Income (\$/calf)	470	476	490
Income (\$/pregnancy)	413	439	442
Costs			
Treatment + bull cost (\$/pregnancy)	66	71	144
Gross margin (\$/pregnancy)	347	367	297

Discussion Conception rate and cycle did not differ, reflecting stratified allocation and confirming that joining weight drives early conception independent of reproductive strategy. Calves born to the FTAI group were heavier at weaning likely due to being older. However, higher FTAI costs outweighed these benefits. Modest inheritance and partial capture of FTAI sire genetic merit limits immediate economic impact. In conclusion, although FTAI can improve calving outputs and offer genetic potential, natural mating remains the most economically efficient strategy under these conditions.

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Maternal supplementation of dietary guanidinoacetic acid on creatine production in twin-bearing Merino ewes and newborn lambs

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Introduction Perinatal lamb mortalities are a major economic and welfare issue for Australian sheep enterprises, with approximately 12 million twin lambs lost each year (Young *et al.* 2014). Maternal supplementation with dietary guanidinoacetic acid (GAA) during pregnancy has potential to improve twin lamb survival by enhancing creatine production. Creatine is an important organic compound for energy metabolism and neonatal brain protection (Dickinson *et al.* 2014). This study aimed to determine whether supplementing varying amounts of GAA into the diets of twin-bearing Merino ewes during late pregnancy would influence circulating concentrations of creatine in ewes and newborn lambs. We hypothesised that maternal GAA supplementation would enhance creatine production in ewes and neonatal lambs, with the greatest effects expected at the highest dosage rate.

Materials and methods Multiparous ewes were assigned to 1 of 4 dietary treatments based on live weight, body condition score and age: 0 g (Control, CTL; $n = 15$), 6 g (Low GAA, LG; $n = 15$), 9 g (Medium GAA, MG; $n = 15$) or 12 g of GAA/ewe.day (High GAA, HG; $n = 15$) supplemented from day 120 of gestation (dG 120) until parturition. Blood samples were taken on dG 120 before feeding (0 h) and at 2, 4, and 24 hours post-feeding, as well as on dG 129 and 138 prior to feeding. Immediately after birth, a blood sample was collected from the lambs at the birth site. Data were analysed in IBM SPSS Statistics 29 using a linear mixed model with treatment as a fixed factor and ewe as a random factor.

Results On dG 120, LG ewes showed higher creatine concentrations 2 hours after feeding compared with CTL and MG ewes ($P < 0.05$; Table 1), and both LG and MG ewes tended to have elevated concentrations than CTL ewes at 24 hours post-feeding ($P = 0.059$). By dG 129, HG ewes had higher creatine concentrations than CTL ewes, and by dG 138, all GAA-supplemented groups showed increased creatine concentrations compared with CTL ewes before feeding ($P < 0.05$). At birth, HG lambs had higher plasma creatine concentrations than LG and MG lambs, though not different from CTL lambs ($P < 0.05$; Table 1).

Table 1. Mean plasma creatine concentrations of ewes at days 120 before feeding and at 2, 4 and 24 hours post-feeding, 129 and 138 of gestation prior to feeding receiving either CTL, LG, MG or HG supplemented diets and plasma creatine concentrations of lambs at birth*.

Creatine, mg/dL	Treatment				P value
	CTL	LG	MG	HG	
<i>Ewes</i>					
dG 120					
0 h	2.13 ± 0.15	2.57 ± 0.14	2.46 ± 0.14	2.46 ± 0.14	0.173
2 h	2.20 ± 0.15 ^a	2.72 ± 0.14 ^b	2.20 ± 0.14 ^a	2.40 ± 0.14 ^{ab}	0.033
4 h	2.10 ± 0.15	2.53 ± 0.14	2.21 ± 0.14	2.25 ± 0.14	0.180
24 h	2.01 ± 0.15	2.45 ± 0.14	2.54 ± 0.14	2.36 ± 0.14	0.059
dG 129	2.64 ± 0.18 ^a	3.04 ± 0.17 ^{ab}	3.08 ± 0.17 ^{ab}	3.44 ± 0.17 ^b	0.025
dG 138	2.53 ± 0.18 ^a	3.14 ± 0.17 ^b	3.15 ± 0.17 ^b	3.23 ± 0.17 ^b	0.029
<i>Lambs at birth</i>					
	0.84 ± 0.15 ^{ab}	0.83 ± 0.15 ^b	0.60 ± 0.14 ^b	1.26 ± 0.15 ^a	0.020

* Data are estimated marginal means ± standard error of the mean; row-wise superscripts indicate different treatment means ($P < 0.05$).

Discussion This study demonstrated that on day one of the supplementation period, LG ewes had higher creatine concentrations shortly after feeding. However, by dG 129, creatine levels were higher in HG ewes than in CTLs, and by dG 138, all GAA-supplemented ewes exhibited elevated plasma creatine relative to the CTL group. This improvement suggests that the maternal creatine pool increased over time, consistent with greater creatine production or improved systemic availability induced by GAA. In contrast, although HG lambs had higher creatine at birth than LG and MG lambs, they did not differ from CTL lambs. In conclusion, the improved ewe creatine following GAA supplementation shows promise for the industry, but more in-depth research is required to clarify the translational relevance of this improvement to neonatal physiology.

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Anticlostridial antibody responses of twin Merino lambs after L-glutamine supplementation

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Introduction Glutamine (Gln) plays a significant role in immune function, providing an important energy source for enterocytes, lymphocytes, macrophages and neutrophils. In dairy cattle, Gln supplementation enhances immune response in mature animals (Caroprese *et al.* 2012) and young calves (Ceja *et al.* 2023) through the increase in cytokine production, particularly in the presence of inflammation. While Gln is well known for its contribution to immunity in piglets and dairy cows during weaning (Wu *et al.* 2024), the impact in pre-weaning Merino lambs remains poorly characterised. The aim of this study was to determine if Gln supplementation would enhance the immune response to a routine anticlostridial vaccination.

Materials and Methods This study utilised 50 twin-born Merino lamb (25 pairs), one lamb allocated to the control group, and the other to the glutamine group. For two weeks after birth, lambs received a daily oral dose of either 6 mg/mL.kg of bodyweight of Gln or water (control). Lambs were vaccinated with 1 mL of Zoetis Glanvac® 3 anticlostridial vaccine (Zoetis, New Jersey, United States) at lamb marking at 6 weeks $\pm$ 3 weeks, followed by a booster at weaning at 12 weeks $\pm$ 3 weeks. Blood samples via jugular venepuncture (lithium heparin tubes; 4 mL, BD Vacutainer®) were collected immediately prior to the initial vaccination and 12 days post booster. Anticlostridial antibody analysis was performed on plasma at pre-vaccination and 12 days after booster vaccination and evaluated using an ELISA method (Khan *et al.* 2020). Antibody levels were expressed as optical density readings on a spectrophotometer (450nm – 650nm) at a dilution of 1:800 and read against positive and negative controls. Titre values were log transformed and analysed using lmer4 package in R Statistical Software (v 4.5.2 2025). Ewe ID and sex were fitted as random effects, and treatment and time point as fixed effects.

Results Glutamine supplementation did not affect the lambs' response to vaccination (Table 1). There was no difference between Gln and control antibody titres in either pre or post samples.

Table 1 Anticlostridial antibody responses (titre) for glutamine (Gln) and control animals at pre vaccination and post booster, and the difference in titre (Post – Pre). Values are presented as means $\pm$ SEM.

Pre-vaccination (n=25)			Post-vaccination (n=25)			Vaccine Response (Post – Pre)		
Gln	Con	P-value	Gln	Con	P-value	Gln	Con	P-value
8.92 $\pm$ 0.276	8.83 $\pm$ 0.276	0.835	10.47 $\pm$ 0.276	10.69 $\pm$ 0.276	0.568	1.56 $\pm$ 0.317	1.85 $\pm$ 0.311	0.464

Discussion While this study found no effect of Gln supplementation on clostridial antibody response, the findings remain valuable but future research may benefit from changes in study design. The lack of response in comparison to findings seen in dairy cattle may reflect the difference in immune cell stimulation. In dairy cattle, the immune response was mediated using phytohemagglutinin, stimulating T-cells (Caroprese *et al.* 2012), whereas vaccine administration stimulates antibodies, and some T-cells making the response more targeted.

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Ewe lamb joining performance: a case study within the national shedding sheep reproduction project

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Introduction The MLA-funded project ‘Quantifying and improving the reproductive performance of Australia’s shedding sheep flock’ aims to benchmark reproduction across shedding breeds and identify when and why reproductive losses occur. With 20 core sites and over 150 000 trait records, the project provides a national framework for understanding key drivers of fertility. This case study examines ewe-lamb joining at a single South Australian site during one breeding season in UltraWhite sheep to assess how age, live weight and nutrition influence pregnancy outcome. Animals were assigned to two age categories at joining (6–8 months and 9–10 months). Biological maturity was defined relative to expected mature flock weight. Based on earlier work showing that nutritional status affects conception (Paganoni et al. 2022), we hypothesised that starting live weight, average daily gain (ADG) during joining, and biological maturity would each contribute to reproductive performance.

Materials and methods Pre- and post-joining live weights were recorded and ADG (g/day) calculated across the 5-week joining period. Pregnancy outcome was determined by ultrasonography approximately 90 days from ram entry and classified as empty, single or twin. Conception was defined as the proportion pregnant at scanning. ‘Wet’ was defined as rearing ≥ 1 lamb to marking based on the presence of an actively lactating udder. Ordinal logistic regression in R (v4.X) assessed the effects of standardised starting weight, ADG and age group on pregnancy outcome, with predicted probabilities generated across the observed ADG range. Wet-at-marking analyses were restricted to ewes that scanned pregnant.

Results Older ewe lambs (9–10 months; $n = 609$) were heavier at joining (47.4 vs 44.4 kg; $P < 0.0001$) and gained weight faster (63.5 vs 35.1 g/day; $P < 0.0001$) than younger ewe lambs (6–8 months; $n = 352$). Conception ($\approx 84\%$ vs 40%) and twinning rates ($\approx 18\%$ vs 6%) were more than doubled in the older cohort ($P < 0.0001$). Both joining weight and ADG independently increased the odds of progressing from empty to pregnant and from single to twin ($P < 0.001$). Adding age group significantly improved model fit ($P < 0.0001$), with younger ewe lambs showing markedly lower odds of favourable pregnancy outcome even at equivalent weight and ADG. Among pregnant ewes, older ewe lambs were more likely to be wet at marking ($\approx 70\%$ vs 52% ; $P < 0.001$). A 50 g/day increase in ADG reduced the predicted probability of scanning empty by 10–12% in older ewe lambs compared with 4–6% in younger ewe lambs.

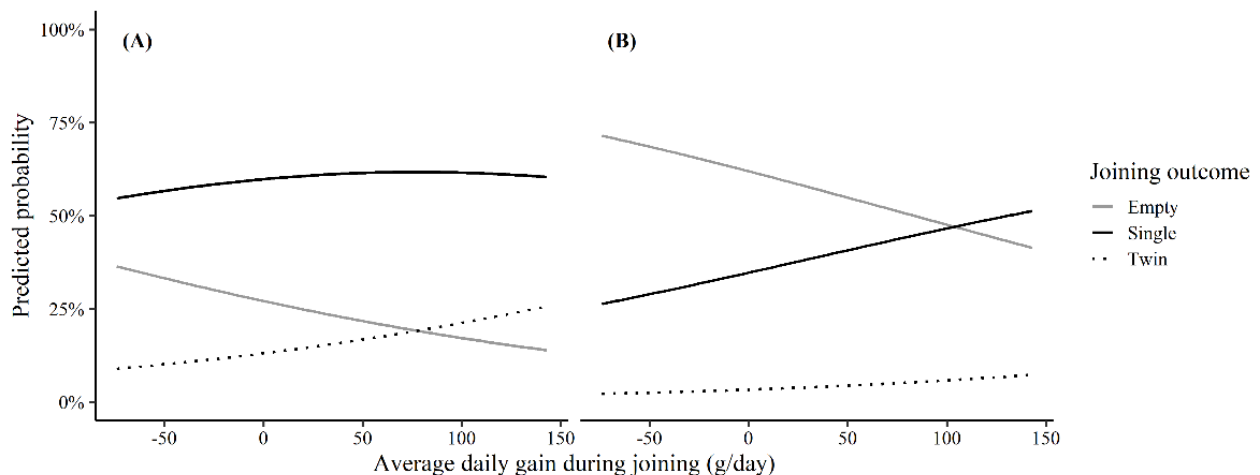


Figure 1. Predicted probabilities of empty, single and twin pregnancies across the observed ADG range for older (panel A) and younger (panel B) ewe lambs.

Discussion Biological maturity plays an important role in ewe-lamb reproductive performance. Here, younger ewe lambs underperformed older ewe lambs at both conception and lamb-rearing stages, even when live weight and ADG were comparable. These findings indicate an age-related penalty likely linked to differences in cycling activity, ovulation rate and uterine maturity (Kenyon et al. 2014). In conclusion, joining decisions should therefore consider weight, nutrition and physiological maturity to optimise reproductive success.

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Maternal diet during mid-late gestation programs the serotonergic system in the progeny of triplet-bearing ewes

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Introduction Maternal nutrition during gestation can have profound effects on fetal growth and development with carryover effects on offspring growth, body composition and metabolism in livestock. Both positive and negative programming effects on the offspring in terms of production, health and metabolic outcomes can occur in response to altered maternal nutrition during gestation. In sheep, adoption of management practices and more fecund genetics to increase lamb output per ewe mated has resulting in a greater proportion of ewes conceiving triplets, resulting in fetal growth restriction and associated increases in lamb mortality and morbidity. Such losses limit the potential productivity gains and is an animal welfare issue. The impact of maternal diet during gestation on metabolic function of the dam and potential programming of the offspring in triplet-bearing ewes is poorly understood. Serotonin is a biogenic amine that plays an integral role in regulation metabolic and immune function (Yabut *et al.* 2019). The aim of this study was to evaluate the impact of maternal nutrition in mid-late gestation in triplet-bearing ewes on the offspring peripheral serotonin signaling from birth to weaning.

Materials and methods Archived serum samples from ewes and lambs were sourced from a prior study were used (Knol *et al.* 2019). Briefly, triplet bearing ewes were housed indoors in individual pens indoors and fed a fodder-beet based diet (FB) versus a lucerne-based diet (Ctrl), from 100 days gestation to 4 days post-lambing. Thereafter, they were transitioned back to a pasture-based outdoor grazing system to weaning. Ewe serum samples were collected ~7 days pre-lambing and 4 days post-lambing. Lamb serum samples were collected at birth prior to suckling of colostrum, 4 days post-birth and weaning at approximately 12 weeks of age. Serotonin concentrations were determined by metabolomic profiling using the Absolute IDQ p180 kit via a commercial service (Biocrates Life Science, AG) using ewe (n=10/group per timepoint) and lamb serum (n=20, representing 6-7 triplet-sets per group per timepoint) that was stored at -80°C following collection prior to analysis. The effect of maternal diet on serum serotonin concentration values were tested for differential abundance using permutation ANOVAs as implemented in the lmpm R package version 2.1.0 (Wheeler *et al.* 2024).

Results Maternal diet affected ewe and lamb serum serotonin concentrations at each timepoint evaluated with ewes fed the FB diet, and their progeny, having lower concentrations compared to Ctrl ewes and their progeny (Figure 1).

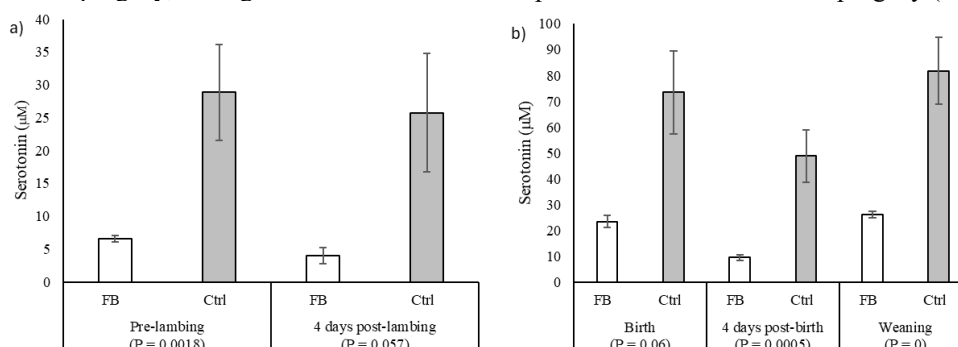


Figure 1. Effect of feeding triplet-bearing ewes a fodder beet-based diet (FB) versus a control lucerne-based diet (Ctrl) from 100 days gestation to 4 days post-lambing on ewe (a) and lamb (b) serum serotonin concentrations.

Discussion This study demonstrated that maternal diet differing in macronutrients fed to triplet-bearing ewes from 100 days gestation to 4 days post-partum influences the peripheral concentrations of serotonin in both the ewes while consuming the diet, as well as in their progeny from birth to weaning. These results indicate that maternal diet during pregnancy and early lactation can program the serotonergic system in the offspring up to weaning. Serotonin regulates many physiological functions that are important in ruminants including lactation performance, metabolic status and immune function. Serotonin is also an immunomodulatory biogenic amine that functions as a neurotransmitter and as a stress-response mediator. Environmental stressors (e.g. temperature, nutrition disease) are known to negatively affect the immune system and are associated with altered serotonin metabolism. The chronic effect of maternal diet on the serotonergic system in the dam progeny indicates the potential for modifying stress adaptation and immune response in both the dam and progeny.

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Nutrient restriction effects on ovulatory follicle and corpus luteum development and progesterone production of *Bos taurus* cows

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Introduction Establishment and maintenance of pregnancy is a central concern to the cattle industry, as it strongly impacts efficiency and profitability of beef cow-calf operations (Mercadante et al., 2015). The objective of this study was to determine if nutrient restriction impacts ovulatory follicle size and corpus luteum (CL) development and function of *Bos taurus* cows enrolled in oestrous synchronization programs.

Materials and Methods A total of 26 Angus cows were housed in a facility equipped with a Calan gate system for individual animal intake, stratified by body weight (BW) and randomly assigned one of two nutritional treatments: 1) 100% of nutrient requirements (MTN; n=13) or 2) 70% of nutrient requirements (REST; n=13). A corn silage, soybean meal, and mineral total mixed ration (TMR) was fed for the duration of the experiment, offered twice daily at 0800 h and 1600 h. The ration was mixed as a batch and weighed out individually. Individual daily intakes were calculated and adjusted weekly based on BW. Cattle underwent an acclimation period of 14 days and were exposed to nutritional treatments for 30 days prior to oestrous synchronization. Body weight was measured daily using an automated scale and a conventional livestock scale at the beginning and end of the experiment. Cows were synchronized using a 7-day CO-synch + CIDR (Controlled Internal Drug Release, EAZI-BREED CIDR; 1.38 g P4; Zoetis Animal Health) protocol (Larson et al., 2006) beginning on day -10. Ultrasonography (Ibex portable ultrasound, 5.0-MHz linear multi-frequency transducer, Ibex, E.I. Medical Imaging) of the ovaries was performed at each event of the oestrous synchronization protocol on days -10, -3, 0, 5, and 7. Volume of CL and follicle diameter was calculated according to Mercadante et al., 2015. Blood samples were taken on days -10, -3, and daily from day 0 through 7 to observe changes in progesterone (P4). Data were analysed as repeated measures using the MIXED procedure of SAS, with cow as experimental unit, fixed effects of diet, day, and all the interactions.

Results Initial BW tended to differ between treatments ($P = 0.07$; 600 ± 32 kg), but MTN had greater final BW than REST cows ($P < 0.01$; 687 ± 24 and 556 ± 27 kg, respectively) and greater average daily gain (1.35 ± 0.18 and -0.72 ± 0.21 kg/d, respectively). Diameter of the largest follicle was similar ($P = 0.851$) between treatments at the CIDR insertion (12.6 ± 0.6 mm) and CIDR removal (12.9 ± 0.4 mm) but were greater ($P = 0.04$) for MTN than REST cows at 60 hrs after CIDR removal (14.01 ± 0.6 and 12.37 ± 0.5 mm, respectively). Volume of CL was similar ($P > 0.1$) at 5 (3211 ± 113 mm³) and 7 (5280.3 ± 212 mm³) days after ovulation. Concentration of P4 did not differ on days -10, -3, or 0-5. However, on days 6 and 7, P4 was greater ($P < 0.05$) for MTN than REST (2.07 ± 0.15 and 1.65 ± 0.15 , and 2.27 ± 0.15 and 1.83 ± 0.15 ng/mL, respectively).

Discussion This experiment demonstrated that subjecting mature *Bos taurus* cows to nutrient restriction at 70% of required energy levels led to a reduction in follicle size and circulating P4 concentrations, while it did not affect CL volume. Indicating an effect on the P4 production capacity by the luteal cells. The observed decrease in follicle size and circulating P4 could potentially impede successful pregnancy establishment, as both factors have been shown to impact oocyte quality, embryo elongation and maternal recognition of pregnancy signalling.

Conclusion Nutrient restriction to 70% of maintenance during oestrous synchronization negatively affects diameter of the ovulatory follicle and circulating P4, but it did not affect CL volume in multiparous *Bos taurus* beef cows. All of which have direct negative impacts of pregnancy establishment and maintenance in cattle.

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The significance of natural ovarian cyclicity in the Merino ewe on the outcome of artificial insemination programs conducted in spring

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Introduction Approximately 50% of Merino artificial insemination (AI) programs in Australia are conducted in spring, a time when a significant percentage of ewes are in anoestrus. Our observations indicate that this percentage varies widely between years ranging from 12% to 88% over a four-year period. In addition, there is evidence that anoestrous ewes are more likely to conceive in spring AI programs compared with ewes that are cycling (Walker et al., 2023). Therefore, the objective of this study was to better understand the patterns of oestrous cyclicity in spring and how these patterns affect pregnancy outcomes following laparoscopic AI.

Materials and methods This experiment was conducted at SARDI's Turretfield Research Centre from September to December and was approved by the PIRSA Animal Ethics Committee (approval #20/23). Ovaries from 199 multiparous ewes were observed by ultrasonography over four cycles (prior to oestrous synchronisation). A 7.5 MHz linear-array transducer (Mindray Z6, BCF Ultrasound Australasia, Mitcham, Victoria, Australia) was used to detect the presence of corpora lutea (CL) to determine cyclical status. In each cycle, if no CL was present, ewes were re-scanned 5 days later to ensure that these ewes were not peri-ovular at the first scanning. After the first observation of the fourth cycle, ewes were treated with intravaginal pessaries (300 mg progesterone; Eazi-Breed CIDR, DEC Pharmaceutical, Hamilton, New Zealand). Pessaries were removed after 14 days when ewes received 400 IU eCG (Novormon, Syntex, Buenos Aires, Argentina) followed by exposure to testosterone-treated wethers ($n = 20$) fitted with harnesses and crayons. Occurrence of oestrus was recorded, and ewes were inseminated with frozen-thawed semen commencing 42 h after pessary removal. Pregnancy status was determined 50 days later by trans-abdominal ultrasonography. Data were analysed using a Chi-square test to determine significant effects ($P < 0.05$; IBM SPSS Statistics V26).

Results The percentage of cycling ewes was similar for each of the four cycles (overall mean 74.7%). Only 46.2% cycled regularly over the four cycles whilst 26.1%, 16.0%, 10.9% and 0.8% failed to cycle on at least one, two, three or four occasions respectively. Ewes that had a CL present at either cycle two, three or four had lower pregnancy rates compared with ewes that were non-cycling (Figure 1). Overall, ewes that did not cycle at any stage during the study period tended to have a higher pregnancy rate (100%) compared with ewes that cycled on all four occasions (51.2%) or cycling randomly throughout the trial period (59.6%; $P = 0.075$).

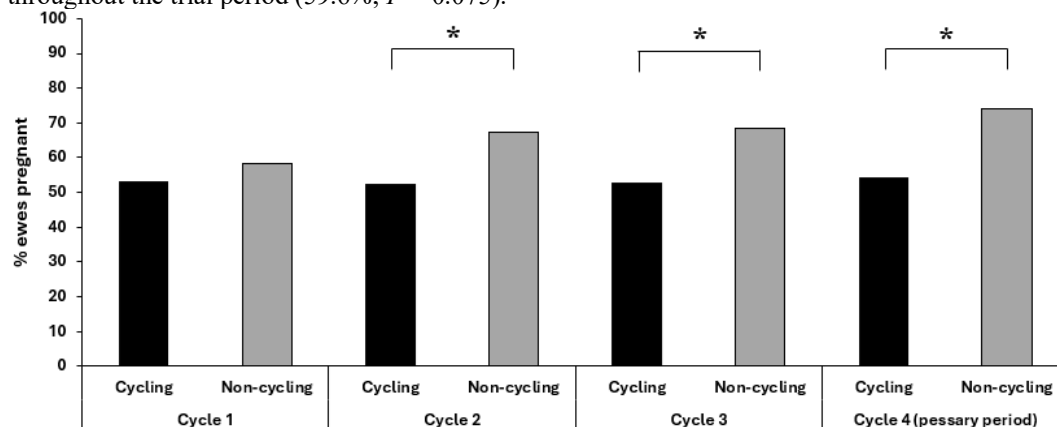


Figure 1. Percentage of ewes pregnant following laparoscopic artificial insemination (AI) in spring according to their cycling status in the four cycles prior to AI. Cyclicity was determined by either the presence (cycling) or absence (non-cycling) of a CL. *Signifies a difference between cycling and non-cycling ewes in each cycle $P < 0.05$.

Discussion This study characterises the cycling behaviour of Merino ewes during the so-called non-breeding season (spring), a time of substantial AI activity. Approximately half the ewes cycled throughout the four-cycle period whilst most of the remainder exhibited a random “on and off” behaviour. Importantly, ewes that failed to cycle consistently or did not cycle achieved higher pregnancy rates than ewes that cycled regularly indicating a physiological unresponsiveness to the synchrony program in the latter. Future research needs to replicate these results across multiple years and genotypes to confirm their reliability after which improved strategies for oestrous synchronisation can be considered

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Early insights into the role of Virtual Fencing in supporting drought resilience in South Australian beef systems

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Introduction Increasing drought frequency is driving the need for targeted livestock management in grazing beef operations. Virtual Fencing (VF) uses GPS-enabled collars that emit an audio cue followed by a mild electric pulse if an animal crosses a virtual boundary, allowing livestock movement to be controlled without physical fencing (Campbell, et al., 2020; Schillings, et al., 2021). This work is part of a larger, long-term project addressing the question “can VF help protect vulnerable land and guide livestock to nutritional feed in open grazing paddocks?” This paper summarises early insights and challenges faced during the implementation of VF across four commercial beef enterprises and identifies the potential management benefits, limitations and implications for drought preparedness.

Materials and Methods Four commercial beef operations across South Australia (Minnipa, Mt. Jagged, Karoonda and Kangaroo Island) implemented VF with n=100, 35, 64 and 180 cattle respectively fitted with the technology. Each site implemented VF in rotational, strip and cell grazing systems whilst excluding livestock from sensitive zones such as sand hills, riparian zones, native vegetation and/or vineyards. All sites used the Gallagher eShepherd VF technology (eShepherd, Gallagher Group Limited, Hamilton, New Zealand). Anecdotal observations, challenges and benefits were collated from the four producers who have been implementing VF on their farms for 4 to 8 months. This project has been approved by the PIRSA Animal Ethics Committee (project #15/24).

Results The cattle responded well during the training period with all animals achieving an audio-to-pulse ratio of $\leq 80\%$, indicating animals learned to respond to the audio cue before receiving a pulse. This has been sustained throughout the trial. The GPS capability was highly regarded by all host sites as individual animal locations can be pinpointed, this was utilised during calving and when moving animals. Some limitations were highlighted especially in VF boundary designs with water point placement and digital connectivity representing logistical constraints. There have been zero reports of injury or irritation from wearing the VF collars across all sites. The producers have reported that VF primarily improved grazing control and increased pasture rest opportunities. These early insights indicate that VF could be a potential long-term solution to support livestock management, protect vulnerable land and improve feed utilisation. In combination these factors could help producers during drought conditions while preparing for future drought events.

Discussion The implementation of VF at these sites has been successful thus far and has shown early potential to support drought resilience by enabling flexible and responsive grazing systems. Initial observations suggest that VF can shift producer behaviour from reactive drought response to proactive management of livestock and pasture/feed on offer. There is the opportunity to further explore the GPS capabilities of the technology especially as a welfare tool during intensive periods such as calving. Infrastructure limitations such as water point placement also create an opportunity to test the ‘boundaries’ of VF with creative solutions that could be implemented by producers. The remainder of this project work will assess pasture utilisation and recovery, grazing distribution, and system efficacy. Extension activities will be produced to aid in producer decision-making to evaluate VF as a long-term drought management tool in both intensive and extensive enterprises.

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We gratefully acknowledge the Future Drought Fund Long-Term Trials for funding this research and to the participating producers for their collaboration.

Evaluating the efficiency of anthelmintics in grazing beef cattle in one property in Southern NSW

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Introduction Nematode infections reduce weight gain and compromise welfare in beef cattle in Southern NSW. Anthelmintics remain the most practical control method; however, inappropriate use has led to increasing resistance, threatening productivity and animal health (Allworth et al., 2023). This study evaluated the efficacy of commonly available anthelmintics under pasture-based conditions.

Materials and methods a total of 200 mixed-sex Angus weaners (n= 40 hd/group) were assigned to five groups (n=40): control, Oxfendazole, Levamisole, Moxidectin, and Levamisole + Moxidectin combination. The weaners were managed as a single herd, grazed on canola, silage, and lucerne, and had not received any prior anthelmintic treatment. The selected anthelmintics were widely used commercial products, and the moxidectin formulation was the routine drench administered on the property. Faecal samples collected from 15 weaners in each group on days 0, 14, 28, 60, 90. Faecal egg count reduction test (FECRT) and larval differentiation were used to assess efficacy according to the formulae mentioned in Denwood et al. (2023). All results were statistically analysed by Linear Mixed Model analysis via R software when fixed factors were time and anthelmintics groups and random factors were EID.

Results: All treatments significantly reduced faecal egg counts (FEC) on day 14 compared with the control group. The efficacy of the anthelmintics was 99%, 98%, 97%, and 99% for Oxfendazole, Levamisole, Moxidectin, and the Moxidectin + Levamisole combination, respectively. Levamisole showed reduced effectiveness against *Ostertagia*, indicating possible resistance, while Moxidectin demonstrated lower efficacy against *Haemonchus*.

Table 1. Summary of the broad-spectrum efficacy (%) of different anthelmintic treatments evaluated in grazing beef cattle at the Charles Sturt University research station. The efficacy > 95% is considered as susceptible.

Treatment	Mean of FEC	Efficacy of anthelmintics	Efficacy against <i>Ostertagia</i> (%)	Efficacy against <i>Haemonchus</i> (%)	Efficacy against <i>Trichostrongyl</i> (%)	Efficacy against Other Sp
Oxfendazole	2	99	100	100	-	100
Levamisole	6	98	<u>49</u>	100		100
Moxidectine	10	97	100	<u>96</u>		100
Levamisole+Moxidectine Combination	3	99	100	100	100	100
Control	287	-	-	-	-	-

Discussion Although all drenches reduced egg counts by more than 95%, closer examination showed that some worm species survived specific treatments. Levamisole showed reduced efficacy against *Ostertagia*, which is consistent with existing knowledge of this molecule, while moxidectin exhibited reduced effectiveness against *Haemonchus*, aligning with the global trend of emerging resistance to this chemical class. To mitigate this risk, integrated resistance management strategies are recommended. The use of combination drenches containing multiple active ingredients with different modes of action is one such approach. In the present study, the levamisole–moxidectin combination achieved high efficacy across all detected parasite species, supporting this strategy. In addition to combination products, rotation between anthelmintic classes and targeted selective treatment approaches are also critical to avoid unnecessary drenching. Complementary measures including incorporating faecal egg count monitoring, quarantine drenching for introduced stock, and paddock spelling or mixed grazing can further slow the progression of resistance and maintain long-term efficacy of available treatments.

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Prevalence and implications of sub-acute ruminal acidosis in dairy cows in Malaysia

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Introduction Dairy cattle farming is a significant contributor to Malaysia's agricultural sector and national food security. Optimal animal health and productivity are paramount for the sector's sustainability and growth. Sub-acute ruminal acidosis (SARA) is a prevalent metabolic disorder in high-producing dairy cows, associated with diets rich in rapidly fermentable carbohydrates and characterised by recurrent periods of moderately depressed ruminal pH (typically 5.2–5.6) without overt clinical signs. The objective of this study was to estimate the prevalence of SARA in Malaysian dairy herds and to describe its implications for feeding management and body condition.

Materials and methods A cross-sectional study was conducted in five states of Malaysia. Thirty dairy farms, each with approximately 8–12 lactating cows, were enrolled, and all lactating cows present on the day of the visit were examined, giving a total of 332 cows. Herd management information, including feeding practices and milk production, was collected using a structured questionnaire. Rumen fluid was obtained once per cow by rumenocentesis and ruminal pH was measured immediately. Cows with ruminal pH ≤ 5.5 were classified as SARA positive, cows with pH 5.6–5.8 as marginal, and cows with pH ≥ 5.9 as SARA negative. Body condition score (BCS; 1–5 scale) was recorded for each animal. Data were analysed using independent t-tests to compare mean pH and BCS between SARA and non-SARA cows, and descriptive statistics were used to summarise farm- and cow-level prevalence.

Results Among 332 cows, 83 (25%) were SARA positive (pH ≤ 5.5), 186 (56%) had marginal pH values between 5.6 and 5.8, and 63 (19%) were SARA negative (pH ≥ 5.9), giving an overall SARA prevalence of 25%. More than one-third of the farms (12/30) had at least three cows with pH ≤ 5.5 . Mean ruminal pH was 5.41 ± 0.23 in SARA-positive cows and 5.79 ± 0.24 in SARA-negative cows. Farms feeding high-concentrate, low-fibre rations showed a higher proportion of SARA-positive cows than farms using more balanced diets. Mean BCS was slightly lower in SARA-positive cows (3.05 ± 0.04) than in SARA-negative cows (3.11 ± 0.05); this difference was small but consistent with reduced rumen health in affected cows.

Table 1. Animal Body Condition Assessment group with mean and standard Error

	Mean	SE	Mean	SE	pH- value
Animal Body Condition (ABC-1)	3.05 ¹	0.04	3.11 ¹	0.05	pH ≤ 5.5
Animal Body Condition (ABC-2)	3.09 ²	0.05	3.15 ²	0.05	pH ≥ 5.8

*Values are least-square means, standard error of the mean (SEM), and P value from linear mixed effects model accounting for repeated measures; row-wise superscripts indicate different treatment means ($P < 0.05$).

Discussion The study identified a notable prevalence of SARA in Malaysian dairy herds, particularly on farms using high-concentrate, low-fibre diets. These findings support the role of intensive feeding systems and poor ration balance as key contributors to SARA and indicate potential negative effects on body condition and overall productivity. Effective prevention through appropriate fibre inclusion, controlled concentrate feeding and regular monitoring of rumen pH is crucial. Further work is warranted to quantify the longer-term effects of SARA on milk yield and reproductive performance and to develop region-specific control strategies for Malaysian dairy herds.

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The effects of incubating multispecies pasture with increasing doses of sugarcane extract (*Saccharum officinarum*) on *in vitro* methane production.

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Introduction Plant secondary compounds (PSC) are metabolites produced by most plant species as a form of protection against environmental stressors (Chomel *et al.* 2016) and they can alter ruminal fermentation (Bodas *et al.*, 2012). This experiment aimed to assess the effects of stacking two sources of dietary PSC – multispecies pasture and polyphenol-rich PolyGainTM on *in vitro* total gas production (TGP) and methane as a proportion of TGP (%CH₄) compared to a perennial ryegrass (*Lolium perenne* L; PRG) control. We hypothesised that i) %CH₄ will be less when multispecies pasture is incubated *in vitro* compared to PRG, and ii) methane reduction *in vitro* will be greater when ruminal fluid is incubated with PolyGainTM than when there is no addition of PolyGainTM, regardless of the feed substrate.

Materials and methods This study was conducted in October (Spring) 2025 at the Ellinbank SmartFarm, Victoria, Australia (38°14'S, 145°56'E) using ruminal fluid from 16 spring-calving, rumen-cannulated Holstein-Friesian dairy cows. Cows were fed one of two pasture diets: PRG-dominant pasture or a 12-species mixture (MULTI) comprising 4 herbs, 4 grasses and 4 legume species, and each supplemented with or without 55 g/d of PolyGainTM (PGN) for 28 days. One gram of dried and ground feed substrate (PRG or MULTI as per the donor animal's diet) was incubated *in vitro* at 39°C for 24 h with ruminal fluid, Kansas state buffer and either 0 mg (0), 9.17 mg (1), 45.84 mg (2) or 91.67 mg (3) of PGN using the ANKOM gas production system. Gas samples were collected from the headspace of each bottle and were analysed for methane concentration by gas chromatography. Cumulative pressure data were used to estimate TGP using the ideal gas law. All data were analysed by ANOVA using Genstat version 24.

Results Overall, MULTI substrate produced more total gas (mL/g dry matter incubated; $P = 0.012$) and %CH₄ ($P = 0.004$) compared to PRG (Table 1). The addition of PGN had no main effect on TGP ($P = 0.411$) nor %CH₄ ($P = 0.085$) at any dose level. There was a significant interaction between pasture and PGN dose whereby %CH₄ increased ($P = 0.039$), and TGP showed a tendency to increase ($P = 0.054$) with increasing dose of PGN when MULTI was incubated *in vitro*, but not PRG.

Table 1. Means, SEDs and P -values for total gas production (TGP; mL/g dry matter incubated) and methane as a proportion of TGP (%CH₄) observed when perennial ryegrass (PRG) or a 12-species pasture mixture (MULTI) were incubated with increasing doses of PolyGainTM (PGN) *in vitro*.

Parameter	Incubated with increasing doses of PolyGam [®] (1 G/L) <i>in vitro</i> :								SED	<i>P</i> -value		
	PRG				MULTI					Pasture	PGN Dose	Pasture × Dose
	PGN Dose <i>in vitro</i>											
	0	1	2	3	0	1	2	3				
TGP (mL/gDMi)	73.11	75.73	64.93	70.46	90.12	85.14	90.13	94.49	7.329	0.012	0.411	0.054
%CH ₄	6.33	6.39	6.04	6.30	7.62	7.59	8.14	8.85	0.580	0.004	0.085	0.039

PRG = perennial ryegrass; MULTI = multispecies pasture; PGN = PolyGain; TGP = total gas production; DMi = dry matter incubated; %CH₄ = methane as a proportion of TGP; SED = standard error of differences of means

Discussion Both the TGP and %CH₄ observed in our study were lower relative to those reported in previous research, which may be partly due to variable concentrations of PSC present during Spring at the time of our study. High *in vitro* gas production is common among pasture mixtures containing herbs and legumes due to their low fibre concentrations resulting in rapid fermentation (Carmona-Flores *et al.*, 2020). The effect of PSC on ruminal fermentation can also be variable, as PSC concentrations are known to fluctuate with season, weather, time of harvest and state of physiological stress of the plant, as well as between plant species (Qaderi *et al.*, 2022). In conclusion, fermenting MULTI substrate *in vitro* resulted in greater TGP and %CH₄ compared to PRG, and the addition of PGN resulted in greater %CH₄ and marginally greater TGP when incubated with MULTI substrate, but not PRG, compared to no addition of PGN. Consequently, our hypotheses were not supported. Future research should investigate how seasonal differences in PSC concentrations could influence *in vitro* methane production among similar forage blends as these may explain the variability observed in this study.

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A mask system for measurements of exhaled methane in sheep

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Introduction In the Australasia region, agriculture is a significant contributor to greenhouse gas emissions, with livestock being a primary source of methane (CH₄). Technology advances are helping quantify gas emissions, but methods such as respiration chambers, sulphur hexafluoride (SF₆) tracers, and GreenFeed systems face barriers to on-farm adoption due to high costs, maintenance needs, disrupting animal behaviours, and technical complexity (Pressman et al., 2025). This study investigated the use of a mask system to collect exhaled breath for spot measurement of CH₄ in sheep.

Materials and methods A custom-designed mask was developed to fit securely over the sheep's face and ensure efficient capture of exhaled breath and prevent ambient air contamination by covering both nostrils and mouth. The mask included a valve that allowed the animal to inhale ambient air, preventing any breathing restriction or related stress. During exhalation, the valve directed the breath flow into the Agscent Air device (Agscent Pty Ltd, Australia) enabling continuous measurement of CH₄ emissions uploaded to an online software. Two Agscent Air devices were used to collect spot samples prior to supplementation (baseline) and over a seven-hour period post-supplementation, at one-hour intervals for each animal. Each CH₄ measurement lasted seven minutes, with the first two minutes excluded from analysis to prevent inaccurate measurements of CH₄. For testing the mask system, 16 Merino wether lambs were randomly selected from a commercial flock at Roseworthy Campus (Adelaide University) and blocked by initial body weight (mean $\pm$ SEM; 30.24 $\pm$ 1.6 kg) prior to allocation to one of the two groups, control vs bromoform. All lambs were housed individually in raised, enclosed pens with slatted floors, with free access to water and oaten hay. The treatment supplements consisted of finely ground corn, mixed with roughage pellets and canola oil without or with bromoform (234.6mg/day) extracted from red seaweed (SEAFEED; Sea Forest, Triabunna, Tasmania, Australia). Area under the curve (AUC) was calculated to summarise the integrated response of CH₄ emissions over time for each animal as an experimental unit. The AUC was analysed using linear mixed models in ASReml (RStudio; v4.4.1; R Core Team, 2024).

Results The mask system was effective in detecting a 60% reduction on CH₄ emissions of wether lambs supplemented bromoform in comparison to the control group ($P < 0.001$; Figure 1). A reduction in CH₄ emissions was observed within the first two hours post feeding, with levels remaining consistently lower than those of the control group (Figure 1).

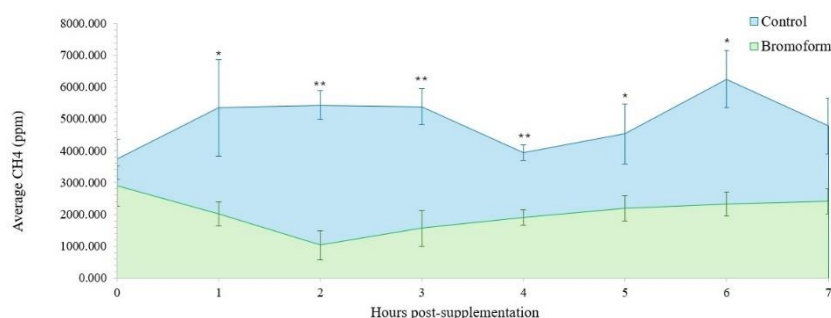


Figure 1. Methane (CH₄) measurements at baseline and post feeding with masks connected to an Agscent Air device to detect the difference between control (n=8) and treatment-fed (n=8) Merino lambs ($P < 0.05$). Means $\pm$ SEM; * = $P < 0.05$, ** $P < 0.001$.

Discussion The mask system enabled effective measurement of exhaled CH₄ emissions effectively from the exhaled breath of wether lambs per treatment group (Figure 1). The results of this study align with findings from previous research using alternative methods to detect 50 to 80% CH₄ mitigation in ruminants fed bromoform (Kinley et al., 2020). When connected to the Agscent Air device, the mask system functioned as a portable and practical tool for conducting repeated short-term spot measurements. Other devices, such as respiration chambers and sulphur hexafluoride (SF₆) tracer systems, are known for their high accuracy and ability to minimise the influence of environmental factors (Pressman et al., 2025). However, their high cost and labour-intensive operation make them impractical. The mask system offers flexibility in being attached to several portable gas analysers, promising simple and potentially repeatable on-farm research strategies. Further studies are required to validate these findings, and to compare the accuracy of the mask system with other devices. Continued refinement of measurement technologies will be essential to advance the adoption of sustainable livestock production and climate change mitigation, to enable accurate estimates of CH₄ emissions.

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Effect of milk powder formulations on diarrhea in goat kids

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Introduction After colostrum, pre-weaning milk feeding is an important nutritional phase for the rearing of goat kids. However, as goat milk is expensive, cheaper alternatives and substitutes (i.e whole cow milk, cow milk replacer, milk whey) have been used by farmers, with whole cow's milk or cow milk replacer being the preferable cost-effective choice in many situations (Zamuner *et al.* 2023). Cow milk has lower fat (-30%), protein (-19%), total solids (-16%) and a higher proportion of long-chain saturated fatty acids and lactose (+8%) compared to goat milk. The differences in the nutritional composition of the milk, specifically the lactose, could impact kid's digestion potentially resulting in digestive disorders (i.e. diarrhea and bloating) and death (Galina *et al.* 1995). Therefore, this experiment aimed to evaluate the morbidity and mortality of goat kids fed with different goat and cow milk powder formulations.

Materials and methods This experiment was conducted at Meredith Dairy farm from June to July 2024. Male goat kids (n=416, 100 to 108 per group) were randomly assigned at birth to 1 of 4 milk-powder formulations: goat milk powder (GP), cow milk powder (CP), goat mix (GM), and cow mix (CM). Body weight (BW) at birth did not differ between groups. The goat mix included lactose (8.5%) and whey protein (3%) to match the level of lactose in the CP formulation. The cow mix included cream (22%), whey protein (27%) and lactose (4%) to simulate the level of fat, protein and lactose in the GP formulation. Goat kids were *ad libitum* fed their assigned milk formulation until weaning at week 5 (Kid Feeder LKF1200; DeLaval). Kids body weight was recorded at birth, and at weeks 2, 5, 7, and 9. Signs of diarrhea and bloating were recorded daily, as a binary variable (0,1) for absence/presence. All dead kids had a field necropsy undertaken to identify the most probable cause of death. All data were analysed using the logistic procedure and repeated measure analysis using the Mixed procedure of SAS (*Statistical Analysis System*, version 9.4.01). The model included the treatment as a fixed effect, the ID of the kid as a random effect, and the day of birth as a covariate.

Results The main ailment was diarrhea, with similar days of diarrhea between formulations from 0-2 weeks of age (Figure 1). However, the odds of diarrhea were lower in goat kids with greater BW at birth, such that for +1 kg of birth weight, the odds of diarrhea decreased by a factor of 1.6 (OR= 0.6; 95% CI= 0.4-0.8). At 2 to 5 weeks, the CP group had the highest proportion of kids with at least 1 diarrhea event (56%, $P < 0.03$) compared to CM (27%) and GP (25%), but similar to GM (45%). During this period the odds of diarrhea were 3.0 times greater for goat kids fed CP compared to CM (OR=3.0; 95% CI= 1.3-6.8), and PG (OR, 3.2; 95% CI= 1.5-6.9). Throughout the entire 9-week experimental period, the main cause of death was pneumonia (46%), followed by unknown (13%), bloating (10%) and trauma (10%). There was no noticeable effect of milk type on the causes or timing of death. There was a tendency that kids fed CM were less likely to die compared with the GP group (OR= 0.12; 95% CI= 0.01-1.00, $P = 0.05$). The goat kids fed with the GP and CM formulations had overall a better growth performance. At 7 weeks, kids fed GP (13.0±0.1kg) and CM (12.5±0.1kg) had higher body weight by 18% than those fed CP (11.0±0.1kg) and GM (11.4±0.1kg; $P < 0.05$).

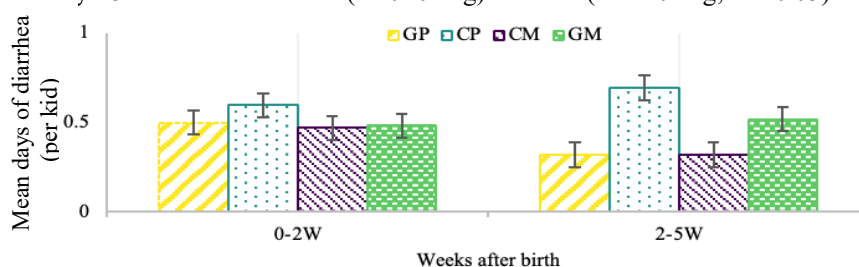


Figure 1. Mean days of diarrhea per kid, fed different milk powder formulations from birth to 5 weeks old. Error bars represented 95% CI. GP=Goat milk powder; CP=Cow Milk powder; GM=Goat mix; CM=Cow Mix. Diarrhea recorded daily as a binary variable.

Discussion These results suggest that the CP formulation may influence the incidence of diarrhea in kids from weeks 2 to 5. The GM formulation had similar proportion of kids with at least 1 diarrhea event to CP, suggesting that the level of lactose in the milk formulation might affect the occurrence of diarrhea. However, the exact cause of diarrhea cannot be determined from this experiment, and *ad libitum* feeding could influence it. These results are part of a larger experiment which will support a broader understanding of the impact of the milk powder formulations on goat kids' metabolism and growth. It was concluded that farmers should be aware of the possible effect of milk powder formulations on the incidence of diarrhea and should select their feeding strategies also based on related health outcomes for goat kids.

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The effect of wind direction on sheep behaviour in arid Australia

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Introduction Pastoralists and previous literature (Orr, 1980; Squires, 1976; Stafford Smith, 1988) suggests that sheep walk into the wind direction and spend time in areas of the paddocks in the direction of the prevailing wind. However, these previous studies used either human observation or changes in pasture conditions to monitor sheep behaviour, rather than precise global positioning system (GPS) locations. In addition, only one study (Stafford Smith, 1988) was conducted in arid Australia. Understanding the relationship between wind and sheep behaviour is key to managing Australia's natural resources and planning for a sustainable future. We hypothesised that sheep spend at least 25% of their day walking into the wind direction.

Materials and methods This study was conducted in March – April 2025 in Kingoonya, South Australia. The study site was largely dominated by *Atriplex vesicaria* (bladder saltbush) and offered one central and one South-East watering point in the 56 km² paddock. A mob of 600 Merino ewe hoggets (approximately 80 mm of wool) were stratified for liveweight and condition score to select 100 for GPS tracking. These 100 Merino ewes were fitted with modified collars attached with Moovement GPS tags (Moovement, Brisbane, Australia) over four weeks. Local weather data, from a weather station positioned in the same paddock collected rainfall, temperature, humidity, wind direction and wind speed every 15 minutes. The final data used the GPS co-ordinates from sheep which had a minimum of 21 locations per day (McGavin et al., 2018) and time intervals between sheep locations no longer than three hours apart. The GPS and weather data were cross referenced, and generalised additive mixed models were used (R Core Team, 2025) to analyse the relationship between wind and sheep behaviours. The models displayed the predicted proportion of sheep movements to be within 22.5° of the wind direction that that time. The model accounted for temporal effects and the clustered nature of the data.

Results Time of day, which was correlated with temperature, had a significant ($p < 0.001$) influence on sheep movements into the wind (Figure 1). The common watering time for sheep in this study was approximately 11 a.m with maximum daily temperatures occurring at approximately 4 p.m. Sheep came in to drink in the late morning before the heat of the day, followed by an increase in windward movements in the late afternoon to evening. Windward activities occurred in the early morning too, but for shorter periods. Sheep movements into the wind were more defined on hot days ($>32^{\circ}\text{C}$), than on cooler days ($<32^{\circ}\text{C}$) where grazing activities were longer. These results suggest that wind, coupled with temperature and water availability, influence sheep behaviour in arid environments.

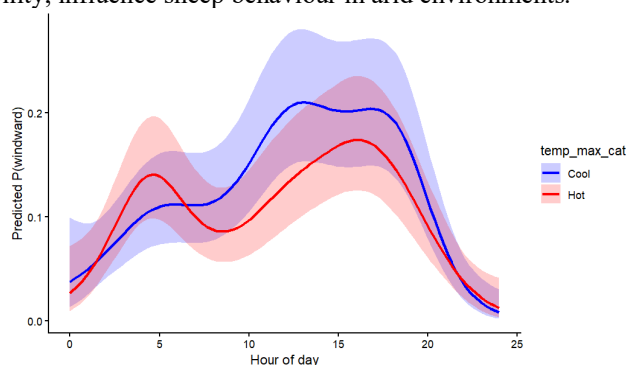


Figure 1. The predicted proportion of sheep movements into the wind across the hours of the day (0 representing midnight). The solid lines are the smoothers for the GAMM, for cool (blue line at $<32^{\circ}\text{C}$) and hot (red line at $>32^{\circ}\text{C}$) days. The shaded areas are the confidence intervals.

Discussion The sheep behaviours were influenced by wind direction and time of day which correlated with fluctuating hourly temperatures. Pastoralists and livestock managers could time stock viewing and health assessments to the identified watering time of late morning. In conclusion, pastoralists should consider prevailing wind conditions when designing grazing schedules and installing new water points to improve livestock productivity, distribution and environmental sustainability.

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Science Snapshots

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Virtual fencing in the rangeland cow-calf system: the efficacy and welfare implications of virtual fencing in a Northern Australian beef production system

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Introduction Virtual fencing (VF) is a rapidly advancing commercially available precision livestock management tool. With considerable large scale adoption in both Southern beef and dairy production systems, VF may have potential to revolutionise sustainability and pasture management practices in rangelands, (Bennett *et al.*, 2026). Northern Australian rangeland beef systems are typified by extensively grazed *Bos indicus* cattle, native pastures, few inputs and infrequent mustering. Consequently, calves often remain with their mothers over the recommended age for weaning. Very little VF research has been conducted in these systems and thus critical knowledge gaps remain. For example, there is little understanding of best VF practice in relation to both *Bos indicus* cattle and the cow-calf unit, (Boyd *et al.*, 2023; James *et al.*, 2025). It is also important to note that the minimum body weight for the eShepherd VF collars to fit suitably is 200 kg, meaning that calves <200 kg cannot be collared (Gallagher, 2026). If VF is to be implemented in the northern rangelands, it is essential to understand the cow-calf dynamics when cows are collared and the calves are not. Particularly in relation to behavioural and stress responses given the lider-follower behaviour and spatial proximity changes over time of extensively raised calves. Determination of a) virtual fence efficacy and b) welfare implications for both cows and calves are the two overarching aims of this project. To achieve this, a series of experiments will be conducted over four years, using eShepherd VF collars in Northern pastoral cow calf-systems. An initial experiment will function as a foundational case study to both gain key insights into cow and calf behaviour in a virtually fenced setting and use this to validate observational methodology. The objectives are 1) To investigate and quantify efficacy of VF, behavioural changes due to VF and adaptability of *Bos indicus* cows pre- and post-calving in a VF environment, and 2) To investigate and quantify the frequency and duration of interactions with the VF exclusion zone by the uncollared calves.

Materials and Methods A commercial herd of 100 Brahman cows fitted with Gallagher eShepherd VF collars will enter a VF training phase of 7 days in a holding paddock directly preceding the experimental period. For the experiment itself, cattle will be moved to a rotation paddock of ~250 ha with native vegetation, native and improved pastures and a single water point. Cows will enter the experimental paddock approximately 8 weeks prior to expected onset of calving and remain there for a total of 4-5 months. The experimental design includes a virtually fenced exclusion zone of ~250 m² with a neighbouring paired control zone of the same size which cows can freely enter. Calves, once born, will remain uncollared and thereby not excluded by VF from the treatment zone. A grid of video trap cameras will be installed across both zones to capture cow and calf zone interactions (counts, frequency and duration). Virtual fence interactions by individual cows will be recorded by the VF collars. Data will be analysed using general linear models, or the non-parametric equivalent as appropriate. Further experiments will be conducted to investigate cow and calf welfare when VF is applied.

Expected outcomes Virtual fencing continues to improve as a valuable livestock management strategy due to its versatility and rapid adaptability. It is expected that this initial case study will provide a fundamental understanding of the efficacy of VF for virtually fenced cows and non-collared calves in northern cow-calf systems. Future experiments will investigate the welfare implications of VF for cows and calves in these extensive systems. This research aims to contribute to best practice industry guidelines for Northern beef producers by quantifying the efficacy of VF, VF adaptability of the cow-calf unit over time and by identifying the welfare benefits and risks of VF. This research is fundamental to the potential adoption of VF in Northern Australian beef rangeland production systems.

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A maize-rich diet mitigates heat stress in pen-fed lambs but reduces marbling

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Introduction Maize is fermented more slowly in the rumen than wheat (Gonzalez-Rivas *et al.* 2017), and thus may potentially-reduce heat stress in ruminants by lowering the rate of metabolic heat production. Previous studies reported that feeding mixed-grain diets to sheep containing 48-50% maize for three weeks reduced physiological indices of heat stress (HS), such as rectal temperature (RT), respiration rate (RR), flank temperature, and heart rate, and increased dry matter (DM) intake (Gonzalez-Rivas *et al.* 2017; Prathap *et al.* 2022). We hypothesize that feeding a maize-rich pellet diet (30% of the diet) will mitigate heat stress, improve carcass characteristics, and meat quality in feedlot lambs by reducing body tissue catabolism during the summer.

Materials and methods Sixty lambs (40 females, 20 desexed males; 36.1 ± 4.47 kg live weight, LW) were randomly housed in 20 pens (3/pen) by weight and fed for 68 days (26 February – 4 May, 2025) with either a control lamb finisher pellet diet (no maize) or a maize-rich diet, offered *ad libitum* or restricted to 3.5% of LW. Pelleted diets were made by a commercial Australian feed mill; the control diet comprised barley, wheat, canola meal, rice bran, mill mix, rice flour, rice hulls, lime bulk, Celsea® (granular), salt, CaCl₂, bentonite, (NH₄)₂SO₄, sheep premix, molasses, Bovatec® (20%), monocalcium phosphate, and canola oil, whereas the maize-rich diet was the same formulation with 30% maize replacing barley and wheat. They were iso-energetic (13.1 and 12.9 MJ/kg dry matter). Feed intake was recorded daily, and RT was recorded on days 8, 14, 22, 45, and 53, while RR and panting score (PS) were recorded on days 9, 11, 17, 18, 28, 46, and 53 of the study at 1400 h. Lambs were slaughtered in a commercial abattoir, and at 24 h *post-mortem*, the longissimus lumborum muscles were collected, aged for 5 days, and then analysed for colour stability across 3 days of retail display, Warner–Bratzler shear force (WBSF), cooking loss, and intramuscular fat (IMF). Data were analysed in R (version 4.5.1) using linear mixed models, fitted with environment, diet, and sex as fixed effects. Random effects of lambs nested in pen (1 | pen: lamb-ID) were included for physiological variables, and pen (1 | pen) for feed intake and meat quality variables, with appropriate covariates for cooking loss (pre-cook weight, and cook-batch) and shear force (pre-cook weight).

Results Environmental data indicated that lambs experienced moderate heat stress during the first 29 days (temperature humidity index, THI: 22.8 ± 2.05) and no HS thereafter (THI: 17.2 ± 2.69). Mean RT and PS were greater in the HS period, while RR was not affected (Table 1). The maize-rich diet significantly reduced RR and PS. For RT, the interaction between diet and environment approached significance, whereas the interaction between environment and sex was significant. For RR, there was a significant interaction between diet and sex (Table 1). Dry Matter intake was lower in HS than the no HS period (3.0 vs 3.2%; SED = 0.08; $P = 0.011$), but feeding a maize-rich diet did not increase DM intake, with both groups consuming 3.3% of LW. The intramuscular fat (IMF) of the lamb carcass was lower in the maize-rich diet (3.47 vs 3.13%; SED = 0.27; $P = 0.021$), without affecting WBSF (28.0 vs 25.1 N; SED = 1.65; $P = 0.551$) or cooking loss (24.5 vs 24.0%; SED = 0.52; $P = 0.329$). The maize-rich diet tended to increase the R630/580 reflectance ratio of meat, with the control diet (2.84 vs 2.90; SED = 0.05; $P = 0.065$).

Table 1. Comparison of rectal temperature, respiration rate, and panting score of lambs (mean $\pm$ standard error)

Items	Environment (E)		Diets (D)			Sex (S)		<i>P</i> values					
	HS	No HS	C	T	F	M	E	Diet	Sex	E×D	E×S	D×S	E×D×S
RT (°C)	39.9 (0.03) ^a	39.8 (0.04) ^b	39.8 (0.05)	39.8 (0.05)	39.8 (0.04)	39.8 (0.05)	< 0.001	0.109	0.197	0.059	0.042	0.282	0.326
RR (bpm)	154 (3.10)	147 (4.33)	153 (4.20) ^a	148 (4.20) ^b	153 (3.43)	148 (4.85)	0.984	0.007	0.082	0.896	0.467	0.006	0.617
PS	2.0 (0.05) ^a	1.5 (0.08) ^b	1.9 (0.07) ^a	1.6 (0.07) ^b	1.8(0.06)	1.8 (0.08)	0.046	0.007	0.388	0.325	0.747	0.025	0.561

HS, heat stress (0-29 days; temperature humidity index, THI = 22.8 ± 2.05); THI: 17.2 ± 2.69); no HS, 30-68 days of study (average THI = 17.2 ± 2.69); C, control diet (0% maize); T, maize-rich diet (30% maize); F, female lamb; M, desexed male lamb; bpm, breaths per minute, panting score (1–1.5, mild HS; 2–2.5, moderate HS (Lees *et al.*, 2019)); $P < 0.05$, significant.

Discussion The association of a maize-rich diet with lower RR and PS suggests that feeding lambs a 30% maize-rich diet may be effective in ameliorating moderate heat stress. A maize-rich diet may reduce marbling (IMF) in lamb carcasses without compromising key eating-quality traits such as shear force and cooking loss. A non-significant tendency for R630/580 to increase suggests a possible dietary effect on meat colour, but further data are needed to confirm this. In conclusion, a maize-rich diet may be effective in ameliorating moderate heat stress; however, further studies are needed during a typical heat-stress period.

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Understanding reproductive management in northern Australian beef cattle: A study of practices

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Introduction Reproductive performance in northern Australia remains a persistent challenge (McCosker *et al.* 2023), with considerable diversity in how beef producers manage their herds. Although strong scientific evidence shows that several reproductive management practices can improve herd productivity, their implementation remains variable. However, low or inconsistent implementation should not be interpreted as a lack of interest or capability. Northern beef producers operate within complex production, economic, environmental and social constraints, and their management decisions reflect practical experience, risk considerations, resource availability, and long-term business priorities. Understanding these decisions requires moving beyond simple adoption metrics and examining the broader context in which producers operate. This study aims to identify the socioeconomic and environmental factors that influence producers' decisions to implement different reproductive management practices across the northern Australian beef systems.

Materials and methods Thirty-two structured interviews were conducted with beef cattle producers across Queensland, Northern Territory, and Western Australia using in-person, telephone, and video call formats. Audio-recorded interviews were transcribed and analysed using hierarchical clustering method to group respondents based on 30 selected management practices. The COM-B model (Capability, Opportunity, Motivation, Behaviour) was applied as a theoretical framework to map factors influencing the implementation decisions of selected management practices. Descriptive statistics examined individual-level data within clusters and COM-B factors. The thematic analysis was conducted to identify the major barriers in implementing management practices among beef cattle producers.

Results Cluster analysis revealed three producer groups differentiated by management intensity, financial awareness, and reliance on supplementation. Cluster 1 ("Non-adopters") was characterised by consistently low uptake of intensive breeding, reproductive, animal health, veterinary, and supplementation practices. Cluster 2 ("Moderate adopters") demonstrated high adoption of several key breeding, reproductive, health, and supplementation practices; however, this group exhibited comparatively lower levels of awareness of resource monitoring and financial management than Cluster 3 ("Adopters"). The adopters group represented the most comprehensive management strategy, combining high adoption of reproductive, health, and supplementation practices with strong resource monitoring and a lower level of financial awareness.

Analysis of COM-B factors across three beef producer clusters revealed distinct profiles. Adopters were experienced, older producers with strong industry networks, higher enterprise diversification, diversified marketing, a unanimous belief in innovation, and good property and farm supply accessibility, but they used digital tools less and participated in training less. Moderate adopters operated the largest properties, had the highest training engagement, but reported lower satisfaction with capital investment and succession planning. Non-adopters had the highest educational qualifications, the greatest training participation, and the strongest succession planning, but had smaller herds, poorer property accessibility, poor accessibility for farm suppliers, and the heaviest reliance on single marketing channels. These contrasting capability, opportunity, and motivation profiles highlight differentiated pathways for supporting the adoption of sustainable management practices among northern Australian beef producers.

The thematic analysis revealed time and labour constraints as common challenges across groups. Financial barriers, including high costs, limited access to capital, and the need for management changes to deliver short-term returns, were also important factors shaping decisions. Scepticism about the effectiveness or relevance of new practices, coupled with a lack of demonstrated success, was also detected as an important factor. Broader systemic factors, such as information overload, limited extension support, and poor internet connectivity in remote areas, further influenced how producers accessed information and decided which practices aligned with their goals and circumstances.

Discussion Beef cattle producers' management decisions are shaped by the interplay of capability, opportunity, and motivation rather than any single driver. Education and farming experience fostered confidence in navigating complex management decisions (Menchon *et al.* 2025), while high biological adoption did not necessarily translate into financial system integration. Structural factors, including input accessibility, cooperative involvement, and market access, defined what was practically feasible within each production context. Training participation and confidence in investment decisions further influenced how producers engaged with different practices. These findings highlight the need for extension programs that move beyond information transfer to build financial management capacity and harness existing social networks and cooperatives to support sustainable adoption of management practices in beef cattle systems.

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Comparison of different diagnostic methods for the surveillance of *Haemonchus contortus* infections in sheep

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Introduction Gastrointestinal nematode infections are the second most important endemic disease impacting sheep in Australia (Shephard *et al.* 2022). *Haemonchus contortus* infections have previously been sporadic in Victoria, however there are concerns that it is becoming endemic (Emery *et al.* 2016). Due to climate change impacting weather conditions throughout Australia, surveillance of infections is important to enhance management decisions. However, many sheep owners are not testing regularly due to cost, time and labour. The current industry standard test is larval culture, which takes 1-2 weeks and requires an experienced specialist (Taylor 2010). The time taken to yield this result and provide this information to farmers is a significant issue, as infections with *H. contortus* can cause rapid death within a few days (Besier *et al.* 2016). It was hypothesised that colorimetric loop-mediated isothermal amplification (LAMP) would be suitable for rapid surveillance testing for *H. contortus*.

Materials and Methods The colorimetric LAMP (New England Biolabs, USA) was optimised with control samples, and the specificity and sensitivity of the assay using both control samples and spiked samples was determined. Following optimisation, 27 faecal float samples from an agricultural consultant company were provided with larval culture results for LAMP testing. Samples were also tested with conventional PCR (Promega, Madison, WI, USA), and Nemabiome deep amplicon sequencing (Millennium Science, Mulgrave, VIC). Cohen's Kappa statistic was used to determine agreement between tests. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) were calculated using larval culture as the reference standard.

Results The colorimetric LAMP assay was faster than the industry standard, producing results within two to four hours compared to seven days with larval culture. The assay required at least ten *H. contortus* eggs to go into the DNA extraction to yield positive results. Colorimetric LAMP and larval culture had moderate agreement (74%; $k=0.42$). In the results that disagreed, 23% ($n=6$) yielded a false negative result with colorimetric LAMP, and 3% ($n=1$) yielded a false positive result. The colorimetric LAMP sensitivity was 70%, specificity was 85%, PPV was 93% and NPV was 50% compared to larval culture. There was perfect agreement between conventional PCR and the colorimetric LAMP assay (100%; $k=1$). When compared to Nemabiome deep amplicon sequencing, there was fair agreement with colorimetric LAMP (70%; $k=0.28$), and there was also fair agreement with larval culture (70%; $k=0.15$) (Table 1).

Table 1 Comparison of diagnostic results to detect *Haemonchus contortus* infections

	Larval Culture	PCR	Nemabiome
LAMP	20/27 (74%) $k = 0.45$ $p = 0.010$	27/27 (100%) $k = 1$ $p < 0.001$	19/27 (70%) $k = 0.37$ $p = 0.030$
Nemabiome	19/27 (70%) $k = 0.15$ $p = 0.43$	19/27 (70%) $k = 0.37$ $p = 0.030$	
PCR	20/27 (74%) $k = 0.42$ $p = 0.01$		

Discussion This study indicated that colorimetric LAMP could be a promising tool for the rapid surveillance of *H. contortus* infections, providing results in a shorter timeframe. Further examination is being completed to mitigate the false results. The false positive sample tested positive across all biomolecular tests, and the farm had a known history of *H. contortus* infections, so it was noted that an issue with larval culture likely occurred. In false negative results, some samples had low egg numbers in the aliquot provided, potentially being less than the threshold. This study concludes that colorimetric LAMP could be a valuable surveillance tool, providing stakeholders with a rapid diagnosis, improved clinical outcomes to optimise animal health, and develop an understanding of where infections are present.

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SeaFeed Sustain™ as a stabilised carrier for methane abatement in livestock production

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Introduction Bromoform is an effective inhibitor of CH₄ production in ruminants. However, its broad application across livestock production, including pasture-based grazing systems, requires delivery in a stabilised product. This study investigated SeaFeed Sustain™, a stabilised granular format for the delivery of bromoform, and its effects on methane emissions and performance using feedlot finished beef cattle.

Materials and Methods Thirty-five Angus steers were divided into two treatment groups (Bromoform vs Control) based on their maternal exposure to bromoform; steers born from bromoform supplemented dams remained in the bromoform group (Wenham *et al.* 2026). There was no difference in initial body weight (BW) between treatment groups (mean $\pm$ s.d; = 599.1 $\pm$ 47.56). The bromoform group (n = 20) received Sustain™ (Sea Forest Limited; Triabunna; Tasmania; Australia) containing 0.7 mg of bromoform per kg of BW (494mg bromoform/ head /day), along with 400 g of soybean meal per animal, per day. The control group (n = 15) was given the same carrier daily, without bromoform. Supplementation was delivered once every morning, before the high-grain based diet was offered, starting from Day 1 and continued until Day 92. Methane was measured using two Greenfeed units, and animals were rotated between two pens once every two weeks, to remove the pen effect. Final BW was taken at Day 85 and cold carcass weight was measured post-mortem at Day 93 in a commercial abattoir located 124 km from the trial site. All data was analyzed in R (using packages *biometryassist* and *ASRemL*) considering animal as the experimental unit. For animal performance general linear models were used with treatment as fitted as a fixed effect. CH₄ was analyzed via a mixed model, considering animal ID as repeated measures. Significance was declared at P < 0.05.

Results Treatment did not have any effect on final BW (kg) at Day 85 (P = 0.60; Fig 1B) or cold carcass weight (kg; P = 0.70; Fig 1C). Average CH₄ emission was reduced by 73g/day (39.5%) in the Sustain group compared to the control group (P<0.001; Fig 1A).

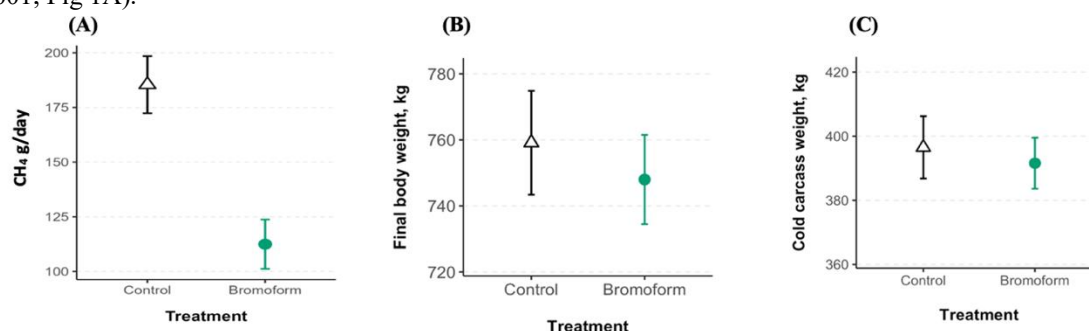


Figure 1. Effect of treatment, control and bromoform on (A) overall CH₄ emissions (P<0.001), with no effect on (B) final bodyweight (P = 0.60) measured at Day 85 and on (C) cold carcass weight (P = 0.70).

Discussion Bromoform delivered as Sustain™ significantly reduced CH₄ production in a beef feedlot, a reduction of 0.147g CH₄/mg CHBr₃ for Angus steers fed high-grain based diet compared to the control group, indicating its effectiveness as a methane mitigation strategy. Sena *et al.* (2025) demonstrated greater methane mitigation at lower bromoform doses compared to the current trial, and reported a 10% reduction in average daily gain, whereas no adverse effects on animal performance were observed in the current study. Therefore bromoform delivered as Sustain™ has the potential to be used in intensive beef production systems, to achieve substantial methane mitigation without compromising animal performance. Further research is required to validate these findings across a broader range of production systems and potential bromoform supplements commercially available.

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Influence of Maize Genotypes and Harvest Maturity on Fermentation Quality and Nutritional Value of Whole-Crop Maize Silage Under Hot Summer Conditions

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Introduction High-quality preserved forages are essential for sustaining dairy productivity under hot summer conditions. Maize is widely used for silage due to its high biomass yield and energy density; however, genotype selection and harvest maturity strongly influence fermentation dynamics and nutritive value. We hypothesized that maize genotype and harvest maturity influence silage fermentation characteristics, digestibility, and energy value under tropical heat stress conditions. The objective of this study was to evaluate the effects of genotype and harvest stage on yield, fermentation quality, chemical composition, starch degradability, and estimated energy value of whole-crop maize silage during hot summer conditions.

Materials and methods Six maize genotypes (DK9108, P30Y87, P3939, QPM-300, W94 and local Afgoi) were planted in 72 plots (8m x 10m), blocked within three replicate fields in a randomized complete block design at University of Agriculture Peshawar. A recommended fertilizer dose for maize 250: 90: 90 kg/ha of N: P: K, respectively was also provided from the Di-ammonium Phosphate (DAP), urea, and sulfate of potash (SOP). Maize seed was sown manually with hands in ridges with a row-to-row spacing of 75 cm and plant to plant space at 20 cm with a seed rate of plant population of 66,000 per hectare for optimal production. Irrigation was applied at recommended crop growth stages to maintain optimal soil moisture. Weed control was achieved using a pre-emergence atrazine program followed by a selective post-emergence herbicide for broadleaf and grass weed suppression, as advised by agronomy experts from The University of Agriculture Peshawar and CIMMYT. Whole-crop maize samples were collected at target whole-crop DM of 25, 30, 35 and 40% (19–41 DAF), chopped with a forage chopper and ensiled in laboratory mini silos (1.5 L) for a period of 90 days and stored at ambient room temperature (32–38°C) till analysis. Chemical analyses included DM, crude protein (CP), starch, neutral detergent fibre (NDF), acid detergent fibre (ADF), neutral detergent insoluble CP (NDICP), acid detergent insoluble CP (ADICP), pH, ammonia-nitrogen (NH₃-N), and organic acids (HPLC). In vitro DM digestibility (DMD) was determined using the Tilley and Terry method. Carbohydrate subfractions were determined using the Cornell Net Carbohydrate and Protein System (CNCPS). Total digestible nutrients (TDN) were calculated and metabolizable energy (ME) was estimated using NRC (2001) equations. Data were analyzed using PROC MIXED (SAS), with genotype and harvest maturity as fixed effects and replication as a random effect. Tukey–Kramer adjustment was applied for multiple comparisons ($\alpha = 0.05$).

Results Maize genotype and harvest maturity significantly influenced yield, fermentation characteristics and nutritive parameters ($P < 0.001$). Genotype P3939 exhibited the highest DM yield (17 t/ha), starch concentration (36.7% DM), lactic acid (5.3% DM), lowest silage pH (3.7), and highest estimated ME (2.51 Mcal/kg). Advancing harvest maturity from 25% to 35% DM increased starch concentration (29.1% to 35.0%), in vitro DMD (65.3% to 67.3%), and ME (2.34 to 2.47 Mcal/kg). Concurrently, pH declined from 4.1 to 3.6. CNCPS subfraction analysis indicated that superior genotypes contained greater proportions of rapid and immediately degradable carbohydrates, contributing to higher ruminal starch availability and energy density. No butyric acid was detected in any treatment, and NH₃-N concentrations remained stable across maturities. No significant interaction was observed between genotype and harvest maturity for fermentation parameters ($P > 0.05$).

Discussion Genotypic differences in starch concentration and carbohydrate subfractions were associated with improved fermentation quality and estimated energy value. Advancing harvest maturity to 32–35% whole-crop DM enhanced starch accumulation and digestibility without compromising fermentation stability under high ambient temperatures. The absence of butyric fermentation and stable NH₃-N concentrations indicate effective preservation across treatments. Selection of heat-tolerant, high-starch genotypes such as P3939 and harvesting at 32–35% whole-crop DM was associated with improved silage fermentation characteristics, energy density and digestibility under hot summer conditions. These findings provide practical guidance for genotype selection and harvest scheduling in hot summer dairy systems and support climate-resilient forage management strategies.

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Periparturient mortality in six Merino flocks in western Victoria

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Introduction Intensive supervision of all lambing ewes is difficult in Australia. If ewes at higher risk of periparturient mortality could be identified, producers could adjust their management to reduce this risk. Previous research in other locations and/or breeds of sheep has found that ewes in lower body condition score are at higher risk of periparturient mortality (Flay *et al.*, 2023). The aim of this study was to investigate the risk of periparturient death of Merino ewes at different condition scores, and explore the causes of death of these ewes.

Materials and Methods A total of 4,470 Merino ewes from six flocks in southern Victoria were monitored (1537 in Year 1, and 2,993 in Year 2; between 255 – 1,169 ewes on each farm; 3 different farms each year) (University of Melbourne Animal ethics approval nos. 27776 & 30522). Ewes were monitored from pre-lambing treatments (Year 1) or around joining (Year 2), until after lambing. Ewe identification, age and condition score were recorded when ewes were yarded for husbandry events. Wherever possible, post-mortem examination was conducted for ewes that died or were euthanased between set stocking for lambing and marking (n=36 (Year 1); n=31 (Year 2)), and their identity recorded. Ewes present after lambing were recorded as having survived, and as many as possible condition scored.

Results Year 1 was a year of below median rainfall in the regions of study, and in Year 2 effective autumn rainfall began at least 6 weeks later than the average for that area, with some ewe flocks moved out of containment very close to the start of lambing. Ewe mortality ranged between less than 1% to over 6% on the six farms. On one farm in Year 1, only one ewe was confirmed to have died from a monitor flock of 252 ewes, and this farm was excluded from the generalised linear model for that year. Up to 4.5% of ewes in individual flocks were neither found dead, nor recorded as present after lambing. On one farm, some ewes were sold before the final visit, making conclusions on mortality rate of the cohort challenging. In total across the six farms, the outcome for a total of 3951 ewes could be determined. Ewes which were neither found dead nor alive at the end of the study periods have been excluded from the preliminary analysis. Some ewes had multiple contributing factors for their death, making a total of 95 causes of death for the 67 ewes which were examined post-mortem over the two years. The most common causes of death across the two years of the study were metabolic disease (n=25), dystocia (n=22) and pneumonia (n=10, although 9 of these occurred on one farm). In some cases, the long interval between ewe death and postmortem made determining the cause of death difficult. Interim results of a binomial generalised linear model conducted on the data from some farms suggest a significant association between condition score at pre-lambing treatments and periparturient mortality ($P < 0.05$) on some but not all farms.

Discussion The incidence and causes of ewe mortalities seen in this study are comparable to those reported in the literature previously (Kirk *et al.* 2025), but the incidence and causes of death could be very different in a wet year. The significant association between pre-lambing condition score and risk of mortality on some farms in this study is similar to findings in other studies (Behrendt *et al.*, 2011), but this was not the case on all farms. The lack of an association between mortality and condition score at joining differs from that found in Composite and Romney ewes in New Zealand. Further work, involving more ewes on more farms, would be helpful to confirm whether there is an association between mortality and condition score at other timepoints during the production cycle in Australian Merinos.

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Untargeted metabolomic profiling of plasma revealed parity-driven metabolic changes in Holstein-Friesian dairy cows

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Introduction High-producing dairy cows experience a period of negative energy balance (NEB) during early lactation when energy intake does not meet the demands of milk synthesis. To sustain production, cows undergo extensive metabolic and physiological adjustments involving carbohydrate, lipid, and amino-acid metabolism (Mekuriaw, 2023). The efficiency and magnitude of these adjustments may vary with parity, as primiparous cows must simultaneously support lactation and somatic growth, while multiparous cows have reached metabolic maturity. The objective of this study was to characterise the parity-driven metabolic differences in lactating cows on a pasture-based commercial dairy farm. We hypothesised that parity influences systemic metabolism, resulting in distinct plasma metabolite profiles that reflect parity-specific energy and physiological demands.

Materials and Methods The animal study was approved by the University of Melbourne Animal Ethics Committee (AEC No: 2025-30607-70832-9) and was conducted on a commercial dairy (Hermitage Dairy) in Northeast Victoria, Australia. Twenty pregnant lactating Holstein cows were selected based on comparable milk yield and body weight and were blocked into two groups (n = 10 each): first parity (primiparous) and third parity (multiparous). Blood samples were collected from the tail vein into heparinised tubes, plasma separated by centrifugation, and stored at -80 °C until analysis. Untargeted profiling of polar metabolites was done using Gas Chromatography coupled with Triple Quadrupole Mass Spectrometry. Peak integration, log transformation, and normalisation were performed before multivariate and univariate analyses (one-way ANOVA). Analyses were done in R. Partial Least Squares–Discriminant Analysis (PLS-DA) was used to visualise metabolic separation between parity groups, while a heatmap illustrated differential abundance. The level of significance was fixed at $p < 0.05$.

Results Distinct clustering of samples from primiparous and multiparous cows was evident in PLS-DA score plots and heat map, confirming clear metabolic separation in amino-acid, organic-acid, and carbohydrate metabolism by parity (Figure 1a, b). Two key metabolites displayed strong parity effects: 2-ketobutyric acid levels were significantly higher in third-parity cows, while myo-inositol concentrations were elevated in first-parity cows (Figure 1c).

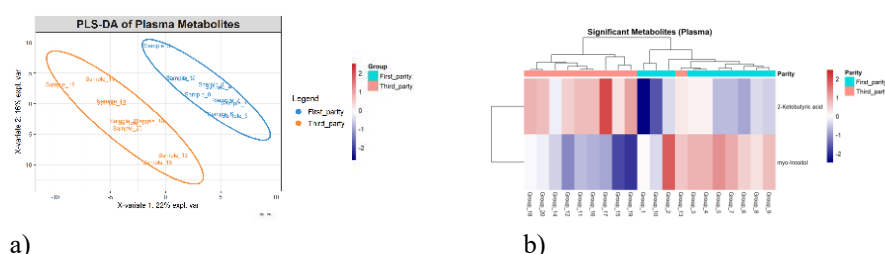


Figure 1. a) PLS-DA, b) heatmap of top metabolites and, c) heat map of significantly altered metabolites

Discussion Primiparous cows showed increased myo-inositol, a metabolite associated with membrane phospholipid turnover, osmo-protection, and insulin signalling, which may reflect metabolic instability and compensatory adaptation to energy deficiency (Mekuriaw, 2023). In contrast, higher 2-ketobutyric acid in multiparous cows imply a stable, homeostatic redirection of amino-acid flux toward gluconeogenesis, supporting efficient energy metabolism for sustained lactation. Collectively, these data demonstrate that parity influences metabolic strategies: first-parity cows rely on protective biochemical responses to cope with NEB, while multiparous cows maintain a balanced metabolic state through efficient substrate cycling. These findings suggest parity-dependent modulation of energy and substrate utilisation pathways in lactating Holstein cows suggesting additional nutritional management in primiparous cows to cope with NEB.

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From pen to carcass: predicting untrimmed hot carcass weight using in-pen automated weighing

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Introduction. Hot carcass weight (HCW) is considered one of the most important traits for assessing an animal's economic value within the beef industry. A common practical approach to determining HCW is manual crush weighing, which can cause handling stress, bruising, and compromise growth. Advances in automated technologies, such as Walk-on Weighing (WoW) systems, enable in-pen Live Weight (LW) collection with minimal disruption. If these in-pen measurements can accurately predict HCW, they may provide a practical, low-labour alternative to conventional weighing while enabling high-frequency LW and HCW monitoring. This study hypothesises that the accuracy of HCW predictions derived from previously published equations using WoW in-pen LW data will be comparable to the accuracy achieved using traditional crush-weighing measurements.

Materials and methods. Angus ($n=30$), Charolais ($n=29$), and Brahman ($n=30$) steers were slaughtered every 50 days in a 200-d serial slaughter trial. Full LW was collected the day before slaughter using a calibrated crush and scale system in centralised yards (Tru-Test XR5000 and MP600 load bars), whereas in-pen LW was continuously recorded via 4 WoW units (Intergado, MG, Brazil) located at water troughs. The HCW was predicted from 5 published models and applied to the last recorded WoW and crush LW (Alhassan et al., 1975; Ferrell, 1976; Fox et al., 1976; Garrett & Hinman, 1969; Lofgreen et al., 1962). Animal LW was converted to shrunk LW (SBW = $LW \times 0.96$), and then empty body weight (EBW = $SBW \times 0.891$) (NASEM, 2016) to reduce biological variation from gut fill. Untrimmed HCW was recorded within two hours of slaughter, and results were analysed in RStudio using deviation metrics and concordance correlation coefficients (CCC) analyses between observed (Y) and predicted (X) HCW.

Results. Across all equations, prediction accuracy and precision were high ($R^2 = 0.98$ for all models), with CCC close to unity for both WoW and crush-derived HCW (Table 1). The Garret & Hinman (1969) equation yielded slightly higher CCC and lower mean bias for the WoW-based predictions compared to the other model, whereas the Alhassan et al. (1975) equation yielded slightly higher CCC and smaller mean bias with crush-derived LW.

Table 1. Performance of WoW and crush-derived full body weight (FBW) models in predicting HCW.

	WoW Models					Crush-FBW Models				
	Lofgreen	Garrett	Alhassan	Ferrell	Fox	Lofgreen	Garrett	Alhassan	Ferrell	Fox
Observed HCW (kg)	313.29	313.29	313.29	313.29	313.29	313.29	313.29	313.29	313.29	313.29
Predicted HCW (kg)	295.27	316.06	327.04	309.25	300.64	285.72	305.87	315.92	299.43	290.73
Mean bias (kg)	18.03	-2.77	-13.75	4.04	12.65	27.57	7.42	-2.63	13.86	22.56
RMSE (kg)	10.28	10.28	10.28	10.28	10.28	10.79	10.79	10.79	10.79	10.79
MAE (kg)	18.59	8.49	14.90	9.02	13.85	27.85	12.15	8.88	16.52	23.15
CCC	0.95	0.99	0.97	0.97	0.97	0.89	0.98	0.99	0.96	0.93
Cb	0.96	0.99	0.98	1.00	0.98	0.90	0.99	1.00	0.97	0.94

Observed HCW = Mean observed HCW, Predicted HCW = Mean predicted HCW, Mean bias = observed - predicted, RMSE = root mean squared error, MAE = mean absolute error, CCC = concordance correlation coefficient, Cb = bias correction.

Discussion. Feedlots currently lack an effective method to predict real-time HCW of individual animals while on feed, which limits objective decision-making. In-pen weighing systems provide point-in-time LW and can overcome such limitations. The WoW-derived LW produced HCW predictions as accurate and precise, or superior to crush LW across all five previously published models and reduces labour demands and handling stress associated with crush-based weighing. The five models selected are widely recognised and frequently cited for predicting HCW. However, they were not developed under Australian conditions or have not been calibrated using the industry-recognised hot standard carcass weight (HSCW) following standard trimming procedures. While these equations performed well in predicting untrimmed HCW, their accuracy relative to Australian commercial systems using HSCW should be validated in further studies. The results support the hypothesis that WoW in-pen automated weighing systems offer a practical, accurate, and real-time method to predict untrimmed HCW as an alternative to crush-based weighing, with all models performing similarly to their equivalent crush-based predictions, which can assist decision-making around optimal carcass endpoints.

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Individual wet corn gluten feed components in high forage rations fed to Holstein steers contribute to changes in nutrient digestibility

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Introduction Components of corn gluten feed, such as solvent-extracted germ meal, bran, and steep liquor, are secondary products from the corn wet milling industry. Sweet Bran (SB; Cargill, Blair, NE, USA) is a branded form of wet corn gluten feed. It is used to partially replace corn grain, fibre, and soybean meal in cattle diets (Boddugari *et al.* 2001; Brouk *et al.* 2006; Weiss 2012), as a source of energy and protein. Due to the distinct nutrient profiles of each SB component, this study aimed to evaluate the digestibility of high-forage diets fed to Holstein steers, in which individual SB components partially replaced corn silage. We hypothesised that diets containing bran and solvent-extracted germ meal would exhibit more similar digestibility patterns to those with steep liquor.

Materials and methods This study was conducted at the Kansas State University Feed Intake Facility and was approved by the Institutional Animal Care and Use Committee. Twelve ruminally and duodenally fistulated Holstein steers (497 ± 19 kg initial body weight) were blocked by initial body weight and assigned randomly to one of four diets in a 4 x 4 balanced Latin Square design. Periods consisted of 18 d for diet adaptation with sample collections on d 19 to 21. Treatments were without any SB component (CON), with solvent extracted corn germ meal (Germ), with corn bran (Bran), and with corn steep liquor (Steep). Diets (dry basis) included 15% alfalfa hay, approximately 13% ground corn, a vitamin and mineral supplement, and urea (in CON and Bran). The CON contained 70% corn silage; and 35% for the silage was replaced by Bran, Germ, or Steep. Titanium dioxide was dosed twice daily (10 g/dose) into the rumen from d 7 through 21 to track digesta flow. Ruminal, duodenal, and faecal samples were taken from d 19 to 21, covering all 2-h post-feeding intervals. Samples were analysed for chemical composition to determine diet apparent digestibility. Data were analysed using the MIXED model procedure of the Statistical Analysis System (SAS version SAS Studio; SAS Inst. Inc., Cary, NC, USA). Fixed effects included treatment and period, with animal as a random effect. Statistical significance was declared at $P \leq 0.05$, tendency when $0.05 < P < 0.10$.

Results Cattle fed the CON consumed less dry matter (DM) compared to other treatments ($P < 0.01$; Table 1). Feeding Steep diet tended to increase ruminal DM digestibility ($P = 0.08$) and improved total tract DM digestibility as well as apparent ruminal and total tract protein digestibility ($P < 0.01$) compared with other treatments. Additionally, total tract starch digestibility was greater for the Steep diet ($P = 0.03$), whereas ruminal starch digestibility did not differ among treatments ($P = 0.44$). Germ and Bran exhibited greater neutral detergent fibre digestibility than other treatments ($P < 0.01$), and had similar overall nutrient digestibility, while the CON had the poorest digestibility percentages.

Table 1. Intake and apparent digestibility of high-forage diets containing components of Sweet Bran fed to Holstein steers*

Item	CON	Germ	Bran	Steep	SEM	P-values
DM intake (kg/d)	8.79 ^b	11.18 ^a	11.26 ^a	11.99 ^a	0.69	<0.01
Total tract apparent digestibility (%)						
DM	89.58 ^c	90.90 ^b	89.98 ^{bc}	93.20 ^a	0.59	<0.01
Protein	87.71 ^c	88.26 ^{bc}	89.34 ^b	93.01 ^a	0.59	<0.01
NDF	84.31 ^c	88.67 ^a	87.50 ^{ab}	87.04 ^b	0.75	<0.01
Starch	99.40 ^b	99.39 ^b	99.32 ^b	99.67 ^a	0.09	0.03
Ruminal apparent digestibility (%)						
DM	83.17	84.36	84.32	86.42	1.12	0.08
Protein	73.56 ^b	71.97 ^b	75.13 ^b	80.13 ^a	1.53	<0.01
NDF	81.06 ^b	86.89 ^a	87.40 ^a	82.75 ^b	1.36	<0.01
Starch	95.35	94.68	93.86	94.93	0.73	0.44

*CON = control; Germ = solvent-extracted germ meal; Bran = corn bran; Steep = corn steep liquor; DM = dry matter; NDF = neutral detergent fibre. Values are least-square means, and standard error of the mean (SEM). Means without a common superscript letter are different. P-values represent treatment effect.

Discussion Including corn by-products, especially Steep liquor, enhanced digestibility, leading to greater DM intake. Steers fed Steep liquor had improved protein utilization, and a potential advantage in post-ruminal energy supply from starch. Germ and Bran provided greater energy availability from fibre. A limitation of this study is that the diets were not isocaloric or isonitrogenous, future studies should consider this factor. To conclude, adding corn steep liquor to the diet increased ruminal and total tract nutrient digestion compared to other components of wet corn gluten feed.

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Modulation of methane emissions, and rumen microbiome on dairy cows through dietary supplementation of *Lactobacillus* spp.

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Introduction Enteric methane is a major contributor to agricultural greenhouse gas emissions, yet the mechanisms by which microbial interventions influence rumen methanogenesis and microbial communities remain poorly understood. Direct-fed microbials (DFM), such as *Lactobacillus* spp. (LAB), are widely used to improve rumen health and feed efficiency and have shown potential to reduce methane emissions (Philippeau et al., 2017). However, studies on their influence on rumen microbiome and archaeal communities are limited. The objective of this study was to investigate the effect on rumen bacterial and archaeal populations from feeding two different formulations of LAB daily in the ration of dairy cattle.

Materials and methods Forty spring calving Holstein Friesian dairy cows, grazing perennial ryegrass (PRG) (*Lolium perenne* L.), were randomly allocated to one of the three treatment diets: 1) CON: Control, fed a basal diet (n = 14); 2) FML: basal diet plus freeze dried LAB (n = 13) delivering 10×10^{10} CFU /day, and 3) LML: basal diet plus Liquid LAB (n = 13) delivering 11.5×10^{10} CFU /day, with all diets for 35 days. The basal diet comprised 6.9 kg DM/d of a grain mix plus PRG pasture at an allowance of approximately 25 kg DM/cow per day. Methane emissions from individual cows were estimated using the modified SF₆ tracer technique (Deighton et al. 2014) during the last 5 days of the experiment. Ruminal fluid (~400 mL) was collected from each cow via the mouth using an oro-ruminal sampling probe (Moate et al., 2014) at 4h after milking in the morning on the last day of the experiment. Microbial DNA was extracted from 10 ml of ruminal fluid subsample and sequenced as per Sepulveda et al. (2025). Data analysis was undertaken with R (version 4.4.2) using RStudio (2024.12.1). Relative abundance and alpha diversity were calculated using the *phyloseq* package (McMurdie & Holmes, 2013), while data manipulation was performed with *dplyr* and plotting with Microsoft Excel.

Results Methane yield was not significantly affected by the inclusion of either form of LAB (P = 0.472) but was 6% numerically lower for the FML cows. Rumen microbiome species richness as measured by the Chao1 index, was lower in cows supplemented with both formulations of LAB, compared to CON (P = 0.032). The bacterial community remained stable and dominated by *Prevotella* spp., with no significant shifts following LAB supplementation (Figure.1). In contrast, archaeal composition was altered by FML, favouring phylum Candidatus Thermoplasmatota over Euryarchaeota and increasing the relative abundance of methylotrophic methanogens (*Candidatus Methanomethylophilus*) while reducing hydrogenotrophic methanogens (*Methanobrevibacter* spp.).

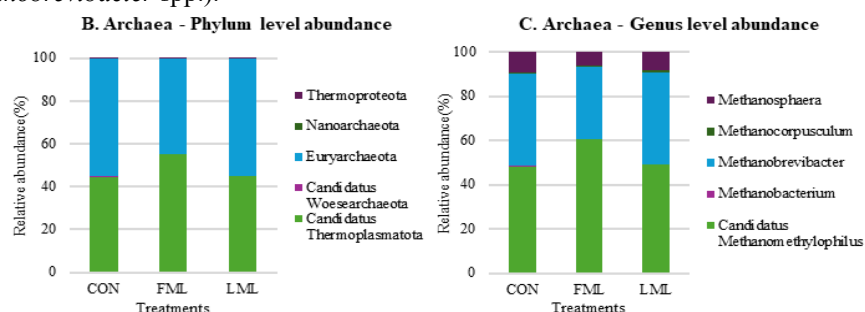


Figure 1. Relative abundance of top five bacteria at the genus level (A), and archaea at the phylum (B) and genus levels (C).

Discussion Although methane production did not differ significantly among treatments, FML supplementation altered archaeal composition in a manner consistent with reduced methanogenic potential, whereas LML showed minimal impact. FML appeared to promote methylotrophic methanogens at the expense of hydrogenotrophic species, a shift generally associated with lower methane yield per unit substrate and reported to be negatively correlated with methane emissions (Martínez-Álvaro et al., 2020). However, methane output does not always correspond directly to methanogen abundance (Pitta et al., 2022). These findings highlight the potential of FML as a microbiome-modulating strategy for methane mitigation, warranting further investigation in larger, longer-term studies.

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Australian Wool Education Trust assists students to connect to the sheep industry

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Introduction The Australian Wool Education Trust (AWET) was established following the closure of the University of New South Wales Department of Wool and Animal Science, with initial funding from the Australian Wool Testing Authority and later contributions from Australian Wool Innovation. The Trust supports national education through four strategic objectives, including support for the education of students, growers, and others capable of contributing to the wool industry. The AWET South Australia Student Champion initiative, aimed to strengthen student engagement with the wool sector through education, extension, and capability development across tertiary and secondary environments. It demonstrated how structured learning and professional development activities can build communication skills, technical understanding and career awareness for future workforce.

Materials and Methods The project was conducted from March to November 2025. Funding provided by AWET supported the author to participate in, present to, and lead a range of events including industry conferences and workshops, and mentoring and community engagement activities. These included:

Professional development: Participation, presentation and journal paper submission at the Primary Industries Education Foundation Australia 2025 and Australasia-Pacific Extension Network 2025 conferences highlighted AWET's support for emerging educators and extension leaders. Additional technical training was completed via the SA Livestock Consultants Course (three weeks including sheep and wool modules), the Parawa Ag Bureau Sheep and Cattle Workshop with Dr Alex Ball and Dr Colin Trengove, and the SA Livestock Advisor Update.

Teacher and school engagement: At the Agricultural Teachers Association of South Australia (ATASA) Conference in Jamestown educators were introduced to AWET resources and the Student Compendium as tools for developing curriculum links to the wool industry (Norman, 2025). Additional engagement occurred through the Urrbrae Agricultural High School Careers Expo and the Yorke Peninsula Field Days Ag Learning Centre where students, teachers and parents discussed pathways into wool production research and advisory careers.

University engagement: Two Lunch and Learn sessions were delivered for first- and second-year undergraduate students in animal and agricultural science. The sessions titled Unlocking Opportunities in the Wool Industry introduced students to wool career pathways, AWET scholarships and the University of New England Wool Education Modules. The program included an industry guest presentation by the Australian Wool Innovation South Australia Industry Relations Officer. Sessions were designed to promote peer learning and encourage students to explore opportunities for placement scholarships and early career development.

Networking and representation: Project activities included participation at the Rural Media and Communicators South Australia / Northern Territory Royal Adelaide Show Breakfast enabling direct engagement with national and state industry representatives and communication professionals. These events supported broader visibility of AWET programs and strengthened cross sector connections.

Results Over 80 university students attended the Lunch and Learn Sessions, increasing awareness of wool industry careers and AWET programs. Feedback indicated students gained motivation and confidence to apply for scholarships, seek work experience and pursue internships. The sessions also developed communication, leadership, and organisational skills among presenters, demonstrating capability growth through student-led extension.

Professional learning through conferences and technical workshops deepened understanding of the wool industry's consultancy and extension practices, while the SA Livestock Advisor Update and Parawa programs enhanced practical knowledge of production systems and industry challenges. Participation in ATASA, Urrbrae, and regional field day events expanded AWET's visibility and created sustained dialogue between educators, students, and professionals. Ag Institute Australia media releases (AIA, 2025) and a co-authored article submitted to the Rural Extension and Innovation Systems Journal, recognising AWET's contribution to developing future educators and industry leaders.

Discussion This project highlighted how AWET's investment enables students to transform learning into extension and capability-building outcomes. The Lunch and Learn model provided an effective peer-to-peer platform that promoted the wool industry while enhancing professional skills in communication and leadership. Integrating professional development with outreach created meaningful capability gains and built stronger connections between universities, schools, and industry. Student-led initiatives such as this demonstrate a scalable approach to supporting Australia's next generation of livestock professionals, who can collaborate across sectors, communicate science effectively and drive innovation in the animal industries.

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Bromoform concentrations in milk of dairy cows when fed bromoform-based products twice daily

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Introduction There is a growing concern about the safety of products derived from livestock fed antimethanogenic feed additives (AMFA; Eason and Fennessy, 2024). Bromoform is a potent AMFA which can be partially transferred to milk in a positive linear fashion with dose when fed twice daily to dairy cows (Alvarez-Hess et al., 2024), but its transfer to milk in cows eating different forages and at different stages in lactation is unknown. We hypothesize a positive linear relationship between bromoform dose fed and bromoform in milk regardless of basal forage or stage in lactation.

Materials and methods We present an initial exploration of data collated from eight experiments, including groups of cattle at various days in milk (DIM) (Early: 35-100 DIM, Mid: 101-200 DIM, Late: 201-300 DIM). Cows received *ad libitum* forage, either grazed perennial ryegrass (*Lolium perenne* L.) pasture (n= 267) or vetch hay (n= 169, *Vicia sativa* L.). In all experiments cows received an AMFA with a base constituent of oil-based bromoform (132 to 448 mg bromoform per day), twice daily at milking mixed through the cow's grain allocation (5.9-6.2 kg DM/d) for at least 28 days prior to measurement. For all experiments, milk samples were collected from PM and AM milkings individually via proportional inline milk meters and then bulked to form a day sample for each cow, which was then subsampled for analysis. Post collection, samples were handled in one of two ways; ColdHot method (n= 139): PM milk samples were immediately cooled overnight at 4°C and mixed with AM samples, that were not cooled, and ColdCold method (n= 297): both samples were cooled prior to mixing. In both cases, samples were analysed for bromoform concentration as per Jordan et al. (2023), limit of detection 2.0 µg/L) and analysed by linear regression across all experimental data.

Results Mean bromoform concentration in milk with increasing bromoform dose fed from the eight experiments are presented in Figure 1A, B. There was a strong positive correlation between bromoform concentration in milk and bromoform eaten ($R = 0.897$). About 1.2% of the bromoform eaten was found in the milk. Variability was greater in the HotCold method ($R^2 = 0.58$) than the ColdCold method ($R^2 = 0.81$, Figure 1B).

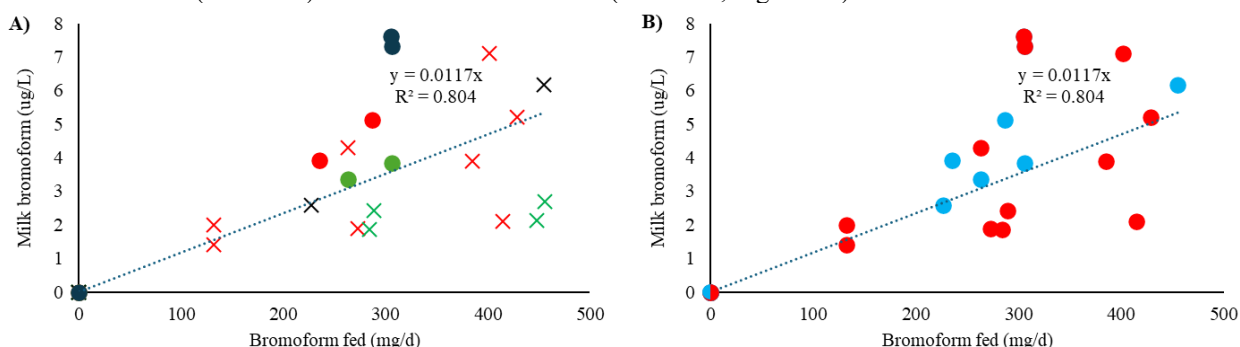


Figure 1 A) Experimental characteristics; forage type (x = hay, • = pasture) and stage of lactation (red = early, green = mid, black = late), **B)** Sample handling post collection (red = HotCold, blue = ColdCold)

Discussion Our results indicate greater bromoform in the diet yields greater transfer to milk. However, variability in the data is high, possibly due to differences in processing of samples post collection. Of the methodology used here, samples cooled before mixing appear to yield more consistent data. This variability suggests the need for a consistent protocol in handling and analysis of milk samples collected for bromoform analysis. While lipophilic, bromoform is easily volatilised, with a vapour pressure of 5.4 mmHg at 25°C on dry surfaces (Baselt, 2014). As such, immediate cooling of samples to below 25°C upon collection may be necessary for most accurate quantification. Regardless, Biesterbos et al. (2025) suggest maximum safe limits of bromoform in milk at 964 µg/L in adults consuming large amounts of cow's milk. The highest rate of bromoform fed with the resultant greatest amount of transfer to milk was 402 mg/d fed and 7.1 µg/L in milk. Given this is over 100 times less than the reported safe adult limit, it is unlikely that there would be health risks associated with milk from dairy cows when fed bromoform twice daily at levels up to 400 mg/d.

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Metabolomic profile of heat tolerant Droughtmaster cows

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Introduction As climate change progresses, it is critical to investigate differences in and identify heat tolerance phenotypes in cattle. A method of classifying heat tolerance in cows based on body temperature was developed by Rhoad (1944). Recently this method has been adapted for bolus derived rumen temperatures (Pryor et al., under review). However, the metabolomic differences in divergent heat tolerant phenotypes has received limited attention. This study evaluated the metabolomic differences between cows, classified into different heat tolerant categories based on rumen temperatures. It was hypothesised that Tolerant cows would have differing metabolomic profiles when compared to Susceptible and Neutral cows.

Materials and methods Twenty-four grazing Droughtmaster cows (>3 years) were grouped into heat tolerance categories (Susceptible, Neutral, Tolerant) based on their heat tolerance coefficient (Pryor et al., under review). The heat tolerance coefficient was calculated as 100 minus 18 times the difference between the observed rumen temperature and a reference temperature. The reference temperature was derived from averaged rumen temperatures collected across three consecutive thermoneutral days at 10-min intervals. The heat tolerance test was conducted over three consecutive days, with rising maximum ambient temperatures (Day 1 = 30°C, Day 2 = 33°C, Day 3 = 35°C). Cows were held in unshaded yards between 1000h and 1500h, each day. At 1500h, cows were moved into a handling facility and a 10mL blood sample was collected using a K₃-EDTA vacutainer via coccygeal vein. Plasma samples were obtained from blood samples by centrifuging at 1400 × gravity (2500 rpm) for 10 minutes at 4°C and storage at -80°C. Plasma from a subset of three cows per heat tolerance categories were analysed for differences in metabolites relative abundance (Shimadzu GCMS-TX8050 NX). Raw metabolite peak intensities were normalised using Metaboanalyst (<https://www.metaboanalyst.ca/>). Repeated measures Anova simultaneous component analysis compared the heat tolerance category's metabolite differences using false discovery rates. Emmeans were calculated for significant metabolites to compare between the individual heat tolerance categories.

Results Tolerant cows had lower rumen temperatures (38.8 ± 0.2 °C) and higher HTC (106 ± 4.1) values when compared to the Neutral (39.1 ± 0.2 °C; 102 ± 3.4) and Susceptible cows (39.4 ± 0.3 °C; 96 ± 5.8 ; $P < 0.05$). Three metabolites were identified across the heat tolerance categories (Table 1).

Table 1. Normalised emmean and standard error peak intensities for the heat tolerance categories, Tolerant, Neutral and Susceptible cows, significant metabolites

Metabolite	Tolerant	Neutral	Susceptible
Glutathione	-0.83 ± 0.36^a	0.56 ± 0.3^b	0.27 ± 0.44^b
N-Acetyl Beta Neuraminic Acid	0.81 ± 0.42^a	-0.95 ± 0.15^b	0.14 ± 0.35^a
Uridine	-0.74 ± 0.09^a	0.47 ± 0.48^b	0.27 ± 0.44^{ab}

Note. Different letters indicate significant differences across the rows ($P < 0.05$)

Glutathione was lower in the Tolerant cows across the three days when compared to the Neutral and Susceptible cows ($P < 0.05$). Similarly, uridine was lower in the Tolerant cows when compared to the Neutral cows ($P < 0.05$) and tended to be lower when compared to the Susceptible cows ($P = 0.07$). Oppositely, N-acetyl beta neuraminic acid (Sialic acid) was higher in the Tolerant cows and the Susceptible cows when compared to the Neutral cows ($P < 0.05$).

Discussion Glutathione can be utilised to protect cells from reactive oxygen species (ROS) during heat stress (Lakritz et al. 2002). Interestingly, Tolerant cows showed lower levels of glutathione, regardless of the ambient temperature, indicating that they may have an inherently lower basal levels of glutathione. Higher levels of uridine in Neutral and Susceptible cows may indicate poorer heat tolerance capabilities as uridine has been shown to help decrease body temperature and to have a role in metabolic rates (Deng et al., 2017). Higher levels of sialic acid in Tolerant cows may indicate an inflammatory response, however, if the sialic acid was used as an antioxidant in the Neutral and Susceptible cows, their lower levels may indicate elevated ROS levels (Sweidan and Abuajamieh, 2025). These three metabolites show clear roles in heat stress responses in animals and distinct differences between the heat tolerance categories. There is a need to investigate the physiological pathways that are enhanced during heat stress on a larger sample size, but this study highlights that differences do exist between the heat tolerance categories metabolomic profiles.

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Development of an In Vitro Culture Model of Mammary Epithelial Cells Isolated from Goat Milk for Lab-grown Milk Production

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Introduction Climate change decreases dairy production due to hot temperature (Thammacharoen et al., 2020.). The loss of production could be compensated by lab-grown milk (Kwon et al., 2024). Since mammary epithelium cell (MECs) is required for this production, tissue biopsy and cell lines are usually adopted. However, the use of biopsy was limited by their invasive nature, while cell lines also tend to lose their ability to produce milk component. Then, milk is an alternative source of MECs even they are expected be mature cells. The goat milk contains a larger amount of young cell. Therefore, we hypothesized that goat milk-MECs could be isolated, cultured and be differentiated by lactogenic hormone in vitro.

Materials and methods Five individual Saanen goat milk samples were collected from one small-holder farm during routine milking. Cell pellets were seeded with propagation media containing DMEM/F-12, 10% FBS, 1% penicillin-streptomycin, and 10 ng/ml EGF. After two passages, cells were used for growth curve analysis using daily cell counting and MEC characterization. This latter step used immunofluorescent staining with anti-cytokeratin 18 (CK-18, red) which was imaged at 400× for 30 area to calculate CK-18 positive cell density. With 7th passage, seeded cells were incubated with and without lactogenic hormone (Prolactin, Hydrocortisone, and Insulin) for 9 days. The casein protein expression was measured by immunofluorescent staining with anti-casein (green). These signals were imaged by the same procedure as characterization. The percentage of area that found casein positive cell (positive area) were calculated and compared to non-hormone treated group using paired-student t-Test.

Results The growth curve showed a sigmoid pattern with 4-parameter model ($P < 0.05$, $R^2 = 0.93$). Most of the cell were CK-18 positive ($98.5\% \pm 1.06\%$, Fig1a) and the density of these cells were 134 ± 26 cell/cm². Importantly, there was no fibroblast-like cell were observed in this study. Regarding to hormone treatment, the average percentage of positive areas in hormone treated group was statistically different from non-hormone counterparts ($P < 0.05$, (Fig1b,c).

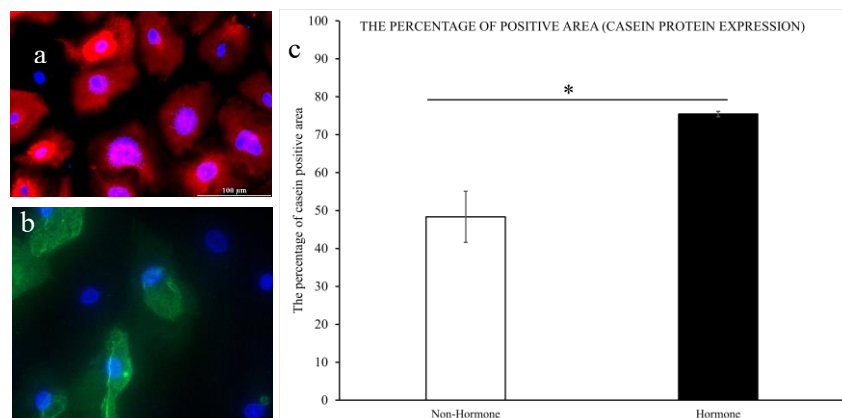


Figure 1. a) Mammary epithelium cell (CK-18 positive, red), b) Casein protein expressed cell (green), and c) The average percentage of positive areas which indicate the distribution of casein protein expression.

Discussion This study demonstrated that mammary epithelial cells (MECs) can be isolated from goat milk, with CK-18-positive epithelial cells predominating. The increased positive area within the culture suggests these milk-derived MECs can differentiate and produce milk components. Even though varied lactation stage of donor is our limitation, a capable of organoid construction will further be investigated. This technique would enhance sustainable dairy production.

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Milk production responses to sequential stocking rates in hyper-diverse pasture managed under contemporary and regenerative pastoral systems.

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Introduction Interest in regenerative pastoral dairy production systems is increasing, driven by environmental legislation and regulatory pressures, and market pressures. In temperate countries, pasture-based dairy systems can provide most or all of the annual feed for dairy cows. Dairy system profitability, resilience, and environmental performance are strongly influenced by pasture use efficiency and the optimisation of output per hectare rather than per cow. Stocking rate (SR) is defined as the number of cows per unit area of land use during a specific period (Coffey et al., 2018). Therefore, the objective of the study was to optimise the stocking rate for dairy cow production under standard contemporary [ryegrass/clover under industry best practice (Std-Con)], hyper-diverse pasture (containing 18 species) following industry best practice (Div-Con), and hyper-diverse pasture managed regeneratively (Div-Reg) pastoral systems.

Materials and methods This study was conducted in the *Whenua Haumanu* Dairy farmlets, at Massey University- Dairy Farm 1, New Zealand. Each pasture system was treated as an individual farmlet of 13-paddocks (total effective area = 36.32ha; individual paddock size ~ 0.5-1ha), which were balanced for the location block, edaphic factors, breed groups (Holstein-Friesian, Jersey and crossbred), age of cow, and lactation number. Feed allocation for each system was determined by individual nutritional requirements relative to lactation stage and body condition score and adjusted to optimise overall farm pasture production. Supplemental feed requirements were fulfilled entirely by on-farmlet conserved pasture. From June 2022 to June 2023, all three systems were stocked with 2.2 cows/ha (24 cows per system) and from June 2023 to June 2024, with 2.5 cows/ha (30 cows per system). A total of 1458 individual cow monthly herd-test records included milk yield, percentage and yield of fat and protein were used. Accumulated milk and milksolids yield for each cow were estimated as the sum from day five of lactation to the maximum days (40-298 days) in milk. The 4th-order Legendre polynomial regression and least-squares means for each SR and system were obtained from a generalised linear model that included the fixed effect of SR, system, breed group, and individual cow as a random effect.

Results The year and SR were confounded, as each SR was applied in a different year. However, SR was the only major management change among years. The effect of SR and system on the average milk production and composition is presented in Table 1. While the total milk production (kg) was numerically increased with increased SR for all three systems (Std-Con from 76796 to 105373, Div-Reg from 79705 to 115398 and Div-Con from 82350 to 104998), there were no significant effects of either SR or system on overall average milk production and milksolids (kg Fat+ Protein) per cow ($P>0.05$). The percentage of fat and protein remained constant throughout the two phases of the experiment. However, output per land area significantly increased with increased SR, with no statistically significant interaction in performance between the SR and systems.

Table 1. Effect of stocking rate and systems on total lactation production and composition during the experiment

Stocking rate	2.2 cow/ha (June 2022 to May 2023)			2.5 cow/ha (June 2023 to May 2024)			<i>P</i> value		
	Std-Con	Div-Reg	Div-Con	Std-Con	Div-Reg	Div-Con	SR ¹	S ²	SR ¹ ×S ²
Lactation length (Days)	262±8	253±8	257±8	247±7	255±7	244±7	0.0491	0.8596	0.2704
Average milk production (kg/cow)	3238±167	3320±164	3386±163	3416±157	3592±153	3418±155	0.0632	0.8164	0.5276
Milksolids (kg/cow)	315±15	317±15	325±15	333±14	341±14	327±14	0.0650	0.9632	0.5082
Milksolids (kg/ha)	620±35 ^a	627±35 ^a	643±35 ^a	824±33 ^b	855±32 ^b	822±33 ^b	<.0001	0.8973	0.6085
Fat (%)	5.7±0.1	5.6±0.1	5.7±0.1	5.8±0.1	5.7±0.1	5.6±0.1	0.1057	0.3294	0.3346
Protein (%)	4.4±0.1	4.4±0.1	4.4±0.1	4.4±0.1	4.4±0.1	4.4±0.1	0.1271	0.8637	0.7545

^aValues are least-square means ± standard error of the mean (SE) and *P* value; ¹Stocking rate; ²Systems.

Discussion The present study shows that increasing SR or adopting a diverse pasture sward (under contemporary or regenerative management) did not result in a statistically significant change in per-cow production efficiency compared with standard pastures under contemporary management. However, increasing SR across all three systems increased the milksolids production per ha. This suggests diverse pastures and both management can drive sustainable and resilient dairy farming systems without compromising per-cow performance at both tested sequential SR levels.

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Effects of dietary ammonium chloride in late gestation on sow reproductive performance in spring and summer

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Introduction Season is an important factor directly impacting sow health and reproductive performance. Sows have a higher anoestrus rate, lower conception rate, prolonged farrowing, and a reduced litter size in summer because of heat stress (Williams et al., 2013). Pigs lack functional sweat glands, so they rely on panting to mitigate the body heat under heat wave. Panting will increase expiration of CO₂ which affects acid-base balance (Das et al., 2016). Ammonium chloride (NH₄Cl) is a dietary acidifier, which has been used to maintain acid-base balance in animal to reduce heat stress, particularly in chickens (Teeter and Smith, 1986). This study aims to investigate the effects of dietary NH₄Cl supplementation in late gestation on sow reproductive performance in spring and summer.

Materials and methods On day 101.1 ± 0.1 of gestation, 48 Landrace × Large White sows of parity 4 to 8 were selected and assigned equally to two treatments in each of two seasons (spring and summer, n = 24 each). Control sows were fed a commercially formulated basal diet and treatment sows were fed the basal diet supplemented with 20 g/day NH₄Cl until farrowing. The NH₄Cl was mixed with about 300 g basal diet and then applied on top of their daily feed allowance daily at 0700 h). Sow blood samples were collected at day 112 of gestation via an ear vein and whole fresh blood was measured for blood gases using i-STAT CG8+ (i-STAT Alinity). The comparison of blood parameters and sow performance between spring and summer in control and treatment groups was performed using generalized linear mixed models fitted with 'glmmTMB' package in R version 4.4.3. The fixed effects were treatment, seasons and their interaction, and the random effect for the comparison of blood parameters was gestational day, for farrowing duration comparison it was litter size, for total born it was individual sows, for weaning-to-estrus interval (WEI) it was farrowing duration, and for colostrum yield it was born alive.

Results In the control sows, season affected blood pH, partial pressure of oxygen (PO₂) and WEI, whereas season affected PO₂ in treatment sows only (P < 0.05, Table 1). Comparing control and treatment sows within season, farrowing duration of treatment sows was shortened 37% compared to control in spring (P = 0.02) and non-significantly reduced by 96 min in summer. In the treatment group in summer, stillborn rate was reduced (P = 0.04), and colostrum yield was higher (P = 0.02).

Table 1: Sow blood parameters and reproductive performance in control and treatment in different seasons

Variables	Control					Treatment					P-value (Interaction)
	Spring		Summer		P-value	Spring		Summer		P-value	
	n	Mean ± SE	n	Mean ± SE		n	Mean ± SE	n	Mean ± SE		
Blood pH	12	7.56 ± 0.02	9	7.48 ± 0.02	0.01	7	7.51 ± 0.02	8	7.46 ± 0.02	0.16	0.53
HCO ₃ ⁻ (mmol/L)	12	26.73 ± 0.95	9	25.21 ± 1.09	0.30	7	25.21 ± 1.24	8	22.13 ± 1.16	0.08	0.48
PCO ₂ (mmHg)	12	30.32 ± 1.23	9	33.76 ± 1.42	0.08	7	31.07 ± 1.61	8	30.78 ± 1.50	0.89	0.20
PO ₂ (mmHg)	12	99.42 ± 8.44	9	55.33 ± 9.75	0.002	7	107.00 ± 11.06	8	64.88 ± 10.34	0.009	0.92
Farrowing duration (min)	12	413.29 ± 52.08	12	402.31 ± 50.70	0.89	9	260.33 ± 37.88*	11	305.45 ± 40.20	0.42	0.48
Total born (piglet)	12	13.33 ± 1.13	12	13.25 ± 1.13	0.96	9	12.56 ± 1.23	11	14.45 ± 1.28	0.29	0.41
Colostrum yield (kg)	12	2.43 ± 0.48	12	1.43 ± 0.48	0.15	9	3.53 ± 0.55	11	3.13 ± 0.50*	0.59	0.55
WEI (day)	8	3.63 ± 0.15	12	4.17 ± 0.12	0.01	6	4.00 ± 0.19	9	4.11 ± 0.14	0.64	0.16
	n	Mean (95%CI)	n	Mean (95%CI)	P-value	n	Mean (95%CI)	n	Mean (95%CI)	P-value	P-value (Interaction)
Stillborn rate (%)	12	8.04 (4.35 – 14.37)	12	13.73 (8.19 – 22.11)	0.16	9	2.28 (0.67 – 7.43)	11	6.21 (3.10 – 12.04)*	0.14	0.59

* Indicate a significant difference between Control and Treatment in the same season at P < 0.05.

Discussion Feeding 20g/day of NH₄Cl in the maternal diet for 2 weeks before farrowing reduced seasonal effects on farrowing duration and stillborn rates and increasing colostrum yield.

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PregoPaws: Pilot study investigating detection dogs for cattle pregnancy diagnosis

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Introduction Pregnancy diagnosis in cattle is typically invasive, requiring skilled personnel and substantial animal handling (Jaskowski *et al.* 2019; Pohler *et al.* 2020). The development of a rapid, non-invasive diagnostic technique capable of detecting pregnancy as early as 42 days of gestation could offer significant benefits to the livestock industry. Dogs (*Canis lupus familiaris*) possess an exceptional sense of smell and have been successfully trained to detect a wide range of biological conditions and diseases in humans and animals. Despite proven ability in both medical and veterinary contexts, including oestrus detection in cattle (Curry and Roth, 2021; Kiddy *et al.* 1978; Fischer-Tenhagen, 2011), limited research has explored canine detection of pregnancy. Curry *et al.* (2021) trained and evaluated one hound to detect pregnancy in Polar bears (*Ursus maritimus*), achieving 97% and 100% specificity across testing sessions. As the ability of dogs to detect pregnancy non-invasively has been trialled, dogs may be a useful diagnostic tool for livestock management, however, minimal evidence supports this claim. This is the first known investigation into pregnancy diagnosis of cattle using trained detection dogs. This study evaluated the feasibility of using trained detection dogs to distinguish between pregnant and non-pregnant cattle based on the odour of biological samples, with the goal of developing a practical, low-stress field diagnostic tool for cattle production systems. It is hypothesised that dogs can achieve this differentiation with an accuracy greater than 50%, or random chance.

Materials and methods In this pilot study, three male dogs (terrier-hound mix, gundog, and terrier type) underwent 20 weeks of systematic training using clicker-based positive reinforcement protocols. Two dogs were imprinted on samples from pregnant cattle (positive discrimination), while one dog was imprinted on samples from non-pregnant cattle (negative discrimination). The training program included 69 sessions, of which 71% were completed in less than five minutes, and 53% included 5–10 repetitions. Vaginal swabs were collected from the Gatton Research Dairy herd (n = 95; 51 pregnant, 44 non-pregnant) during routine veterinary examinations, with pregnancy status confirmed via rectal palpation at >42 days gestation. Samples were stored at 4°C for no more than three days to preserve odour compounds associated with reproductive status. Dogs were evaluated using a five-arm scent wheel configuration and could present freely to locate one target odour (either pregnant or non-pregnant, depending on training protocol) among four distractor samples.

Results Training protocols successfully established discriminatory behaviour in all three dogs to varying degrees, confirming their ability to detect pregnancy-associated olfactory cues in cattle. Accuracy results varied with dog one and two achieving 20% and 10% respectively when trained to positively discriminate, and dog three with 40% accuracy when trained to negatively discriminate. The overall prevalence was 28%, with a range of 14–48%, and a 95% confidence interval.

Discussion Despite disproving the hypothesis, concluding that dogs cannot detect pregnancy in cattle from vaginal swab samples greater than random chance, the preliminary findings support the concept of canine olfactory detection as a novel, non-invasive approach to pregnancy diagnosis in cattle. These findings demonstrate strong potential for developing canine-assisted pregnancy detection as a practical, non-invasive tool suitable for application in some cattle production systems. Ongoing training aims to refine dog selection and training progression to achieve clear and reliable discrimination under controlled conditions. However, current pregnancy testing methods remain highly effective and provide valuable additional information which enables producers to allocate and manage cows as defined calving groups and optimise herd management decisions. The approach investigated in this study is not intended to replace existing techniques but to expand the range of tools available to producers, which hopefully will support increased adoption of whole-herd pregnancy testing and evidence-based decisions to improve production.

In conclusion, this proof-of-concept study provides suggestive evidence that trained detection dogs may be able to discriminate between pregnant and non-pregnant cattle based on olfactory cues in biological samples. While the small sample size (n = 3 dogs) limits definitive conclusions, these preliminary findings establish a foundation for future research to evaluate the performance of detection dogs undertaking crush side training on entire subjects, prior to exposing proven teams to unfamiliar beef and dairy herd environments across Queensland. As a novel approach, this technique shows promise as a practical, low-cost diagnostic tool that could transform reproductive monitoring in cattle by integrating canine olfaction into routine herd management practices.

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Using LCMS-Derived Chemical Data to Predict the Methane Mitigation Potential of Temperate Pasture Species and Species Combinations

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Introduction Enteric methane is a byproduct formed when feed is anaerobically fermented in the ruminants. Pasture chemical composition, specifically nutrient profiles and plant secondary metabolites governs methane formation during ruminal fermentation (Gerber *et al.* 2013). Current quantification relies on *in vitro* and *in vivo* experiments both of which are labour-intensive and restrict the number of forages that can be evaluated. Liquid chromatography–mass spectrometry (LCMS) enables high-throughput characterisation of plant secondary metabolites associated with enteric methane production. This study sought to integrate untargeted LCMS datasets with *in vitro* methane measurements to develop predictive mathematical models, including conventional statistical and machine-learning approaches for estimating the methanogenic potential of diverse forages.

Materials and methods Eighty pasture samples, including 41 monoculture and 39 multispecies samples were fermented anaerobically *in vitro* to determine their methane production potential over 24 h. Concurrently, 20 mg of each pasture sample was extracted using 1 mL of 80% methanol and the extract was analysed for their chemical profiles using LCMS. The LCMS chromatographic peak data was aligned (both mass to charge ratio and retention time) and filtered to remove noise (Refiner MS, Genedata) with resulting peak intensity data used for modelling. The data was imported into PLSToolBox (Eigenvector) running on MATLAB (MathWorks) with different algorithms tested for accuracy in predicting methane data. Models included partial least square regression (PLSR), a hybrid approach combining PLSR with a genetic algorithm (GA) for variable selection, and an artificial neural network (ANN) approach. For all models tested, the total dataset was split 75:25 into training ($n = 60$) and validation ($n = 20$) sets using the Kennard-Stone algorithm. Data were pre-processed, mean centred or auto scaled testing. Venetian blinds cross-validation was used on each model with 10 splits, with blind thickness set to 1. Model overfitting was tested by performing permutation testing ($n = 200$) and a P value less than 0.01 was indicative of a model that was not overfitted. Model quality was assessed using root mean square error (RMSE).

Results Among the three models, PLSR+GA exhibited the greatest calibration, cross-validation and prediction performance compared to PLSR and ANN when auto scale pre-processing was applied to both positive ($R^2 = 0.985, 0.877, 0.901$) and negative mode data ($R^2 = 0.782, 0.649, 0.938$) (Table 1). Similarly, the PLSR+GA hybrid model produced the lowest permutation test in positive mode (averaged across preprocessing methods) and the second lowest in the negative mode.

Table 1. The errors of calibration, cross-validation of LCMS data when trained to predict *in vitro* methane to total gas production using different models in negative and positive modes

Model	Variables	Preprocessing	Calibration		Cross validation		Prediction		Permutation test (<i>P</i>)
			RMSE	R ²	RMSE	R ²	RMSE	R ²	
Negative mode									
PLSR	744	Auto scale	0.004	0.862	0.001	0.380	0.006	0.851	0.0009
PLSR	744	Mean centred	0.006	0.723	0.001	0.375	0.006	0.855	0.0007
PLSR+ GA	134	Auto scale	0.006	0.782	0.007	0.649	0.006	0.938	0.0007
PLSR+ GA	134	Mean centred	0.006	0.732	0.010	0.424	0.01	0.796	0.0001
ANN	744	Auto scale	0.007	0.744	0.013	0.150	0.007	0.722	0.0005
ANN	744	Mean centred	0.004	0.902	0.011	0.299	0.007	0.724	0.0001
Positive mode									
PLSR	475	Auto scale	0.001	0.928	0.009	0.490	0.008	0.650	0.003
PLSR	475	Mean centred	0.007	0.731	0.009	0.479	0.010	0.484	0.0007
PLSR+ GA	131	Auto scale	0.003	0.985	0.005	0.877	0.003	0.901	0.0007
PLSR+ GA	131	Mean centred	0.011	0.266	0.011	0.103	0.011	0.319	0.0005
ANN	475	Auto scale	0.0005	0.998	0.008	0.580	0.009	0.540	0.001
ANN	475	Mean centred	0.005	0.831	0.009	0.532	0.009	0.529	0.001

R^2 ; coefficient of determination

Discussion. A hybrid modelling approach provided the greatest calibration fit and subsequent cross validation and independent prediction performance compared to conventional and machine learning algorithms alone. This study provides proof of concept that robust prediction models can be made using LCMS data to facilitate rapid screening of large numbers of pasture samples without dependence on resource intensive *in vitro* assays thereby supporting the development of low-methanogenic forage systems.

References

Gerber PJ *et al* (2013). *Food and Agriculture Organization of the United Nations*

The effect of maternal bromoform supplementation during late gestation and early lactation on progeny performance and microbiome diversity

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Introduction Agricultural emissions of methane (CH₄) account for a total of 36.5 % of global emissions, where 8 % is attributed to enteric CH₄ produced within cow-calf grazing systems (IPCC, 2022). Bromoform inhibits CH₄ production in ruminants; however, there is a lack of understanding of its use in breeding herds, considering both the dam and progeny. Supplementation with bromoform results in significant shifts in the microbiome (Krizsan et al 2023). This is critical to consider in breeding herds, as the faecal microbiota of neonatal calves is substantially composed of oral and vaginal microbiota of dam origin; hence, the maternal microbiome influences the establishment of the progeny microbiome. The intestinal microbiota has an important effect on the immune system, nutritional status and metabolism; therefore, changes that occur early in life impact long term health, performance and wellbeing. This study assessed the growth and faecal microbiota of calves provenient from cows fed bromoform during late gestation and early lactation.

Materials and Methods Twenty-one days prior to calving, 80 late gestation Angus cows were grouped into two treatment groups (Control – CON; n=40, and bromoform – BRO; n=40) based on body weight (BW; 749±13.1 kg) and year of birth (2017±0.51 years). Once per day, both treatment groups were supplemented with a homogeneous mixture of concentrate (250 g/head), a mineral and multivitamin mix (50 g/head) and canola oil (75 mL/head), with or without (CON) the inclusion of bromoform (0.69 mg of bromoform/kg of BW/day; BRO) until 21 days post calving. A subset of calves (n = 20/treatment group) was selected (when parturition was observed), and their body weights were collected at three timepoints (birth, seven, and 21-days post-birth). Faeces were collected from the calves at seven days post-calving for metagenomic sequencing. Calf BW was analysed in R, where treatment (T; bromoform vs control) and timepoint (TP; birth vs 7 days vs 21 Days) and their interaction (T x TP) were fitted fixed effects. A probability of P < 0.05 was considered significant and the calves were the experimental unit. Differences in Beta diversity among groups was evaluated using PERMANOVA based on Bray-Curtis dissimilarities.

Results There was no interaction between time point and treatment for the body weight of the progeny (P = 0.983; Figure 1A). There was also no effect of treatment on progeny body weights over the entire study duration (P = 0.494). Additionally, no difference was observed in the diversity of archaea in the faecal matter of the progeny at seven days.

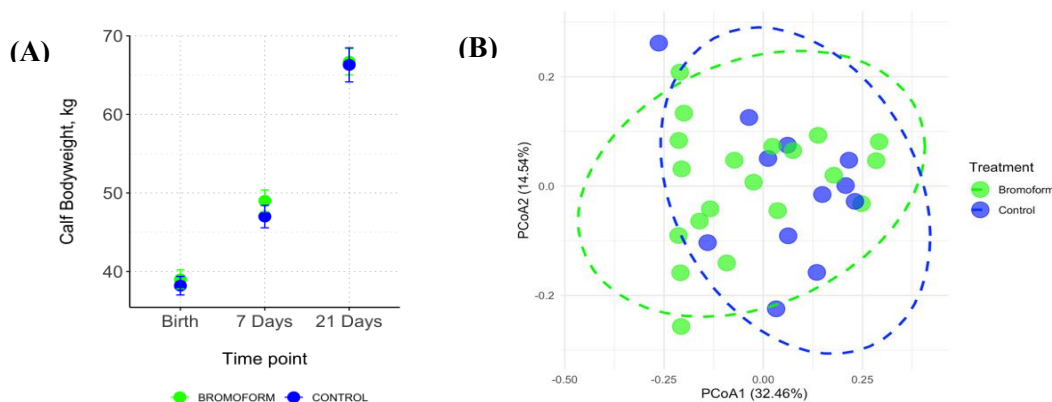


Figure 1. (A) Interaction between timepoint and treatment and the effect on calf bodyweight (P=0.983). (B) Beta diversity by principal coordinates analysis (PCoA) of Bray-Curtis dissimilarities of archaeal communities in rectal faeces of calves at seven days of age, and dashed lines indicate 95% confidence intervals.

Discussion Maternal supplementation of bromoform extract oil during late gestation and early lactation did not impact progeny body weight, nor did it significantly change the diversity of archaea in the gastrointestinal tract of the progeny. This data suggests that bromoform can be used in extensive breeding systems to mitigate methane without having any negative impacts on progeny performance until 21 days post birth. Further studies are warranted that evaluate a longer supplementation period, alternate doses of bromoform and further measurement points on both the cow-calf pair to ensure safety before large-scale adoption in breeding herds.

References

IPCC (2022) *Climate Change 2022: Impacts, Adaptation and Vulnerability*. DOI <https://www.ipcc.ch/report/ar6/wg2/>
 Krizsan SJ et al. (2023) *Frontiers in Animal Science*. 4: 1112969. DOI <https://doi.org/10.3389/fanim.2023.1112969>

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Early risk prediction of sheep facial eczema using computer vision: a feasibility study

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Introduction Facial Eczema (FE) is an endemic disease caused by sporidesmin, a toxin produced by a fungus that grows on the leaf litter at the base of the pasture sward. It occurs predominantly in New Zealand, but also occurs in Australia, South Africa, and Europe. Facial eczema can reduce lifetime productivity by up to 25 percent, causing significant economic losses and animal welfare concerns (Menna et al. 2009). FE induces liver damage that can manifest as subtle changes in animal facial characteristics and behavioural patterns, which are difficult to detect with the naked eye in the early stages. Gamma glutamyl transferase (GGT) levels are used to measure the severity of liver damage caused by FE, with a level greater than 70 IU/L indicating liver damage. This paper applies deep learning models to explore the correlation between early liver damage caused by FE (indicated by elevated GGT) and red, green and blue (RGB) / infrared thermography (IRT) facial images (Figure 1).

Materials and methods Data were collected on 104 sheep across 3 different farms by Beef + Lamb New Zealand as part of an epidemiological study, which comprises 293 red, green and blue (RGB) images, 205 infrared thermography (IRT) images, and GGT results. All images were manually annotated with facial regions to exclude non-feature regions. Several data augmentation techniques were employed, including rotation, horizontal flipping, noise injection, and Mosaic.

ResNet-18 (He et al. 2016) was used as the feature extractor and implemented with PyTorch. Feature-level fusion was also explored to integrate the features from RGB and IRT images. After randomly partitioning the dataset into training and testing sets with a ratio of 80:20, all models were trained using the stochastic gradient descent optimizer with a learning rate of 0.001 and batch size of 32 for 100 epochs on an A6000 Ada GPU. All experiments were repeated five times to calculate the mean and standard deviation of the performance metrics (e.g., accuracy and F-score).

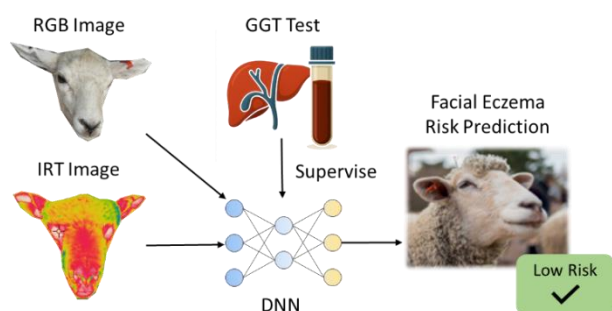


Figure 1. The proposed system pipeline

Results Prediction using RGB images showed a weak correlation with GGT levels ($0.1 \pm 5.6\%$). Binary classification was defined using a GGT threshold (>53 IU/L classified as high-risk; otherwise low-risk), ensuring a balanced number of positive and negative samples. The RGB-only model achieved an accuracy of $62.9 \pm 5.3\%$ and an F1-score of $74.5 \pm 4.7\%$, while the IRT-only model yielded an accuracy of $55.4 \pm 4.9\%$ and an F1-score of $67.3 \pm 5.9\%$. The combined RGB-IRT model showed intermediate performance with an accuracy of $61.6 \pm 2.7\%$ and an F1-score of $75.1 \pm 0.7\%$.

Discussion This feasibility study concluded with two primary findings. First, the regression model for predicting GGT levels from image data shows low correlation, primarily due to the confounding effects of individual metabolism and other diseases that affect facial features. Second, binary classification for FE risk prediction yielded encouraging results. The RGB-only model achieved promising performance with an F1-score of 74.5%. However, incorporating IRT images reduced the accuracy of the combined model, suggesting an increased risk of overfitting, likely due to the limited number of available IRT images. These findings suggest that while non-invasive RGB facial image analysis may hold promise for early FE risk prediction, additional data are needed to validate this hypothesis. Although current models cannot predict exact GGT values, they may be capturing subtle patterns indicative of a physiological state that crosses a clinically significant threshold. These preliminary results suggest that practical applications remain some way off. Future work will focus on three key directions: 1) expanding the dataset by collecting more images; 2) incorporating more robust biomarkers for FE, such as qPCR assays for fungal spores; and 3) adopting a wider array of FE-related behavioral features, including water intake and photophobia (light-avoidance). Additionally, we propose to measure the concentration of sporidesmin in the pasture. Ultimately, we aim to develop a comprehensive multimodal animal health monitoring system for modern farms which can integrate environmental risk factors with animal behavior and physiological responses to improve production.

References

- Menna M et al. (2009) *New Zealand Journal of Agricultural Research* **52**: 345–376. doi:10.1080/00288230909510519
 He K et al. (2016) *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*: 770–778. doi:10.1109/CVPR.2016.90

We gratefully acknowledge Beef + Lamb New Zealand Limited and Ministry for Primary Industries under the Sustainable Food and Fibre Futures programme “Eliminating Facial Eczema impacts” (SFFF 21153) for funding this work and providing access to the data.

PROGRAM

MONDAY 13 th July 2026			
1200	Registration		
1300 - 1630	EMCR Workshop: Tanya Perry - The Network Effect: Turning Conversations into Career Moves Workshop Partner: MLA		Hindley 3 Workshop Sponsor: Drought Hub
1700 - 1730	Happy hour		Partnered by MLA
1730 - 1815	Welcome and Opening Panel – Breakthroughs that matter- The cross-species science briefing. Facilitated by Matt Bekker Panel: Beef: Dr Penny Shulz; Dairy: Dr Jo Newton; Swine: Dr Lauren Staveley; Ovine: Dr Shawn McGrath; Equine (companion/performance): Dr Sam Franklin; Poultry: Dr Kapil Chousalkar		
1815 - 1900	Drinks and Canapes		
TUESDAY 14 th July 2026			
0730	Registration		
0830 - 1030	Plenary 1 Session Chairs: Mariana Caetano & Kapil Chousalkar		Hindley 1 & 2 Session Sponsor: Adelaide University
0830 - 0900	Conference Welcome		
0900 - 0945	Keynote 1 Underwood lecture: Prof Ermias Kebreab - Innovative Pathways to Low-Emission Livestock		
0945 - 1030	Keynote 2: Prof Sonia Liu - Precision Nutrition in Poultry Production: Challenges and Successes		
1030 - 1100	Morning Tea		
1100 - 1230	Room: Hindley 1 Stream: Methane Abatement 1 Session Chair: Renata Tognelli & Charlotte Adam	Room: Hindley 2 Stream: Nutrition 1 Session Chair: Mena Farazi & Tom Keogh	Room: Hindley 3 Stream: Health Session Chair: Kiro Petrovski & Elena Dehnavi
1100	47 The effect of bromoform supplementation on microbial communities of pregnant beef cattle Yohannes Messele	106 Efficacy of single and combined bacillus probiotic supplementation in broiler diets Lynette Hilly	149 Producer perspectives on buffalo fly management: Insights from an Australian survey Kathryn Dawson
1110	53 Evaluation of gross, histopathological, and residues in tissues of grassfed Angus steers supplemented bromoform and a phytogenic compound at finishing Samuel Warrick	16 Supplementation of Rhodes grass hay with whole cottonseed improves average daily gain of Brahman cross steers in tropical Western Australia James Dougherty	265 Bloat Alert: What did we learn from making this app available to Australian producers for four years? Shawn McGrath
1120	198 Methane inhibition alters carbon isotope ratios of wool in Merino sheep Cesca McInerney	110 Bagasse as a prebiotic for bacillus probiotics Lynette Hilly	31 Correlations between IgG and immune-related miRNAs in colostrum and calf blood Hue Do
1130	418 Commercial-scale evaluation of a low-methane ration for reducing enteric methane emissions in sheep Imelda Soriano	257 Multi-omics analysis of milk and plasma reveals differences in dairy goats divergent for feed efficiency Jayde Kirkham	277 Supplementation with a specific yeast cell wall limits intestinal damage during a coccidiosis challenge Alison Leary
1140	213 Medicago spp. reduce methane when measured in vitro using abattoir derived ovine rumen fluid Alyce Lowe	175 Effect of silage additives on chemical composition, fermentation, and aerobic stability of whole-crop maize silage under tropical conditions Nadar Khan	194 Effects of maternal gastrointestinal parasitism on growth of goat kids Morteza Moradi
1150	223 Synergistic effects of pyromellitic diimide, rhubarb, fumarate, and monensin on	87 Nutritional modulators of bone strength in Broilers: Evaluating Moringa oleifera, a probiotic, and	393 Effect of CLOSTAT 500 (Bacillus subtilis PB6) on performance, carcass characteristics, and health

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	methane reduction and hydrogen utilization in sheep fed lucerne pellets <i>Fran Cowley</i>	organic acid as antibiotic growth promoter alternatives <i>Xola Nduku</i>	of Australian feedlot cattle <i>Juliana Leite de Campos</i>
1200	327 Gross and histopathological observations of the rumen after brominated compounds fed to sheep for 60 days <i>Stephanie Payne</i>		202 Genetic parameters for saliva antibody tests against internal parasites in Merino sheep <i>Sarah Preston</i>
1210	199 Annual methane emissions profile for sheep grazing pasture in southern Western Australia <i>Umar Khan</i>		
1220 - 1330	Lunch Sponsored by: Beachport Liquid Minerals		
1330 - 1415	Plenary 2 Hindley 1 & 2 Session Chair: Alan Humphries		
1330 - 1415	Keynote 3 Harry Stobbs Memorial Lecture: Dr Elizabeth Boughton - In Search of Greener Pastures: Insights on Water, Carbon, and Biodiversity Pathways from Subtropical Beef Systems		
1415 - 1500	Science Snapshot Session 1 Session Chairs: Melindee Hastie & Leesa-Joy Dunstan		
1415	Introduction		
1420	207 Comparison of different diagnostic methods for the surveillance of <i>Haemonchus contortus</i> infections in sheep <i>Rebecca Farnell</i>		
1424	208 The effect of wind on sheep behaviour in arid Australia <i>Samantha Connor</i>		
1428	The effect of SeaFeed Sustain™ as a stabilised carrier for the abatement of methane in livestock production <i>Ruby Frick</i>		
1432	314 Effect of milk powder formulations on goat kid's diarrhea <i>Kimberley Capdevila Ospina</i>		
1436	244 The effects of incubating multispecies pasture with increasing doses of sugarcane extract (<i>Saccharum officinarum</i>) on in vitro methane production <i>Monique Berkhout</i>		
1440	246 The effect of maternal bromoform supplementation during late gestation and early lactation on progeny performance and microbiome diversity <i>Kellie Wenham</i>		
1444	249 Metabolomic profile of heat tolerant Droughtmaster cows <i>Pippa Pryor</i>		
1448	268 Understanding reproductive management in northern Australian beef cattle: A study of practices <i>Sampath Dissanayake</i>		
1452	153 Using LCMS-derived chemical data to predict the methane mitigation potential of temperate pasture species and species combinations <i>Dilini Weerathunga</i>		
1456	590 Virtual fencing in the rangeland cow-calf system: the efficacy and welfare implications of virtual fencing in a Northern Australian beef production system <i>Hannah Cummings</i>		
1500 - 1530	Afternoon Tea Sponsored by ZNE Ag CRC		
1530 - 1700	Science Snapshot Session 2 Session Chairs: Sarah Meale & Fazel Almasi		
1530	Introduction		
1535	28 Effects of dietary ammonium chloride in late gestation on sow reproductive performance in spring and summer <i>Thien Van</i>		
1539	92 The use of a mask system to collect exhaled breath for methane measurements in sheep <i>Tianna Boyce</i>		
1543	116 Prevalence and implications of sub-acute ruminal acidosis in dairy cows in Malaysia <i>Abdirahman Barre</i>		

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1547	121 Periparturient mortality in six Merino flocks in western Victoria <i>Bea Kirk</i>
1551	283 Early insights into the role of virtual fencing in supporting drought resilience in South Australian beef systems <i>Bianca Agenbag</i>
1555	129 Influence of maize genotypes and harvest maturity on fermentation quality and nutritional value of whole-crop maize silage under tropical conditions <i>Nadar Khan</i>
1559	132 PregoPaws: investigating detection dogs for cattle pregnancy diagnosis <i>Ella Watkins</i>
1603	197 Bromoform concentrations in milk of dairy cows when fed bromoform-based products twice daily <i>Aodan o Neachtain</i>
1607	243 Modulation of methane emissions, and rumen microbiome on dairy cows through dietary supplementation of <i>Lactobacillus spp</i> <i>Sreemol Suthan Nair</i>
1611	140 Untargeted metabolomic profiling of plasma revealed parity-driven metabolic changes in Holstein-Friesian dairy cows <i>Naseema Kolathingal-Thodika</i>
1615 - 1620	Stretch Break
	Session Chairs: Michael Rose & Dilini Weerathunga
1620	55 Australian Wool Education Trust assists students to connect to the sheep industry <i>Jordan Norman</i>
1624	272 A maize-rich diet mitigates heat stress in pen-fed lambs but reduces marbling <i>Nani Gopal Das</i>
1628	156 Individual wet corn gluten feed components in high forage rations fed to Holstein steers contribute to changes in nutrient digestibility <i>Ludmila de Souza Monteiro</i>
1632	157 Development of an in vitro culture model of mammary epithelial cells isolated from goat milk for lab-grown milk production <i>Sapon Semsirmboon</i>
1636	163 Evaluating the efficiency of anthelmintics in grazing beef cattle in one property in Southern NSW <i>Forough Ataollahi</i>
1640	165 From pen to carcass: predicting untrimmed hot carcass weight using in-pen automated weighing <i>Jack Mayhew</i>
1644	308 Early risk prediction of sheep Facial Eczema using computer vision: A feasibility study <i>Xintao Zhao</i>
1648	178 Milk production responses to sequential stocking rates in hyper-diverse pasture managed under contemporary and regenerative pastoral systems <i>Varthani Susruthan</i>
1652	International Year of Rangelands and Pastoralists (IYRP) Update <i>Beth Penrose</i>
1705 - 1800	AAAS Biennial General Meeting
1800 - 1900	Practical Pathways to Lower livestock Emissions – ZNE Ag CRC Session

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WEDNESDAY 15 th July 2026			
0815 - 1700	Registration open		
0850 - 1030	Plenary 3 Session Chairs: Alice Weaver & Kieren McCosker		Room: Hindley 1 & 2
0850 - 0900	Day 2 Welcome		
0900 - 0945	Keynote 4 McClymont Lecture: Assoc Prof Jimena Laporta - Early-Life Heat Stress: Management Strategies and Multigenerational Consequences		
0945 - 1030	Keynote 5: Prof Mike Steer - The Science Behind South Australia's Harmful Algal Bloom: Understanding Karenia and Its Effects on Marine Life		
1030 - 1100	Morning Tea		Sponsored by: CQU
1100 - 1210	<i>Room: Hindley 1</i> Stream: Climate Change and Heat Stress Session Chair: Amy Bates & Jeremy Cottrell	<i>Room: Hindley 2</i> Stream: Methane Abatement 2 Session Chair: Surinder Chauhan & Apeh Omede	<i>Room: Hindley 3</i> Stream: Reproduction Session Chair: Di Mayberry & Jamee Daly
1100	162 Effect of melatonin on semen quality in Merino rams under summer heat conditions <i>Megan Tschärke</i>	341 Australian government program to reduce methane emissions in livestock <i>P. Naidu Bodapati</i>	204 Ewe lamb joining performance: a case study within the national shedding sheep reproduction project <i>Anne Collins</i>
1110	200 Understanding accumulated heat load and chill to manage animal welfare health and productivity under variable climatic conditions <i>Vicki Mayne</i>	94 Methane yield of dairy cows is correlated with the ratio of methane and carbon dioxide in their breath <i>Richard Williams</i>	44 Oestrous cyclicity in Merino ewes during Spring <i>Alice Weaver</i>
1120	219 Identification and evaluation of pasture legumes adapted to low rainfall environments and climate extremes in southern Australia <i>Alan Humphries</i>	326 Long term supplementation of grazing sheep with an essential oil blend - effects on methane, reproduction, productivity and health <i>Stephanie Payne</i>	107 An economic comparison of fixed-time artificial insemination and natural mate in commercial Angus beef heifers <i>Jena Alexopoulos</i>
1130	80 Assessing climate effects on sheep liveweight using automatic weigh system technology <i>Danica Parnell</i>	288 Water-based delivery of bromoform formulations to mitigate methane in cattle <i>Tshering Gyeltshen</i>	192 Maternal supplementation of dietary guanidinoacetic acid on creatine production in twin-bearing Merino ewes and newborn lambs <i>Billie-Jaye Brougham</i>
1140	241 Evaluation of protein fractionations of two recognised and two novel tropical legumes for the seasonally dry tropics of northern Australia <i>Saranika Talukder</i>	188 The effect of bromoform extract oil combined with a probiotic on greenhouse gas emissions in Angus weaners <i>Kellie Wenham</i>	345 Nutrient restriction effects on ovulatory follicle and corpus luteum development and progesterone production of Bos taurus cows <i>Vitor Mercadante</i>
1150	172 Association between sheep activity and heat-load related parameters <i>Hamideh Keshavarzi</i>	254 Methane mitigation of beef steers via a molasses lick block containing an anti-methanogenic compound <i>Bridgette Logan</i>	224 Maternal diet during mid-late gestation programs the serotonergic system in the progeny of triplet-bearing ewes <i>Sue McCoard</i>
1200	398 Identifying leverage points for building resilient animal-source food systems in Southern Africa through systems mapping <i>Nobuhle Lungu</i>	151 Annual methane emissions profile for Angus cows grazing the South-West coastal pastures of Western Australia <i>Darren de Vos</i>	332 Anticlostridial antibody responses of twin Merino lambs after L-glutamine supplementation <i>Leesa Dunstan</i>
1210 - 1310	Lunch APL		Sponsored by:

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1310 - 1340	Poster Session		
	Can forage conservation be used as a method to lower methane emissions on farms. <i>Kristy Bailes</i> Effects of de-fatted Pongamia (<i>Millettia pinnata</i>) seed cake on intake and digestibility in cattle. <i>Mingbo Ni</i> Functional Anti-Allergic Pet Yogurt Enriched with Fermented Herbal Extracts. <i>Sungkwon Park</i> Rumen Microbiome Composition in Ewes Supplemented with SeaFeed™ Pellets and Rumen Modifiers. <i>Ibrahim Ahmad</i> Validation and Commercialization of an Eggshell Powder-Based Composite Feed Additive for Improving Growth and Robustness in Pre-Weaning Hanwoo Calves. <i>Sungkwon Park</i>		
1340 - 1500	Room: Hindley 1 Stream: AgTech Session Chair: James Dougherty & Steph Sammes	Room: Hindley 2 Stream: Nutrition 2 Session Chair: Saranika Talukder & James Drouillard	Room: Hindley 3 Stream: Production 1 Session Chair: Shawn McGrath & Don Nguyen
1340	35 Exclusion of sheep from an environmentally sensitive area using an automated virtual fencing device <i>Megan Willis</i>	214 Breeding pasture legumes for improved livestock health and welfare <i>David Peck</i>	211 Nitrogen isotopes in tail hair reveal differences in calf survival and cow liveweight production <i>Luis Prada e Silva</i>
1350	41 Vegetation classification through clustering of drone imagery to investigate livestock-pasture interactions <i>Sabine Schmoelzl</i>	212 Optimising grain mixes to balance herd nutrient intake when dairy cows have access to differential access time to pasture <i>Meaghan Douglas</i>	397 Adaptive growth responses of indigenous goats to water restriction <i>Oluwakamisi Akinmoladun</i>
1400	388 Data-driven benchmarking of paddock productivity in Australian beef systems <i>Faysal Hasan</i>	102 Comparison of extraction techniques of ruminal fluid: impact on pH, protozoa, ammonia-N and volatile fatty acid profiles of dairy cows <i>Charlotte Adam</i>	51 Influence of body weight at calving on subsequent milk production of dairy heifers <i>Nur Nazratul Fareha Mohd Yasid</i>
1410	191 Preliminary results on walk over weighing system usage and its effect on feedlot cattle performance <i>Madison Luke</i>	263 Pre-calving nutrition improves calf growth in northern beef herds <i>Luis Prada e Silva</i>	262 A network of mixed farming long-term experiments in Southern Australia <i>Danica Parnell</i>
1420	237 The On Animal Tracking System (OATS): an affordable open-source, wireless telemetry system <i>Glen Charlton</i>	307 Backgrounding cattle reveal potential for sorghum utilization in confinement feeding systems <i>Tatiana Jones</i>	324 Factors influencing sale of village chickens in resource-limited communities in South Africa <i>Marizvikuru Mwale-Manjoro</i>
1430	297 Customising pasture and animal productivity forecasts using on-farm data and machine learning <i>Tom Keogh</i>	508 Growth rate drives intramuscular fat deposition in lambs <i>Hussein Al-Moadhen</i>	342 Optimum productive life in pasture-based and intensive dairy systems <i>Joanna Newton</i>
1440	260 Can Global Navigation Satellite System (GNSS) data alone distinguish between cattle behaviours? <i>Gamaliel Simanungkalit</i>		309 Production of composite lambs under mixed farming systems in Southern New South Wales <i>Jessica May Wyse</i>
1450 - 1530	Afternoon Tea		
1530 - 1700	Plenary 4		
	Session Chairs: Steve Larkin & Sean Miller		
1530 - 1615	Keynote 6: Dr Peter Crisp - Mini Livestock: Uses, Challenges and Opportunities		
1615 - 1700	Keynote 7: Dr Penny Schulz - Adoption Session		
1830 - 2230	Conference Dinner		
	National Wine Centre		

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THURSDAY 16 th July 2026			
0815 – 1700	Registration open		
0850 - 1030	Plenary 5 Session Chair: Charlie Rikard-Bell		Room: Hindley 1 & 2
0850 - 0900	Day 3 Welcome		
0900 - 0945	Keynote 8 Barnett Lecture: Dr Lauren Hemsworth - Animal Behaviour and Welfare Assessment		
0945 - 1030	Keynote 9: Dr Joel Alves - How Rabbits Invaded the World, and What We Can Learn from It		
1030 - 1100	Morning Tea		Sponsored by APRIL
1100 - 1230	<i>Room: Hindley 1</i> Stream: Behaviour and Wellbeing Session Chair: Megan Willis & Joanna Newton	<i>Room: Hindley 2</i> Stream: Methane Abatement 3 Session Chair: Joe Jacobs & Kellie Wenham	<i>Room: Hindley 3</i> Stream: Production 2 Session Chair: Luis Prada e Silva & Hue Do
1100	303 Sheep remember a spatial maze one year after initial testing <i>Jessica Monk</i>	112 Faecal NIRS to predict methane yield of cattle offered diverse subtropical forages <i>Hayley Norman</i>	245 Preliminary study on the effect of breeding objectives on muscle fibre characteristics and meat quality <i>Huiling Huang</i>
1110	123 Non-steroidal anti-inflammatory drug use in ewes undergoing laparoscopic artificial insemination a literature review <i>Danila Marini</i>	226 A techno-economic assessment of the potential to reduce enteric methane from Australian livestock systems <i>Dianne Mayberry</i>	270 Dual energy x-ray absorptiometry data can predict commercial cut weight with good precision <i>Farrah Preston</i>
1120	269 The effect of season on the behaviour of sheep around a natural waterway <i>Rene Corner-Thomas</i>	279 Water delivery and efficacy of antimethanogenic additives in grazing sheep in South Australia <i>Alyce Lowe</i>	280 Do cooking methods influence sensory properties of premium beef cuts? <i>Don Nguyen</i>
1130	305 Repeatability of flight time and its relationship with growth in goats during an animal house trial <i>Jessica Monk</i>	284 The importance of defining methane phenotypes and time windows using Arcoflex sensors in dairy cows <i>Fazel Almasi</i>	292 Carcass characteristics and meat quality of Australian goat breeds and their crosses <i>Don Nguyen</i>
1140	189 Investigating the impacts of stocking density on sheep welfare, from controlled conditions to commercial reality <i>Amy Tait</i>	313 Assessment of methane reduction efficacy of 3-NOP delivered to cattle through drinking water <i>Gonzalo Martinez-Fernandez</i>	296 Contactless ML-Enabled Microwave Sensing for Grass Seed Detection in Sheep <i>Amus Goay</i>
1150	125 Can early-life enrichment shape the learning ability of sheep <i>Danila Marini</i>	344 Efficacy of tribromomethane rumen boluses on methane emissions in beef steers <i>Katerina Stasinopoulou</i>	333 The influence of secondary Improvac vaccination timing on pork quality <i>Melindee Hastie</i>
1200	186 Comparing single-trait and multi-trait analyses incorporating breech and body strike records to improve flystrike prediction accuracy in Australian Merino sheep <i>Elena Dehnavi</i>	231 Towards low-emission grazing systems: preliminary methanogenic potential screening of northern Australia forage plants <i>Sophia Escobar-Correas</i>	195 Producer perspectives on goat pain management <i>Kathryn Dawson</i>
1210	364 Brushing for enrichment: Implementing cattle brushes in a commercial feedlot <i>Hannah Cummings</i>	252 Nutritional and anti-methanogenic potential of edible shrubs from central NSW <i>Richard Meyer</i>	240 Shedding scores and liveweights across lifetime for Wiltshire cross ewes <i>Paul Kenyon</i>
1220	26 Reimagining herd grouping through a data-driven, multivariate cow profiling approach <i>Duranga Senanayake</i>	43 Effect of Antimethanogenic additive (3 NOP: Bovaer®) feed frequency on methane emission reduction in Merino grazing ewes in South Australia <i>Jamee Daly</i>	181 BREEDPLAN 200 day weight and milk EBV's predict weaning weight differences in Brahman <i>Kim Hubbard</i>

APPENDIX 1: 36th Australian Association of Animal Sciences Conference Program

1230 - 1330		Lunch		Sponsored by: Elanco			
1330 - 1430		<i>Room: Hindley 1</i> Stream: Methane Abatement 4 Session Chair: Monique Berkhout & Leah Marett		<i>Room: Hindley 3</i> Stream: Adoption and capacity building Session Chair: Bereket Zeleke Tunkala & Bianca Agenbag			
1330	253 Assessing the effect of feeding Asparagopsis-based feed additives on bromoform, dibromomethane and bromomethane residues in milk during a whole lactation <i>Renata Tognelli</i>	183 Using Merino Flock Profiling to increase the adoption of ASBVs as a breeding decision tool for commercial Merino producers <i>Anne Collins</i>					
1340	255 Engaging key producer influencers to influence change in knowledge, skills and attitudes to reducing emissions in agriculture <i>Emma McInerney</i>	234 Feedlot TECH: Livestock Health Fundamentals eLearning Course <i>Emily Litzow</i>					
1350	256 Enteric methane emissions from Wagyu heifers fed a grower and finisher diet with varying doses of 3-nitrooxypropanol <i>David Innes</i>	298 Undergraduate and Post-graduate elective livestock consultancy course at Adelaide University <i>Kiro Petrovski</i>					
1400	274 Effect of bromoform and phytogenic compound on growth performance and greenhouse gas emissions of grassfed Angus steers during the finishing phase <i>Yohannes Messele</i>	158 Student compendium internships build students skills, confidence, network and brand <i>Emily Steer</i>					
1410	347 Performance of Nellore cattle receiving a bromoform-based additive during the feedlot finishing phase <i>Luiz Oliveira</i>	250 Bridging the academic-industry divide: initial findings of the AAAS ECN mentor program <i>Pippa Pryor</i>					
1420	138 Geometric dose-response of Lactobacillus spp. on milk yield and enteric methane emissions in late-lactation dairy cows <i>Sreemol Suthan Nair</i>	Beyond the Feed: Creating value and community through social media <i>Jo Newton</i>					
1430 - 1500		Afternoon Tea				Sponsored by: Number 8 bio	
1500 - 1700		Plenary 6 Session Chair: Sam Franklin & Danila Marini					
1500 - 1545		Keynote 10: Prof Chris Whitton - The use of speed and stride data in racehorses to assess limb injury risk					
1545 - 1630		Keynote 11: Assoc Prof Alexandra Whittaker - From Leash to Legislation: Shaping Sustainable Policy for Companion Animal Welfare in a Tech-Driven World					
1630 - 1700		Conference Close and announcement of the next AAAS Conference for 2028					

FRIDAY 17th July 2026

0800 - 1500	Field Trip in SA
0800 - 1500	Monarto Zoo



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Species	Chickens
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Administration Period	7 consecutive days

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1. Rodriguez-Gonzalez E et al. Anthelmintic Benzimidazoles in Eggs. Chapter 44 in Egg Innovations and Strategies for Improvements (ed. P. Hester), Elsevier, 2017. 2. Lacey E. et al. The role of the cytoskeletal protein, tubulin, in the mode of action and mechanism of drug resistance to benzimidazoles. Int J Parasit. 18 (7):885-936. 1988. 3. Chassaing C. et al. Highly Water-Soluble Prodrugs of Anthelmintic Benzimidazole Carbamates: Synthesis, Pharmacodynamics, and Pharmacokinetics. J Med Chem. 52:1111-1114. 2008. 4. Committee for Medicinal Products for Veterinary Use. Flubendazole (extrapolation to poultry). Summary Report (4). European Medicines Agency. July 2006. 5. Froyman R. & De Keyser H. Flubendazole: safety regarding egg production and reproductive performance of breeder chickens. Av Dis 27:1 (43-48). 1983. Flubenol™ oral wormer for pigs and chickens contains 50 mg/g flubendazole. Flubenol™, Elanco and the diagonal bar logo are trademarks of Elanco or its affiliates. ©2025 Elanco or its affiliates. PM-AU-23-0030.



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