

ANIMAL PRODUCTION IN AUSTRALIA

Proceedings of the Australian Association of Animal Sciences

Volume 33

The new face of animal science in Australia

33rd Biennial Conference

Guest Editors: David Pethick, Graeme Martin, Hayley Norman, Robin Jacob

Esplanade Hotel, Fremantle, Western Australia, and online
1–3 February 2021

© CSIRO 2021

ISSN 1836-0939

eISSN 1836-5787

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, electrostatic, magnetic tape, mechanical, photocopying, recording, or otherwise, without permission in writing from the Australian Society of Animal Production and CSIRO Publishing.

Refereeing of Papers

The papers in this volume have been refereed to the journal standards. The material is subject to copyright and may not be presented elsewhere.

The criteria for acceptance of papers are that the material is of interest to members and industry, has some innovation aspect, is sound, advances scientific knowledge or its application in any field of animal science or animal production, and is presented in a form consistent with instructions to authors. It is also expected that one of the authors of a paper would be present at the conference to present the material as an oral or poster presentation.

Ethical Clearance

It is incumbent upon the authors, where necessary, to have had experiments approved by a relevant animal ethics committee.

Authenticity

The Journal assumes that the authors of a multi-authored paper agree to its submission. The Journal has used its best endeavours to ensure that work published is that of the named authors except where acknowledged and, through its reviewing procedures, that any published results and conclusions are consistent with the primary data. It takes no responsibility for fraud or inaccuracy on the part of the contributors. For submitted manuscripts, unpublished data and personal communications the Journal assumes that the authors have obtained permission from the data owner to quote his or her unpublished work.

Citation of Papers

These papers were presented at the 33rd biennial conference of the Australian Association of Animal Sciences (AAAS) held at the Esplanade Hotel, Fremantle, Western Australia (1–3 February 2021).

Invited papers are published in a special issue of Volume 61 of *Animal Production Science*. The one-page papers are published online only as an accessory publication to the special issue of the Proceedings of the 33rd Biennial Conference of the Australian Association of Animal Sciences.

Papers should be cited as:

Animal Production Science **61** (followed by the page numbers).

or in the abbreviated form:

Anim. Prod. Sci. **61** (followed by the page numbers).

From ASAP to AAAS, the new face of animal science in Australia

The Australian Society of Animal Production (ASAP)

A society dedicated to Animal Production in Australia was first discussed in 1946. However, it was not until 14 December 1950 that a meeting was convened in New South Wales to discuss the formation of the Society. The meeting followed the distribution of a circular letter to several scientists and others penned by Professor Pat McMahon, Miss Helen Newton Turner and Mr Bob Hayman (Franklin 1956). The 22 attendees at the initial meeting resolved to establish the Australian Society of Animal Production and formed a steering committee to draft a constitution and consult with interested parties in other states.

Active branches were soon established in New South Wales, Victoria and Queensland. In May 1951, the nature, aims, scope of the Society and the draft constitution were discussed by representatives of all states at the 28th Meeting of the Australian and New Zealand Association for the Advancement of Science.

Further drafts were made of the constitution and a South Australian branch was established in 1953. Final agreement on the constitution was reached during the 30th Meeting of the Australian and New Zealand Association for the Advancement of Science in January 1954, the first Federal Council elected, and the Australian Society of Animal Production was launched. The principal aim of the Society was 'To promote the advancement and further the interests of Animal Production in Australia'.

The first biennial ASAP conference was held at Armidale in 1956. The conference program included presentations on sheep production (mineral deficiencies, wool growth efficiency, reproductive performance), beef cattle production (mineral deficiencies, carcass appraisal), ruminant nutrition, pasture research and improvement, genetics and breeding (ewe culling criteria, variation between Merino strains, evaluation and selection of beef cattle, poultry nucleus breeding systems), fodder conservation and droughts. The inaugural ASAP President, M. C. ('Frankie') Franklin, stated that the diverse membership of ASAP was reflected by the disciplines of the authors who submitted papers. These ranged from scientists working in agricultural science, veterinary science, architecture, animal husbandry, pure science (chemistry) with contributions from agricultural colleges, stock food manufacturers and primary producers.

By 1958 the ASAP membership had grown to more than 500. The second ASAP President, David Wishart, attributed the increase to the common interest of the Society's members in the application of science to animal production and variation due to the range of aspects to which ASAP members viewed the subject (Wishart 1958). He went on to highlight:

- the need to feed and clothe the rapidly increasing world population;
- the importance of animal products to meet this need;
- the opportunity to increase the efficiency of animal production in developed areas of Australia and expand animal production in undeveloped areas of the country; and
- the value of considering the soil–plant–animal relationship to enable efficient and economical output of animal production from the national pasture and crop production.

The importance of a systems approach to animal production research was also highlighted by Tom Ewer, the Society's 3rd President, in 1960, who said ASAP members had a 'duty to the Society and colleagues of farmers and graziers of trying to 'see things in the round' (Ewer 1960). ASAP membership continued to grow, approaching 900 members by 1962. Hector Lee, the 4th ASAP President, noted that most members belonged to specialist discipline groups and encouraged the Society to become the common ground on which members may meet in order to come to appreciate the wider view articulated by Professor Ewer (Lee 1962).

The Society continued to flourish from these early beginnings with the importance of animal production to feed and clothe the global population, a systems approach to animal production research and of ASAP's role in facilitating the coming together of specialist disciplines as a common theme for the next 20 years. During this time, ASAP was the premier forum aimed at all production species and all disciplines. The biennial conference, which moved between different states, together activities at a state or branch level brought together those with a stake in animal production at all levels. A key feature of these activities was the involvement of producers, which helped to ensure that research and development in animal production research was focused towards on-farm application (Hynd 2018).

The Australian Association of Animal Sciences (AAAS), the reinvention of ASAP

The animal production research landscape has undergone significant change since the mid-to-late 1970s. Until then, there had been significant growth in applied research and development occurring in state departments of primary industries with a peak in research and extension funding (Bell 2020). However, this period was followed by decades of uncertainty and organisational change that, combined with the impact of market forces and changing public attitudes towards livestock production and consumption of animal products (Mayberry *et al.* 2021), reduced political enthusiasm for public funding of RD & E to support animal production in Australia (Bell 2020). Agricultural research is now increasingly seen as a private rather than public good; state governments are conducting less applied research for livestock industries (National Committee for Agriculture Fisheries and Food 2017), with reductions in their extension capacity and capability.

During the same period, there was a dramatic rise in new technologies, particularly molecular biology and computing power (Bell 2020). These contributed to a shift in scientific emphasis towards the development of molecular solutions to animal production problems, which directed funding away from broader, systems-based disciplines (Hynd 2018). There has also been an evolution in the tertiary training of animal scientists with a move away from generic agricultural science degrees, with a livestock major, to specific animal science degrees with a broader focus encompassing traditional livestock species, horses, companion animals and wild fauna (Mayberry *et al.* 2021).

In 2018, the ASAP President, Phil Hynd, discussed the changing landscape of animal production research and its impact on the relevance of ASAP to its members and suggested that it was time to reinvent ASAP to:

- focus on all production animal species to ensure idea and technology swapping;
- focus on application of real-world animal production systems and value chains;
- focus on young people in animal production in all sectors of the industry; and
- provide better value for members.

The ASAP Federal Council convened a strategy meeting later in 2018 to invigorate the Society based on broader engagement across the animal sciences and the Australian Association of Animal Sciences (AAAS) was born. The Council commissioned a Business Plan and to reinvigorate the Association based on the core values of:

- professional integrity;
- evidence-based science;
- ethical sustainable animal enterprises; and
- lifetime support.

Dr Sue Hatcher

AAAS PO Box 8358, Orange East, NSW 2800, Australia

References

- Bell AW (2020) Animal science Down Under: a history of research, development and extension in support of Australia's livestock industries. *Animal Production Science* **60**, 193–231.
- Ewer TK (1960) Presidential address. The speed of change. *Proceedings of the Australian Society of Animal Production* **3**, 7–16.
- Franklin MC (1956) Presidential address. *Proceedings of the Australian Society of Animal Production* **1**, 7–17.
- Hynd P (2018) Welcome from the Australian Society of Animal Production President. *Animal Production Science* **58**, iii.
- Lee HJ (1962) Presidential address. The common ground. *Proceedings of the Australian Society of Animal Production* **4**, 8–11.
- Mayberry D, Hatcher S, Cowley F (2021) New skills, networks and challenges: the changing face of animal production science in Australia. *Animal Production Science* **61**, 201–207.
- National Committee for Agriculture, Fisheries and Food (2017) Grow. Make. Prosper. The decadal plan for Australian agricultural sciences 2017–2026. Australian Academy of Science, Canberra, ACT, Australia.
- Wishart DS (1958) Presidential address. *Proceedings of the Australian Society of Animal Production* **2**, 5–9.

Welcome to the Animal Production 2021 Conference

The theme for the 33rd conference is ‘The new face of animal science in Australia’ and we welcome you to the new era of the science of Australian animal production.

For the past 64 years the biennial conference of ASAP has brought together animal production scientists, consultants, extension specialists, producers, and students to share information – from fundamental to applied science. The cross-species forum has exposed animal scientists to areas outside of their own discipline, facilitated the sharing of knowledge, fostered collaborative research, and provided applied solutions for Australia’s livestock industries, a tradition that AAAS will strengthen.

AAAS was founded on the key principles of ASAP, but with a focus on meeting the needs of the many animal scientists working across various disciplines and industries in Australia. A key early focus of AAAS is to engage the many students studying animal science programs across Australia to rebuild the membership base and create initiatives that are of value to them and the large number of scientists and professionals working in animal science and the associated industries.

The two years since the 2018 conference have been an incredibly challenging time for Australian animal scientists with environmental challenges such as drought, floods and fires, and a global pandemic impacting food and fibre production, global supply chains and consumer demand. The latter has forced rapid change to the way the way animal scientists work, collaborate and extend their research and development outcomes to end users. Working remotely from home has been the norm in 2020, which increased online meetings and forced novel thinking to enable discussion and sharing of knowledge and research outcomes. It has also demonstrated the capacity of animal scientists to adapt to the ‘new normal’ and develop innovative means to continue the research, development and extension required to provide food and fibre to both the domestic and global populations.

The COVID-19 pandemic forced us to postpone the 33rd Conference for 6 months until February 2021 in the hope that we could convene a face-to-face meeting. However, 2020 has reinforced the value of flexibility and resilience to all and the utility of technology to stay connected. Our move to a ‘hybrid’ format for the conference further connects us with our theme of ‘The new face of animal science in Australia’. The need for animal scientists to come together and identify opportunities across species and between discipline areas and employ the capability provided by continual innovation in technology in their research is perhaps more important now than ever.

The AAAS biennial multi-species conference continues to provide a unique opportunity for animal scientists to learn from each other. This Special Issue of *Animal Production Science* contains invited papers from submitted abstracts and is complemented by contributed one-page papers that together represent a significant body of knowledge relevant to animal scientists both in Australia and globally.

Dr Michael Campbell
AAAS Federal President
Charles Sturt University

Dr Sarah Blumer
AP20 Committee Chair
Murdoch University

AAAS Federal Council 2020–2022

President: Dr Michael Campbell
President-elect: Dr Dianne Mayberry
Past President: Professor Michael Friend
Secretary: Dr Stephanie Muir
Treasurer: Dr Sue Hatcher

Animal Production 2020 Committee Members

Dr Sarah Blumer (Chair)
Dr Fiona Anderson
Ms Beth Paganoni
Dr Honor Calnan
Ms Mandy Curnow
Professor Michael Friend
Dr Robin Jacob
Ms Prue Jenkins
Ms Esther Jones
Dr Sue Low
Professor Graeme Martin
Dr Dianne Mayberry
Dr Hayley Norman
Dr Kelly Pearce
Associate Professor Andrew Thompson
Dr Megan Trezona
Dr Tim Watts
Ya-Chun Yu

Conference organiser

Ms Kylie Crawford, Conference Design

Presidents of the Australian Association of Animal Sciences

M. C. Franklin	1954–55	Armidale
D. S. Wishart	1956–57	Melbourne
T. K. Ewer	1958–60	Brisbane
H. J. Lee	1960–62	Adelaide
H. N. Turner	1962–64	Sydney
R. H. Watson	1964–66	Melbourne
N. T. M. Yeates	1966–68	Armidale
G. I. Alexander	1968–70	Brisbane
F. H. W. Morley	1970–72	Canberra
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
P. I. Hynd	2000–02	Adelaide
A. R. Egan	2002–04	Melbourne
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
P. I. Hynd	2014–16	Adelaide
P. I. Hynd	2016–18	Adelaide
M. A. Friend	2018–20	Wagga Wagga
M. A. Campbell	2020–22	Wagga Wagga

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	1992	Michael Freer Hugh McLeod Gordon John Ryves Hawker David Roy Lindsay Mary Esther Rose
1962	Mervin Clarence Franklin Hedley Ralph Marston		
1964	Phillip Gurner Schinckel	1994	Russel William Moubray Hodge Keith Johnston Hutchinson James Patrick Langlands Douglas Barrie Purser John Edward Vercoe
1966	Helen Newton Tumer		
1968	Keith Valentine Leighton Kesteven Archibald James Vasey Rodger Henry Watson	1996	Ronald Alfred Leng John Clive Ratcliffe Frank William Nicholas
1970	Eric John Underwood David Sutcliffe Wishart		
1972	Hector John Lee George Russell Moule	1998	Robert Thomas Cowan David James Farrell Justin Joseph Lynch John Lionel Wheeler
1974	Frederick Harold William Morley		
1976	Alan Charles Hassall Lancelot Harnilton Lines Ian Wilbur McDonald Patrick Reginald McMahon	2000	Bernard Michael Bindon Barrie John Restall Geoffrey Edward Robards
1978	Albert Henry Bishop Victor Gordon Cole Leslie Alfred Downey Reginald John Moir Robert Lovell Reid Wallace Carl Skelsey Percival James Skerman Dudley Martin Smith Neil Tolmie McRae Yeates	2002	Frank Annison John Nolan Barry Norton
		2004	Keith William Entwistle Neil Patrick McMeniman William Anthony Pattie
		2006	Norman Adams Heather Burrow Graham Faichney David Masters David Pethick
1980	Graham Ian Alexander Gordon Lee McClymont Terence James Robinson Derek Edward Tribe	2008	David Blair Coates Hugh Dove Peter Thomas Doyle Adrian Roderic Egan Christopher Morris Oldham
1982	Sydney John Miller Norman McCall Tulloh Henry Greig Turner William Maxwell Willoughby		
1984	William George Allden Robert Henry Hayman James Irwin Faithfull Maple-Brown Jim Harcourt Shepherd	2010	Laurie Robert Piper Philip Ian Hynd Dennis Paul Poppi Cyril Richard Stockdale Peter Charles Wynn

1986	George Alexander Charles Hoani Scott Dolling Ian Lind Johnstone Dennis John Minson William Henry Southcott	2014	Frank Rowland Dunshea Robert Maxwell Herd
1988	John Lovick Corbett Haydn Lloyd Davies Peter Everard Geytenbeek Geoffrey Roger Pearce Laurence Cecil Snook	2016	Alan William Bell John Langtree Black Robert Menzies Dixon
1990	Alan Axelsen James Philip Hogan Trevor William Scott Robert Humphrey Weston	2018	Bruce Lipson Hancock Sue Faye Hatcher David Lawrence Hopkins Athol Victor Klieve Christopher Simon McSweeney
2012	Wayne Leslie Bryden Geoff Norman Hinch Stuart Ross McLennan Victor Hutton Oddy	2020	Edward Charmley Roger Stephen Hegarty Robert Arthur Hunter Graeme Bruce Martin

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 Ben Byers John Terrell Williams
1990	Barry Graham Lukins
1994	Christopher John Thwaites Edmund Wyndham
1996	Eric John Hilder
1998	Narelle Yvonne Morse Evan Hollinworth Macdonald Barnett
2000	Gordon Terrell Williams
2002	David Macfie Richard Moss
2004	David Hennessey
2006	Anthony (Tony) 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.

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. Masters
2020	M. Gill

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 Professor (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	P. L. Greenwood and A. W. Bell
2016	H. Dove
2018	F. Provenza
2020	M. J. Rivero and M. R. F. Lee*

The Stobbs Lecture

The 27th Council presented a lecture to honour **Professor H. (Harry) Stobbs** (1932–1978), BSc(Agric), PhD. Harry was recognised nationally and internationally for his contributions to our understanding of the plant/animal interaction, particularly his work on understanding grazing behaviour on different sward types in the tropical environment.

The Stobbs Lecturers have been:

2008	G. Edwards
2010	D. Swain
2012	P. Gregorini
2014	D. Pacheco
2016	A. de Vega
2018	J. Vendramini
2020	H. C. Norman

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 nationally and 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, J. L. Barnett and P. H. Hemsworth
2014	I. Veissier and M. Miele
2016	A. J. Tilbrook and C. R. Ralph
2018	P. H. Hemsworth
2020	C. Lee* and D. L. M. Campbell

Fellows elected 2020



Edward Charmley

BSc (University of Aberdeen), PhD (University of Reading)

Ed Charmley is a ruminant nutritionist and livestock production specialist. Ed comes from a farming background in the UK and received his bachelor's degree from the University of Aberdeen and a PhD from The Grassland Research Institute near Reading. After immigrating to Canada, he specialised in forage utilisation from both grazed and conserved herbage. He worked for Agriculture and Agri-Food Canada in the Maritime provinces on understanding forage use in the diet to optimise animal performance and beef quality. In 2005, Ed moved to Australia to join CSIRO Livestock Industries in Rockhampton where he established a program of work in extensive beef production covering the sub-tropical rangelands and savannas. In 2010, following the closure of the Rendel Laboratory, Ed relocated to Townsville where he established a livestock team and revived the Lansdown Research Station for field research. Ed has a strong track record in extending discovery science to applied situations to improve economic and environmental sustainability of beef enterprises. He combines inclusive leadership with a broad knowledge of the industry he serves and a readiness to adapt to change in research culture, innovative technologies and industry realities.

In his role as research scientist, he has jointly secured more than \$30 million of external funding in the field of greenhouse gas abatement, ruminant feed efficiency and digital solutions for the northern beef industry. In these fields, he delivers

industry impact through awareness and adoption of new production methods and practices. His research efforts resulted in the Australian government implementing a 24% reduction in livestock greenhouse gas emissions for the national inventory. His team developed measurement techniques that are now used to quantify emissions from extensive grazing systems globally. The facilities at Lansdown Research Station are well known for benchmarking enteric emissions using the only open circuit respiration chambers in northern Australia. Ed has been instrumental in the establishment of the Livestock Productivity Partnership between CSIRO, Meat & Livestock Australia, the University of New England and NSW Department of Primary Industries to improve the efficiency of beef production systems.

Ed leads a program within the Livestock Productivity Partnership and is an inclusive leader who is a valued mentor to many scientists. He has published more than 130 peer-reviewed papers with an h-index of 23. He sits on the Northern Australia Beef Research Council, is an associate editor for the *Journal of Agricultural Science*, Cambridge and an Adjunct Professor with James Cook University.

In recognition of his contribution to the beef industry of northern Australia, through research and leadership, the Australian Association of Animal Sciences is pleased to enrol Dr Ed Charmley as a Fellow.

**Roger Stephen Hegarty**

BAgrSc (Hons) (University of Queensland), PhD (University of New England), GDEd (University of New England)

Roger Hegarty graduated in Agricultural Science (Honours1) from the University of Queensland in 1984, and was awarded the Bell Medal for his Honours Thesis. He received a PhD (University of New England; UNE) in ruminant nutrition in 1990 and a Graduate Diploma in Education (UNE) in 2004.

Roger was appointed as a Livestock Research Officer at the NSW Agriculture Nutrition and Physiology Laboratory, Elizabeth Macarthur Agricultural Institute, Camden, in 1990. In 1996 Roger moved to the NSW Department of Primary Industries (NSW DPI), Beef Industry Centre, Armidale. At this early stage of his career, Roger recognised the contribution of ruminant methane, one of the so-called greenhouse gases (GHG), to global climate change and, in 2001, established a large animal methane facility in Armidale with joint funding from NSW DPI and UNE. In 2008, Roger took a year's leave of absence from NSW DPI to fill an interim role as the leader of the methane research team at AgResearch, Palmerston North, New Zealand.

Prior to his appointment as Professor of Animal Nutrition at UNE in 2011, Roger had been an Adjunct Lecturer at UNE for many years. Throughout his career in the DPI and at UNE, he has conducted extensive research on protein and energy nutrition of ruminants. Specific topics include the nutritional manipulation of lamb carcass composition and skin biology, and the role and importance of protozoa in the rumen microbiome. Over the past two decades a major focus of his research has been developing strategies for studying and reducing GHG emissions, including the measurement and management of methane emissions from ruminants, the breeding of sheep and cattle with below-average methane output, and the dietary inclusion of nitrate, lipids and tannins – and the elimination of rumen protozoa – as strategies for reducing ruminant methane emissions. He has gained an international reputation for his research on breeding ruminants with lower GHG emissions, which has been conducted with international collaborators. Roger has evaluated dietary

strategies for reducing GHG emissions by grazing ruminants, including the use of nitrate as an inhibitor of methane emissions while also acting as a non-protein source in feedlots and lick block supplements. He has also pioneered methods for collection of supplement intake and animal growth data at remote locations using satellite technologies. Roger has published over 133 journal articles as well as reviews, book chapters and invited conference papers. He has served on the International Scientific Committee and the organising committee of GHG and Animal Agriculture, and the organising committee for Recent Advances in Animal Nutrition – Australia for more than a decade. He is also a member of the editorial panel for the *Journal of Animal Physiology and Animal Nutrition*.

Roger has played a major role with the Australian and New Zealand Governments in developing national enteric methane research. Roger has conducted numerous consultancies and served on science advisory groups for the Australian GHG Office, Department of Climate Change and for the Australian Climate Institute and Australian Farm Institute. He has been invited to present aspects of his research in Australia, New Zealand, UK, Germany, Canada, Japan, Thailand, Switzerland and Ireland and has facilitated workshops in South America, Asia and North Africa under the auspices of the Global Research Alliance.

Throughout his career, Roger has been passionate about delivering clear and articulate messages, with humour, to his audiences at scientific meetings, with livestock producers, and in lectures to his students. He has numerous PhD and other postgraduate students. Roger has contributed to ASAP and now the Association over many years as an active member, and a contributor to the biennial conference.

In recognition of his contribution to the ruminant industries through teaching, research and leadership, the Australian Association of Animal Sciences is pleased to enrol Professor Roger Hegarty as a Fellow.

**Robert Arthur Hunter**

BAgrSc (Hons) (University of Queensland), PhD (University of Queensland)

Bob Hunter has an Agricultural Science degree with first class honours and a PhD from the University of Queensland. Bob's whole professional career was with CSIRO, serving in Townsville, Perth and Rockhampton. The aim of much of Bob's research was to increase annual liveweight gain of cattle in northern Australia mainly by reducing dry season weight loss. The focus was initially on the quantitative digestion of low-quality tropical grasses and on newly introduced tropical legume species. This research showed that in cattle, the rumen was even more important in the digestion of forages than it was with sheep. Studies then followed on the effects of supplementation with non-protein nitrogen, rumen degradable protein and rumen undegradable protein on rumen function and feed intake of low-quality forages with different digestion characteristics. In Rockhampton, the research was extended to include the effects of forage quality and protein supplementation on feed intake of cattle of different genotype, during pregnancy and lactation, and at different stages of maturity. While in Townsville, with Brian Siebert, a dual deficiency of sulphur and sodium was diagnosed and remedied in grass legume pastures on the western slopes of the Atherton Tableland. Supplementation with these elements is now routine husbandry in that area.

In the early 1980s, hormonal growth promotants (HGP) were a new husbandry option in northern Australia, even though there was scant information about benefit where cattle took years, rather than months, to reach market weight. Bob was sent on study leave to the University of Nottingham where he worked with Professor Peter Buttery on the mechanism of action of HGP. On his return to Rockhampton, research focussed on the metabolic regulation of liveweight gain and liveweight loss of cattle fed fibrous grass diets. Experiments that measured protein turnover and energy metabolism led to the discovery that trenbolone acetate was associated with a 10% reduction in maintenance energy requirements through a concomitant reduction in the rate of protein turnover. Associated with the reduced rate of protein degradation, there was a reduction in urea recycled to the rumen that caused a reduction in feed intake on protein-deficient diets. Trenbolone acetate was thus a useful

agent for reducing the rate of dry season weight loss of non-breeding cattle provided the ruminal deficiency of nitrogen was overcome. The long periods of intermittent growth for steers to reach market weight was addressed by developing strategies for sustained growth promotion by sequential use of anabolic steroids with different mechanisms of action. These strategies had the spin-off effect of requiring less feed per unit of liveweight gain and had an environmental benefit as well provided the stocking rate was not increased.

Between postings in Townsville and Rockhampton, Bob spent 4 years in Perth where research centred on selenium supplementation to prevent the growth check or more seriously white muscle disease in growing lambs and weaners. It became obvious that not all intraruminal selenium pellets were giving the expected length of protection from deficiency. Bob initiated research with the CSIRO Division of Mineralogy and it was discovered that selenium was released into the rumen through a chemical reaction with the iron matrix. The smaller the grain size of the selenium and the larger the reactive surface the faster the reaction rate. With larger grain size selenium, the initial reactive surface was reduced and release occurred primarily by fissures of iron selenide migrating slowly through the selenium particles. Optimisation of grain size became a critical issue in manufacture of pellets.

Appointment as Officer-in-Charge of the Rendel Laboratory, Rockhampton, in 1993 commenced a period of research leadership and site management. Bob realised the importance of an appropriate balance between livestock production and environmental preservation. He established a small group of scientists who explored strategies for reduction in methane emissions from cattle. The group also undertook research, commissioned by a coal mining company, that defined the metabolic consequences of ingestion of high macro mineral loads in the drinking water. This research provided scientific evidence of the mineral loads that can be metabolically processed and eliminated from the body before productivity is compromised. This research is now captured in the Australian Water Quality Guidelines for Cattle. Bob was the Northern

Deputy Director of the Cooperative Research Centre for the Cattle and Beef Industries (CRC) and played a significant role in sourcing a leased property for the herd of Brahman cows and their offspring that were central to the CRC genetics program in northern Australia.

Bob was active internationally presenting invited papers and conducting commissioned consultancies in S E Asia, Brazil and Papua New Guinea, USA and the UK. He led a decade-long ACIAR project that established a profitable beef industry on the infertile red soils of south central China. He is the author of 120 plus peer-reviewed journal papers, conference proceedings, invited book chapters and reviews. He served sequential terms on the editorial boards of the *Australian Journal of Agricultural Research*, *Animal Production Science*, and the *Journal of Agricultural Science, Cambridge*. He was also a long-term reviewer for

the Swedish-based International Foundation for Science. He has been a member of the Australian Society of Animal Production since 1970 and was a regular presenter of papers at biennial conferences. He had executive positions on ASAP committees: secretary of the Western Australian Branch where he instigated a regular newsletter to members, and two separate terms as president of the Central Queensland Sub-branch. In each of these positions he organised producer-focused symposia on subjects of topical importance from which proceedings were published.

In recognition of his contribution to the livestock industries, especially in northern Australia, through research and leadership, and his unwavering support of ASAP/AAAS, the Australian Association of Animal Sciences is pleased to enrol Dr Bob Hunter as a Fellow.



Graeme Bruce Martin

BSc (Agric) (Hons) (University of Western Australia), PhD (University of Western Australia)

Graeme Martin graduated in Agricultural Science (Honours I) in 1975 and gained his doctorate in sheep reproductive endocrinology in 1981, from the University of Western Australia (UWA). He then worked for 2 years at the INRA Station de Physiologie de la Reproduction at Nouzilly (France) and for 3 years at the Medical Research Council's Reproductive Biology Unit in Edinburgh (UK).

In 1986, Graeme returned to Australia to take up a joint position at the UWA and CSIRO. In 1994, he transferred fully to the University and in 2001 he was promoted to Professor (Chair). He has served as the Head of Animal Science, Dean of the Faculty of Natural and Agricultural Sciences, Dean of the UWA Graduate Research School, Chair of the Academic Board (the peak academic committee of the University), Head of the School of Animal Biology, and Deputy Director of the UWA Institute of Agriculture. He has been a dedicated teacher, researcher and mentor for his entire career at UWA with a genuine commitment to industry. In recognition of that commitment, Graeme was awarded the Moir Medal of the Australian Society for Animal Production (1991), listed in the first edition of *The Australian Sheep and Lamb Industry Roll of Honour* (2010) and has been invited as a keynote speaker at Lambex conferences in 2010 and 2018. He currently leads a major multidisciplinary project, UWA Future Farm 2050 (www.ioa.uwa.edu.au/research/future-farm).

Graeme's research has covered both basic and applied science, mostly on reproductive physiology in sheep, with a strong focus on how environmental factors influence reproduction, particularly the brain mechanisms that are involved. Graeme's long-term goal has been to use this research to develop clean, green and ethical systems of animal production. From 1990 until 2014, he also led a project on ratites (emu, ostrich), with a strong emphasis on reproductive biology and reproductive technology, that was designed to support the development of new industries. He has also had

smaller projects on rats, dogs and marsupials (most targeting new approaches to contraception), and on the management of reproduction in endangered African mammals (African Painted Dog, Pygmy Hippopotamus, White Rhinoceros).

Graeme has published more than 360 peer-reviewed articles in international journals, books and proceedings, has an h-index of 48 and has earned national and international scientific recognition, as indicated by invitations to present 30 plus symposium papers at major conferences in many countries. In 2019 he was elected to the Académie d'Agriculture de France and he has just been awarded the 2021 Marshall Medal from the Society for Reproduction and Fertility, the UK society's highest honour for 'outstanding contributors to the study of fertility and reproduction'. He has supervised more than 40 PhD students to completion and examined 20 PhD theses and 5 MSc theses. Graeme is passionate about science communication, from peer to peer, and also to industry and the broader community. His work has appeared at least 280 times in mass media.

A feature of Graeme's career in animal production R&D is collaboration with many institutions, locally, nationally and internationally. International collaborators include: the Institut National de la Recherche Agronomique (France), the Roslin Institute (United Kingdom), the Royal Veterinary College (London), Universidad Nacional Autónoma de México, the Universidad de la República Oriental del Uruguay, The University of Yamaguchi (Japan), The University of Oxford, The University of Bristol, and Rothamsted Research.

Graeme has served the scientific community in many ways. Since 1989, he has been an elected member of the Research Committee of the Keogh Institute for Medical Research (Queen Elizabeth II Medical Centre). He has been active in several scientific societies throughout his career,

including ASAP/AAAS, where he is a current member of the conference organising committee for the 33rd Biennial Meeting in 2021. He has been particularly active in the Society for Reproductive Biology (Australia) where he has served as a member of the Executive Committee (including 2 years as treasurer) and convened the Junior Scientist Committee for several years. He was a member of the Editorial Board of *Reproduction, Fertility & Development* for many years, served as the Chair during 2000–2006, and

is currently the Editor-in-Chief (<http://www.publish.csiro.au/nid/44/aid/1801.htm>). He has also served on the editorial boards of *Reproduction* (UK), *Animal Reproduction Science*, *Domestic Animal Endocrinology and Reproduction in Domestic Animals*.

In recognition of his significant contribution to the animal industries of Australia through research, education and leadership, the Australian Association of Animal Sciences is pleased to enrol Professor Graeme Martin as a Fellow.