THE UNIVERSITY OF SYDNEY

2016 Annual Report

Poultry Research Foundation

Faculty of Veterinary Science

Governance Statement

The Poultry Research Foundation recognises the importance and benefit of reviewing its adoption and alignment with governance principles and provides the following report.

Principle 1 – Lay solid foundations for management and oversight

Nature of the entity:

The Poultry Research Foundation is a part of the University of Sydney (ABN 15 211 513 464) and not separately incorporated under a State or Commonwealth Act. The Foundation is required to gain prior approval for its fundraising activities from the appropriate University delegate. The Foundation's activities are not-for-profit and covered by the DGR status of the University of Sydney. The University is exempted from the requirement to hold an Authority to Fundraise and obligations upon holders of such an authority but is still required to comply with the balance of provisions of the Charitable Fundraising Act.

Roles of board / council and management:

The Foundation operates under the authority of the Senate of the University of Sydney, as approved in June 2011, and has no powers of delegation. The Foundation conducts its affairs pursuant to the Foundation Rules and the relevant policies of the University.

Principle 2 – Structure of the council to add value

The Council of the Foundation in 2015 consisted 14 members. (Refer to page 7)

Council members were elected at the Foundation's AGM on 9th April, 2014. There is not a separate nomination committee of Council. The full Council resolves on nominations for co-opting of members to fill vacancies outside of the process of election at the AGM There was not a performance evaluation of the Council undertaken in the reporting period.

Principle 3 – Promote ethical and responsible decision-making

Council members have been provided with the University of Sydney Foundation Governance Guide, Foundation Rules, Code of Conduct, Work Health & Safety policy and the External Interests policy. All these policies are available on the University's Policy Register, as are other relevant University policies regarding harassment, grievance procedures and the Delegations of Authority.

Principle 4 – Safeguard integrity in financial reporting

The annual accounts of the Foundation are prepared by the financial staff of the University, signed off by the Director of the Foundation and included in this Annual Report to the Senate. The Foundation is part of the University and therefore does not have its own audit sub-committee. While the Annual Financial Report of the University is audited by the Audit Office of NSW, the Annual Accounts of the Foundation have not been audited.

Principle 5 – Make timely and balanced disclosure

The Foundation complied with the reporting and disclosure requirements of the Senate. These include an annual budget and this Annual Report

Members and Council have been made aware of the processes for disclosure pursuant to the Code of Conduct, External Interests policy, which include protected disclosure to the ICAC, to the Ombudsman or to the Auditor General.

Principle 6 - Respect the rights of shareholders, members, staff, volunteers, clients & other stakeholders

The Foundation Council and/or membership consists of invited industry professionals, industry bodies and University representatives, whose input is invited via the Annual General Meeting and Council meetings of the Foundation. Each year the Foundation conducts a General Meeting in Oct/Nov and the AGM in March/April.

Principle 7 - Recognise and manage risk

The Foundation recognises its activities within University premises or other premises require risks such as health and safety, environmental protection, privacy, trade practices, and compliance with the Charitable Fundraising Act to be considered and managed. The Foundation has managed these risks during the year by complying with risk management procedures as outlined by the University.

Principle 8 – Remunerate fairly and responsibly

No member of a Council is entitled to receive any remuneration for acting in that capacity except reasonable remuneration on a basis which has first been approved in writing by the University Officer (Foundations). Members of the Foundation Council may be reimbursed for reasonable expenses after written approval of the University Officer (Foundations). Any such instances are recorded in the minutes of the Council.

Foundation Objectives

OBJECTIVES OF THE FOUNDATION

The objectives of the Poultry Research Foundation are to advise the Senate of the University of Sydney and the Vice-Chancellor on matters associated with poultry research, education and scholarship within the University of Sydney and to provide an interface between the Australian poultry and allied industries and the University.

In doing so, the Foundation shall increase the resources of the University by way of membership to the Foundation and utilising benefits given by members in provision of services and other non-financial contributions.

AIMS OF THE FOUNDATION

1. To provide an interface between the poultry and allied industries in Australia and the University of Sydney.
2. To undertake research of relevance to these industries.
3. To assist in the training of scientific and technical personnel to service the private and public sectors of these industries.
4. To act in an industrial liaison capacity.

PRIORITIES 2016

1. Develop links between the University of Sydney and the Poultry CRC
    a. Research projects
    b. Educational programs
    c. Postgraduate scholarships
2. Develop research projects lead by the Director of Poultry Science
3. Complete infrastructure maintenance of the Poultry Unit
4. Promote postgraduate opportunities within the Poultry Research Foundation
5. Organise the 2017 Australian Poultry Science Symposium
6. Management of the Foundation is vested in a Council which comprises the President, Deputy President, Director, Faculty of Veterinary Science Dean and Provost Nominee along with elected Industry Members from the categories of Governors and Executive Members, Honorary Governors and Ex Officio Members.
7. The administrative office and Research Unit are based at Camden.

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President's Report

2016 has proven to be an exciting and challenging year for the Poultry Research Foundation. The diversity and value of work being conducted at Camden continues to impress. Participation by industry remains strong with 2 Governors, 8 Executive Members and 10 Associate members subscribing to the PRF. We laid plans for a brighter, bolder Australian Poultry Science Symposium and bid on a future that would expand our research activities and bring new participants to the fold.

The 27th Australian Poultry Science Symposium was held in February 2016 and was attended by a record of 249 delegates who travelled to Sydney from 16 countries. It was the last time the APSS was held in the Veterinary Science Conference Centre given the decision to stage the 2017 event at the Sheraton on the Park in the Sydney CBD. The 2016 Symposium explored many challenges and opportunities including water and physiology, productivity and efficiency, health and welfare, food safety and quality, welfare, alternatives to antibiotics, efficient use of Phosphorus and Avian Influenza. The social programme was greatly accentuated by the addition of a humorous "Great Debate" on the importance of gut microflora.

During the year, we congratulated three of our students who successfully submitted their PhD theses (Emma Bradbury, Kate Hartcher and Dean Powell) and greeted four more PhD students who commenced their studies (Ryan Hopcroft, Alannah Mackay, Kevin Prescilla and Christine Sydenham). Yeasmin Akter joined our team as a visiting post-doctoral research fellow from Bangladesh and we wished one of our technical staff, Kate Dehon all the best in her new career in the NSW Ambulance.

In late 2016, a submission was made to the Australian Research Council (ARC) for an Industrial Transformation Training Centre (ITTC) five-year grant under the banner of the Australian Poultry Advancement Centre (APAC). I congratulate Dr Peter Groves and Keith Merchant for their indefatigable efforts in bringing this bid together. I also wish to thank the organisations that chose to support this bid by signing on at Governor, Partner or Member level. Many of these are current PRF members but we also welcomed new participants to the fold. The participants have also been very supportive in complimenting this bid with commitments of place ten post-graduate students in industry as part of their research activities – a requirement of the ITTC. We await a decision in July 2017 as to whether or not the bid has been successful.

What will be the future of the Poultry Research Foundation? The difficulty appears to lie in the definition of the activities of a "Foundation" being confined to that of fund raising, according to the University. Having said that, the University acknowledges the value of our activities and is supportive of those continuing. So perhaps the answer lies in a name change. It would be great to remain the PRF but choose another word beginning with "F". Perhaps these options are worthy of consideration: Facility or Federation or Fellowship or Forum? The intent would be for participants in the Australian Poultry Advancement Centre to automatically be members of the PRF. Those who do not wish to participate in APAC might wish to be members of the PRF. This would give us the best of both worlds and provide us with a connection with the past and continuity beyond the five-year ARC/ITTC grant.

We have a proud heritage and shared belief among our ranks in the vitality and relevance of what we achieve together. Our mission is to navigate the transition that 2017 presents with confidence and unity. Our best days lie ahead!.

Judy O'Keeffe
President

Director's Report

The major themes for APSS in 2016 were "Water, Energy and Food: Global Security", focusing on peak food, peak phosphorus, water physiology, wet litter, food safety and alternatives to antibiotics. We enjoyed 12 quality invited speakers from Australia, UK and USA and we had 62 submitted papers and 248 attendees (a record). A post-symposium questionnaire was provided for feedback on the symposium's quality, venue and accommodation. As we moved to planning for 2017 it was obvious we had outgrown the Veterinary Science Conference Centre and need to evaluate larger venues. We evaluated several other centres on campus but were unable to find one of adequate size and with our needed breakout and meeting rooms available. We then looked at possible hotel venues in Sydney CBD. Only the Sheraton-on-the-Park and the Sofitel (Wentworth) fitted our requirements. With some extended negotiation we settled on the Sheraton-on-the-Park. Although accommodation there was expensive, there were ample alternatives of all standards nearby and the CBD location provided much better attractiveness for delegates, especially from overseas. With guidance from the organizing committee, themes of 'Gut health and physiology', 'Adult bird nutrition' and 'Low protein diets' were chosen. We invited 8 quality speakers to invigorate the symposium. This off campus symposium is an experiment and its success or otherwise will guide us to the future. I offer thanks to Jo-Ann Geist and Ben Geist for so much input into making APSS so successful.

Research work, both funded and contract, has continued strongly with heavy utilization of our facilities through the year. The work of our students and staff is summarised in the report and will be repeated at the meeting. The quality of our research activities continues at a high level, aided well by our amazing technical support staff; Joy Gill, Melinda Hayter, Wade Chen, Kylie Warr and Don Nicolson.

A major effort was directed towards establishing a research centre through 2016. Success here relied on gaining substantial financial support from industry. The initial intention was to allow the establishment of an entity that would continue the PRF tradition and membership. When our final submission was made in December to ARC for an Industrial Transformation Training Centre for free range poultry production was made, only eight of our member companies (out of 20) decided to become partners. In contrast we achieved commitment from 11 companies that have never been PRF members. Although this ITTC will be an immensely worthwhile venture, this would not meet the needs for the transition of the PRF. The outcome of the ITTC application will not be known until June 2017. If it succeeds, it can be a stand-alone, valuable research and training centre for the University and the poultry group. However we need to look forward for the PRF to continue its valuable work. To this end a proposal to change the Foundation to a new entity will be put to the 2017 AGM. If supported, a new entity will be created, continuing with the objectives of the PRF, continuing to foster APSS and maintaining the liaison function so vital to the effective functioning of our research efforts.

In 2016, we had 3 PhD Students successfully submit their thesis and graduate from the University of Sydney. On behalf of everyone who is part of the PRF, we wish Emma Bradbury, Kate Hartcher and Dean Powell all the best in their future endeavours and hope that they have a long and successful career.

Peter Groves
Director

Poultry Research Foundation Members

GOVERNORS	EXECUTIVE MEMBERS	ASSOCIATE MEMBERS
Baiada	Feedworks	Alltech Biotechnology
Inghams	DSM Nutritional Products	BEC Feed Solutions
	Elanco Animal Health	Biomin Australia
	Evonik Degussa Australia	Bio Processing Australia
	Novus Nutrition	Cordina Chicken Farms
	Ridley Agriproducts	International Animal Health
	Weston Animal Nutrition	Kemin (Aust)
	Zoetis	Phibro Animal Health
		Ruth Consolidated Industries
		The Egg Basket (Sales)

HONORARY GOVERNORS
Emeritus Professor E. Frank Annison
Dr. Balkar S. Bains
Dr. Derick Balnave
Prof. Wayne Bryden
Mr. John Darling
Mr. Ern Newton
Dr. Ron MacAlpine

INVITEES
The Deans of Agriculture and Natural Resources
The President, World's Poultry Science Association (Australian Branch)
The Program Manager, RIRDC Chicken Meat Program
The Program Manager, Australian Egg Corporation Ltd
A Representative, Poultry CRC

Poultry Research Foundation Council

PRESIDENT	Ms. Judith O'Keeffe
DEPUTY PRESIDENT	Dr. David Cadogan
DIRECTOR	Assoc. Prof. Peter Groves
GENERAL MEMBERS	UNIVERSITY COUNCIL MEMBERS
Baiada Poultry Pty. Limited Mr. Greg Hargreave	**Executive Dean -** **Faculty of Veterinarian Science** Prof. Rosanne Taylor
Biomin Mr. Neil Gannon	**Division of Alumni &** **Development – University** **Foundations** Ms. Melissa Bonevska
Elanco Animal Health Ms. Avril Grieve	**The Pro-Dean -** **Faculty of Veterinary Science** Assoc. Prof. Paul Sheehy
Inghams Enterprises Pty Ltd Ms. Katherine Balding	**Associate Dean for Research -** **Faculty of Veterinary Science** Prof. Katherine Belov
Novus Nutrition Mr. Stuart Court	
Phibro Animal Health Mr. Thomas Wakeford	
Weston Animal Nutrition Ms. Christine Sydenham	
Zoetis Mr. John Reeves	

Poultry Research Foundation Staff and Students

Director

Dr. Peter Groves *BVSc, MANZCVSc(Epidemiology), PhD (Sydney)*

Academic Staff

Dr. Wendy Muir *BScAgr, PhD (Sydney), GradDipEd (UNE), GradCertEducStud(Higher Education)*
Dr. Jeff Downing *WDA (Wagga Agr. Col.), BSc, PhD (Macquarie), GradCertEducStud(Higher Education)*
Dr. Greg Cronin *BAgrSc, MAgrSc (Melbourne), PhD (Wageningen NL), GradCertEducStud(Higher Education)*
Dr. Sonia Yun Liu *BEng, MFoodSc (Queensland), PhD (Sydney)*
Dr. Cormac O'Shea *BAgrSc, PhD (Ireland)*
Dr. Mini Singh *BScGen (India), MScVetSc, PhD (Sydney)*

Honorary Research Fellows
Adj. Assoc. Prof. Peter Selle *BVSc, PhD (Sydney)*

Visiting Research Fellows
Assoc. Prof. Yeasmin Akter *BSc (Bangladesh), MSc (Bangladesh), PhD (Malaysia)*

Administration Staff
Mrs. Jo-Ann Geist
Mr. Benjamin Geist

Project Management Staff
Mrs. Joy Gill
Mrs. Melinda Hayter

Project Support Staff
Ms. Kate Dehon
Mr. Don Nicholson
Mr. Duwei (Wade) Chen
Mrs. Kylie Warr

Postgraduate & Masters Students
Mr. Tugrul Durali - *Comparison of free range and conventional meat chicken production systems.*
Ms. Ha Hong Truong - *Starch utilisation and glucose absorption in broiler chickens with emphases on grain sorghum, phytase enzyme and whole grain feeding.*
Ms. Amy Moss - *Feeding strategies to enhance the efficiency of chicken meat production.*
Ms. Angela Scott - *Avian Influenza Risk Mitigation for the Free-Range sector of the Australian Poultry Industry.*
Mr. Ryan Hopcroft - *Manipulating residual yolk usage.*
Mr. Kevin Prescilla - *Evaluating the nutritional motivation for feather eating as a cause for feather pecking.*
Ms. Christine Sydenham - *Utilisation of synthetic amino acids and low-protein diets in chicken-meat production.*
Ms. Alannah Mackay - *A preliminary investigation into the relationship between feather-pecking and integument microflora.*
Mrs. Shiva Greenhalgh - *Investigation of variation in feed efficiency and egg quality in laying hens.*
Ms Luijie Li - *The role of selenohomolanthionine as an antioxidant in heat-stress broilers.*
Mr Ziying Ye - *Manipulating energy density and dietary electrolyte balance in diets of free range laying hens.*

Honours/DVM Students (conducting thesis projects under Poultry Research Foundation supervision)
Ms Jessica Leigh (AVBS) (Supervisors: Wendy Muir & Peter Groves)
'Maternal flock age and pre-starter diet – their effect on bone mineralisation and leg strength in Cobb 500 broiler chicks'
Ms Georgia Campbell (B.Agr.Sc.) (Supervisors: Robyn Alders & Cormac O'Shea)
'Effect of egg production systems on egg quality and nutrient content'

Staff Memberships and Affiliations

Dr. Peter Groves:
Member: Australian Veterinary Poultry Association
Member: Commercial Poultry Veterinarians (an SIG of AVA)
Adjunct Senior Lecturer: Charles Sturt University - Department Agriculture & Veterinary Sciences
Member: National Newcastle Disease Technical Working Group

Dr. Wendy Muir:
Member: Australian Poultry Science Symposium Organising Committee
Member: Worlds Poultry Science Association
Associate Editor: Animal Production Science

Adj. Assoc. Prof. Peter Selle:
Member: Australian Poultry Science Symposium Organising Committee
Associate Editor: Poultry Science

Dr. Greg Cronin
Member: Editorial Advisory Board, Applied Animal Behaviour Science
Member: Australian Society for Animal Production
Associate of the Animal Welfare Science Centre

Dr. Jeff Downing:
Member: Worlds Poultry Science Association
Member: Pork CRC Research and Development Committee
Member: Pork CRC Education Committee
Member: Australasian Pig Science Association

Dr. Mini Singh
Member: Worlds Poultry Science Association
Member: Australian Society for Animal Production

Dr. Sonia Yun Liu
Member: Worlds Poultry Science Association
Member: Human Food Chain Node, Global Food and Nutrition Security Research Node, Charles Perkins Centre

Dr. Cormac O'Shea
Member: Australasian Pig Science Association
Member: Global Food and Nutrition Security Research Node, Charles Perkins Centre

Dr. Peter Selle
Member: World Poultry Science Association

Conference Attendance, Presentations, Acknowledgements and Awards

Conference Attendance and Presentations by PRF Staff and Students

27th Annual Australian Poultry Science Symposium, Sydney NSW, February 2016
Presentations by Sonia Yun Liu, Peter Selle, Amy Moss, Ha Hong Truong, Ryan Hopcroft, Peter Groves, Dean Powell, Greg Cronin, Mini Singh
Attended by Wendy Muir, Jeff Downing, Cormac O'Shea, Kate Hartcher, Emma Bradbury

9th Animal Feed Manufacturers Association Forum, Sun City, South Africa, March 2016
Presentations by Sonia Yun Liu & Peter Selle

XXV World's Poultry Congress, Beijing, China, September 2016
Presentation by Wendy Muir, Kevin Prescilla & Greg Cronin

6th Australian and New Zealand Spatially Enabled Livestock Management Symposium, Camden, NSW, March 31 – April 1, 2016
Presentation by Greg Cronin, Angela Scott

Australian Society for Animal Production, 31st Biennial Conference, Stamford Grand, Glenelg, South Australia
Presentation by Greg Cronin

Australasian Veterinary Poultry Association Scientific Meeting, 1-2 June 2016, Gold Coast, QLD, Australia
Presentation by Mini Singh, Angela Scott & Peter Groves

Awards

Top Publication by View Count 2010-2015 in Scopus - *awarded by The Faculty of Veterinary Science*
Selle PH, Cowieson AJ, Cowieson NP, Ravindran V (2012) Protein-phytate interactions in pig and poultry nutrition; a reappraisal. *Nutrition Research Reviews* **25**, 1-17.

Acknowledgments

Thank you to all of our research partners who funded research projects, student scholarships and post-doctoral fellowships throughout 2016:

RIRDC
Poultry CRC
AECL
Feedworks
Danisco
DSM
AB Vista
Baiada
Bioproton
Zoetis

Australian Poultry Science Symposium 2016

The 27th Annual Australian Poultry Science Symposium was held 14th-17th February, 2016. The Poultry Research Foundation in conjunction with the World's Poultry Science Association (Australian Branch) organised this combined meeting which presented subjects of "Food Security" and "Water and Avian Physiology", along with the hot topics of "Free Range Performance" and "Avian Influenza Update". This year we returned again to the Veterinary Science Conference Centre at Sydney University, with the Welcome BBQ held on the lawns surrounding the Roundhouse on Monday evening. We had 5 international invited speakers, hailing from the USA, UK and Switzerland, as well as 6 local researchers who were invited to present some of their recent work.

2016 saw us reach a record crowd of 249 attendees over the 3 days of the conference. In total, there were 73 contributing papers presented in a very busy program. We resisted the temptation to do split sessions this year, however had to reduce presentation time which was not ideal. Other options will need to be looked at into the future to allow each author reasonable time to present their research.

As always, the conference symposium dinner was very well received by around 180 people. This year it was held at the National Maritime Musuem, Darling Harbour. There were spectacular views of the city and guests were privileged to explore the HMAS Vampire, with welcome canapés and drinks served on the helipad at the rear of the decommissioned ship.

INVITED SPEAKERS:

Assoc. Prof. Wayne Bryden - University of Queensland, Australia
Assoc. Prof. Robyn Alders - University of Sydney, Australia
Dr. Aaron Cowieson - DSM Nutritional Products, Switzerland
Mr. Mark Dunlop - Department of Agriculture and Fisheries, Queensland, Australia
Prof. Nick Sparks - Scotland's Rural College, Roslin Institute, UK
Dr. Mitchell Groves - Safe Food Production Queensland, Australia
Dr. Margaret Sexton - PIRSA, Australia
Dr. Dana Cordell - University of Technology Sydney, Australia
Assoc. Prof. Robert Speight - Queensland University of Technology, Australia
Dr. Travis Schaal - Hy-Line International, USA
Prof. Robert Wideman Jr. - University of Arkansas, USA
Mr. Steve Pritchard - Premier Nutrition, UK

Sponsorship of the APSS 2016 was kindly supported by:			
Invited Speaker Sponsors	Poultry Research Foundation RIRDC Chicken Meat Program Australian Egg Corporation Ltd Hy-Line DSM Nutritional Products		
Gold Sponsors	Poultry CRC		
Silver Sponsors	Dupont/Feedworks Pty Ltd DSM Nutritional Products Ltd. BEC Feed Solutions / Adisseo Alltech Australia Elanco Animal Health		
Bronze Sponsors	Biomin Australia Novus Nutrition Ruth Consolidated Industries Jefo Zoetis Australia	Item Sponsors	Evonik Industries Zoetis Australia Kemin BASF Dupont/Feedworks Novus Nutrition Oxford University Press

Foundation Research in Review

The Poultry Research Unit has been very active in both the broiler and layer research fields for more than 50 years here at Camden. Some major contributions to research and industry during this time have been in the areas of:

- Amino Acid Digestibility Studies (RIRDC)
- Modulation of lean tissue deposition by dietary fatty acids (RIRDC, ARC)
- Development of a non-invasive test for stress in laying hens (RIRDC)
- Mucosal immunity in chickens (RIRDC)
- Nutritional and toxicological evaluation of transgenic plants (CSIRO)
- Application of feed enzymes (Industry)
- Mycotoxins in poultry feeds (ADAB)
- Egg Shell Quality (RIRDC)
- Amino acid balance for heat stressed broilers (Industry)
- Nutritional requirements of recently imported layer stock (RIRDC)

We will continue to serve the needs of research, industry and teaching over years to come.

Current Research Projects

Associate Professor Peter Groves:

RIRDC Chicken Meat project 9075: "Post-hatch management for improved broiler locomotion." This project follows on from previous studies which evaluated the effects of incubation conditions on subsequent broiler leg strength. There were strong indications that some leg weakness issues in modern broilers may be due to limitations in phosphorus supply remaining in the remnant yolk sac when chicks hatch and a delay in access to feed may lead to poor bone mineralization in the chick's early life. The current project explores whether alterations to early dietary phosphorus and calcium levels can affect this and subsequent leg strength. Further information on other mineral contents of yolk are coming to light.

Co-supervisor for the POULTRY CRC "Avian Influenza Risk Mitigation for the free-range sector of the Australian Poultry Industry". This project will survey a cross section of the NSW poultry industry attempting to identify risk factors for exposure to Avian Influenza virus. The aim of the project is to determine strategies that will minimize the exposure risks, especially for free range farming operations.

Dr. Wendy Muir:

RIRDC Chicken Meat Project No: PRJ–9075 "Post hatch management for improved broiler locomotion" with senior investigator Dr Peter Groves, and RIRDC Chicken Meat, funded PhD student Ryan Hopcroft. Dr Groves has provided an outline of this project above.

Australian Poultry CRC Project – in association with Professor Sandra Velleman at Ohio State University and PhD student Dean Powell, "Investigating the effect of nutritional status on chicken satellite cell determination, proliferation and differentiation". During 2016 two publications arising from the in-vivo studies undertaken at the PRF, University of Sydney have been published in Poultry Science. Dean submitted his thesis in February 2016 and Graduated in December 2016. During 2016 Dean was working for the Australian Pesticide and Veterinary Medicines Authority, Canberra.

Dr. Jeff Downing:

Poultry CRC Project: "Proteomic measures of albumen degradation as indicators of egg freshness". The objective of the project is to find specific proteomic makers of albumen degradation which can be used to assess egg freshness. We developed the 2D-PAGE methodology and found it was not suitable in isolating individual proteins. In 2016 we moved to using N-Tails analysis to identify a candidate protein marker and this continues. We have investigated the effects hen age, ambient temperature and acute stress have on egg quality overtime when stored at different temperatures. A full report was provided to the Poultry CRC.

RIRDC Chicken Meat project: "Electrolyte supplementation of broilers prior to transport". In this project three studies investigated the electrolyte supplementation of broilers for 2 days prior to transport and the effect this had on carcass yield and meat quality after transport and processing. The full report has been accepted by RIRDC.

Dr. Greg Cronin:
During 2016 Greg Cronin continued research into the factors associated with the onset of severe feather pecking in free range laying hens, specifically on developing a model to induce feather pecking. In March 2016 Ms Alannah Mackay commenced her PhD studies on the initiation of feather pecking and development of a model to induce this problem behaviour. Three peer-reviewed papers were published by Kate Hartcher in 2016 from her PhD research on factors in the rearing environment and the occurrence of feather pecking in free range laying hens. Kate was awarded doctorate in December 2016.
Greg initiated a collaborative project at Roseworthy Sth Aust, with Dr Cameron Ralph from the Animal Welfare Science Centre, SARDI, on "Environmental enrichment and welfare in sucker and weaner pigs". The project is being funded by Aust Pork Ltd.

Dr. Sonia Liu:
Extension of Geometric Framework in poultry:
The remaining three feeding studies and lab analyses were completed in 2016. One paper has been published in British Journal of Nutrition (impact factor 3.7) and the other four papers are under preparation. They will be submitted in 2017 for publishing in British Journal of Nutrition or equivalent.
Principle investigator of RIRDC Chicken-Meat Project No: PRJ-010216 'Formulating broiler diets based on protein and starch digestive dynamics'. This project is aiming to establish the relationship between digestion rates in ingredients and complete diets to explore the possibilities to include digestion rate into least-cost feed formulation. This project includes seven feeding studies and in 2016, two feeding studies have been completed. The digestive dynamics of starch and protein was measured in feed grains commonly used in Australia. Another two feeding studies have been scheduled in 2017.
Co-investigator of RIRDC Chicken-Meat Project No: PRJ-008695 'The factors influencing sorghum starch digestibility in broiler chickens'; RIRDC Chicken-Meat Project No: PRJ-009099 'Whole grain feeding for chicken meat production'; RIRDC Chicken-Meat Project No: PRJ -010489 'Survey and review of grain sorghum in chicken-meat production'.
Other ongoing projects:
Retrospective analyses of retained PGLP grain sorghum samples (Australian Feed Grain Partnership)
The impact of exogenous enzymes on the post-enteral availability of amino acids and glucose (Bioplatform)
The supplementation of amylase on starch digestibility (commercial fund)
Measurement of AME matrix values (Poultry Hub, in collaboration with the University of New England)

Dr. Mini Singh:
Poultry CRC Project 1.5.7: Co-investigator for the project "Avian Influenza Risk Mitigation for the Free-Range sector of the Australian Poultry Industry". Co-ordinated on-farm surveys, expert opinion workshop while maintaining close collaboration with industry bodies, poultry integrators, and growers to maintain poultry health and improve bird welfare by directly addressing a critical infectious disease threat for the industry.
Instrumental in organizing a National Forum - Avian influenza risk mitigation for the Australian poultry industry, at the Stamford Plaza Sydney Airport on 23 August 2016. Was able to gain attendance from 62 participants representing key industry and government stakeholders across most sectors of the Australian poultry industry. Participants included egg, chicken meat and duck meat producers and their value chain, researchers, veterinary advisers, and representatives of the Australian Egg Corporation Ltd (AECL), Australian Chicken Meat Federation (ACMF), Animal Health Australia (AHA), Victorian Farmers Federation (VFF), Queensland United Egg Producers (QUEP) and State and Australian Governments.
Australian Poultry CRC Project – in association with PhD student Kevin Prescilla on "Evaluating the nutritional motivation for feather eating as a cause for feather pecking". Three trials completed and two more planned for 2017.
Was awarded the University of Sydney DVC-R Compact funding for the 2016 Food Security Collaborative Project in association with Evonik (SEA) Pte. Ltd., looking at the impact of amino acid supplementation on feather pecking in group cages.
Conducted Alkane analysis for collaborative projects with PIRSA-SARDI and UNE looking at consumption of Saltbush and pastures in free range laying hens and broilers.

Adjunct Associate Professor Peter Selle:
Perhaps the highlight of the year was the "Sorghum Summit" in the Charles Perkins Centre on March 21st 2016. This meeting was held under the auspices of the Feed Grain Partnership and sponsored by Feedworks and ADM – our thanks to Dave Cadogan and John McLeish for their support. The participants were a 40-strong eclectic blend of pig and poultry nutritionists, sorghum breeders and growers and academics of various persuasions. Speakers included Professor Jenni Brand-Miller, Professor Frank Dunshea, Sonia Yun Liu, Ha Truong, Amy Moss, Ian Sawyer, Peter V Chrystal, David Cadogan, Alan Cruikshank and Peter Selle. Dr Kylie Hewson chaired most of the meeting. The various power-point presentations are available on the Feed Grain Partnership web-site so it was a great exercise in extension.

On the one hand we feel that sorghum is a maligned and under-valued feed grain for chicken-meat production and, on the other, there is the suspicion that local sorghum crops may be somewhat inferior to those grown in North and South America. It does appear that kafirin and phenolic compound concentrations in grain sorghum are independent, limiting factors and this should be established beyond doubt by the retrospective analyses of retained PGLP grain sorghum samples project.

There is very considerable interest in the development of 'low-protein diets' with, axiomatically, high inclusions of synthetic amino acids. It is a near certainty that there will be an increasing R&D focus on the successful development of 'low-protein diets' as evidenced by the work-shop held in conjunction with APSS next year. We are particularly interested in the catabolism of glucose and amino acids in the gut mucosa and the impact this "catabolic ratio" has on the post-enteral availability of glucose and amino acids. There may be distinct differences between synthetic and protein-bound amino acids in this important respect.

Again, we would like to acknowledge the extraordinary analytical support of Dr Ali Khoddami which is ongoing, our collaborations with Dr Leon McQuade and Mr Bernie McInerney of the Australia Proteome Analytical Facility (APAF - Macquarie University) and the continuous support of Mr Denis McGrath and the Feed Grain Partnership.

But none of this would be possible without the Queen Grandmother, Joy Gill and her great team in the lab, the feedmill and the brick-building etc. According to Ha (and she is 100% correct) "*Joy has a life-time of knowledge and two life-times of energy*".

Principle Investigator
RIRDC Chicken-Meat Project No: PRJ-008695 'The factors influencing sorghum starch digestibility in broiler chickens';
RIRDC Chicken-Meat Project No: PRJ-009099 'Whole grain feeding for chicken meat production'.
RIRDC Chicken-Meat Project No: PRJ -010489 'Survey and review of grain sorghum in chicken-meat production'.
Australian Feed Grain Partnership: 'Retrospective analyses of retained PGLP grain sorghum samples'.
Bioplatforms Australia [in conjunction with Australian Proteome Analytical Facility (Macquarie University) and Feedworks]: 'Metabolic fates of amino acids and glucose in enterocytes'
Co-Investigator (Principle Investigator: Dr Sonia Yun Liu)
RIRDC Chicken-Meat Project No: PRJ-010216: 'Formulating broiler diets based on protein and starch digestive dynamics'.

Dr. Cormac O'Shea
A new twist from an old tale; can "selenium restrain the infectivity of Salmonella in broilers through modifying oxidation / reduction balance"? During infective stage, Salmonella use an inflamed gut to good advantage, switching from slow fermentation to anaerobic respiration by utilizing metabolites of oxidative stress. Thus Salmonella can outcompete obligate fermentative microbes, amplifying cellular invasion. Selenium may have a role to play in attenuating oxidative stress and therefore starving Salmonella of the nutrients required for metabolic switching. Marie Bashir Institute Funded Project
"Investigation into the effect of light intensity in mediating gastrointestinal mucosal integrity and inflammatory cytokine gene expression in broiler chickens". Birds reared in low lux may be heavier than birds kept at higher lux. This study aims to expand on the role of melatonin which acts as a signaling hormone and antioxidant. Studies in rats show that light can affect the level of melatonin at mucosal interfaces. Increased levels of melatonin in the gastrointestinal mucosa may contribute toward improved gut integrity and absorption.

"Effect of incremental levels of a novel selenoprotein on growth performance, meat quality, antioxidant and selenium status in heat-stressed broilers". During heat stress, broilers may undergo higher levels of cellular oxidation due to the production of free radicals. Therefore, higher levels of selenoprotein may be merited to mitigate oxidative stress. This study sought to establish a heat stress model in broilers and investigate the merit of incremental levels of a selenoprotein in alleviating oxidative stress.
"Investigations into calcium and phosphorus on feed efficiency and egg production in laying hen".
Dietary calcium and phosphorus levels appropriate for multiple production traits are still being elucidated due to complex interactions between the two minerals and with other nutrients. This study is a continuation of a body of work funded by the AECL looking at how to optimise dietary calcium and non phytate phosphorus in layers.
Individual feed efficiency in laying hens: Exploring the relationship between feed efficiency and egg quality in laying hens.
The role of phosphorylated tocopherol in heat stressed broilers: Improving meat quality in broilers.

Research Collaboration and Industry Services

The PRF continues to collaborate with the Charles Perkins Centre and a three-year joint post-doctoral fellowship began in February, 2014, to extend the Geometric Framework to broiler nutrition. The project aims to extend the Geometric Framework (GF) for nutrition to commercial poultry nutrition and diet optimization. The primary objective is to use the Geometric Framework for the first time to understand regulation of protein and carbohydrate intake in broiler chickens. This will enable diets to be formulated to optimise multiple output criteria including meat yield and flesh quality, feed efficiency, animal health and welfare, and environmental waste.
Dr Sonia Liu was recently nominated by RIRDC Chicken-meat to lead the industry and research discussion of synthetic amino acids in low-protein diets.
Dr. Wendy Muir is collaborating with Prof. Sandra Velleman (Ohio State University) on muscle development in broiler chickens.
Dr. Greg Cronin is collaborating with Prof. Paul Hemsworth and Dr. Jean Loup Rault (both from the University of Melbourne) on free-range laying hen behaviour and welfare, and broiler welfare. Greg is also collaborating with the Animal Welfare Science Centre on three projects: (1) with Dr Cameron Ralph (SARDI) on environmental enrichment for sucker and weaner pig welfare; (2) with Dr Bec Doyle (Uni of Melbourne) on cognition tests for lactating sows; and (3) Dr Jean-Loup Rault (Uni of Melbourne) on piglet survival.
Dr. Peter Groves is continuing collaborations with Dr Jean-Loup Rault from the University of Melbourne in a project examining broiler behavior and welfare under free range conditions. Several collaborative projects with UNSW and Birling Avian Laboratories are continuing, looking at Salmonella antigens and the production of egg yolk antibody (IgY) to a number of human cancer antigens. Dr Groves is co-supervising three postgraduate students, including one at University of Melbourne and two at UNSW.
Cormac O'Shea is collaborating with 3 companies investigating various feed supplements in broiler diets. He is also collaborating with research partners at the University of Western Sydney Meat Science. Dr. Christine Hutchison at the UWS is a collaborator looking at meat quality in broilers.
Other current collaborators include Dr. Narasimha Murthy, University of Mississippi looking at transdermal iron delivery in piglets. Dr. Niamh O'Connell, Queen's University, Belfast investigating the role of stress in accumulation of carcinogenic metabolites in eggs. Prof Torres Sweeney, University College Dublin Animal Models of Ulcerative Colitis. Prof Frank Dunshea Heat stress in broilers.
Dr. Jeff Downing is collaborating with Dr Dana Cambelll (CSIRO) investigating the free range space allowance for laying hens on their production and welfare. Two papers were published and one submitted from this work in 2016.

Communications

Publications from PRF Staff & Students for 2016:

Bradbury EJ, Wilkinson SJ, **Cronin GM**, Thomson PC, Walk CL, Cowieson AJ (2016) Evaluation of the effect of a highly soluble calcium source in broiler diets supplemented with phytase on performance, nutrient digestibility, foot ash, mobility and leg weakness. *Animal Production Science* (In Press) http://dx.doi.org/10.1071/AN16142

Bradbury EJ, Wilkinson SJ, **Cronin GM**, Walk CL, Cowieson AJ (2016) Effects of phytase, calcium source, calcium concentration and particle size on broiler performance, nutrient digestibility and skeletal integrity. *Animal Production Science* (In Press) http://dx.doi.org/10.1071/AN16175

Campbell DLM, Hinch GN, **Downing JA**, Lee C (2016) Fear and coping styles of outdoor-preferring, moderate-outdoor and indoor-preferring free-range laying hens. *Applied Animal Behaviour Science* **185:** 73-77.

Campbell DLM, Hinch GN, **Downing JA**, Lee C (2016) Outdoor stocking density in free-range laying hens: Effects on behaviour and welfare. *Animal* (In Press) https://doi.org/10.1017/S1751731116002342

Cronin GM, Beganovic DF, Sutton AL, Palmer DJ, Thomson PC, Tammen I (2016) Manifestation of neuronal ceroid lipofuscinosis in Australian Merino sheep: Observations on altered behaviour and growth. *Applied Animal Behaviour Science* **175:** 32-40.

Cronin GM, Tran M, **Hartcher KM**, Hemsworth PH (2016) Free-ranging by laying hens soon after the pop-holes open. *Proceedings of the Australian Poultry Science Symposium* **27:** 72-75.

Cronin GM (2016) Balancing animal welfare and productivity in the pig and poultry industries: Two examples. More from less. Animal Welfare and Productivity. *Prococeedings of the Dairy Research Foundation Symposium, 16th June, 2016, Wagga Wagga, NSW.*

Cronin GM, Hopcroft RL, Groves PJ, Hemsworth PH (2016) The impact of a feather-pecking outbreak in an experimental free-range layer flock on growth, egg production, plumage damage and mortality. *Proceedings of the Australian Society for Animal Production, 31st Biennial Conference, Stamford Grand, Glenelg, South Australia.* Paper 1156, pp 59.

Cronin GM, Hopcroft RL, Hemsworth PH (2016) The effects of light intensity in weeks 1 to 7 of rearing for chicks, and stressors consisting of combined transport, relocation and mixing in week 16, on plumage damage, social avoidance and mortality, in adult free-range laying hens. *Proceedings of the 22nd World's Poultry Congress, Sept 5-9, 2016, Beijing China.* Paper S5-0025, pp. 482.

Doran R, **Hopcroft RL, Cronin GM** (2016) ISA Brown laying hens on the range are initially more attracted to overhead cover than perches. *Proceedings of the Australian Poultry Science Symposium* **27**: 87-90.

Dunlop MW, **Moss AF, Groves PJ**, Wilkinson SJ, Stuetz RM, **Selle PH** (2016) The multidimensional causal factors of 'wet litter' in chicken-meat production. *Science of the Total Environment* **562:** 766-776.

Dunlop MW, **Moss AF, Groves PJ**, Wilkinson SJ, Stuetz RM, **Selle PH** (2016) The multidimensional causal factors of 'wet litter' in chicken-meat production. *Engormix*, Published: 18/11/2016

Edwards JR, Manning JK, **Cronin GM**, Bishop T, Ingram LJ (2016) The effect of pasture type on sheep grazing behaviours. *Proceedings of the 2016 SELM Symposium, 31 March to 1 April 2016, Camden, NSW.* pp. 26.

Glencorse D, Bathgate R, **Cronin GM**, Grupen C, Thomson P, Clark C (2016) Predicting timing of oestrus in sows through behaviour patterns using tri-axial accelerometers. *Proceedings of the 2016 SELM Symposium, 31 March to 1 April 2016, Camden, NSW.* pp. 24.

Groves PJ, Muir WI (2016) Hock bruise in broilers are indicative of leg weakness. *Proceedings of the Australian Poultry Science Symposium* **27:** 59.

Groves PJ, Sharpe SM, **Muir WI**, Pavic A, Cox JM (2016) Live and inactivated vaccine regimens against caecal *Salmonella* Typhimurium colonisation in laying hens. *Australian Veterinary Journal* **94:** 387-393.

Groves PJ, Muir WI (2016) Earlier hatching time predisposes Cobb broiler chickens to tibial dyschondroplasia. *Animal* **11:** 112-120.

Groves PJ, Harris T, Sharpe SM (2016) Administration of a live *Salmonella* vaccine using an inactivated oil-emulsion vaccine as a vehicle for commercial chicken flocks. *Animal Production Science* (In Press) **http://dx.doi.org/10.1071/AN16521**

Hartcher KM, Hickey KA, Hemsworth PH, **Cronin GM**, Wilkinson SJ, **Singh M** (2016) Is range use related to fearfulness and plumage damage? *Proceedings of the Australian Poultry Science Symposium* **27**: 76.

Hartcher KM, Wilkinson SJ, Hemsworth PH, **Cronin GM** (2016) Severe feather-pecking in non-cage laying hens and some associated and predisposing factors: a review. *World's Poultry Science Journal* **72:** 103-114.

Hartcher KM, Hemsworth PH, Wilkinson SJ, Thomson PC, **Cronin GM** (2016) The association between plumage damage and feather-eating in free-range laying hens. *Animal* **10:** 854-862.

Hartcher KM, Hickey KA, Hemsworth PH, **Cronin GM**, Wilkinson SJ, **Singh M** (2016) Relationships between range access as monitored by radio frequency identification (RFID) technology, fearfulness and plumage damage in free-range laying hens. *Animal* **10:** 847-853.

Hartcher KM, Hickey KA, Hemsworth PH, **Cronin GM**, Wilkinson SJ, **Singh M** (2016) Using radio frequency identification (RFID) technology to improve our understanding of the relationships between range access, fearfulness and plumage damage in free-range laying hens. *Proceedings of the 2016 SELM Symposium, 31 March to 1 April 2016, Camden, NSW*. pp. 28.

Henriksen SE, **Cronin GM**, Ingram LJ, JK Manning (2016) Alternatives to direct behaviour observations for extensively managed livestock. *Proceedings of the 2016 SELM Symposium, 31 March to 1 April 2016, Camden, NSW*. pp. 10.

Hopcroft RL, Cowieson AJ, **Muir WI**, Freilihk J, Jovanovski M, **Groves PJ** (2016) Residual yolk sac calcium and phosphorus uptake over three days. *Proceedings of the Australian Poultry Science Symposium* **27:** 60.

Iqbal Z, Sharma N, Sharma NK, M'Sadeq S, Perez - Maldonado RA, Ramirez - Cuevas S, Robert J, Hilliar M, **Singh M**, Wu S, Swick RA, Ruhnke I (2016) Effect of pasture and feed additives on performance and egg quality in ranging laying hens. *Proceedings of the Australian Poultry Science Symposium* **27:** 145.

Larsen H, **Cronin GM**, Smith CL, Hemsworth PH, J-L Rault (2016) Use of different outdoor areas in commercial free-range layers using RFID technology. *Proceedings of the Australian Poultry Science Symposium* **27**: 77.

Larsen H, **Cronin GM**, Gebhardt-Henrich SG, Hemsworth PH, Smith CL, Rault J-L (2016) Individual tracking of free-range laying hens on an Australian commercial property using Radio Frequency Identification. *Proceedings of the 2016 SELM Symposium, 31 March to 1 April 2016, Camden, NSW*. pp. 8-9.

Larsen H, **Cronin GM**, Hemsworth PH, Smith C, Rault J-L (2016) Fear and access to the outdoor range in commercial free-range laying hens. *Proceedings of the 50th Congress ISAE, Edinburgh UK, 12-15 July 2016*. pp. 143.

Liu SY, **Truong HH**, Khoddami A, **Moss AF**, Thomson PC, Roberts TH, **Selle PH** (2016) Comparative performance of broiler chickens offered ten equivalent diets based on three grain sorghum varieties as determined by response surface mixture design. *Engormix,* Published: 22/08/2016

Liu SY, Cowieson AJ, **Selle PH** (2016) The influence of meat-and-bone meal and exogenous phytase on growth performance, bone mineralisation and digestibility coefficients of protein (N), amino acids and starch in broiler chickens. *Animal Nutrition* **2**: 86-92.

Liu SY, **Truong HH**, Khoddami A, **Moss AF**, Thomson PC, Roberts TH, **Selle PH** (2016) Comparative performance of broiler chickens offered ten equivalent diets based on three grain sorghum varieties as determined by response surface mixture design. *Animal Feed Science and Technology* **218:** 70-83.

Liu SY, **Sydenham CJ**, **Selle PH** (2016) Feed access to, and inclusions of fishmeal and corn starch in, sorghum-based broiler diets influence growth performance and nutrient utilisation as assessed by the Box-Behnken response surface design. *Animal Feed Science and Technology* **220:** 46-56.

Liu SY, **Selle PH**, Raubenheimer D, Cadogan DJ, Simpson SJ, Cowieson AJ (2016) An assessment of the influence of macronutrients on growth performance and nutrient utilisation in broiler chickens by nutritional geometry. *British Journal of Nutrition* **116:** 2129-2138.

Liu SY, Raubenheimer D, **Selle PH**, Gous RM, Hargreave G, Simpson SJ, Cadogan DJ, Cowieson AJ, (2016) Protein and energy ratios influence performance in broiler chickens. *Proceedings of the Australian Poultry Science Symposium* **27:** 170-173.

Mackay AH, Phalen D, **Singh M, Groves PJ, Cronin GM** (2016) Testing a model to initiate feather pecking in free-range laying hens. *Proceedings of the Australian Society for Animal Production, 31st Biennial Conference, Stamford Grand, Glenelg, South Australia*. Paper 1220, pp. 74.

Manning JK, **Cronin GM**, Gonzalez LA, Merchant A, Ingram LJ (2016) Heterogeneity in extensive production systems: how does it affect the grazing preference of beef cattle? *Proceeding of the Australian Society of Animal Production Conference, Southern NSW Branch, 2-3 February 2016, Camden NSW*. pp. 8.

Manning JK, **Cronin GM**, Gonzales LA, Merchant A, Ingram LJ (2016) The effect of pasture biomass on the grazing behaviour of beef cattle. *Proceedings of the 2016 SELM Symposium, 31 March to 1 April 2016, Camden, NSW*. pp. 6-7.

Manning JK, **Cronin GM**, Gonzales LA, Merchant A, Ingram LJ (2016) The impact of forage availability on livestock behaviour in Australian heterogeneous paddocks. *Proceedings of the Australian Society for Animal Production, 31st Biennial Conference, Stamford Grand, Glenelg, South Australia*. Paper 790, pp. 51.

McDonnell MJ, Bouwhuis MA, Sweeney T, **O'Shea CJ**, O'Doherty JV (2016) Effects of dietary supplementation of galactooligosaccharides and seaweed-derived polysaccharides on an experimental Salmonella Typhimurium challenge in pigs. *Journal of Animal Science* **94:** 153-156.

Moss AF, Truong HH, Cadogan DJ, Partridge GG, **Liu SY, Selle PH** (2016) The economic feasibility of elevated phytase inclusions in maize-based broiler diets. *Proceedings of the Australian Poultry Science Symposium* **27:** 166-169.

Moss AF, Sydenham CJ, Truong HH, Liu SY, Selle PH (2016) The interactions of exogenous phytase with whole grain feeding and effects of barley as the whole grain component in broiler diets based on wheat, sorghum and wheat-sorghum blends. *Animal Feed Science and Technology* (Accepted for publication)

Moss AF, Truong HH, Liu SY, Selle PH (2016) Exogenous phytase in poultry nutrition: recent advances and the potential for enhanced efficacy with complementary enzymes. *Poultry Science* (submitted for publication)

Moss AF, Chrystal PV, **Truong HH, Liu SY, Selle PH** (2016) Effects of pre- and post-pelleting whole grain additions and exogenous phytase on the performance of broiler chickens offered wheat-based diets plus phytase and protease supplementation of pre-pelleted whole grain diets. *Animal Feed Science and Technology* (submitted for publication)

Moss AF, Selle PH (2016) Causal Factors of 'Wet Litter' in chicken-meat production, Rural Industries R&D Corporation, Project Summary.

Muir WI, Groves PJ (2016) Using incubation temperature to manipulate broiler leg strength strength - an assessment in two commercial broiler lines. *Proceedings of the XXV World's Poultry Congress 2016, Beijing, China. September 2016* pp. 472.

Mukhopadhya A, Sweeney T, **O'Shea CJ**, O'Doherty JV (2016) A comparative study of alternatives to pharmacological doses of zinc for improving gut health parameters in weaning piglets. *Journal of Animal Science* **94:** 472-475.

O'Shea CJ, Wilkinson SJ, **Liu SY**, Bao Y, Dhand Y, **Selle PH**, Cowieson AJ (2016) An investigation into the interaction between dietary calcium and phosphorus on egg production and quality of laying hens using the geometric framework. *Proceedings of the Australian Poultry Science Symposium* **27:** 91-94.

O'Shea CJ, O'Doherty JV, Callanan JJ, Doyle D, Walsh AM, Ryan M, Thornton K, Sweeney T (2016) Seaweed-derived fucoidan and laminarin have distinct effects on inflammation in a porcine model of dextran sodium sulphate-induced ulcerative colitis. *Journal of Nutritional Sciences* **5:** e15.

Powell DJ, Velleman SG, Cowieson AJ, **Singh M, Muir WI** (2016) Importance of hatch time and access to feed on broiler muscle development. *Proceedings of the Australian Poultry Science Symposium* **27:** 56.

Powell DJ, Velleman SG, Cowieson AJ, **Singh M, Muir WI** (2016) Influence of chick hatch time and access to feed on broiler muscle development. *Poultry Science* **95(6):** 1433-1448. *(This paper was the Editor's choice in Volume 95(6).)*

Powell DJ, Velleman SG, Cowieson AJ, **Singh M, Muir WI** (2016) Influence of hatch time and access to feed on intramuscular adipose tissue deposition in broilers. *Poultry Science* **95(6):** 1449-1456.

Prescilla KM, Cronin GM, Liu S, Singh M (2016) Identifying feather pecking and feather eating ISA Brown hens using artificial feather presentation. *Proceedings of the Australian Poultry Science Symposium* **27**: 82-85.

Prescilla KM, Cronin GM, Liu S, Singh M (2016) Identifying feather eating ISA Brown hens using artificial feather presentation. *Proceedings of the 22nd World's Poultry Congress, Sept 5-9, 2016, Beijing China*. Paper S5-0035, pp. 486.

Rault, J-L, Clark KV, **Groves PJ, Cronin GM** (2016) Effects of light intensity on broiler productivity and leg health. *Proceedings of the Australian Poultry Science Symposium* **27:** 51.

Rault J-L, Clark K, **Groves PJ, Cronin GM** (2016) Light intensity of 5 or 20 lux on broiler behavior, welfare and productivity. *Poultry Science* **96:** 779-787.

Scott AB, Singh M, Hernandez-Jover M, Barnes B, Glass K, Moloney B, Lee A, **Groves P,** Toribio J-A (2016) On-farm surveys to inform avian influenza risk assessment model. *Proceedings of the Australian Poultry Science Symposium* **27:** 196.

Selle PH, Truong HH, Khoddami A, **Moss AF,** Roberts TH, **Liu SY** (2016) The impacts of hammer-mill screen size and grain particle size on the performance of broiler chickens offered diets based on two red sorghum varieties. *British Poultry Science* http://dx.doi.org/10.1080/00071668.00072016.01257777

Selle PH, Truong HH, McQuade L, **Moss AF, Liu SY** (2016) Reducing agent and exogenous protease additions, individually and in combination, to wheat- and sorghum-based diets interactively influence parameters of nutrient utilisation and digestive dynamics in broiler chickens. *Animal Nutrition* **2:** 303-311.

Selle PH, Khoddami A, **Moss AF, Truong HH, Liu SY** (2016) RVA starch pasting profiles may be indicative of feed grain quality. *Proceedings of the Australian Poultry Science Symposium* **27:** 255-258.

Selle PH, Liu SY (2016) Phytate as an antinutrient. 9th AFMA Forum, 1st–3rd March 2016. Sun City, South Africa. Animal Feed Manufacturers' Association. Pretoria, Republic of South Africa.

Singh C, Verdon M, **Cronin GM,** Hemsworth PH (2016) The behaviour and welfare of sows and piglets in farrowing crates or lactation pens. *Animal* (In Press).

Singh M (2016) CRC AI Risk Project An overview. *2016 Poultry Information Exchange (PIX) and Australasian Milling Conference (AMC), PIX/AMC 2016, Gold Coast. Australia, 1-2 June 2016.*

Singh M, Ruhnke I, De Koning C, Drake K, Hinch G, Skerman A (2016) Nutrient loading on free range layer farms. Proceedings of the Australian Poultry Science Symposium **27:** 29.

Singh M, Hernandez CE, Lee C, Hinch G, Cowieson AJ (2016) Wanderers versus stay at home: who has the better guts? *Proceedings of the Australian Poultry Science Symposium* **27:** 78.

Sydenham CJ, Truong HH, Moss AF, Selle PH, Liu SY (2016) The differing impacts of fishmeal and corn starch inclusions in sorghum-soybean meal diets on growth performance, nutrient utilisation, starch and protein digestive dynamics of broiler chickens. *Animal Feed Science and Technology* (in preparation)

Truong HH, Yu S, **Moss AF, Liu SY, Selle PH** (2016) Phytate degradation in the gizzard is pivotal to phytase responses in broiler chickens. *Proceedings of the Australian Poultry Science Symposium* **27:** 174-177.

Truong HH, Liu SY, Selle PH (2016) Starch utilisation in chicken-meat production: the foremost influential factors. *Animal Production Science* **56:** 797-814.

Truong HH, Cadogan DJ, **Liu SY, Selle PH** (2016) Addition of sodium meta-bisulfite and microbial phytase, individually and in combination, to a sorghum-based diet for broiler chickens from 7 to 28 days post-hatch. *Animal Production Science* **56:** 1484-1491.

Truong HH, Neilson KA, Mclnerney BV, Khoddami A, Roberts TH, **Liu SY, Selle PH** (2016) Sodium metabisulphite enhances energy utilisation in broiler chickens offered sorghum-based diets with five different grain varieties. *Animal Feed Science and Technology* **219:** 159-174.

Truong HH, Neilson KA, Mclnerney BV, Khoddami A, Roberts TH, Cadogan DJ, **Liu SY, Selle PH** (2016) Comparative performance of broiler chickens offered nutritionally equivalent diets based on six diverse, 'tannin-free' sorghum varieties with quantified concentrations of phenolic compounds, kafirin, and phytate. Animal Production Science http://dx.doi.org/10.1071/AN16073

Truong HH, Moss AF, Liu SY, Selle PH (2016) Pre- and post-pellet whole grain inclusions enhance feed conversion efficiency, energy utilisation and gut integrity in broiler chickens offered wheat-based diets *Animal Feed Science and Technology* **224:** 115-123.

Truong HH, Chrystal PV, **Moss AF**, **Liu SY**, **Selle PH** (2016) Effects of rapidly digestible protein (casein) or exogenous phytase on protein and starch bioavailability in broiler chickens offered maize-soy diets (in preparation)
Vigors S, Sweeney T, Kelly AK, **O'Shea CJ**, O'Doherty JV (2016) The effect of divergence in feed efficiency on the intestinal microbiota and the intestinal immune response in both unchallenged and lipopolysaccharide challenged ileal and colonic explants. *PloS One* (In Press) http://dx.doi.org/10.1371/journal.pone.0148145
Vigors S, Sweeney T, Fahey A, **O'Shea CJ**, O'Doherty JV (2016) The relationship between feed efficiency and the expression of genes associated with appetite control in the hypothalamus and intestine of pigs. *Journal of Animal Science* **94:** 222-225.
Vigors S, Sweeney T, Kelly AK, **O'Shea CJ**, O'Doherty JV (2016) Pigs that are divergent in feed efficiency, differ in intestinal enzyme and nutrient transporter gene expression, nutrient digestibility and microbial activity. *Animal* **10:** 1848-1855.

Invited Presentations from PRF Staff & Students for 2016:

Cronin GM (2016). Balancing animal welfare and productivity in the pig and poultry industries: Two examples. More from less. Animal Welfare and Productivity. Proc. Dairy Research Foundation Symposium, *Wagga Wagga NSW 16 June 2016*.
Singh M (2016) Poultry CRC AI Risk Project: An Overview. AVPA Scientific Meeting, 1-2 June 2016, Gold Coast, Australia.
Singh M (2016) Free Range Production Survey and Range Nutrients. Egg Masterclass, 16th August 2016, Canberra, Australia.

Financial Report and Statements

2016 was another busy year with the facilities being fully utilised again, with all the researchers looking for spare space in the sheds.

We lost one member in 2016 - ADM who had been a proud sponsors and contributors to the Foundation since its inception but due to company restructures was unable to continue at present but hopes to return at a future date, we would like to formally acknowledge their support over the years and hope to see them return. We would also like to thank all the current foundation members for their continued to support of the Foundation through this uncertain time and trust that we can continue to meet their needs.

The finance reports show that the $ 8,735 deficit wasn't really the case as there was an adjustment of $16,941 from 2015 giving us an overall surplus of $ 8206 for the year. Hopefully all the adjustments have now been picked up within the University accounting system and we will have a straightforward year for 2017.

The increase in Salaries, which should have seen a decrease due to the removal of Jo-Ann Geist's salary, is due to a journal that was raised to cover off an overspend on a research account for casual salaries along with the Foundation supporting two PhD Students, Miss Amy Moss and Miss Alannah MacKay.

Our only major equipment purchases this year through the Foundation was a new Freeze Dryer along with 2 Pumps so that we have backup if one goes down. The unit is experiencing a huge workload with the number of trials that we are currently running. The other increase included in the report was for renovations to office space (the Blue Room) as noted on the financial statement.

It will be interesting to see where 2017 leads, but the accounts are in good order to move forward.

Jo-Ann Geist
March 2017

The University of Sydney

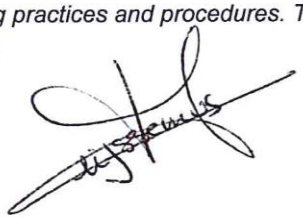
The Poultry Research Foundation

Income Statement

for the year ended 31st December 2016

	Notes	2016	2015
		$	$
INCOME			
Business and Investment Income	2	340,338	189,090
Scholarships, Donations & Bequests		-	-
Memberships and Subscriptions		56,000	64,500
Symposium Income		181,157	178,659
Total Income		**577,494**	**432,249**
EXPENDITURE			
Salaries		154,375	131,658
Consumables		13,348	12,868
Equipment and Repairs & Maintenance	3	37,384	8,556
Services and Utilities	4	119,666	33,818
Travel, Conferences and Entertainment		30,296	33,020
Contributions to University areas		24,186	12,433
Commercial Business Expense		49,797	49,431
Other Expenses	5	157,177	16,643
Total Expenditure		**586,229**	**298,426**
SURPLUS / (DEFICIT)		**(8,735)**	**133,823**
Accumulated Funds brought forward 1st January		508,165	240,127
Prior Year Adjustment	6	16,941	134,215
Accumulated Funds as at 1st January		525,106	374,343
ACCUMULATED FUNDS AS AT 31ST DECEMBER		**516,371**	**508,165**

I certify that the Income Statement and Balance Sheet of the Foundation have been prepared in accordance with the University's accounting practices and procedures. These Foundation accounts form part of the University of Sydney's financial reports.



Anne-Laure Rijssemus
Finance Director
Divisions of Natural Sciences, Engineering & Information Technologies and Business
31st March 2017

The University of Sydney

The Poultry Research Foundation

Balance Sheet

as at 31st December 2016

	Notes	2016 $	2015 $
ASSETS			
CURRENT ASSETS			
Short Term Investments		516,371	508,165
Total Current Assets		**516,371**	**508,165**
TOTAL ASSETS		**516,371**	**508,165**
LIABILITIES			
CURRENT LIABILITIES			
Total Current Liabilities		-	-
TOTAL LIABILITIES		-	-
NET ASSETS		**516,371**	**508,165**
EQUITY			
Accumulated Funds		516,371	508,165
TOTAL EQUITY		**516,371**	**508,165**

Notes to the Financial Statements

1. Accounting Policies
   - The financial statements have been prepared on a modified accrual accounting basis.
   - All fixed assets are expensed in the year of purchase.
   - Employee entitlements for Long Service Leave are held centrally in the University's accounts.
   - The University (including the Foundations) is exempt from income tax.
2. Income increased in 2016 due to strong commercial research performance.
3. It includes an one-off payment of $18k for an office renovation project, and higher general costs of repairs for aged equipment
4. It includes $77k for catering cost related to the 2016 Australian Poultry Science Symposium (APSS), as well as payments for the 2017 APSS.
5. Other Expenses includes:
   - $50k of Commercial Business Expenses due to increased commercial research activities.
   - $84k of Spendvision Accrued Expenditures for which the coding was delayed until January 2017.
6. The adjustment represents the reimbursement of salary expenditure from Research Grant projects. realised in prior years