



CRC FOR HIGH
INTEGRITY
AUSTRALIAN
PORK

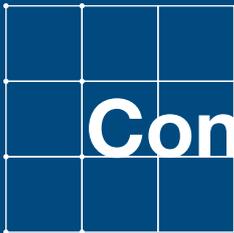


Annual Report 2012–2013



An Australian Government Initiative





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PORK CRC ANNUAL REPORT 2012–2013

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Mission Statement

To differentiate Australian pork as a 'high integrity' meat that is welfare-optimal, premium quality, nutritious, in high demand nationally and internationally, and which is produced while conserving energy and water, minimising greenhouse gas emissions and maintaining efficiency and cost of production at levels which encourage investment, growth and sustainability.

Outcomes

A key challenge for Australia's pork industry is to produce high quality food for sale at a reasonable price, and with a satisfactory return on production capital invested, without negatively impacting pig welfare, the environment or the health of the consumer.

Through innovative, collaborative, whole value chain research, development and education programs within a CRC, the Australian pork industry can meet this challenge and has unique potential compared with other foods, meats and sources of pork by facilitating production that:

- 1.** Is efficient and ethical, without the need for sow confinement in stalls or crates, or widespread use of medications.
- 2.** Safely delivers key nutrients, enhancing the health and well-being of consumers.
- 3.** Utilises innovative feed sources and effluent management systems, resulting in emissions of less than 1 kg of CO₂ per kg of pork produced.
- 4.** Contributes significantly to Australia's economic growth and food security without drawing on the ecological capital of other parts of the world.

Chairman's Report

Welcome to the second annual report of the Co-operative Research Centre for High Integrity Australian Pork.



Dr John Keniry AM

At the time of writing, the CRC has been operating for just over two years. The research is divided into four programs which collectively focus on increasing the consumer appeal of pork and modifying production systems to align with consumer trends in welfare, medication, human nutrition and carbon consciousness, while still maintaining a competitive cost structure within the industry. The first two years have been devoted principally to establishing research contracts required to meet our milestones. Worthwhile progress, which is reported on within the body of the report, has been made across all four programs and we have completed almost all of the projects carried over from the first CRC.

During the year, we were involved in the first year review of the CRC which was led by Chair of CRC Committee, Mr Neville Stevens AO, assisted by officers from the CRC secretariat in Department of Innovation. We came through that review very well and were able to discuss with the review panel the need to revise some of our milestone commitments, particularly those within Program 1 which required modification due to rapid market-driven movements by commercial producers to reduce sow confinement. These changes were understood and accepted by the panel and formally agreed to shortly after the review.

As I indicated in my chair's remarks last year, further

funding for a Pork CRC will not be available at the conclusion of the present CRC in June 2019. Throughout the year, discussions have been on-going between board members and core participants with a view to devising a structure and funding arrangement that can be put in place by 2019 to continue a collaborative research program for the pork industry without continued funding from the Australian Government. Progress towards that end has been substantial, but a definitive proposal is yet to be finalised. Hopefully, a conclusion can be reached in 2014.

As foreshadowed at last year's AGM, I have elected to retire as chair and director at the conclusion of the forthcoming AGM in November 2013.

The board is supporting the appointment of Dennis Mutton as chair, who joined the board as a director in 2012 and has engaged himself meaningfully and professionally in the activities of the CRC since that time. Apart from that change in board composition, no other changes are being recommended to Participants by the Nomination Committee at the forthcoming AGM.

My retirement from the board will bring to an end eight years as chair of the present CRC and its predecessor, The CRC for an Internationally Competitive Pork Industry. In this, my final chair's report, I think it is appropriate to make some observations based on my experiences over those eight years.

Firstly, I will make some general observations on the trans-Tasman pork industry. On both sides of the Tasman, the pork industry is exposed to a highly concentrated domestic retail sector and significant competition from imports, from countries whose governments do not always have the same rigorous approach to free markets and lack of producer subsidies as do the Australian and New Zealand Governments. In the face of this highly competitive situation, the domestic producers demonstrate remarkable resilience and adaptability. Compared with some other rural industries, pork producers thirst for new, more efficient ways of doing things and information and technology transfer is well developed. In this regard, their peak bodies play a major role, and are well focused on achieving good outcomes for their members. Those same peak bodies have always been supportive of the CRCs and have worked constructively with them. The same must also be said of our Participants, both commercial producers and research providers, plus third parties. They have been universally supportive of, and interested in, the work of the CRC. Our major Participant, the Australian Government, operating through Department of Innovation, has provided not just a large proportion of our cash, but also much support, discipline and encouragement along the way. There have been many excellent CRC's which

have benefitted industries and Pork CRC has been one of them.

The Pork CRCs have demonstrated very well the ability of major producers, who on a day-to-day basis compete vigorously for domestic market, to work together on pre-competitive research and to work constructively to implement outcomes for the benefit of industry as a whole. To that end, I pay a special tribute to the many CRC board members over the years who have contributed their in-depth knowledge of pork production and marketing to the CRCs, and then applied it to focus and then drive the research agenda of the CRCs towards commercially beneficial outcomes.

And, of course, nothing is achieved other than through the endeavour of people. Throughout the eight years, we have benefitted from the wisdom of a number of directors, both independent and non-independent and our board meetings have been forums for free expression of ideas and constructive debate. It has been a privilege to have been involved and I thank my fellow directors most sincerely for the interactions.

Then there is the management. We were extremely fortunate in the early days of the first CRC to entice Roger Campbell to return to Australia to take on the role of CEO. Roger's interest in science, coupled with his comprehensive domestic

and international knowledge of pigs and pork production, are surpassed only by his enthusiasm and commitment to achieving research outcomes for Australasian producers and for seeing them implemented throughout the industry. Throughout the period, Roger has had substantial support from his central office staff, his program leaders and, of course, the scientists. I want to say a special thank you to Roger and his team. They have achieved a huge amount for the industry and, consistent with the aims of the CRC program, have developed the next generation of scientists to carry the industry forward.

While much has been achieved, much more remains to be done. I believe both the team and the structure are in place to maintain the momentum, and I wish the team and the trans-Tasman industry continued success.



**Dr John Keniry, AM
Chairman**



CEO's Report

Since the establishment of the CRC for High Integrity Australian Pork (Pork CRC) in 2011...



Dr Roger Campbell

Australia's pork industry has moved quite rapidly to group housing of pregnant sows and during the past year has enjoyed relatively high and stable pig prices and certainly wasn't disadvantaged compared to our global competitors in terms of feed costs. Longer term success will continue to be linked with further differentiating the industry on how pork is produced and ensuring our pork is of consistently high eating quality.

I am pleased to advise in our second annual report that we have achieved excellent outcomes across our R&D and Utilisation programs that will assist producers to maximise animal welfare and performance in group housed systems for sows, offer opportunities for further differentiating how we manage sows and piglets and to increase the eating quality and demand for Australian pork.

In Program 1 – *Reduced Confinement of Sows and Piglets* – we released the manual Feeding Pregnant Sows in Group Housing Systems – An Update. Published in conjunction with Australian Pork Limited, it provides information generated by Pork CRC researchers on the effects on sow performance of feeding levels in early and late gestation. The research outcomes effectively turned upside down the traditional 'rules' of how to feed pregnant sows. Most relevant to group housed sows, has been the finding that higher feeding levels in early gestation has no adverse effects on subsequent reproduction, and there is increasing evidence

that higher feeding levels may enhance subsequent reproduction, especially in more prolific genotypes. These findings are very pertinent to group housed sows because higher feeding levels and greater access to feed after mixing can help reduce aggression and enhance welfare. University of Adelaide and SARDI researchers showed that in late gestation increasing feed intake in the final 3-6 weeks of gestation had little or no effect on piglet birth weight or survival and no obvious effects on sow reproduction, suggesting the practice may be a waste of feed and for younger sows feed intake could be reduced in lactation.

Researchers have also been able to develop protocols to induce oestrus in lactating sows and have shown that it is possible to achieve similar levels of reproductive performance in sows mated during lactation to those conventionally weaned and mated. This is innovative R&D at its very best, because similar outcomes have not previously been achieved and the research has the potential to enable weaning age to be increased and piglet performance and health improved without adversely affecting reproduction. Linked with this, our research on alternative farrowing systems has shown there are many farrowing systems which provide the sow with more room and freedom, but all have different performance and welfare outcomes and implications. Our researchers have also shown that most of the freedom-type pens developed for

Europe require modification for Australian situations, especially for our summer. One of the projects was conducted on Melville Charles' farm and managed by Geordie Charles and Clara Singh, a Pork CRC postgraduate student with the University of Melbourne. They looked at the welfare and performance of sows and piglets farrowed in conventional crates, but moved to pens or crates three days after birth. In Clara's work there was no effect of housing, after three days, on piglet survival or performance to weaning, but more positive welfare outcomes for sows and piglets housed in pens subsequent to three days. In a larger project in the same facilities, however, piglet survival was significantly lower in the lactating pen and this is a common outcome with the alternative farrowing systems to date. The project is continuing to collect more welfare and performance data and we thank Melville and Geordie for allowing us access to their facilities and their excellent inputs and contributions. The outcomes from other projects in the area are detailed under Program 1 in the annual report.

For sows grouped in gestation, management and feeding immediately after mixing appears to be one of the secrets to success based on sow welfare and reproduction. All our commercial participants have converted from gestation crates to group housing and it would be fair to say all do it differently from one another and across their units. All are achieving good to excellent results and we will provide industry with case



The University of Melbourne is leading projects which will develop a predictive model of pork quality that will hopefully become the basis for providing the supply chain with information on how to assure that only the highest quality pork is produced.

studies across the participants in 2013/14.

Program 2 – *Herd Health Management* – has seen the development of new diagnostics for a range of pathogens, progress on the selection of pigs for robustness and disease resilience and some very novel alternative health therapies, with a project managed by Dr Jae Kim at DAFWA showing that the impact of *E. coli* infection on animal performance and health can be markedly reduced by including some common but novel ingredients in the diet. Other researchers are investigating the effects of dietary fibre and specific amino acids on *E. coli* disease.

In Program 3 – *Healthy Pork Consumption* – Heather Channon, APL and Frank Dunshea, University of Melbourne, caught everyone's attention, including processors, wholesalers and retailers, when they published the first results of four projects on eating quality pathways for Australian pork. They showed that some cuts, particularly the loin, had high fail rates based on consumer perception of eating quality and repurchase intentions. The fail rate for the loin was as high as 36%, which is clearly a constraint on enhancing demand and purchases of high integrity Australian pork. However, the research outcomes enable us to also identify pathways to premium quality pork and to develop interventions to reduce the fail rate and it is the first time we have ever had such quantitative data based on consumer perceptions/preferences.

The latter is essential, because the research has clearly demonstrated little relationship between the more traditional measures of pork quality and what the industry and researchers might think contributes to good eating quality and what the consumer thinks. This is exciting research with the potential to lead to greater demand for Australian pork and greater returns for producers, although the responsibility for improving eating quality goes well beyond the farm gate.

We have had similar breakthroughs in our research on the human health attributes of Australian pork. Dr Samir Samman from the University of Sydney showed the plasma indicators of human health differed between participants consuming pork and chicken. Histidine, in particular, was significantly and consistently higher in the plasma of people after consuming pork rather than chicken. Histidine is a positive indicator of cardiovascular health (effects) and of weight loss, and his results may explain some of our previous research in which participants consuming pork lost weight compared to those who remained on their 'normal' diets or were put on alternative diets. We have one long term project with the University of South Australia and a number of shorter term innovation projects looking at the effects of pork on human health and I expect the outcomes will have considerable implications. I've no doubt, as I've said before, "There is something about pork" and hopefully we can confirm

and define its positive effects on human health.

Program 4 – *Carbon Conscious Nutrient Inputs and Outputs* – successfully established the Bioenergy Support Program (BSP) at the University of Queensland where BSP leader Dr Stephan Tait has worked tirelessly providing producers and regulators and many others with advice on the installation and operation of effective Biogas systems.

We have also conducted a number of LCAs and reviews on the use of algae for water remediation and feed, and on grain processing.

Outcomes from research on grain processing and feed manufacture continue to demonstrate there is still considerable money left on the table in how we prepare grain and feed for pigs, and the research is continuing. Our research on NIRS to rapidly determine the nutritive value of grains and protein meals has continued to demonstrate considerable variation in the DE of grains and the reactive lysine content of soy bean meal and canola meal. For grains, much of the variation in DE is associated with growing conditions and can only be taken into account in diet formulation by using the AusScan calibrations to measure what you have.

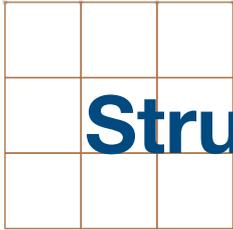
Research in all programs is extremely active and our researchers remain enthusiastic and innovative, hence on behalf of the board and industry I thank them all for their contributions to Pork CRC. Without them, our

students and our participants, who work closely with researchers and students, the technologies and knowledge needed to differentiate the Australian industry would not be generated.

This year will be the last Dr John Keniry will chair Pork CRC. John is stepping down in November, 2013 after chairing the first Pork CRC for six years and the CRC for High Integrity Australian Pork (HIAP) for its first 29 months. John is a unique individual, skilled in management, science and research, and he therefore has the respect of all directors and staff. His leadership was pivotal to the success of the first Pork CRC and the establishment and effectiveness of the CRC HIAP. He has helped me enormously and his guidance and advice will be missed. On behalf of the directors, staff and participants of Pork CRC, I sincerely thank John for all he has done and wish him the best in his future endeavours.



Dr Roger Campbell
CEO

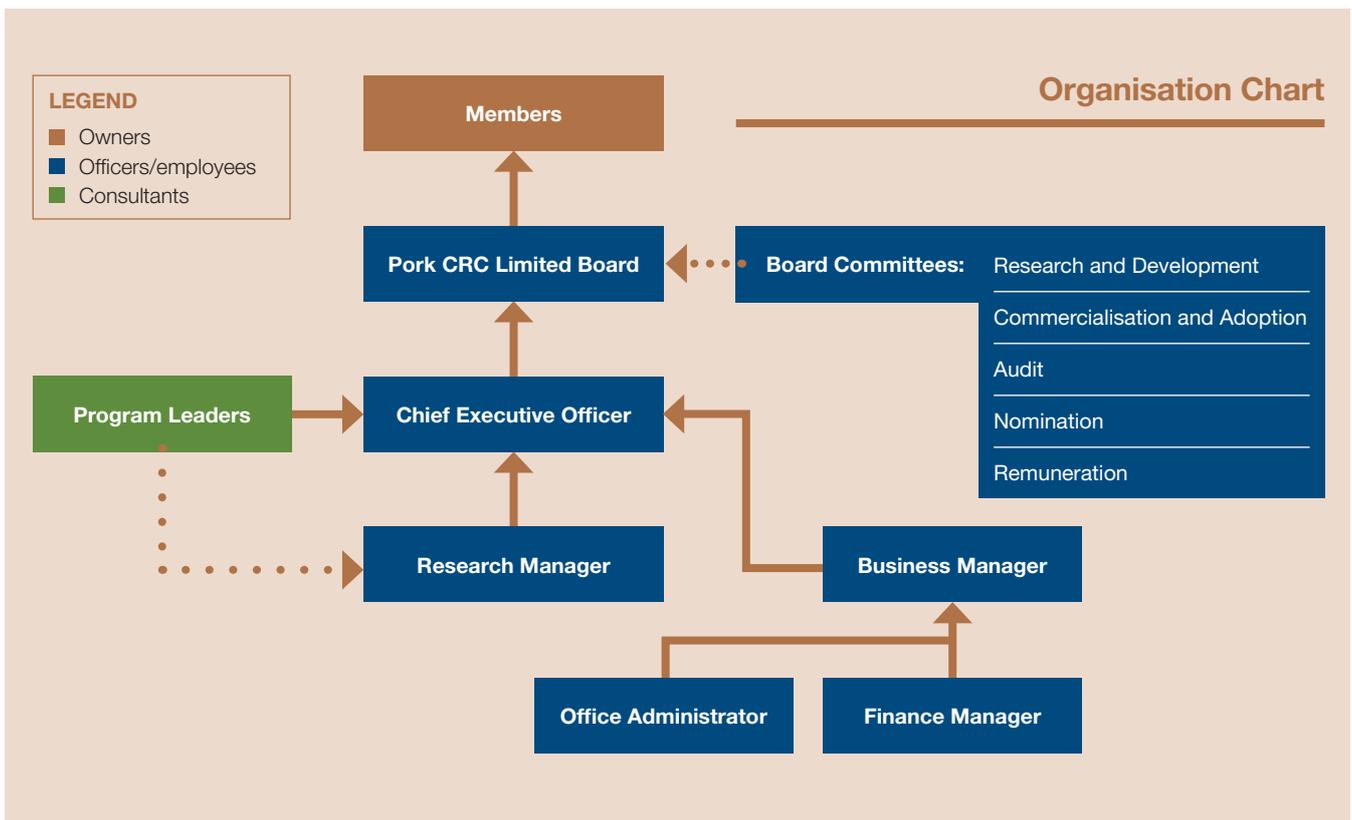


Structure

Pork CRC Limited was established in April 2011 as a company limited by guarantee.

Pork CRC Limited was established in April 2011 as a company limited by guarantee. The governance and management structure ensures effective collaboration between the participants through:

- A high level of involvement of commercial participants on the CRC Board, various committees and in specific research and development projects
- A relatively flat management structure with a high level of involvement from Program and Subprogram leaders
- World-renowned pig research scientist, Dr Roger Campbell, was appointed CRC Chief Executive Officer (CEO) following the achievements of the CRC for an Internationally Competitive Pork Industry. His success in the position has been through his broad knowledge and familiarity with many of the research organisations, researchers and industry participants. His professionalism and expertise is well placed to ensure the strategic objectives of the CRC are met through effective collaboration
- Many of the participants in Pork CRC are also end users of the technology that is being developed, thereby facilitating rapid uptake and collaborative working relationships to ensure outputs remain commercially focused.





Governance

The Board is responsible for decisions relating to the investment of Pork CRC Limited funds, the research program, protection and commercialisation of intellectual property, as well as management of the Pork CRC.

The Board met five times during the 2012–13 reporting period.

Board membership consists of:

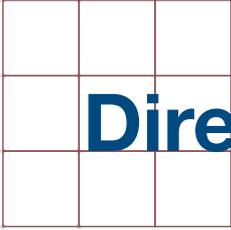
- an independent chair.
- a director nominated by Australian Pork Limited.
- three directors to represent private producer companies, nominated by the directors on the recommendation of the Nomination Committee following consultation with private producer companies.
- two directors to represent public sector research providers, nominated by the directors on the recommendation of the Nomination Committee following consultation with public sector research providers.
- five independent directors.

Members (if seconded by another Member) are also entitled to nominate a director.

All nominees must add skills to the Board in one or more of the following areas:

- a]** as a member of the Australian Institute of Company Directors or other qualifications to be a director.
- b]** Pork production and processing.
- c]** Business management.
- d]** Finance and accounting and/or auditing.
- e]** Corporate governance.
- f]** Marketing.
- g]** Administration and commercialisation of research and development.
- h]** Environment.
- i]** Animal science and welfare.
- j]** Education.
- k]** any other skills determined by the directors from time to time.

Individual Directors have a right to obtain information necessary for them to discharge their duties from executives employed by the Pork CRC. The Pork CRC Board has approved the Governance Charter that provides the procedures for Directors to seek independent professional advice, at the expense of the company if any Director wishes to do so, subject to prior agreement of the Chairman which is not to be unreasonably withheld.



Directors and Officers

Board of Directors for the financial year 2012–2013.



Dr John Keniry AM



Ms Kathryn Adams



Ms Sandra Di Blasio



Mr Rod Hamann



Prof Simon Maddocks



Mr Dennis Mutton



Prof John Pluske



Mr Kenton Shaw



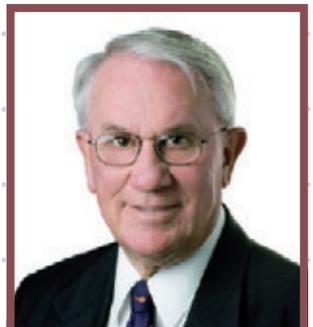
Mr Andrew Spencer



Mr Chris Trengrove



Prof Robert van Barneveld



Dr Hugh Wirth AM

Current Directors

DR JOHN KENIRY AM

**BSc (Hons), PhD, FRACI,
FTS, FAICD**

Dr Keniry has extensive experience as director and chairman of a number of public and private sector organisations. He is presently the Commissioner for Natural Resources in NSW, and is also Chairman of Sheep CRC Limited, Sydney Institute of Marine Science and the Australian Wool Exchange. He has previously held Board positions on the Pig R&D Corporation, the Industry Research and Development Board and was a member for six years of the Prime Minister's Science, Engineering and Innovation Council.

MS KATHRYN ADAMS

**BSc.Agr (Hons), LLM, M.Bus,
M.Env.Stud, Grad Dip Leg Pract,
FAICD**

Kathryn Adams is an Agricultural Scientist and a lawyer. She has extensive experience in industry focussed R&D investment for agribusiness having held senior executive and Board positions in the public and private sectors, including CEO of two R&D Corporations and Director of the Queensland Horticulture Institute. She was the first Registrar of Plant Breeder's Rights in Australia and an Executive Director with the Queensland EPA. After retiring she became a part-time Senior Research Fellow with the Australian Centre for Intellectual Property in Agriculture (ACIPA) at Griffith University and is on a number of agribusiness Boards.

MS SANDRA DI BLASIO

BA (Acc), CPA, GAICD

Ms Di Blasio commenced her working career in the public service as an auditor and then for a major chartered accounting firm both in Adelaide and Sydney. Her most recent role was with BT Financial Group (Westpac) as Head of Operational Risk.

MR ROD HAMANN

RDA(Ag)

Mr Hamann currently holds the positions CEO and Managing Director of Australian Pork Farms Group Limited plus Director of Big River Pork Abattoir. He retains Directorships for Auspork Limited and PorkScan Pty Ltd. He also sits as a member of the South Australian government appointed Pig Industry Advisory Group, the latter charged with recommending state based research projects to the SA Agriculture Minister. He is a Delegate for the peak pork Industry body – Australian Pork Limited – while also being part of the Pork Executive of Pork SA, the state based producer representative group.



PROF SIMON MADDOCKS

BAGSci (Hons), PhD, FAIAST, FAICD

Prof Maddocks currently holds the position of Director Science Partnerships at the South Australian Research & Development Institute (SARDI). He is Chairman of the Governing Board of the Menzies School of Health Research, based in Darwin and Deputy Chairman of the Menzies Foundation in Melbourne. He has extensive experience in research, education, management and governance, and has held previous Board positions with the Salinity CRC and Pest Animal Control CRC. He is a member of the national Primary Industries Standing Committee (PISC) Research, Development and Extension Committee.

MR DENNIS MUTTON

BSc.(Hons), Grad Dip Mgt, JP, FAICD, FAIM.

Mr Dennis Mutton is an experienced Board Chair and Director and an Independent consultant in resource planning and development, leadership, strategic management and regional development. He is Chair of BioSA and the Native Vegetation Council SA. He is also a member of the Premier's Science and Industry Council SA, the Australian Landcare Council and a Director of WPG Resources Ltd. He is the previous Chair of the Grape and Wine Research and Development Corporation and the Council of Rural R&D Corporations. He has had a distinguished career in the South Australian Public Service and industry including as Chief Executive of Primary Industries and Resources SA, the Department of Environment and Natural Resources and the Woods and Forests Department.

PROF JOHN PLUSKE

BSc(Agric)(Hons), PhD (WA)

Prof John Pluske is located at Murdoch University. Prof Pluske is a nutritional digestive physiologist with particular expertise in the nutrition and growth and development of the young and growing pig. He has extensive managerial experience in the University environment.

KENTON SHAW

BAppSci, GradDip ManMgt

Mr Kenton is currently General Manager – Agricultural Operations for Rivalea Australia, having held the role since 2007. A graduate of the University of Queensland, Kenton began employment at Corowa in 1989. He progressed through the organisation; working in various leadership roles across the diverse production systems within the group throughout Southern NSW & Victoria. He is a member of the Victorian Farmers Federation Pork Committee and an Australian Pork Ltd delegate. While responsible for all pig production and more recently feed milling, at Rivalea, a major focus is on implementing sustainable production systems that enhance animal welfare & meet the needs of the public while ensuring long-term viability of the organisation & industry.

MR ANDREW SPENCER

BAGSc (Melb), GAICD

Mr Spencer currently holds the position of APL's CEO which he took up in 2005 after a twenty year career in agribusiness, both in Australia and internationally. A large part of that time was spent in the agricultural chemical industry where he held marketing and general management roles in Australia, Germany and South Africa.

In 2000, Mr Spencer moved to France to work in the agricultural biotechnology and seeds markets, particularly in global cotton, canola and rice cropping segments. Andrew comes from an agricultural upbringing. His family had cattle, sheep and cropping farms, resulting in his choice to complete a degree in Agricultural Science.

MR CHRIS TRENGROVE

A New Zealand pork producer, Mr Trengrove was a Director of NZ Pork for the past 15 years, and was Chairman for nine years. For the past 30 years he has owned and managed a 450 sow outdoor piggery, in partnership with wife Judith, having previously spent a decade in banking. For five years he chaired the R&D Committee of NZ Pork and served for five years on the Massey University/NZ Pork Consultative Committee.

PROF ROBERT VAN BARNEVELD

B.Agr.Sc. (Hons), PhD, RAnNutr, FAICD

Prof Robert van Barneveld holds a range of positions within the pork industry and other primary production sectors. Prof van Barneveld is a Non-Executive Director of the Ridley Corporation, Chairman of PorksCan Pty Ltd, a Director of Sunpork Pty Ltd, Sunpork Fresh Foods Pty Ltd, Swicker's Kingaroy Bacon Factory Pty Ltd, Barneveld Nutrition Pty Ltd, the BECAN Consulting Group Pty Ltd. In addition, he is Deputy Chair of the Autism CRC Ltd. In addition to working as a Consultant Research Scientist and Nutritionist, Prof van Barneveld acts as General Manager of the CHM Alliance Pty Ltd.

DR HUGH WIRTH AM, KSJ

**BVSc (Hons), DVSc (Melb), MRCVS,
FAVA, MAICD**

Dr Hugh Wirth has spent his professional life in mixed veterinary practice. He is currently honorary president of RSPCA Victoria. He is the former national president of the RSPCA and the World Society for the Protection of Animals and is still a member of the Boards of these organisations. He has also held a range of positions within the veterinary profession.

Since 1980 Dr Wirth has been appointed to a large number of national and state government and industry animal welfare advisory committees covering many animal species. He is currently a member of the Australian Animal Welfare Advisory Committee (AusAWAC) and the Victorian Animal Welfare Advisory Committee.

Directors Retiring in Term

MR BRIAN HALSTEAD

BE (Hons), BEc, CPA

November 13, 2012

Mr Halstead has held the positions of Past Chairman Peer Support Foundation, Freightcorp, Past Director – Greening Australia NSW, Unilever Australia Ltd and Unilever New Zealand and Commercial Director EOI Division, Director and Trustee Unilever Aust Superannuation Fund.



Mr Brian Halstead

Company Secretary

MR GEOFF CROOK

BSc (Hons), FCA, GAICD

Mr Geoff Crook was appointed to the position of Company Secretary following incorporation of the Company on 6 April 2011. Mr Crook previously held the roles of business and finance manager with the CRC for an Internationally Competitive Pork Industry, finance and compliance manager with the Grape and Wine Research and Development Corporation and prior to that held the position of Chief Financial Officer and Company Secretary of an ASX listed software company.

Board Committees

Membership as of June 30, 2013

Research and Development Committee

The primary function of the Committee is to provide leadership for the research conducted by the Pork CRC and make recommendations to the Board in relation to investments in research programs and projects.

The Research and Development Committee conducts annual reviews of all projects and monitors research project performance.

The Research and Development Committee consists of the Chairman, Chief Executive Officer, a representative from each Essential Participant, along with Program Leaders and a Pork CRC director with animal welfare expertise:

- Dr John Keniry, Pork CRC, Director (Chair)
- Dr Roger Campbell, Pork CRC, CEO, Leader – Program 6

- Dr Jeff Downing, University of Sydney
- Dr Darryl D'Souza, APL, Leader – Program 3
- Prof Frank Dunshea, University of Melbourne
- Mr Rod Hamann, Pork CRC, Director, APFG
- Dr Ray King, Leader – Programs 1 & 5
- Dr Brian Luxford, Rivalea (Australia) Pty Ltd, Leader – Program 2
- Dr Bruce Mullan, DAWFA
- Mr Dennis Mutton, Pork CRC, Director
- Assoc Prof Mark Nottle, University of Adelaide
- Mr Robert Parkes, Ridley AgriProducts Pty Ltd
- Prof John Pluske, Pork CRC, Director, Murdoch University
- Dr Chris Richards, Chris Richards & Associates Pty Ltd
- Prof Allan Tilbrook, SARDI
- Mr Chris Trengrove, Director, Pork CRC
- Prof Robert van Barneveld, Pork CRC, Director, CHM Alliance Pty Ltd
- Dr Rob Wilson, Leader – Program 4
- Dr Hugh Wirth, Pork CRC, Director
- Mr Graeme Crook, Pork CRC, Committee Secretary

Commercialisation and Adoption Committee

The role of the Commercialisation and Adoption Committee is to make recommendations to the Board on the most appropriate pathways to commercialise outcomes from the Pork CRC programs. This Committee will also make recommendations to the Board in relation to protection of intellectual property.

The Commercialisation and Adoption Committee comprises

an independent Board member as Chair, at least two other directors, the CEO and Company Secretary:

- Ms Kathryn Adams (Chair)
- Dr Roger Campbell (CEO, Pork CRC Ltd)
- Prof Simon Maddocks (SARDI)
- Mr Kenton Shaw (Rivalea [Australia] Pty Ltd)
- Mr Andrew Spencer (Australian Pork Ltd)
- Mr Chris Trengrove (Independent Director)
- Prof Robert van Barneveld (CHM Alliance Pty Ltd)
- Mr Geoff Crook (Company Secretary, Pork CRC Ltd)

Audit Committee

The Audit Committee serves as the representative of the Board for the general oversight of the Pork CRC affairs in the areas of financial accounting and reporting, government reporting, risk management and the underlying internal control environment.

The Audit Committee consists of three Pork CRC Directors, including an independent representative:

- Ms Sandra Di Blasio, Independent Director, Pork CRC (Chair).
- Mr Dennis Mutton, Independent Director, Pork CRC
- Mr Kenton Shaw, Director, Pork CRC.
- Mr Richard Westmacott, Committee Secretary, Pork CRC

Remuneration Committee

The Remuneration Committee makes recommendations to the Board in relation to remuneration policy, establishment of Key Performance Indicators, evaluation of the performance of the CEO and the CRC's compliance with applicable legal and regulatory requirements associated with remuneration matters.

The Remuneration Committee comprises:

- Dr John Keniry, Independent Director, Pork CRC (Chair)
- Mr Rod Hamann, Director, Pork CRC
- Mr Andrew Spencer, Director, Pork CRC

Nomination Committee

The Nomination Committee makes recommendations to the Board in relation to the identification of candidates to be elected as Director as vacancies arise on the Board.

The Nomination Committee comprises:

- Dr John Keniry
- Ms Kathryn Adams
- Mr Rod Hamann
- Mr Andrew Spencer
- Prof Robert van Barneveld

Directors' Meetings

The following tables set out the number of Directors' meetings and committee meetings held during the financial year.

During the financial year, five Board meetings, five Audit Committee meetings, two Research and Development Committee meetings, and four Commercialisation and Adoption Committee meetings were held.

Board Committee meeting attendance

July 1, 2012 to June 30, 2013

The total number of meetings represents the number of meetings attended during the time the Director held office during the year. Meeting attendance includes the use of teleconference technology and written resolutions.



Board of Directors

Meeting dates:

Meetings are held bi-monthly, or as required.

Meetings held:

August 14, September 26, November 12, 2012,
Feb 28 & April 12, 2013

MEMBERS	APPOINTED	RESIGNED	ATTENDANCE
Dr John Keniry (Chair)			5
Ms Kathryn Adams			5
Ms Sandra Di Blasio*	November 13 2012		2
Mr Brian Halstead		November 13 2012	3
Mr Rod Hamann			5
Prof Simon Maddocks			5
Mr Dennis Mutton**	November 13 2012		2
Prof John Pluske			5
Mr Kenton Shaw			5
Mr Andrew Spencer			5
Mr Chris Trengrove			5
Prof Robert van Barneveld			4
Dr Hugh Wirth			5
Mr Geoff Crook (Company Secretary)			5

* Ms Sandra Di Blasio also attended 1 Board meeting prior to being appointed as a Director of the Company

** Mr Dennis Mutton also attended 1 Board meeting prior to being appointed as a Director of the Company

Research and Development Committee

Meeting dates:

Meetings are held quarterly, or as required.

Meetings held:

November 12, 2012, June 17, 2013

MEMBERS	APPOINTED	RESIGNED	ATTENDANCE
Dr John Keniry (Chair)			2
Dr Roger Campbell			2
Dr Jeff Downing			2
Dr Darryl D'Souza			2
Prof Frank Dunshea			1
Mr Rod Hamann			2
Dr Ray King			1
Dr Brian Luxford			2
Dr Bruce Mullan			2
Mr Dennis Mutton			2
Assoc Prof Mark Nottle			1
Mr Robert Parkes			1
Prof John Pluske			2
Dr Chris Richards			2
Prof Alan Tilbrook			1
Mr Chris Trengrove			2
Prof Robert van Barneveld			2
Dr Rob Wilson			2
Dr Hugh Wirth			1
Mr Graeme Crook (Committee Secretary)			2

Commercialisation and Adoption Committee

Meeting dates:

Meetings are held quarterly, or as required.

Meetings held:

October 26, November 12, 2012, February 25, May 23, 2013

MEMBERS	APPOINTED	RESIGNED	ATTENDANCE
Ms Kathryn Adams (Chair)			4
Dr Roger Campbell			3
Prof Simon Maddocks			4
Mr Kenton Shaw			4
Mr Andrew Spencer			3
Mr Chris Trengrove			4
Prof Robert van Barneveld			3
Mr Geoff Crook (Committee Secretary)			4

Audit Committee

Meeting dates:

Meetings are held quarterly, or as required.

Meetings held:

September 20, October 30, 2012, February 18, March 20 & May 20, 2013

MEMBERS	APPOINTED	RESIGNED	ATTENDANCE
Mr Brian Halstead (Chair)		November 13, 2012	2
Ms Sandra Di Blasio (Chair from November 13, 2012)			5
Mr Dennis Mutton (Director)	November 13, 2012		3
Mr Kenton Shaw			4
Mr Richard Westmacott (Committee Secretary)	October 30, 2012		4
Mr Geoff Crook (Committee Secretary)		October 30, 2012	1

Remuneration Committee

Meeting dates: Meetings are held as required.

Meetings held: August 13, 2012

MEMBERS	APPOINTED	RESIGNED	ATTENDANCE
Dr John Keniry (Chair)			1
Mr Rod Hamann			1
Mr Andrew Spencer			1

Nomination Committee

Meeting dates: Meetings are held as required.

Meetings held: August 13, 2012 & January 24, 2013

MEMBERS	APPOINTED	RESIGNED	ATTENDANCE
Dr John Keniry (Chair)			2
Ms Kathryn Adams	November 13, 2012		1
Mr Rod Hamann			2
Mr Andrew Spencer			2
Prof Robert van Barneveld			2



Management

Throughout the reporting period, the Pork CRC was administered by the Chief Executive Officer (Dr Roger Campbell), Business Manager (Geoff Crook), Finance Manager (Richard Westmacott), Research Manager (Graeme Crook) & Office Administrator (Rebecca Smith).

The Pork CRC Management provided focus for all activities and coordinated the research and education programs. The Pork CRC also provided the administration and finance support for these programs.

All projects are managed by Project Leaders who are responsible for day-to-day operations, key deliverables and achievement of milestones. Projects are monitored by the Program Leaders and Pork CRC Management via quarterly reporting requirements, designed to ensure project resources are being utilised efficiently. The programs and projects are reviewed on an annual basis by the Research and Development Committee.

DR ROGER CAMPBELL
Chief Executive Officer

Tel: 08 8313 7683

Mob: 0407 774 714

Fax: 08 8313 7686

Email: roger.campbell@porkcrc.com.au

GEOFF CROOK
Business Manager/
Company Secretary

Tel: 08 8313 7684

Mob: 0439 180 347

Fax: 08 8313 7686

Email: geoff.crook@porkcrc.com.au

GRAEME CROOK
Research Manager

Tel: 08 8313 7973

Mob: 0417 805 422

Fax: 08 8313 7686

Email: graeme.crook@porkcrc.com.au

REBECCA SMITH
Office Administrator

Tel: 08 8313 7743

Fax: 08 8313 7686

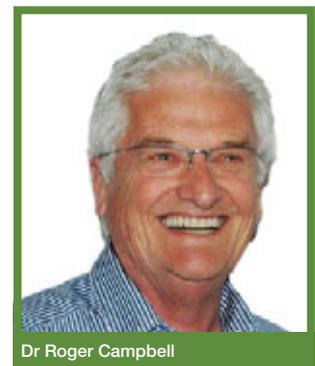
Email: rebecca.smith@porkcrc.com.au

RICHARD WESTMACOTT
Finance Manager

Tel: 08 8313 7685

Fax: 08 8313 7686

Email: richard.westmacott@porkcrc.com.au



Dr Roger Campbell



Geoff Crook



Graeme Crook



Rebecca Smith



Richard Westmacott



A close-up photograph of a small, pink piglet being held gently by a person wearing a white lab coat. The piglet is the central focus, with its head turned slightly to the right. The person's hands are visible, supporting the piglet's body. The background is a soft-focus white fabric, likely part of the lab coat. The overall lighting is bright and natural, highlighting the texture of the piglet's skin and the person's hands.

Research Program Reports

PROGRAMS

Investment across programs and subprograms are summarised in the following tables and, where relevant, a brief description of Research Highlights relating to the 2012–2013 reporting period are included.

1

Reduced confinement of sows and piglets

2

Herd Health Management

3

Healthy Pork Consumption

4

Carbon Conscious Nutrient Inputs and Outputs

5

Improving Sow Reproduction

6

Nutritional manipulations to enhance the performance and feed efficiency of growing pigs

1 Reduced confinement of sows and piglets



Program 1 will support research to develop innovative sow and piglet management and housing systems that progressively rely upon less confinement to optimise sow and piglet welfare while maintaining production efficiency and profitability of pork production.

Program Leader: Dr Ray King, RHK Consulting

The major outcomes will revolve around:

- New pig production systems based on reduced sow and piglet confinement.
- Technologies for optimal reproduction, nutrition and health management of sows housed in groups during lactation.
- Modern, robust genotypes (dam lines) suited to reduced confinement production systems.
- Higher health-status piglets with enhanced gut development through gradual weaning.
- Effective management of sows housed in groups during gestation.

These outcomes will reduce, and ultimately eliminate, the need for sow confinement during farrowing, lactation and gestation through the development of innovative housing, breeding and suckling systems.

The program is comprised of three subprograms that address all objectives of Program 1.



SUBPROGRAM 1A	MATING AND LACTATING INNOVATIONS
SUBPROGRAM 1B	INNOVATIVE WEANING SYSTEMS
SUBPROGRAM 1C	MANAGEMENT OF SOWS IN GROUPS

Subprogram 1A: Mating and lactating innovations

Subprogram Leader:

Prof George Foxcroft, University of Alberta

Projects within subprogram 1A will develop novel techniques for inducing ovulation in sows during lactation and new breeding strategies that are consistent with a reduction or ultimate elimination of sow confinement during lactation and the subsequent gestation, and improved production efficiency.



PROJECT	TITLE	PROJECT LEADER	COLLABORATIVE PARTNERS	TOTAL COST AUD
1A-101	Strategies to enhance oestrous induction in lactating sows	J Downing	University of Sydney	0* 0**
1A-102	Managing the sow to stimulate lactational ovulation	W van Wettere	University of Adelaide	34,312* 168,312**
1A-103	Optimising the time of mating in easy-to-manage lactation systems to improve pregnancy outcomes and weaning	P Langendijk	SARDI, University of Sydney, Rivalea Australia & Murdoch University	172,006* 932,910**
1A-104	Maximising fertility and fecundity of sows mated during lactation	W van Wettere	University of Adelaide, SARDI & APFG	123,643* 1,039,843**
1A-105	Developing commercially-viable, confinement-free farrowing and lactation systems	R Morrison	Rivalea Australia, SARDI, University of Sydney & APL	145,795* 1,036,445**
1A-106	Development of a lactational oestrus induction protocol that can be implemented in confinement free sow housing systems	J Downing	University of Sydney, SARDI, Rivalea Australia & CSU	95,415* 572,925**
1A-107	Reducing early embryonic loss in the pig	M Nottle	University of Adelaide & SARDI	50,000* 210,056**
1A-108	Reducing the labour costs and increasing synchrony and predictability of lactation oestrus	R Kirkwood	University of Adelaide	9,720* 63, 720*

*In this, and all subsequent Project tables – *Cash Budget ** Project Budget*

1

Research Highlights for Subprogram 1A



Dr Rebecca Athorn

LACTATIONAL OESTRUS AND MATING

The initial focus for this subprogram has been to develop strategies that may uncouple mating from the weaning process to allow more flexible management and low confinement housing systems. The Australian pork industry has committed to the introduction of production systems that eliminate the use of sow confinement. The effective mating of sows in lactation can form the basis for a new reproductive management paradigm that improves welfare and production efficiency without the need for sow confinement.

Pork CRC has already invested in several projects to study the response of sows to a wide range of approaches to stimulate oestrus and

ovulation during lactation. These strategies include the use of exogenous hormones, altered litter size, altered suckling pressure and different levels of boar exposure. The desired overall outcome from this work is simple, commercially applicable methods of stimulating oestrus expression in lactating sows while maintaining fertility and subsequent litter sizes, comparable to conventionally weaned and inseminated sows. The target is for 85% of sows to respond to oestrus induction in lactation within 7 days, with the remaining 15% exhibiting a fertile oestrus within 7 days after final weaning.

Results of these studies show that the target of 85% of sows responding to lactation induction procedures within 7 days can be achieved experimentally, without adversely affecting subsequent reproductive

performance, through the use of PG600 administration, direct and intense boar stimulation, reduced litter size or with at least 16 hour separation daily from piglets for three consecutive days. For example, in a large commercial herd, Robyn Terry (Project 1A-104) investigated the effects of taking the sow to the boar shed and providing her with direct physical contact with a boar for 15 minutes each day from day 18 of lactation. Her experiment showed that this type of boar exposure is an effective stimulus of lactational oestrus in multiparous sows, with a reduction in suckled litter size from 11 to 7 piglets further increasing the proportion of sows that exhibit oestrus during lactation (Table1).

TABLE 1: THE EFFECT OF BOAR EXPOSURE AND REDUCED LITTER SIZE AT DAY 18 OF LACTATION ON SUBSEQUENT REPRODUCTIVE PERFORMANCE OF MULTIPAROUS SOWS

TREATMENT	CONTROL	BOAR EXPOSURE	BOAR EXPOSURE AND REDUCED LITTER SIZE
Number of sows	75	151	75
Lactational oestrus (% sows)	24	76	89
Farrowing rate (%)	83	76	75
Total born in subsequent litter	12.5	11.6	12.8

First litter sows are unlikely to respond as well as older sows to lactational oestrus stimulation strategies. However, Pieter Langendijk (Project 1A-103) has been able to stimulate 70% of first litter sows to exhibit oestrus during lactation by combining daily physical boar contact with 8 hours of separation of the litter per day up until weaning. A similar Pork CRC study in collaboration with the University of Alberta, led by postdoc

Rebecca Athorn, will determine effects of these protocols on early embryonic development and litter size at day 30 of gestation in primiparous sows.

However, these strategies are unlikely to be entirely compatible with commercial pork production systems as they often require quite extreme piglet separation techniques and/or moving lactating sows around daily to provide physical

boar contact. Alternative or modified strategies are therefore being explored that may be more adaptable to commercial pork production systems.

For example, Pieter Langendijk has achieved an encouraging 50% response rate in first litter sows with only fence-line boar contact in the farrowing shed and minimal piglet separation through allowing only half the litter to suckle for 8-16 hours per day from day 18 of lactation.

Further studies are being undertaken with the aim of developing oestrus stimulation strategies more applicable to commercial pork production systems. These strategies may rely upon one, two or more of the stimulation procedures that have been/will be investigated.

New areas being investigated include:

- More intense boar stimulation by housing boars in the farrowing shed accommodation
- Group housing of sows and litters in later lactation that can be linked to voluntary access of sows to a boar stimulation area
- Lactation sow housing systems that allow the sow to 'step-out' of the farrowing pen and again achieve voluntary access by sows to a boar stimulation area

- Less invasive piglet separation methods

Results of these additional studies should be available by early 2014, so that commercially applicable lactation induction procedures can be tested in co-operating piggeries later in 2014.



Janine Pollard, Westmill Products, Young, NSW (1000 sows, farrow to finish), Marilyn Franks, Aztec Farms, Griffith, NSW (900 sows, farrow to finish) and Kim Munro, Stirling Piggery, Yeoval, NSW (150 sows, currently looking at options) enjoyed the Melbourne Group Housing Solutions Workshop at the Holiday Inn.



Ian Connaughton, Don KRC, Girgarre, Victoria, addresses the Melbourne workshop.



Melbourne sow housing workshop.



Dr Bruce Welch, PVS Ltd., NZ, addresses the Toowoomba workshop.

1

FARROWING AND LACTATION ACCOMMODATION

The use of farrowing crates can improve the welfare of neonatal pigs by providing warmth in a restricted space and limit the risk that piglets become chilled and die from starvation or being overlain by the sow. Farrowing crates and the concomitant lack of bedding, however, restrict the ability of the sow to move around and perform 'normal' pre-farrowing behaviours such

as nest-site selection, nest building activity and bonding with piglets. The focus of the Pork CRC program is to develop, evaluate and enhance the welfare of sows and piglets in conventional farrowing and lactation systems and in those that do not constrain the sow prior to, during, or after the farrowing process and during the lactation period.

The PigSAFE farrowing pen that was developed in Europe has been recently evaluated

under Australian climatic conditions by Rebecca Morrison (Project 1A-105). Her results indicate that, although initial performance during summer was inferior in the PigSAFE pen system, overall, the pre-weaning mortality rates in sows and litters housed in the low confinement PigSAFE system are now approaching commercially acceptable figures (Table 2).

TABLE 2: SOW AND PIGLET PERFORMANCE IN THE TRADITIONAL FARROWING CRATE AND PIGSAFE HOUSING SYSTEMS

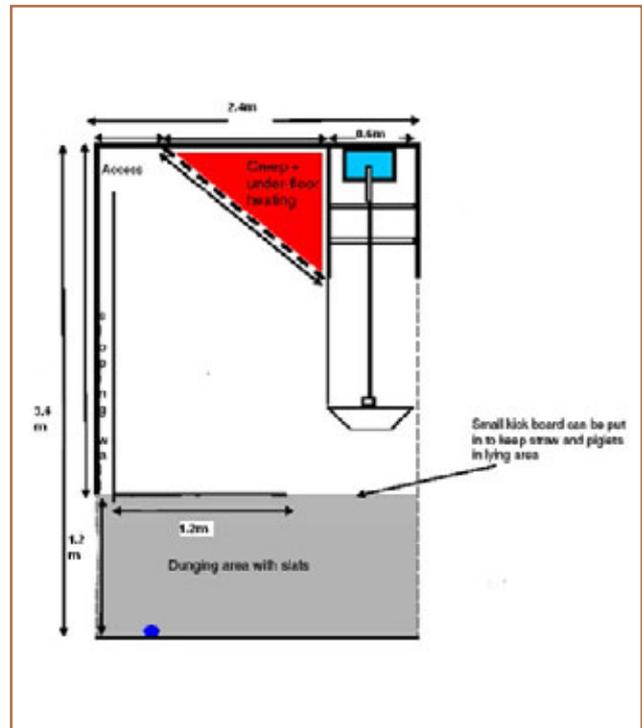
TREATMENT	FARROWING CRATE	PIGSAFE PENS
Number of sows studied	142	141
Total born alive	10.8	11.2
Total weaned	9.2	9.1
Live born mortality (%)	13.5	14.5
Piglet growth rate (g/day)	224	233
Sow feed intake (kg/day)	7.3	7.6



The Rivalea PigSAFE Farrowing Pen.

Observations on the welfare and behaviour aspects of the sows and litters revealed that sows in the PigSAFE system had improved ease of movement scores and also tended to have improved locomotion score at weaning. The current design of the nest area in the PigSafe system was suitable for encouraging the majority (90%) of sows to farrow in the designated nest area under Australian environmental conditions. However a common observation in the PigSAFE system was that in the summer months, when environmental temperatures are higher, piglets were not using the creep area as much, spending much more time in the dunging areas, and were sharing the same space as the sow and thus in more danger of overlay. Thus for

these loose housing systems during lactation, there may be scope for further work to try to keep piglets in the creep area and away from high risk areas and/or provide more protection for the piglets in these high risk areas.



Rivalea's PigSAFE system floor plan.

Subprogram 1B: Innovative Weaning Systems

Subprogram Leader: Prof John Pluske, Murdoch University

Subprogram 1B will use controlled separation of the sow and piglet during lactation without compromising welfare to reduce weaning stress and eliminate the post weaning growth check. Gradual weaning technologies, including new housing systems, multi-suckling

strategies and the development of nutritional supplements will ensure optimal gut integrity and high levels of piglet immunity that enhance piglet quality and optimise lifetime productivity.



PROJECT	TITLE	PROJECT LEADER	COLLABORATIVE PARTNERS	TOTAL COST AUD
1B-101	Novel strategies to enhance creep attractiveness and reduce piglet mortality	A Whittaker	University of Adelaide	15,665* 143,165**
1B-102	Peri-weaning polyamine supplementation a novel strategy to improve piglet survival and growth post-weaning	W van Wettere	University of Adelaide & Massey University	49,872* 138,372**
1B-103	The effects of alternate lactation housing on piglet welfare and performance around weaning	K Plush	University of Adelaide & APFG	19,165* 109,165**

1

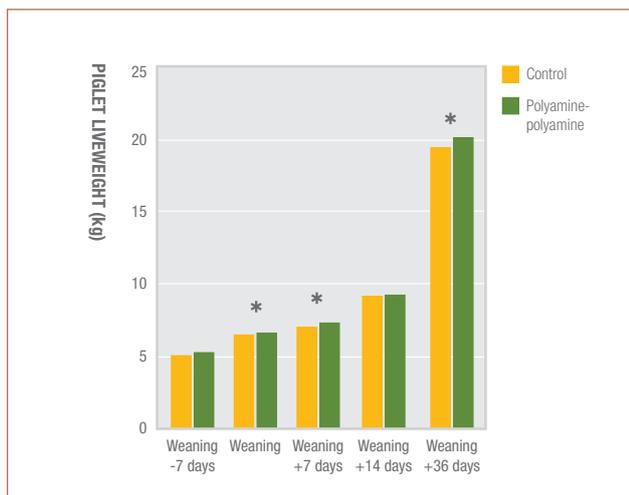
Research Highlights for Subprogram 1B

POLYAMINES AND PIGLET PERFORMANCE

Will van Wettere (Project 1B-102) investigated the effect of polyamine supplementation on growth and survival of piglets around weaning. He demonstrated little effect of polyamine supplementation on overall piglet growth pre and post-weaning when applied to all piglets. However, in a

later experiment where only small and 'at risk' piglets were strategically dosed with polyamine, there was an indication that there was a positive effect of polyamine supplementation on piglet performance around weaning (Figure 1).

Figure 1 – The effect of polyamine supplementation pre and/or post-weaning on piglet liveweight. (W van Wettere, Project 1B-102). *denotes significant treatment effects



Alex Whittaker (Project 1B-101) has investigated several strategies to enhance the attractiveness of the creep area to piglets and, by doing so, encouraging piglets into these areas and reducing the chance of overlay in the early days of life. Two strategies, maternal applied scents and the use of sound, have been used in a preference testing methodology to determine piglet movement and duration of stay in creep areas. Applied maternal scents had no effect on piglet movement, but the initial results from a sound experiment indicate that piglets spent more time near the source

of the sounds of a suckling litter and very little time in the central area where they may be more vulnerable to overlay. This second study indicates that specific sounds may have potential to control the areas of the crate where piglets spend more of their time.

More investment in this program is expected as new housing and management systems in lactation that are commercially viable begin being developed in the other subprograms.



Ian Bayley, Blackwood Piggery, Victoria, addresses the Melbourne workshop.



Melbourne sow housing workshop.



Dieta Salisbury, Salisbury Farms Enterprises, Monto, Queensland (340 sows, farrow to finish, doing some group housing, considering another shed in February next year) and Jenny Taylor, P&J Taylor Piggery, Gayndah, Queensland (500 sows and about to move into new farrowing shed as part of transition to group housing).



Ian Hill, Bailey Creek Pork, Queensland, addresses the Toowoomba workshop.

Subprogram 1C: Management of Sows in Groups

Subprogram Leader: Prof Paul Hemsworth, University of Melbourne

This subprogram investigates the complex and challenging interactions between sows housed in groups. Development of optimum management procedures for group housed sows while accommodating their individual requirements for nutrition, maintenance of health, and well-being is required.

Australian Pork Limited (APL) pig producers voted to voluntarily phase out sow stalls by 2017, from five days after mating until they are moved into farrowing crates. However, recent pressure from retailers and the community has accelerated this timetable for some producers, as well as placing further restrictions

on the housing of sows during gestation. Investment in Subprogram 1C is directed at improving the welfare and reproductive performance of sows housed in groups during gestation.



PROJECT	TITLE	PROJECT LEADER	COLLABORATIVE PARTNERS	TOTAL COST AUD
1C-101	Physical and nutritional interventions to reduce sow lameness	R van Barneveld	CHM & Rivalea Australia & Zinpro	62,500* 598,905**
1C-102	Effects of aggressive characteristics of individual sows and mixing strategies on the productivity & welfare of group-housed gestating sows	P Hemsworth	APL, University of Melbourne, University of Sydney, Rivalea Australia & SARDI	118,598* 312,667**
1C-103	Optimising the management of group-housed gestating sows.	P Hughes	SARDI, University of Adelaide, APFG & University of Melbourne	180,116* 843,730**
1C-104	Lactation Pens	G Charles	CIFE	0* 0**
1C-105	Effects of floor space on the welfare of group-housed sows	P Hemsworth	University of Melbourne, SARDI & Rivalea Australia	404,631* 895,669**
1C-106	Reducing aggression in group-housed gestating sows through manipulation of dietary water holding capacity and hind-gut fermentation substrates to control gut distension and blood VFA levels	R van Barneveld	CHM & University of Melbourne	40,510* 600,748**
1C-107	Improving behaviour, welfare and commercial performance of group housed sows through development of appropriate selection criteria	K Bunter	AGBU (University of New England, NSW DPI), Rivalea Australia & University of Melbourne	250,689* 1,869,667**
1C-108	The sensitivity of sows to stressors throughout gestation	J L Rault	University of Melbourne & SARDI	62,310* 136,310**
1C-109	Animal welfare monitoring in research settings	M Rice	University of Melbourne & Vic DPI	37,466* 93,546**
1C-110	Current system assessment of Commercial performance of group housed sows	R King	Pork CRC	87,175* 87,175*
1C-111	Effects of group housing after weaning on sow welfare and sexual behaviour	J Rault	University of Melbourne, Rivalea & SARDI	69,988* 166,380*
1C-112	Literature review on effects of group housing, both post weaning and post-insemination, on sow productivity and welfare	P Hemsworth	University of Melbourne & SARDI	12,825* 128,525**

Reduced confinement of sows and piglets continued

1



David Moore and Greg Den Elzen, Mondoro, Casino, NSW (1000 sows, farrow to finish, starting to group house) and Richard Baillee, Kewpie Pig Enterprises, Kingaroy, Queensland (2700 sows, about to convert to group housing, has ordered electronic sow feeders).



About 90 pork producers, advisors, equipment manufacturers and researchers attended the Melbourne Group Housing Solutions Workshop, which was part of a \$100,000 initiative by the Board of the CRC for High Integrity Australian Pork.

Research Highlights for Subprogram 1C

A major activity during 2012/13 was the delivery of two Sow Housing Solutions Workshops in October, 2012 to provide the opportunity to discuss options for pork producers who have already or are contemplating shifting to group housing systems during gestation. More than 150 pork producers and other people associated with the Australian pork industry attended these events. The presentations from international and Australian researchers and pork producers, were designed to provide information and confidence to pork producers who need to change to the APL defined reduced confinement accommodation before 2017. These objectives were achieved and the workshops were an outstanding success. The information and experience of pork producers for the shift to lower confinement systems where sows may be completely stall free, or at the very most, restricted for up to 24 hours for insemination is probably more equivocal. Subsequent workshops for producers implementing group housing

from weaning until entry to farrowing accommodation are planned for early 2014.

These workshops highlighted the need to provide producers with an update of how sows should be fed during gestation, particularly when they are in group housing systems. Consequently, a publication ('Feeding Pregnant Sows In group Housing Systems') that consolidated much of the recent sow nutrition work from Pork CRC was prepared, published and launched by Pork CRC CEO, Dr Roger Campbell at the 2013 Victorian Pig Fair. The results indicated contrary findings to traditional beliefs about sow feeding. Increasing feed intake of dry sows in early pregnancy will ensure that the less dominant sows get adequate nutrition and improve overall performance of sows in groups. Conversely, increasing feed intake in late pregnancy has little or no benefit on subsequent sow or piglet performance.



**PROJECT 1C-101:
PHYSICAL AND
NUTRITIONAL
INTERVENTIONS
TO REDUCE SOW
LAMENESS**

Kim Bunter and Cherie Collins investigated the magnitude and subsequent effects of locomotion disorders associated with specific foot lesions in an Australian herd. They found that lesion scores were generally not significantly associated with lameness unless moderate in severity and therefore did not have a strong association with subsequent reproductive performance. Results of this investigation do not support the use of routine foot lesion scoring post-mating in the herd as a standard husbandry technique to identify sows with a greater risk of future lameness. Despite the incidence of lameness in this herd being relatively low, it did affect reproductive performance. The litter size of those sows that were moderately lame

post-mating was reduced by about 0.5 pigs. Further, sows which were lame post-mating had a much higher likelihood of being culled from the herd.

Within the same project, Rob van Barneveld, Rob Hewitt and Tracey Muller examined the effectiveness of feet trimming interventions to reduce the incidence of lameness and attempted to develop methods for the rapid assessment of sow lameness. They found that feet trimming can reduce the incidence of some foot lesions, but it failed to significantly influence the overall reproductive performance of sows. While it appeared that wean-to-oestrus interval may have been influenced by trimming, the additional cost associated with remedial trimming is unlikely to pay dividends from a reproductive perspective alone, although any benefits to the sow from a welfare perspective need to be quantified.

They also found that thermal imaging was successful in detecting heat changes within the limbs of a sow. Thermal imaging was able to identify variations in the temperature in the legs of sows with a severely compromised gait. However, there were a large number of sows that, through thermal imaging, exhibited inflammation in joints and muscle, but did not exhibit a compromised gait. This may indicate early signs of joint inflammation and more precisely, osteochondrosis from mechanical overloading, but further work is required to determine whether the thermal imaging technology can be used for early detection of leg problems and future lameness.

**PROJECT 1C-103,
1C-105:
SPACE AND MIXING –
EFFECTS ON WELFARE
AND REPRODUCTION**

Two major research projects in Program 1C began in 2012/13. These research projects address mixing strategies to reduce aggression and develop stable groups of pregnant sows (1C-105) and define space allowances for group housed sows during gestation that are consistent with optimum reproductive performance and welfare outcomes (1C-103). At this stage there is little to report on these long term projects but the main outcomes expected from these studies will be quantitative space allowances for dry sows in groups that meet welfare and productivity expectations and practical mixing strategies to reduce aggression, injuries and stress and can be easily implemented in commercial pig production units.



Pork CRC CEO Dr Roger Campbell launched sow feeding manual at 2013 Victorian Pig Fair.

Reduced confinement of sows and piglets continued

Education Program

STUDENT	LEVEL	TITLE	SUPERVISOR	INSTITUTION
Centaine Kaesler-Smith	Honours	Effect of oestrus stimulation immediately postpartum on oestrus expression and ovarian cyclicity of lactating sows	W van Wettere	University of Adelaide
Patricia Condous	Honours	Sub-optimal metabolic status pre-mating increases the risk of embryo mortality	W van Wettere R Kirkwood	University of Adelaide
Emma Greenwood	Honours	Identify the effects of high plane feeding in late gestation on the piglets & the sow	P Hughes R Kirkwood	University of Adelaide
Josephine Wilkinson	Honours	Development of a lactational oestrus induction protocol that can be implemented in confinement free sow housing systems	J Downing	University of Sydney
Emily de Ruyter	Honours	Piglets from sow controlled housing experience reduced stress and improved performance around weaning	W van Wettere K Plush D Lines	University of Adelaide
Hannah Lyons	Honours	The development of a two-stage farrowing/lactation system to enable group lactation 12 days after farrowing and facilitate mating during lactation	J Downing	University of Sydney
Jessica Zemitis	Honours	Reducing the labour costs and increasing synchrony and predictability of lactation oestrus	R Kirkwood W van Wettere	University of Adelaide
Mandy Bowling (Ron Lienart scholarship winner)	Honours	Is heart rate variability a useful welfare indicator for the gestating sow?	P Hynd K Plush	University of Adelaide
Anthony Martyniuk	Masters	Optimising the management of group housed sows	W van Wettere P Hughes	University of Adelaide
Clara Singh	Masters	Evaluating the behaviour and productivity of sows and litters that are transferred from farrowing crates to Lactation pens	P Hemsworth	University of Melbourne
Ellen McDonald	PhD	Development of a lactational oestrus induction protocol that can be implemented in confinement free sow housing systems	J Downing	University of Sydney
Alice Weaver	PhD	Effect of lactation and boar exposure immediately postpartum on ovarian function and expression of oestrus	W van Wettere K Kind	University of Adelaide
Robyn Terry	PhD	Boar contact and split weaning: effects on oestrus expression during an extended lactation	W van Wettere K Kind	University of Adelaide
Megan Verdon	PhD	Social strategies of sows in groups: the relationships between the social strategy adopted and sow behaviour, stress physiology and reproduction	R Morrison	University of Melbourne
Diana Turpin	PhD	Higher health status piglets	Dr J Pluske P Langendijk	Murdoch University
Kate Plush	Post Doc/ Industry Placement Program	Animal behaviour & welfare implications associated with group housing of sows & gradual weaning	W van Wettere	University of Adelaide / APFG
Patricia Condous	PhD	Reducing sow confinement during farrowing and lactation	W van Wettere K Plush A Tilbrook	University of Adelaide
Emma Greenwood	PhD	Hierarchy formation in group-housed sows and management strategies to reduce the impact	P Hughes P Hemsworth	University of Adelaide
Dr Rebecca Athorn	Industry Placement Program	Oestrus and mating techniques for sows during lactation	B Luxford	Rivalea
David Lines	Industry Placement Program	Lactation/ reproduction physiology	R Hamann	APFG



Centaine Kaesler-Smith



Josephine Wilkinson



Anthony Martyniuk



Clara Singh



Megan Verdon



Diana Turpin



Rebecca Athorn



David Lines



Pork CRC supported University of Adelaide students - Kate Plush, Emma Greenwood, Patricia Condous, Alice Weaver and Robyn Terry - at Pork CRC Melbourne stakeholders' meeting, November 13, 2012



Herd Health Management

The aim of the program is to enhance animal health, while reducing antibiotic use in commercial pork production. The research will involve novel diagnostic tools to monitor pathogen loads in production units and better characterise virulence genes which cause disease. These technologies will enable the more strategic use of antibiotics.

The program also includes projects on the development of more robust genetic lines that are more resilient to environmental constraints, including disease and the development of alternative health strategies. The overall objective is to provide industry with a range of integrated health strategies.

Program 2 comprises 3 subprograms addressing the major components that will lead to the above outcomes.

Program Leader:
Dr Brian Luxford,
Rivalea Australia



SUBPROGRAM 2A	NOVEL DISEASE DIAGNOSTICS
SUBPROGRAM 2B	HEALTHY ROBUST PIG GENOTYPES
SUBPROGRAM 2C	REPLACEMENT OF ANTIBIOTICS WITH EFFECTIVE INTEGRATED HEALTH STRATEGIES



Subprogram 2A: Novel Disease Diagnostics

Subprogram Leader: Dr Pat Mitchell, Australian Pork Limited

PROJECT	TITLE	PROJECT LEADER	COLLABORATIVE PARTNERS	TOTAL COST AUD
2A-101	Validation of a data collection protocol on Australian Pig Farms	P Mitchell	Rivalea Australia	35,000* 35,000**
2A-102	Real-time detection of airborne pathogens in the piggery	M Marenda	University of Melbourne	280,734* 1,231,572**
2A-103	Comparing The Mucosal And Systemic Immune Response After APP-Alive Vaccination With Natural Challenge	H Brouwers	NSW DPI Chris Richards and Associates	49,490* 147,932**
2A-104	Evaluation of diagnostic tests to detect <i>Clostridium difficile</i> in piglets	T Riley	University of WA	48,102* 99,002**
2A-105	Reduce the risk of post-weaning <i>E.coli</i> diarrhoea using a potentially innovative feeding ingredient, lupin hulls	J Pluske	Murdoch University DAFWA Rivalea Australia	74,342* 295,504**
2A-106	A comprehensive risk factor analysis of <i>E.coli</i> disease in the piggery environment	M Ward	University of Sydney	270,500* 542,000**
2A-107	Antibiotic sensitivity of <i>Haemophilus parasuis</i> plus <i>Actinobacillus pleuropneumoniae</i> and other respiratory pathogens	C Turni	University of Queensland	40,000* 330,000**
2A-108	Evaluation of oral fluid samples for herd health monitoring of pathogens and the immune response in pigs	D Finlaison	NSW DPI Chris Richards and Associates Rivalea Australia	49,856* 155,003**
2A-109	Development and validation of assays to measure gut health in order to identify risk factors for <i>E.coli</i> disease in weaner pigs	A Collins	NSW DPI Nutreco Nederland B V	48,743* 198,080**

Research highlights

WORLD FIRSTS

In the reporting period, two world first outcomes were delivered by researchers from the University of Queensland on establishing antimicrobial resistance and sensitivity tests for *Haemophilus parasuis* and University of Western Australia on an accurate and simple diagnostic test for *Clostridium difficile*. These are detailed below.

PROJECT 2A-104: EVALUATION OF DIAGNOSTIC TESTS TO DETECT CLOSTRIDIUM DIFFICILE IN PIGLETS

Prof Thomas Riley –
University of Western
Australia

Clostridium difficile is a Gram-positive spore forming bacterium and a well-known enteric pathogen of humans. Outside Australia *C. difficile* is reported as a major cause of high-morbidity enteritis and pre-weaning scour in neonatal piglets aged 1-7 days, with outbreak-associated mortality up to 50%. Piglets that recover

from *C. difficile* infection (CDI) can be 10-15% underweight and take longer to wean. To understand the role of *C. difficile* in pig disease it is essential to be able to detect the organism in a timely and cost-effective manner. Unfortunately, veterinary laboratories in Australia have limited experience with this fastidious organism. Few of the commercially available methods developed for detection of *C. difficile* in humans have been validated for animals and none with the molecular types of *C. difficile* found in Australian piglets.



Subprogram Leader,
Dr Pat Mitchell

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The project aim was to guide the pork industry, veterinarians and veterinary diagnostic laboratories about the suitability of currently available commercial assays to detect *C. difficile* in Australian piglets. To achieve this, the researchers evaluated the performance of four commercial assays to detect *C. difficile* in 157 specimens of piglet faeces obtained from neonatal piglets (49 scouring) aged <14 days during the period June 2012 to March 2013. The test population originated from 16 farms across five Australian states.

Assays were performed according to manufacturer instructions and compared against toxigenic culture (TC) as a 'gold standard'. The assays included two commercially available PCR methods for the detection of toxin A and B genes (Assay B & C), an enzyme immunoassay for toxins A and B (Assay D), and culture on a chromogenic agar (Assay CA). Isolates were characterised by PCR ribotyping and PCR detection of toxin genes *tcdA* (toxin A), *tcdB* (toxin B) and *cdt* (binary toxin) which correlates with toxin production.

There was varied performance in detection of *C. difficile* by the assays tested. After correcting for the high number of non-toxigenic strains in the test population, the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) are shown in table 3 compared with the uncorrected values.

TABLE 3: PERFORMANCE OF COMMERCIAL ASSAYS FOR DETECTION OF C. DIFFICILE IN PIG FAECES (a/b)

ASSAY	SENSITIVITY	SPECIFICITY	PPV	NPV
CA	100.0/100.0	95.0/96.0	91.9/88.9	100.0/100.0
D	41.9/38.9	92.6/92.6	78.8/66.7	71.0/80.0
B	27.9/42.9	97.9/97.9	89.5/88.2	67.9/82.3
C	16.1/25.0	95.8/95.8	71.4/69.2	63.6/77.1

a=uncorrected, b=corrected, PPV-positive predictive value, NPV-negative predictive value

This study presents the first reported data worldwide on the performance of a chromogenic medium for recovery of *C. difficile* from animal faecal samples.

The chromogenic agar (CA) (*C. difficile* ChromID™ agar

(CA, BioMérieux)) performed the best of all the comparator assays, with high sensitivity and specificity in recovery of *C. difficile* from piglet faeces irrespective of strain type. Culture on CA is highly selective, fast and requires no extensive training and equipment. It is also

suitable for culture of samples sent over long distances under suboptimal conditions and allows recovery of the organism for epidemiological typing. Thus, culture on CA presents a suitable detection and identification method for veterinary laboratories.



Research Highlights

PROJECT 2A-107: ANTIBIOTIC SENSITIVITY OF HAEMOPHILUS PARASUIS PLUS ACTINOBACILLUS PLEUROPNEUMONIAE AND OTHER RESPIRATORY PATHOGENS

Dr Conny Turni, University of Queensland

The project was designed to allow an understanding of current typical resistance patterns present in key respiratory pathogens so that treatment programs can be designed with specific farm knowledge of resistance

patterns and a broad industry-wide picture being available.

The first step was to produce a validated susceptibility testing method for *H. parasuis*. The project has delivered phenotypic methods (both disc diffusion and Minimal Inhibitory Concentration methods) for testing for antimicrobial sensitivity testing of *H. parasuis* strains. This is a world first and these methods are now available to the industry and can be obtained from Dr Turni.

This developed/validated method, along with existing Clinical and Laboratory

Standards Institute (CLSI) methods for the other key pathogens, was used to test a collection of current, representative isolates of *Actinobacillus pleuropneumoniae*, *H. parasuis*, *Pasteurella multocida* and *Bordetella bronchiseptica*. The results are shown in Table 4.

These are the first antimicrobial resistance tests conducted on isolates collected across Australia for eight years and the information and tests developed should allow the more strategic management of these serious respiratory pathogens than was the case previously.



Dr Conny Turni

TABLE 4: PERCENT OF ISOLATES FROM EACH BACTERIAL SPECIES DISPLAYING ANTIMICROBIAL RESISTANCE

	A. PLEUROPNEUMONIAE (N=71)	H. PARASUIS (N=97)	P. MULTOCIDA (N=51)	B. BRONCHISEPTICA (N=18)
Erythromycin	89	27	14	94
Tetracycline	75	9	28	39
Ampicillin	8.5	2	4	100
Penicillin	8.5	3	4	100
Tilmicosin	25	12	0	22
Tulathromycin	0	1	0	0
Co-trimoxazole	0	6	2	0
Florfenicol	0	0	2	6
Ceftiofur	0	0	0	100

FURTHER HIGHLIGHTS

Researchers from NSW DPI are investigating the use of oral fluids to diagnose pathogen challenges in herds (2A-108), as well as a novel indicator of enteric pathogen challenge in pigs (2A-109). At the University of Melbourne, good progress is being made on real time diagnosis of pathogen loads in the piggery environment (2A-102). Outcomes and implications of these projects will be available in 2013-2014.



Dr Huub Brouwers, NSW DPI and Prof Michael Ward, University of Sydney at Pork CRC supported 2013 Victorian Pig Fair workshop on *E. coli*.

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Subprogram 2B: Healthy Robust Pig Genotypes

Subprogram Leader: Dr Pat Mitchell, Australian Pork Limited



Assoc Prof Susanne Hermesch

Selection strategies will be enhanced by including additional traits that quantify aspects of robustness in pig breeding programs. New methodology and genetic models will be developed that quantify genetic differences of pig genotypes to variation in environmental conditions. The definition and physiological consequences of disease tolerance will be defined in order to evaluate the

benefits of selection for disease tolerance in addition to selection for disease resistance and disease resilience in pigs. A number of outputs and research results have been achieved so far, which are outlined in more detail below.

PROJECT	TITLE	PROJECT LEADER	COLLABORATIVE PARTNERS	TOTAL COST AUD
2B-101	Quantifying variation in environments within and across herds	S Hermesch	UNE & NSW DPI – AGBU	69,998* 165,866**
2B-102	Development of economic methodology to incorporate robustness in pig breeding programs	S Hermesch	UNE & NSW DPI – AGBU	113,350* 159,045**
2B-103	Section for disease resilience - Pilot Study	S Hermesch	UNE & NSW DPI – AGBU NSW – DPI University of Qld	149,335* 410,915**

Research highlights

Assoc Prof Susanne Hermesch and her team continue to make progress in her exciting project to establish selection criteria for robustness and disease resilience in pigs. The results of a proof of concept project will be available to industry and pig breeding companies in 2013-2014.



Subprogram 2C: Replacement of Antibiotics with effective Integrated Health Strategies

Subprogram Leader: Dr Eric Thornton, Consultant

PROJECT	TITLE	PROJECT LEADER	COLLABORATIVE PARTNERS	TOTAL COST AUD
2C-101	Bacteriophage to control Enterotoxigenic <i>E.coli</i>	M Barton	University of SA & Rivalea Australia	64,324* 290,728**
2C-102	Strategies to quantitatively measure and reduce the load of Lawsonia in commercial herds	A Collins	NSW DPI & Rivalea Australia	233,606* 1,102,470**
2C-103	Evaluating the efficacy of a Live APP vaccine with and without bacterin vaccines	H Dunlop	Chris Richards & Associates & APFG	158,140* 632,860**
2C-104	Assessment of a live, attenuated, oral <i>Erysipelothrix rhusiopathiae</i> vaccine	S Oswin	Pfizer & Rivalea Australia	108,000* 943,932**
2C-105	Use of plant derived compounds to condition piglet intake at weaning and reduce post-weaning use of therapeutics	E Roura	University of Qld CHM	259,433* 925,033**
2C-106	Bacteriophage-displayed peptides for the control of pathogens in swine	S Bishop-Hurley	CSIRO	50,000* 95,762**
2C-107	Investigation of oral rennin (chymosin) supplementation as a farm level protocol to improve the passive transfer of immunity in neonatal piglets.	P Cockroft	University of Adelaide	48,596* 122,096**
2C-108	Passive Immunisation for Oedema Disease	A Morris	Chris Richards & Associates & University of Qld	75,000* 427,000**
2C-109	Reducing sucker mortality through use of an innovative in-feed supplement	C Collins	Rivalea & Nutreco	2,934* 364,802**
2C-110	Dietary manipulation of the pro-inflammatory cascade to minimise impacts on production and health indices in weaner pigs experimentally infected with an enterotoxigenic strain of <i>E.coli</i>	JC Kim	DAFWA & Murdoch University & Rivalea Australia	44,464* 281,888**
2C-111	Use of bacteriophage to prevent and treat Enterotoxigenic <i>E.coli</i> (ETEC) infections in pigs	M Barton	University of SA & Rivalea Australia	0* 95,500**
2C-112	Enhancing intestinal barrier function through supplementation of N-acetylcysteine and arginine in diets for weaner pigs experimentally challenged with enterotoxigenic <i>E.coli</i>	J Sweeney	DAFWA & Murdoch University	50,000* 254,000**



Pork CRC CEO, Dr Roger Campbell and producers discuss how best to deal with *E.coli*.



Prof Michael Ward, University of Sydney, looks on as producers discuss how best to deal with *E.coli*.

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Research highlights

PROJECT 2C-102: STRATEGIES TO QUANTITATIVELY MEASURE AND REDUCE THE LOAD OF LAWSONIA IN COMMERCIAL HERDS

Dr Alison Collins, NSW DPI



The project has as its objectives to use a quantitative PCR test developed in previous Pork CRC research to monitor

changes in Lawsonia infection over time and to attempt to link Lawsonia numbers (load) with animal performance in commercial herds.

The change in Lawsonia numbers in one herd over time are shown in the table below.

At the start of the grower-finisher period at 10 weeks no pigs were shedding Lawsonia. However, the number of Lawsonia found in the faeces increased with time between weeks 12 and 16, as did the number of Lawsonia and the number of pens infected.

The number of *L. intracellularis* was negatively correlated with ADG, indicating that pigs heavily infected with *L. intracellularis* had lower weight gains. A strong correlation was demonstrated for ADG between 10 and 15 weeks of age (the peak infection period, Table 5), and the total number of *L.intracellularis* shed at 10, 12 and 14 weeks in the same pens of pigs ($r = -0.624$). Correlations between ADG and total numbers of *L.intracellularis* shed over other periods were less strong ($r = -0.522$ for pigs 12 to 15 weeks of age, and $r = -0.24$ for pigs between 10 and 18 weeks of age). Exponential regressions were fitted to all of these data periods

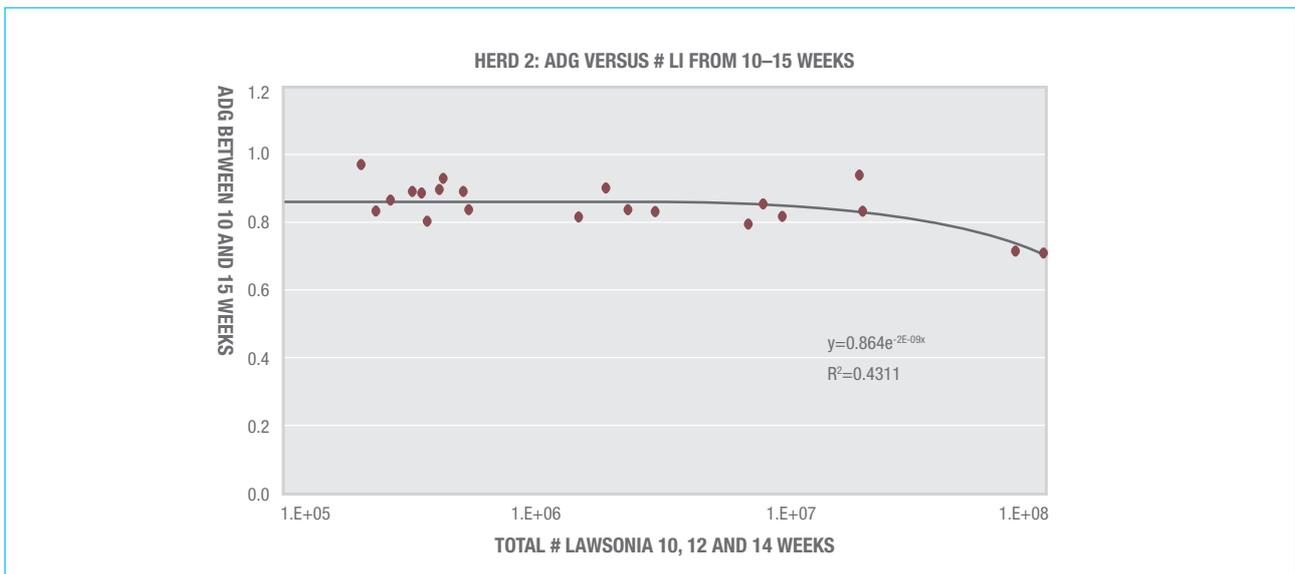
to describe the relationship between ADG and numbers of *L.intracellularis* (Figure 2).

The regression equation for the period between 10 and 15 weeks of age predicted that ADG was reduced from 847 g/day to 707 g/day when faecal shedding of *L.intracellularis* increases from 10^7 to 10^8 *L.intracellularis*, a difference of 140 g/day which equates to a total of 2.9 kg body weight loss over a 21 day period ($R^2 = 0.43$). However, ADG is only reduced minimally over 21 days (322g) with a 10 fold increase from 10^6 to 10^7 *L.intracellularis*.

TABLE 5: SUMMARY OF LAWSONIA LOAD ON POOLED PEN FAECAL SAMPLES

AGE (WEEKS)	MEAN # LAWSONIA	% POSITIVE PENS	% PENS WITH > 10 ⁶ LAWSONIA
10	0	0	0
12	4.3×10^6	16	8
14	5.5×10^6	88	40
16	9.6×10^6	84	44
18	3.5×10^6	32	4

Figure 2 – Exponential regression of ADG, between 10 and 15 weeks of age, and *L.intracellularis* numbers in faeces at 10, 12 and 14 weeks of age in 24 pooled pens of pigs to identify the critical threshold of *L.intracellularis* that causes ADG reductions



**PROJECT 2C-105:
USE OF PLANT DERIVED
COMPOUNDS TO
CONDITION PIGLET
INTAKE AT WEANING
AND REDUCE POST-
WEANING USE OF
THERAPEUTICS**

Dr Eugeni Roura, University of Queensland

The project aims to prevent problems linked to weaning in piglets by taking advantage of the adaptive capacity of pigs to the natural environment and, in particular, to facilitate the adaptation of piglets to an early weaning by using taste and smell cues from plant compounds as flavour conditioning through the sows amniotic fluids and milk to enhance early feed intake, gastrointestinal development and regulate gut microbiota, hence reducing the use of antibiotics. The ultimate goal is reduced antibiotic use in piglets at weaning.

Results have shown that essential oil supplementation of the sows' diet during the first 5 days of lactation resulted in a significant ($P < 0.05$) difference

in essential oil levels in the milk from control sows and the treatment sows, which enables the traceability of essential oil markers into sow milk on a time dependent manner since oral administration. The findings are a world first and have implications with respect to enhancing the performance and health of pigs in the immediate post weaning period.

**PROJECT 2C-107:
INVESTIGATION OF ORAL
RENNIN (CHYMOSSIN)
SUPPLEMENTATION AS A
FARM LEVEL PROTOCOL
TO IMPROVE THE
PASSIVE TRANSFER OF
IMMUNITY IN NEONATAL
PIGLETS**

Prof Peter Cockcroft, University of Adelaide

The project investigated the effects of supplementing new born piglets with oral rennin to increase the uptake of immunoglobulins from colostrum and milk. The project involved gilts and older parity sows. Half the sows and gilts were induced to farrow and the other half farrowed naturally. Three treatments were applied

to the progeny, within the first 12 hours after birth. These were no supplementation, oral supplementation with rennet, and oral supplementation with saline. Piglets assigned to the rennet and saline treatment groups were administered their assigned treatment via stomach tube, twice in the first 12 hours post farrowing. A blood sample was collected from each piglet 48-72 hours post farrowing.

Oral rennet supplementation had no significant effect on serum globulin concentration, piglet survival or performance.

The progeny of gilts, however, had lower serum globulin levels than the progeny of sows. Gilt progeny were also born lighter, had a lower weaning weight (Table 6) and a higher pre-weaning mortality than those born to sows (Figure 3). Similar differences were found between piglets from large and smaller litters.

FURTHER HIGHLIGHTS

In the reporting period there have been major breakthroughs in the control of *E.coli* disease by Dr Sharon Bishop Hurley and her team at CSIRO and Dr Jae Kim and Dr Joshua Sweeney at DAFWA. The findings, however, have potential IP implications and can't yet be released.

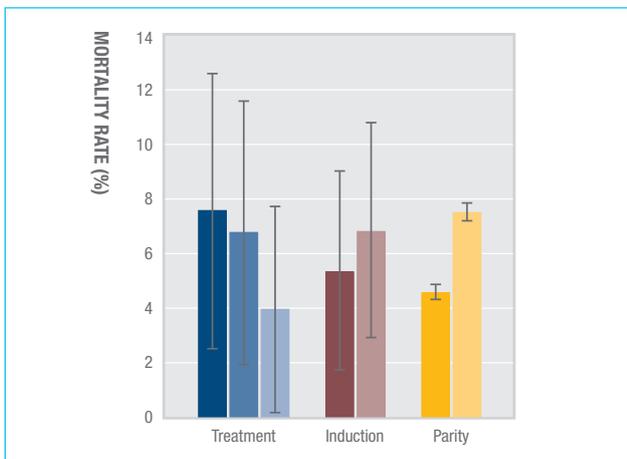


Figure 3 – Mean ± CI mortality rate for piglets in each treatment group

no supplementation (dark blue, ■), rennet supplementation (medium blue, ■), saline supplementation (light blue, ■), piglets derived from induced (dark red, ■) and non-induced dams (light red, ■), and piglets derived from sows (dark yellow, ■) and gilts (light yellow, ■).

TABLE 6: THE BIRTH WEIGHT, WEANING WEIGHT AND SERUM GLOBULIN CONCENTRATION MEASURED 48-72 HOURS AFTER BIRTH OF PROGENY OF GILTS AND SOWS

PARITY	GILTS	SOWS	SIGNIFICANCE
Birth weight (kg)	1.46	1.74	$P < 0.05$
Weaning weight (kg)	6.27	8.06	$P < 0.05$
Serum globulin (g/L)	35.8	42.2	$P < 0.05$

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Education program

STUDENT	LEVEL	TITLE	SUPERVISOR	INSTITUTION
Nicole Dron	Honours	Novel means for collecting diagnostics	T Holyoake	Charles Sturt University
Bethany Bowring	Honours	Development of quantitative PCR assays to measure ratios of beneficial to pathogenic bacteria in pig faeces	A Collins	University of Western Sydney
Yi Wen Lau	Honours	Piglet behaviour and health under different housing conditions	T Flemming	Murdoch University
Sarita Guy	PhD	Selection for robustness in pigs	S Hermes	University of Sydney
Rousset Palou	PhD	Use of plant derived compounds to condition piglet intake at weaning and reduce post-weaning use of therapeutics	E Roura	University of Queensland
Lechelle Van Breda	PhD	A comprehensive risk factor analysis of E.coli disease in the piggery environment	M Ward	University of Sydney
Dr Phil Markham	Post doc	Real time detection of airborne pathogens	M Marenda	University of Melbourne
Tracy Muller	Industry Placement Program	Enhancing gastro intestinal development and the health of piglets at weaning	R van Barneveld	CHM Alliance



Nicole Dron



Sarita Guy



Rousset Palou



Lechelle Van Breda

PROGRAM



Healthy Pork Consumption



The research will develop quality assessment and assurance tools for pork for domestic and overseas markets and an understanding of key Asian markets and how the High Integrity Australian Pork concept fits within these markets. Preliminary research initiated within the current Pork CRC will be expanded to demonstrate the inherent properties of pork that contribute to improved consumer health when pork is consumed as part of a total diet.

Program Leader: Dr Darryl D'Souza (Australian Pork Limited)

SUBPROGRAM 3A	OPTIMAL PORK QUALITY FOR MULTIPLE MARKETS
SUBPROGRAM 3B	INHERENT PROPERTIES OF AUSTRALIAN PORK TO ENHANCE CONSUMER HEALTH
SUBPROGRAM 3C	MARKET DEMAND FOR HIGH INTEGRITY AUSTRALIAN PORK

Subprogram 3A: Optimal Pork Quality for Multiple Markets

Subprogram Leader: Prof Frank Dunshea, University of Melbourne

Optimal Pork Quality for Multiple Markets will develop pork quality predictive models for a range of supply chains, on-line screening tests for taint markers and other quality parameters, carcass assessment technologies to define carcass and primal cuts for different markets, and trace element traceability technologies to underpin the integrity of Australian pork.



FUNDED PROJECTS

PROJECT	TITLE	PROJECT LEADER	ORGANISATION	TOTAL COST AUD
3A-101	Body composition and physiological changes associated with immunocastration at two different live weights	K Moore	DAFWA & University of Melbourne & Murdoch University	73,436* 218,028**
3A-102	Information Management and Data analysis Tool for Physi-Trace	G Lee	University of WA & APL	57,981* 157,981**
3A-103	Effects of various eating quality pathway factors on pork quality	F Dunshea	University of Melbourne & APL & SARDI	174,190* 271,790**
3A-104	On-line lean meat yield measurements in pig carcasses – PorkScan	H Channon	University of Melbourne & PorkScan & Rivalea Australia & APL	341,805* 650,055**
3A-105	Verification of eating quality pathways for delivering consistently high quality pork	F Dunshea	University of Melbourne & APL & DAFWA & SARDI & CHM	106,340* 299,559**
3A-106	Determining the effect of ageing period, cut type, cooking method and internal temperature on sensory and technological quality of pork	F Dunshea	University of Melbourne & SARDI & Rivalea Australia & APL	114,579* 215,098**
3B-101^a	Determining the variability in the eating quality of Australian fresh pork	C Jose	DAFWA & APL	99,929* 168,073**

^a The aim of this project was more aligned to subprogram 3A and was moved from 3B in February 2013.

Research Highlights

**PROJECT 3A-102:
INFORMATION
MANAGEMENT AND
DATA ANALYSIS TOOL
FOR PHYSI-TRACE**

Prof Garry Lee &
Prof John Watling, University
of Western Australia

Physi-Trace is a tool being developed by Australian Pork Limited as a key component of the Pork Supply Chain Integrity Program to provide full supply chain traceability and underpin pork integrity. Physi-Trace has been successfully demonstrated in a number of trace back exercises and real incident scenarios. Although highly successful, the Physi-Trace system requires skilled scientists to generate and interrogate the data. As such, the system is consequently ad hoc and requires continuous involvement of highly trained expert scientists from a selected few Institutes, resulting in relatively high cost.

This project is the first part of a two stage project to develop an automated data analysis tool, based on Physi-Trace technology, to ensure complete, robust and rapid traceability of pork and pork products along the pork supply chain.

Part 1 of this project was completed in March 2013. Specifications for the development of protocols for data screening, collation and interpretation were made to allow direct incorporation of corrected Physi-Trace analytical data into an active database. A preliminary program was developed to test if these specifications were sufficiently robust. Work to date showed that it is possible to enter analytical data into a data sub-set that can be directly accessed by the preliminary computer program to identify

data inaccuracies, select specific analytical lines and isotope masses for each of the 62 elements used for an elemental profile, correct for analytical trains, spectral and isobaric overlap, normalise data intra and inter run and use Certified Reference Material data to ensure accuracy of the data about to be stored. Additional specifications that need to be incorporated into Part 2 of this project were identified from comparisons of computer generated datasets with those produced by the analysts.

**PROJECT 3A-103:
EFFECTS OF VARIOUS
EATING QUALITY
PATHWAY FACTORS ON
PORK QUALITY** Prof Frank
Dunshea,
University of Melbourne

This project aimed to determine the impact of pathway factors, including gender (entire male, female, surgical castrate), ageing period (2 or 7 days), cut type (loin, silverside, shoulder), cooking method (steak (loin only), roast and stir fry), endpoint temperature (70 or 75°C) on consumer acceptability of pork.

Consumers evaluated the pork cuts and the key findings included:

- Juiciness, flavour, overall liking, quality grade and intramuscular fat content were influenced by pig gender. Lower scores were obtained for pork from entire males than surgical castrates, with females intermediate.
- Fail rate, based on the percentage of consumer evaluations that scored either 1 (unacceptable) or 2 (below average) for quality grade was higher for pork from entire males than from females and surgical castrates (Figure 4). It was recommended that entire males should not be included as part of an eating quality system to deliver pork of guaranteed high eating quality to consumers.
- Ageing period, as a main effect, did not influence overall liking for any cuts evaluated, suggesting that a longer ageing period of > 7 days post-slaughter may be required.

- Effects of cooking were large and significant. Cooking to 75°C had the greatest impact on loin steaks – fail rate of loin steaks cooked to 75°C increased by 14 percentage units (P<0.05) compared to cooking to 70°C (Figure 5).

with various inclusion levels of soybean lecithin. Based on these results, including dietary lecithin in pig diets to improve pork tenderness was not shown to be an appropriate intervention that could be implemented by producers.

These results highlighted that a cuts-based eating quality system requires the investigation and incorporation of additional pathway intervention(s) to those included in this study, to reduce consumer fail rates to less than 10% for different cuts cooked using different methods.

The supplementation of finisher pig diets with soybean lecithin was also investigated as a potential means to reduce the contribution of connective tissue to pork tenderness. These studies followed on from earlier research conducted as part of the inaugural Pork CRC that demonstrated positive effects of soybean lecithin supplementation on collagen content and solubility. However, no effect on eating quality was observed between pigs fed control diets and those fed diets

Figure 4 – Effect of gender on the fail rate of pork

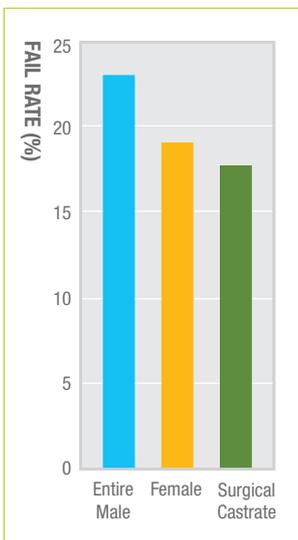
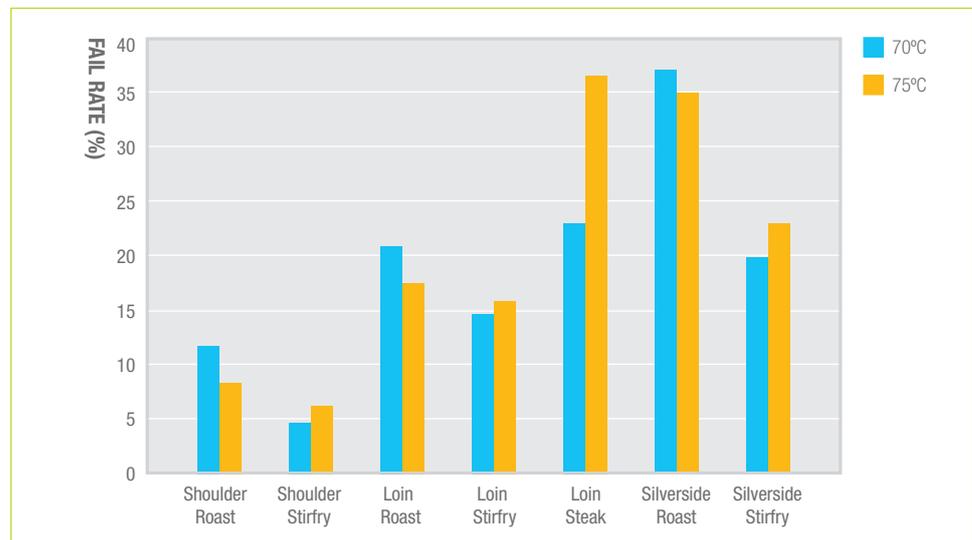


Figure 5 – Effect of endpoint temperature, cut type and cooking method on the fail rate of pork





**PROJECT 3A-104:
ON LINE LEAN MEAT
YIELD MEASUREMENT
OF PIG CARCASSES**

Heather Channon, Australian
Pork Limited on behalf of
PorkScan Pty Ltd.

This project aims to refine an on-line image capture system for accurate prediction of lean meat yield of Australian pig carcasses that is cost-effective to operate, implement and support. Outcomes will be used to commercialise the lean meat yield system for the Australian pork industry by PorkScan Pty Ltd. The first stage of this work, completed in April 2013, identified that a laser scanner may have potential to be used on the slaughter floor for lean meat yield assessment of pig carcasses. The testing stage of this project has commenced, with results expected in December 2013.

**PROJECT 3A-105:
VERIFICATION OF
EATING QUALITY
PATHWAYS TO PRODUCE
CONSISTENTLY HIGH
QUALITY PORK**

Prof Frank Dunshea,
University of Melbourne

Improving the positioning of Australian pork through differentiation is required for the development of new export and domestic market opportunities,

particularly with the increasing threat of fresh pork imports into Australia. The effects of dietary composition and slaughter age typical of pigs in North America and in Europe on eating quality and how it compares against Australian pork, is unknown. A simulation study involving Australian pigs, using feed ingredients typically used in US and Danish diets and slaughtering animals at heavier average live weights than Australian pigs, was conducted and effects on pork eating quality were determined in a 3 (dietary treatment/age at slaughter) x 2 (ageing period) experiment. The hypothesis was that increased age at slaughter (24 vs. 21 or 20 weeks) would result in increased intramuscular fat of pork and together with ageing of pork for 28 d, rather than 7d, would reduce the fail rate to less than 10%. Pork loin steaks from female pigs were cooked to 70°C internal temperature and silverside roasts cooked to 75°C were used.

Key findings included:

- Dietary treatment/age at slaughter did not influence sensory attributes of pork, despite carcase weights of animals slaughtered at 24 weeks being heavier than those slaughtered at 21 and 20 weeks of age (88.2, 70

and 67.8 kg, respectively). This suggests that slaughter weight/dietary treatment may not necessarily discount the inclusion of heavier carcasses in an eating quality system for Australian pork.

- Extended ageing for 28d did not result in additional improvements in pork sensory quality compared with ageing for 7d for both the loin and silverside. This suggests that, for this genotype, pork eating quality was optimised following ageing for 7d.
- Overall fail rate for quality grade score of pork loin steaks was only 11.5% – almost meeting the target of <10%. In contrast, the fail rate of the silverside was 22.6% for quality grade score.
- Intramuscular fat levels were very low in the loin muscle, averaging $0.47 \pm 0.31\%$. The average for the silverside was $2.03 \pm 1.23\%$.

The study demonstrated that more work is still required to implement additional pathway interventions to further reduce fail rates of different pork cuts cooked using different methods.

**PROJECT 3A-106:
DETERMINING THE
EFFECT OF AGEING
PERIOD, CUT TYPE,
COOKING METHOD
AND INTERNAL
TEMPERATURE
ON SENSORY AND
TECHNOLOGICAL
QUALITY OF PORK**

Prof Frank Dunshea,
University of Melbourne

This study was of a similar experimental design to 3A-103 (in which ageing period, cut type, cooking method and endpoint temperature were investigated), except that immunocastrated and entire males were used. This study was conducted to fill knowledge gaps for immunocastrated males and aimed to determine

the influence and size of these factors, and their interactions, on pork eating quality. Key findings included:

- Although intramuscular fat levels were higher in all muscles from immunocastrated males compared with entire males, no significant effect of gender on eating quality was found in this study.
- Fail rate for quality grade and re-purchase intention was lower for pork from immunocastrated males than entire males (17.8% vs. 15.7%, respectively) across all treatment combinations.
- As shown in Project 3A-103, cooking effects had a major impact on eating quality. Cooking pork steaks to 75°C reduced juiciness and overall liking scores compared to cooking to an endpoint temperature of 70°C.
- Shoulder cuts were more preferred than those from the loin and silverside. Fail rates of shoulder roast and stir fry (5.6% and 5.3%, respectively) met the target of < 10% compared with the cuts from the loin and silverside. Fail rates were highest for silverside roasts (26.9%) followed by the loin steak (25%), silverside stir fry (21.9%), the loin roast (19.1%) and the loin stir fry (13.4%).

Cooking education is recommended, focused on retailers and consumers to provide information on cooking practices to optimise performance of different pork cuts. The application of outcomes arising from this study will need to be validated across different supply chains and further modifications made to pathway interventions implemented by these supply chains in order to deliver pork of consistently high quality to their customers. This will be the focus of further Pork CRC research in 2013/14.



3

**PROJECT 3B-101:
DETERMINING THE
VARIABILITY IN
EATING QUALITY OF
AUSTRALIAN FRESH
PORK**

Dr Cameron Jose, DAFWA



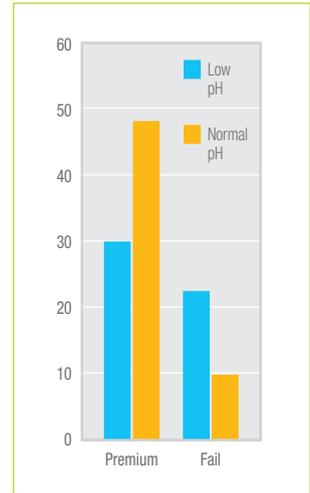
The project aimed to determine the effect of variation in ultimate pH (pHu; pH at 72 hours post mortem) on consumer sensory scores. A total of 160 loins were sourced from entire

male and female pigs from 2 supply chains. The samples were selected based on target ranges of pHu (low 5.35- 5.50; normal 5.51-5.65). Consumers preferred loin steaks with a higher, more 'normal', pHu as observed by linear increases in consumer scores of overall liking, flavour, tenderness and quality grade score. Consumers also preferred meat that had less drip loss/ cook loss (indicator of higher water holding capacity) and was more tender (lower shear force). Further, pigs with a lower pHu were more likely to produce tough meat and have a lower water holding capacity. This work identified that the variation in eating quality of

Australian fresh pork may, to some extent, be due to the variations in pHu. The industry should target reaching a pHu in the 'normal' range of 5.5-5.7 to improve product consistency. The cause of the variation in pHu in the Australian herd is likely due to a shift in muscle fibre types favouring increased post-mortem metabolism and hence a lower pHu. Further work is required to apply these recommendations to industry.

Effects of ultimate pH on the percentage of loins from one supply chain ranked by consumers as premium (above average and excellent) and fail (unsatisfactory and below average) is shown in Figure 6.

Figure 6 – Effects of ultimate pH on the percentage of consumers ranking the loin steak as premium eating quality, or as unsatisfactory or below average (fail rate)



**Subprogram 3B:
Inherent Properties of Australian Pork
to Enhance Consumer Health**

Subprogram Leader: Assoc Prof Karen Charlton, University of Wollongong

This subprogram researches the inherent health properties of pork to address key issues such as obesity, cardiovascular disease and diabetes. Human health models will be developed to validate the effects of pork consumption and new value added products benefiting consumer health.



FUNDED PROJECTS

PROJECT	TITLE	PROJECT LEADER	COLLABORATIVE PARTNER	TOTAL COST AUD
3B-102	Effect of long term consumption of Australian pork for weight loss and weight maintenance on cardiometabolic health, food cravings and cognition and psychological wellbeing in individuals with type 2 diabetes	K Murphy	University of SA & CSIRO	358,875* 696,375**
3B-103	The acute response following the consumption of pork meat: a metabolomic analysis	S Samman	University of Sydney	48,798* 127,298**
3B-104	The role of pork in improving muscle mass, body strength and cognitive function in institutionalized elderly people	K Charlton	University of Wollongong	47,968* 145,763**
3B-105	Volunteers' attitudes towards consumption of fresh Australian pork	K Murphy	University of SA	14,985* 64,985**
3B-106	Health benefits of pork consumption in the diets of Australian children	D Nolan-Clark	University of Wollongong & Landmark Nutrition	44,645* 44,645**
3B-107	Lipemic Index of pork	M Garg	University of Newcastle	50,000* 114,000**
3A-107 ^a	Sensory specific liking and satiety induced by pig meat flavours.	E Roura	University of Qld	49,317* 174,317**

^a The aim of this project was more aligned to subprogram 3B and was moved from 3A in February 2013.

Research Highlights for Subprogram 3B

PROJECT 3B-103: THE ACUTE RESPONSE FOLLOWING THE CONSUMPTION OF PORK MEAT: A METABOLOMIC ANALYSIS

Assoc Prof Samir Samman,
University of Sydney

The objectives of this study were to investigate the acute responses to consumption of meals containing pork (PM) or chicken (CM) and to identify relationships between amino acids and markers of glycemic and lipaemic control. Concentrations of 21 amino acids, glucose, insulin, triglycerides, non-esterified fatty acids (NEFA) and zinc were determined over 5h post-prandially. The meal composition did not influence glucose, insulin, triglyceride, NEFA or zinc concentrations. However, plasma Histidine was higher following the consumption of PM ($P=0.014$), with consistently higher changes observed after 60 min ($P<0.001$). Greater

percent increases were noted at limited time points for valine and leucine+isoleucine in those who consumed CM compared to PM.

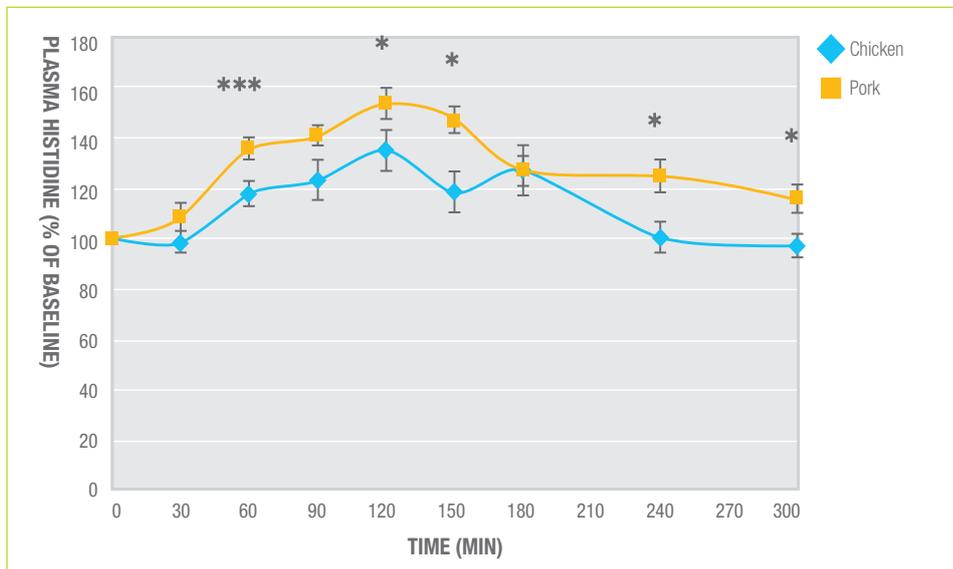
The Histidine results are shown in Figure 7. Serum His levels are reported to be lower in obese women and are negatively associated with inflammation and oxidative stress. In a supplementation trial, His significantly decreased markers of insulin resistance, waist circumference, fat mass, serum NEFA, serum inflammatory cytokines and oxidative stress. The results may help explain the positive effects of pork consumption in previous Pork CRC studies on weight loss in Type 2 diabetics and overweight subjects and improvements in cardio vascular health.

In a previous Pork CRC project in humans, Karen Charlton determined the effects of pork, beef or chicken meals on satiety and hormones that are associated with appetite. There were no significant

differences in measures of satiety after consumption of the test meals at breakfast, however a significantly higher concentration of peptide YY (PYY) and a tendency for an increased cholecystokinin (CCK) were observed in those who consumed the pork meal as compared to the chicken meal. Thus it is possible that increasing the intake of pork, elicits a combination of increased His concentrations and satiety hormones leading to improved glycemic control and reduces BMI and fat mass. The latter changes in cardio-metabolic risk factors have been reported in studies that used pork as the main source of protein in weight reducing diets.

The findings have implications for novel product development for pork and provide further strong evidence supporting the human health attributes of pork.

Figure 7 – Plasma Histidine levels in subjects after the consumption of pork or chicken



PROJECT 3B-106: HEALTH BENEFITS OF PORK CONSUMPTION IN THE DIETS OF AUSTRALIAN CHILDREN

Dr Deborah Nolan-Clark,
Landmark Nutrition Pty Ltd,
Wollongong, NSW

The project was based on an analysis of the 2007 Australian National Children's Nutrition and Physical Activity survey—the most recent nationwide survey on the dietary intakes of Australian children. The project explored the nutrition and health benefits of pork consumption in the diets of Australian children based on data from the 2007 survey.

The main findings were:

- Approximately half of the children surveyed reported eating some type of pork

- The type of pork eaten in the greatest amount was ham, followed by bacon
- Pork was most commonly consumed at home at lunchtime
- Children who reported eating pork had greater intakes of protein, phosphorous and zinc than children who did not eat pork
- Children who ate pork were more likely to meet their nutritional requirements for protein, calcium, iron, thiamine, riboflavin, phosphorous, zinc and iodine than children who did not eat pork
- Despite finding that children who ate pork had a greater energy, total fat and saturated fat intake than children who did not eat pork, there was no difference in weight, waist circumference, or prevalence of overweight/obesity (categorised using body mass index) between children who ate pork and those that did not.

The research will contribute substantially to inform the evidence base surrounding the important contribution of pork to key nutrient requirements in the diets of Australian children. In addition, the analysis of demographic, cuisine context and consumption information of pork consumers and non-consumers will directly benefit the Australian pork industry by helping inform more targeted marketing approaches to increase pork intake in Australian children. Specific opportunities identified include potential to increase fresh pork consumption, particularly in individuals from non-Asian backgrounds, scope to market pork as a key contributor to essential nutrients that assists

Australian children to meet requirements and potential dispelling of myths surrounding pork as a 'weight inducing' food, through provision of evidence whereby no adverse association was found between pork intake, weight, waist circumference and level of obesity (by BMI category).

PROJECT 3A-107: SENSORY SPECIFIC LIKING AND SATIETY INDUCED BY PIG MEAT FLAVOURS

Dr Eugeni Roura, University
of Queensland

The regulation of human reward eating mechanisms has attracted much attention in the past decade. Agents that modulate the hedonic aspect of food have the potential to over-ride the homeostatic mechanisms which control food intake. The project investigated the role of the oral sensory cues from pork meat on the magnitude of the reward and the potential to influence satiety in human subjects. The objective is to illustrate and characterise pork meat sensory qualities that may impact appetite by using standard human sensory and eating behaviour studies, together with developing a novel application based on multichannel olfactometry combined with functional Magnetic Resonance Imaging (fMRI-O). This project is being conducted at the University of Queensland in the Centre for Nutrition and Food Science, in collaboration with the Centre for Advanced Imaging. Preliminary data suggests that pork meat-related taste and smell cues may have a significant impact on satiety ratings, but additional data needs to be generated using fMRI.



Subprogram 3C: Market Demand for High Integrity Australian Pork

Subprogram Leader: Ms Heather Channon (Australian Pork Limited)

This subprogram undertakes research to define and validate the market traction of High Integrity Australian Pork attributes consumer quality and product requirements (carcass and primal cut) specifications for different Asian markets. The forecast growth in imported pork from 2009 to 2019 for the two major Asian importing countries has been estimated to be 35% for China and 49% for South Korea, giving Australia tremendous opportunity to expand exports to these countries if the markets are understood.



FUNDED PROJECTS

PROJECT	TITLE	PROJECT LEADER	ORGANISATION	TOTAL COST AUD
3C-102	Inclusion of lupins in the diet of finisher pigs to reduce the level of cholesterol	J Sweeny	DAFWA	53,573*
		M Trezona		154,273**
3C-104	Enhancing the Iron Content of Pork to Promote Human Health Benefits	J Pluske	Murdoch University DAFWA	82,087* 282,412**
3C-105	Defining the relative importance of consumer drivers and perceptions of Australian pork in targeted export markets	P Haydon	APL, Ipsos Marketing	50,000* 94,000**

Research Highlights

PROJECT 3C-102: INCLUSION OF LUPINS IN THE DIETS OF FINISHER PIGS TO REDUCE THE LEVEL OF CHOLESTEROL

Dr Megan Trezona and
Dr Joshua Sweeny, DAFWA

Lupins contain high levels of pectin, a soluble fibre source that can reduce the absorption and increase excretion of cholesterol through the gastrointestinal tract. This experiment aimed to ascertain the effectiveness of soy lecithin and/or lupins in lowering tissue cholesterol levels and increasing the polyunsaturated fatty acid (PUFA): saturated fatty acid (SFA) ratio of pork. Sixty pigs were allocated to a 2 x 3 factorial experiment (two cholesterol levels (low vs high), and three basal diets (control, 7.5% soy lecithin and 30% lupins)).

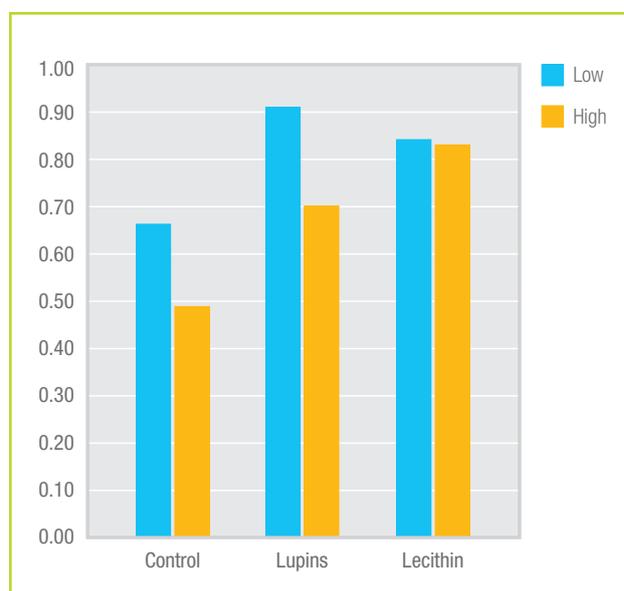
Pigs were slaughtered at approximately 95 kg liveweight.

The high lupin diets did not negatively impact pig growth performance, carcass and objective pork quality. Pigs fed soy lecithin had lower plasma levels of total and low-density lipoprotein (LDL) cholesterol compared to pigs fed the control diets. Neither soy lecithin nor lupins lowered tissue cholesterol.

However, their inclusion in the diet increased the PUFA: SFA ratio in pork, enhancing the fatty acid profile. Inclusion of 30% lupins in the diet increased the PUFA: SFA ratio by 38%-42% in lean tissue of the loin, 23%-44% in the lean tissue in the ham and by 25%-49% in belly fat. The lowest PUFA: SFA ratios were observed in tissue from pigs fed the high fat (high cholesterol) diets. Lupins are a commonly used feed ingredient and can

therefore be easily used as a tool to increase the PUFA: SFA ratio in pork especially when pigs are fed high fat diets.

Figure 8 – effects of including 30% lupins or 7.5% soy lecithin in diets of low and high cholesterol (fat) content offered grower finisher pigs on the PUFA: SFA ratio of the loin



3

Education Program

STUDENT	LEVEL	TITLE	SUPERVISOR	INSTITUTION
Amy Suckling	Hons	Determine whether there is a difference in the incidence of dark meat between free-range & intensive systems	J Pluske	Murdoch University
Henny Akit	PhD	The role of dietary lecithin in reducing collagen cross-linking and improving the health attributes to pork	F Dunshea	University of Melbourne
Heather Channon	PhD	Predicting the eating quality of pork	F Dunshea	University of Melbourne
Tsung-yu (Alex) Hung	PhD	Effect of nano-chromium on growth performance, carcass characteristics, and glucose metabolism of finishing pigs	F Dunshea	University of Melbourne
Karen Moore	PhD	Optimising the production of male pigs immunised against gonadotrophin releasing hormone	F Dunshea	University of Melbourne
Nerylee Watson	PhD	Long term pork consumption benefits	K Murphy	University of South Australia
Dr Cameron Jose	Post-doc fellow	Pork quality	B Mullan	DAFWA



Amy Suckling



Tsung-yu (Alex) Hung



Karen Moore



Dr Cameron Jose

PROGRAM

4

Carbon Conscious Nutrient Inputs and Outputs



Program 4 will reduce effluent emissions through novel management, offsetting traditional nutrient inputs with alternate sources derived from algae, and restructuring grain breeding and ingredient evaluation programs to complement these new nutrient sources.

Program Leader: Dr Rob Wilson (Rob Wilson Consulting)

SUBPROGRAM 4A	FUTURE FEEDS FOR FUTURE NEEDS
SUBPROGRAM 4B	ENHANCED USE OF TRADITIONAL PROTEIN AND ENERGY SOURCES
SUBPROGRAM 4C	CARBON-NEUTRAL PORK PRODUCTION



Subprogram 4A: Future Feeds for Future Needs

Subprogram Leader: Dave Henman, Rivalea Australia

Subprogram 4A will reduce competing demand on feed grains by establishing commercial quantities of algae products that meet the nutrient requirements of pigs. This program will also facilitate

replacement of 10% of existing feed with ingredients derived from waste streams. Two sources of algal products will be investigated – algae specifically grown using nutrients from piggery waste streams and

processed on-farm and algae or co-products derived from large scale production involved with industrial CO₂ mitigation or biodiesel production.

FUNDED PROJECTS

PROJECT	TITLE	PROJECT LEADER	COLLABORATIVE PARTNERS	TOTAL COST AUD
4A-101	Algae for Energy & Feed: a wastewater solution	H Fallowfield	Flinders University & Murdoch University	85,629* 237,229**
4A-102	Evaluation of Algal Meal as an energy and protein source in swine diets	D Henman	Rivalea Australia	0* 20,600**
4A-103	Use of algal biomass and biomass by-products for pig production	M Borowitzka	Murdoch University & Rivalea Australia & DAFWA	19,500* 205,162**
4A-104	Algae pilot plant feasibility study	D Henman	Rivalea Australia & Flinders University & CHM & MBD Energy	40,000* 101,500**

Research Highlights

PROJECT 4A-101: ALGAE FOR ENERGY AND FEED: A WASTEWATER SOLUTION

Prof Howard Fallowfield,
Flinders University

The objective of this project was to conduct an integrating review encompassing both of the priorities under subprogram 4A – Future Feeds for Future Needs – with aspects of subprogram 4C – Carbon-Neutral Pork Production. The 4A review was of the techno-economic and life cycle assessment of algal growth systems and processes suitable to produce algae as a feed source for pigs; review of pig nutrient requirements and the identification of suitable algal species that meet these nutritional requirements. The 4C component was to review current knowledge and future integrated piggery waste management/bio-energy systems and their potential to impact the growth of micro-algae on piggery waste to maximise nutrient and energy recovery from piggery waste streams.

An expert group conducted the review, managed by Flinders University, comprising Neil Buchanan, Dr Natalie

Bolton, Ryan Cheng, Dr Ivo Svoboda (Flinders), Prof Michael Borowitzka & Dr Navid Moheimani (Murdoch University), Dr Tim Grant (Life Cycle Strategies), Dr David Batten (Temaplan Group). The review considered current local and international slurry handling & management practices, including anaerobic digestion (AD), aerobic treatment to facilitate algal culture, performance of algal culture systems for feed, wastewater treatment and fuel, pig and human health benefits and risks associated with adoption of wastewater grown algal technologies and a streamlined life cycle assessment (LCA) of integrated wastewater treatment, GHG abatement and algal technologies for feed and fuel. The objective maintained throughout was to inform the future research required to ‘turn possibility into reality’.

Pig slurry should be viewed as a resource rather than a waste management cost and problem within the Australian pork industry. The overwhelming majority of pork producers use lagoon systems for wastewater treatment. A small, but growing number of producers, are now covering anaerobic lagoons to reduce emissions of the

GHG methane from slurry. The LCA analysis in this, and other studies, indicates that rather than ‘flaring’ this renewable energy source, industry should be encouraged to exploit biogas for water or space heating or in combined heat and power systems, thereby reducing fossil fuel usage and associated GHG emissions.

The review identified high ammonia and suspended solids concentrations in slurry as major inhibitors of algal growth; recommending the integration of controlled, closed vessel aerobic treatment to biologically convert the ammonia to nitrate, followed by solids separation to enable microalgae growth on anaerobic digester effluent.

The LCA indicates that further wastewater treatment by microalgae, followed by additional energy recovery via co-digestion of the algal biomass with pig slurry is the option most likely to achieve the Pork CRC aspirational GHG emission target of 1kg CO₂e/kg HSCW. This approach may also enable subsequent research, on what is a less mature technology, on growing algae for pig nutrition.

The review also considered the fate of pathogens in reuse water and microalgae feed. The reuse of inadequately treated wastewater for shed flushing and wash-down exposes pigs and humans to potential pathogens. Evidence was presented that high ammonia concentrations present in anaerobically digested effluent used for flushing, sensitises pigs to commensal organisms and those pathogens also present within the effluent. The associated morbidity results in increased feed costs due to lower growth rates delaying attainment of slaughter weight.

Integrating current anaerobic digestion technologies with aerobic treatment and high rate algal ponds will remove the ammonia and significantly reduce the pathogen load in reuse water. Research is required to evaluate the disinfection performance of this technology to produce ‘safer’ reuse water and the consequent impact on pig health and the economics of pork production. There is also a risk of pathogen transmission and heavy metals associated with the production of microalgae for pig feed on pig slurry which needs to be better assessed.

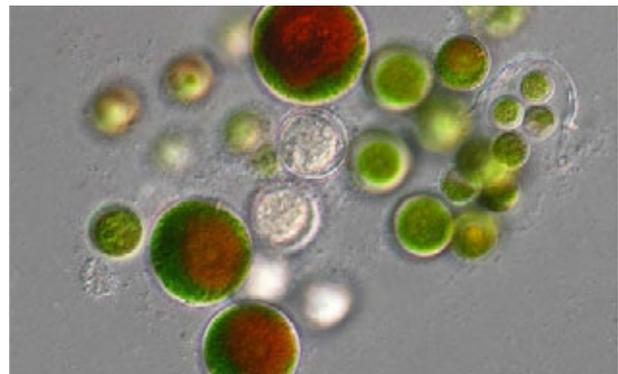
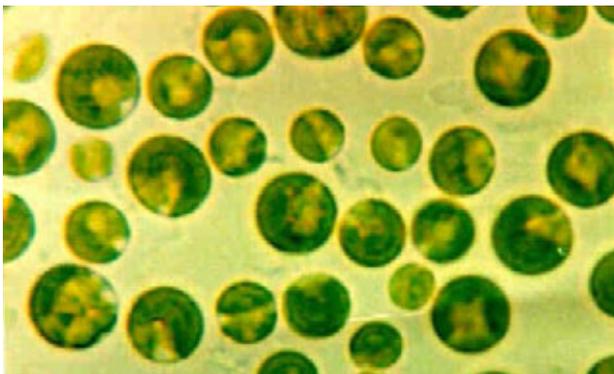


Figure 9 – Light micrographs of selected microalgae mentioned in the text: *Chlorella* and *Haematococcus*

A number of research imperatives were identified from the review, including:

- Infrastructure investment to enable pilot, on-farm research on the integration of anaerobic treatment with aerobic and/or biofiltration technologies, to manage the adverse effects of both solids and ammonia, with HRAPs to enhance wastewater treatment (nutrient and pathogen removal) for reuse and enable growth and biomass

production of microalgae for fuel and fertilizer.

- Life cycle assessment of integrated anaerobic-aerobic-high rate algal pond systems using performance data from pilot scale operation.
- The performance of integrated treatment technologies in providing cost effective reductions in pathogens.
- Identification of the best algae species for pig

nutrition and reliable growth on effluent after integrated anaerobic digestion, aerobic treatment and HRAP treatment of the piggery wastewaters.

- The use of algae for electricity has greater benefits than its use for animal feed. A more thorough investigation is needed on the feed which is offset and the system wide benefits of reducing land use pressure to supply feed for animal production.

The review clearly articulated the research needs to exploit pig slurry as an energy source, recycle nutrients and water and improve pig health via the practical application of algal technology. The LCA supported this approach to assist in meeting the aspirational target of 1kg CO₂e/kg pork.

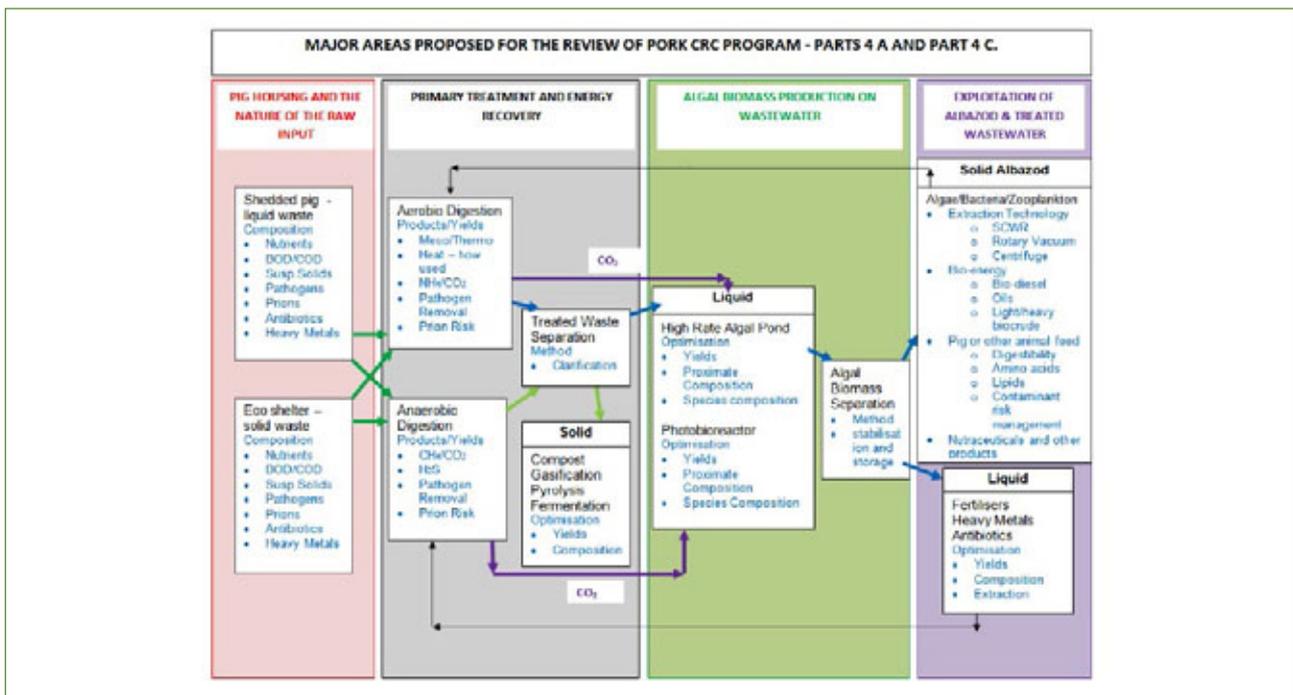


Figure 10 - HRAPs with paddlewheel (Fallowfield & Garrett, 1985a)

Subprogram 4B: Enhanced Use of Traditional Protein and Energy Sources

Subprogram Leader: Dr John Black, JLB Consulting

Subprogram 4B will build on specific outcomes from the previous Pork CRC, including development of real-time near infra-red analysis of feed ingredients and better use of this information in new plant breeding programs. Further development of innovative processing methods will improve the nutritional yield from ingredients.

FUNDED PROJECTS

PROJECT	TITLE	PROJECT LEADER	COLLABORATIVE PARTNERS	TOTAL COST AUD
4B-101	Improved Triticale Production through Breeding	J Roake	University of Sydney	142,549* 399,549**
4B-102	Development of adapted field pea varieties for pork producing regions in northern and southern Australia	S Moore	University of Sydney & Plant Research New Zealand	193,346* 405,746**
4B-103	Selection of feed wheat and/or barley varieties for the Australian pig industry	J Pluske	Murdoch University, Intergrain & DAFWA	135,763* 256,613**
4B-104	Improving the efficiency of pig feed manufacturing and application of additives	P Sopade	University of Qld & Rivalea Australia	68,993* 178,793**
4B-105	Screening of new lines of cereal grains for inclusion in NIRS calibrations for predicting nutritional quality of feed ingredients for pigs	P Sopade	University of Queensland & Symbio Alliance	195,376* 274,876**
4B-106	Quantification of the variability in the amino acid and reactive lysine content of soybean meal and development of NIR calibration for rapid prediction of reactive lysine content	JC Kim	DAFWA	12,850* 133,850**
4B-107	Processing methods of grains – Extension	P Sopade	University of Qld	100,000* 167,000**
4B-108	Increasing amino acid digestibility by Subtilisin protease in Australian Protein meals	Cadogan	Feedworks & University of Sydney & University of Melbourne	25,000* 64,571**
4B-109	Sulphur amino acid supplementation to improve herd feed efficiency in commercial grower production systems	JC Kim	DAFWA Rivalea Australia	0* 370,238**
4B-110	Further development of a reactive lysine NIR calibration for soyabean meal	JC Kim	DAFWA	30,000* 77,000**
4B-111	Improving the Utilisation of Cereals and Pulses by Pigs: The Effect of Grain Type, Milling Conditions and Processing Technology	P Torley	Charles Sturt University & Rivalea Australia	55,072* 160,232**
4B-112	Optimising particle size distribution for grains and protein sources	P Sopade	University of Qld & University of Melbourne & Rivalea Australia	280,000* 496,913**
4B-113	Grain Collection, storage and distribution and data management for 4B subprogram projects	R Trethowan	University of Sydney	358,378* 471,928**
4B-114	Statistics for the Australian Pork Industry	B Cullis	University of Wollongong	187,460* 187,460**
4B-115	Advancing Berkshire triticale supply for the Australian pig industry	J Pluske	Murdoch University & DAFWA	116,480* 169,080**
4B-116	High performance field peas for the Australian pork industry – development, commercialisation and regional uptake	J Pluske	Murdoch University	20,000* 20,000**
4B-117	Strengthening the AusScan pig DE, DE intake index NIR calibrations	P Cakebread	University of Melbourne University of Sydney DAFWA	349,570* 2,275,993**
4B-118	Canola meal NIR calibration implementation	J Spragg	JCS Solutions	19,000* 25,300**

Research Highlights

PROJECTS 4B-104, 4B-107 AND 4B-112: FEED MANUFACTURING AND GRAIN/PULSE PROCESSING

A significant scientific breakthrough from Pork CRC manufacturing and grain processing experiments is the finding that rate of feed digestion is determined by the diffusion rates of enzymes (amylase for starch and proteases for proteins) into feed particles. The diffusion rate of enzymes is many fold slower than the diffusion rate of water. It is affected by several factors including the type of digestive enzyme, the chemical and physical characteristics of the grain, the extent of gelatinisation of starch, whether the starch has become retrograde, the heat and moisture applied to proteins and the presence of other specific ingredients such as sugars that can bind to amino acids and other nutrients. For example, enzyme diffusion rates are approximately twice as fast in barley as in sorghum grain samples, they increase with gelatinisation of starch, but decrease with retrogradation

of the starch as it cools after processing. These findings about the effects of enzyme diffusion rates on feed digestion are important because they lead to an understanding of how different feed processing conditions can result in marked changes in the availability of nutrients to pigs and in pig performance.

'Large' cereal grain and pulse particles are not completely digested in the small intestines of pigs, but are fermented by microbes in the hind-gut. Fermentation of feed by microbes results in greater than 15% of the digested energy not being available to the pig because it is lost as heat of fermentation, methane and voided microbial particles. There is also strong evidence that partially digested feed in the lower small intestine and hind-gut stimulates the release of specific peptides from the intestines that slow the rate of passage of digesta through the digestive tract and significantly reduces feed intake – a phenomenon known as the 'ileal brake'. Thus, it is important to maximise feed particle digestion

in the upper parts of the small intestine.

Experiments have shown that doubling the size of grain particles decreases both enzyme diffusion rate and digestion rate four-fold. Experiments in sub-program 4B showed that removing large particles by screening and regrinding increased feed conversion efficiency in weaner and grower pigs by 10 to 22%.

In contrast and somewhat surprisingly, two experiments showed that increasing conditioning temperature during the feed pelleting process decreased the efficiency of feed use by 10-16% for weaner and grower pigs. This negative impact of conditioning temperature on efficiency of feed use is assumed to be due to increased retrogradation of the starch and reduced rates of enzyme diffusion in the final pellets. The effects of conditioning temperature on the feed efficiency and growth rate of weaner pigs are shown in Figure 11.

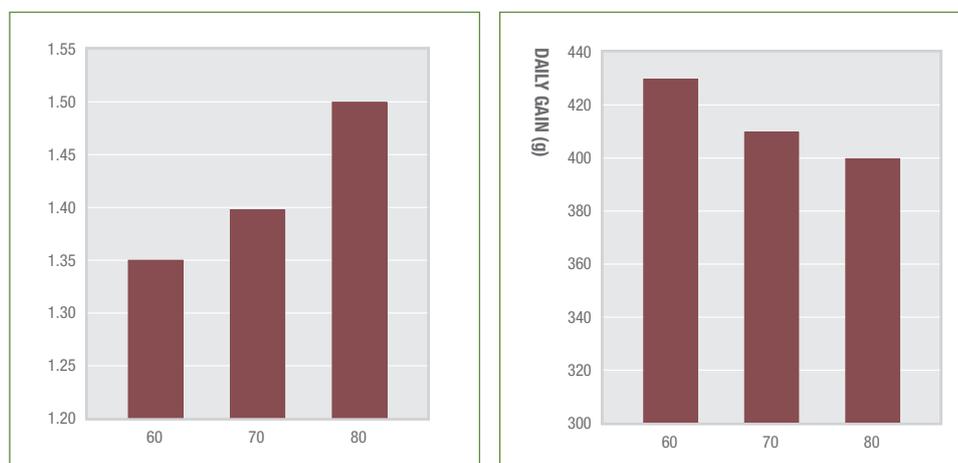


Figure 11 – Effects of processing temperature (60, 70 and 80 C) on the feed conversion ratio (FCR) and average daily gain of pigs for 21 days after weaning.

Carbon Conscious Nutrient Inputs and Outputs continued

4

Research is continuing to define the threshold maximum size of feed particles, depending on enzyme diffusion rates for different feed ingredients and the rate of passage of digesta through the pig gut. It is anticipated that before the completion of the projects, a simple algorithm may be developed to account for many of the factors affecting enzyme diffusion rate to allow an estimate of optimal particle sizes for individual feed ingredients.

A simple manual sieving device was developed in project 4B-112 for use in commercial and on-farm mills to identify grain and pulse particle size distributions. Measurement of real-world samples from mills across Queensland, South Australia and Western Australia indicates that more than 50% of grain particles from these operations are likely to be greater than the maximum size for complete digestion in the small intestine of pigs. There appears to be a real opportunity to improve the efficiency of

feed conversion in pigs across by as much as 15% through reducing feed particle sizes and optimising the temperature of conditioning units.

There have been two other important observations from the feed manufacturing research.

- 1] It has been shown that characteristics of individual grains (wheat, barley, sorghum) that influence pellet quality and nutritional value are not additive when mixed in a diet, with the characteristics of sorghum dominating.
- 2] That pellets made from sprouted wheat samples were softer and less durable than pellets made from either hard or soft normal wheat samples. Although feed disappearance was higher for the sprouted wheat when fed in diets to weaner pigs, efficiency of feed use was approximately 15% less than for the other grains.



Dr Peter Sopade with his grain sieve at Pork CRC Melbourne stakeholder's meeting.



**PROJECT 4B-105:
SCREENING OF NEW
LINES OF CEREAL
GRAINS FOR INCLUSION
IN NIRs CALIBRATIONS
FOR PREDICTING
NUTRITIONAL QUALITY
OF FEED INGREDIENTS
FOR PIGS**

Dr Peter Sopade, University of Queensland

The aim of project 4B-105 was to improve the accuracy and robustness of NIR calibrations for predicting the energy content of cereal grains for pigs by increasing the number and variety of grains included in the calibrations. Two experiments measuring whole tract digestible energy content (faecal DE content) were conducted using 70 grains, including 23 'connectivity' grains that had been included in earlier experiments to allow statistical adjustment of measured values across all experiments used to establish the NIR calibrations. The 47 new grains included maize for the first time, several new grain varieties from cereal

breeding companies, sprouted grains, large and coloured endosperm grains and grains considered to have scans identified as 'outliers' by the NIR software.

There were highly significant (P<0.01) differences in faecal DE values between grain types (wheat, barley, triticale, sorghum, maize) and within grain types. Natural paddock germination of a wheat and a barley sample tended to reduce the faecal DE content of these grains, but it was only significant for wheat when expressed on a dry matter basis. Artificial germination of sorghum for 24h increased faecal DE content by approximately 1 MJ/kg as fed, but continuing germination for 48h reduced the response to approximately 0.5 MJ/kg as fed greater than the non-germinated control. The marked increase in available energy content of sorghum with early germination was most likely related to natural proteases degrading the protein matrix encapsulating starch granules and enhancing

the access of amylase to starch within the digestive tract. However, continuing germination appears to increase energy use through shoot and root development and reduce the positive response observed for short germination times.

The effect of natural germination of wheat on its falling number and faecal DE is shown in Table 7. The collapse in the falling number would result in the grain being downgraded for baking purposes, but, as the results show, its nutritive value for pigs was only marginally reduced by natural germination. The results demonstrate the value of the AusScan calibrations for rapidly determining the nutritive value of grains for pigs and other species and show they are as valuable for grain growers as pork producers.

The latest NIR calibration can predict faecal DE with a standard error of ±0.26 MJ/kg as fed compared with ±0.38 MJ/kg as fed in the earlier calibration. The latest

calibration can predict faecal DE content within 0.52 MJ/kg as fed with 95% confidence. The robustness of the calibration as indicated by a final Ratio of Predicted to Deviation (RPD) value of 2.65 is regarded by NIR specialists as being good for predicting values for unknown samples. However, a RPD value >3 is considered excellent. The ability of the calibrations to predict unknown samples will be improved when more maize and other samples are included.

The table below shows the average and range in faecal DE values obtained across all experiments for wheat, barley and sorghum samples. It is clear that using average values is inadequate for formulating diets when the cost of 1 MJ/kg can be as high as \$18 when wheat is valued at \$250/tonne. The NIR calibrations are available through Pork CRC's AusScan project for measurement of energy value and grain composition.

TABLE 7 – THE EFFECTS OF PADDOCK GERMINATION OF WHEAT ON ITS FALLING NUMBER AND FAECAL DE CONTENT

WHEAT	NORMAL	GERMINATED
Falling Number	462	142
Faecal DE as fed (MJ/kg)	13.04	12.61
Faecal DE (MJ/kg DM basis)	14.97	14.64

TABLE 8 – FAECAL DE VALUES FOR WHEAT, BARLEY AND SORGHUM SAMPLES

GRAIN	AVERAGE FAECAL DE (MJ/KG)	RANGE
Wheat	13.8	12.7- 14.5
Barley	12.9	10.8 -13.9
Sorghum	14.4	13.4- 15.0
Triticale	13.5	12.8 -14.5
Maize	14.0	13.1 – 14.8

4

Subprogram 4C: Carbon-Neutral Pork Production

Subprogram Leader: Janine Price, Australian Pork Limited

4C will involve highly novel research to maximise methane production from effluent ponds so that collection and use of gas is economically viable. Alternative approaches to waste management will also be studied to develop solid-waste pork production systems that mitigate carbon outputs.



FUNDED PROJECTS

PROJECT	TITLE	PROJECT LEADER	COLLABORATIVE PARTNERS	TOTAL COST AUD
4C-101	LCA of waste treatment and additional pork supply chains	S Wiedemann	APL & FSA Consulting	84,655* 233,955**
4C-102	Piggery Biogas Capture and Energy Generation Feasibility Study	E McGahan	FSA Consulting	50,000* 50,000**
4C-104	Bioenergy Support Program	S Tait	University of Qld & University of WA	180,437* 421,087**
4C-105	Assessing stimulation and inhibition of anaerobic lagoons	D Batstone	University of Qld & University of WA	50,000* 117,000**
4C-106	Impact of pig gut microbiology on pig nutrition and health	D Batstone	University of Qld	50,000* 182,600**
4C-107	Potential Pathways to Carbon Neutrality	S Wiedemann	FSA Consulting	37,527* 37,527*
4C-108	Extension to 4C-101 – communication plan	S Wiedemann	FSA Consulting	8,932* 8,932*



Alan Skerman, DAFF QLD, Jeremy Whitby, Queensland Natural Pork Holdings, Stephan Heubeck, NIWA NZ, Janine Price, APL, Hugh Payne, DAFWA, at the Methane 2 markets demonstration site at Jeremy Whitby's Grantham, Queensland piggery.

Research Highlights

PROJECT 4C-102: PIGGERY BIOGAS CAPTURE AND ENERGY GENERATION FEASIBILITY STUDY

Eugene McGahan, FSA
Consulting

Pork CRC is involved in research that will develop and encourage adoption of commercially viable effluent management systems for pig production that significantly reduce the net carbon footprint of piggeries. In particular, the research program will establish pork production systems that are carbon neutral through novel research such as the development of anaerobic digestion techniques. The research program will transform the Australian pig industry by specifically addressing critical environmental and economic issues that confront its sustainability and by investigating the most effective method(s) of reusing biogas to minimise the piggery's reliance

on electricity from the grid and/or imported fuels such as diesel and liquefied petroleum gas (LPG).

There were three main objectives for this project:

- To provide separate feasibility studies to capture and use and/or flare methane gas from covered anaerobic ponds for five existing piggeries.
- To investigate the most effective method(s) of reusing biogas to minimise the piggery's reliance on electricity from the grid and/or imported fuels such as diesel and liquefied petroleum gas (LPG).
- To develop a cost benefit of the capture and reuse of methane.

The assessments covered five different piggeries, with large variations in size, design and operation. This meant that the

assessments provided a range of energy requirements and biogas capture potential. Four of the piggeries are located in Australia (two in South Australia and two in Western Australia) and one in New Zealand.

The project was divided into a staged assessment for each piggery, which provided the operators with advice on: initial investigations regarding layout of the system; the most appropriate anaerobic digestion technology; biogas use and conditioning; digestate management; and financial modelling of the most appropriate biogas use options.

The findings indicate potential for capturing and utilising biogas to minimise piggery reliance on electricity from the grid and/or imported fuels such as diesel and liquefied petroleum gas (LPG).

The five case studies were all economically feasible, with each

piggery having short payback periods of between 1.8 and 8.45 years and delivering a substantial positive return on investment over a 10-year project life.

The research indicates that biogas capture and utilisation technology can be successfully adopted at piggeries. However, all piggeries are different and care should be taken when interpreting these results. Each piggery would require an individual cost benefit and feasibility analysis before any biogas utilisation system was installed due to the variety of factors that affect both the practical and economic feasibility of such a system. These factors include, but are not limited to, piggery size and energy demand and cost. There may, however, be other drivers for piggeries to capture and destroy biogas, such as for odour reduction.

TABLE 9 - SUMMARY OF MOST FAVOURABLE OUTCOMES FROM THE FEASIBILITY STUDIES

PIGGERY	SPU* NUMBER	TYPE OF PIGGERY	TOTAL CAPITAL COST	PAYBACK PERIOD (YEARS)	ROI (10 YEARS) (%)
1	11,892	Multi-site farrow-to-finish	\$410,935	4.2	198
2	5112	Grow-out	\$279,448	8.45	7.6
3	7089 (expanded)	Sow multiplier unit	\$170,179	1.8	597
4	5399 (expanded)	Farrow-to-finish	\$345,636	4.7	151
5	6975	Farrow-to-finish	\$298,319	7.2	64

SPU – standard pig unit: pig equivalent to a grower pig (average weight 40kg) based on volatile solids production in manure.



Figure 12 – Covered anaerobic pond (CAP) in Australia



Figure 13 – Biogas hot water system and heated tiles at Grantham Piggery (Photos courtesy of Alan Skerman, DAFF Qld)

4

PROJECT 4C-104: BIOENERGY SUPPORT PROGRAM

Dr Stephan Tait, University of Queensland

The project aims are to:

- Promote use of biogas energy from covered ponds
- Support producers in assessing site-based feasibility of biogas
- Provide necessary information and resources to streamline the adoption of biogas energy at piggeries
- Identify and cultivate key opportunities for targeted research to benefit the industry

The Australian pork industry has been enthusiastically embracing the benefits of on-farm biogas energy. This is despite a lack of renewable energy incentives in Australia compared to other parts of the world, such as Europe. Biogas energy suits the Australian pork industry well, because pig manure offers a high yield to biogas and significant amounts of heat is required on-farm at piggeries. Biogas is being used at Australian piggeries for direct heating via hotwater or for combined heat and power with on-site use and/or grid exports of excess power. In Australia, the financial returns of direct on-site use of the biogas energy

have typically been far greater than for grid exports, due to prevailing low feed-in tariffs.

Currently around 8% of Australia's national pork production is harvesting biogas, with a further 2% or so under construction. An additional 10% are in various stages of planning and development.

Specifically, 10 producers have invested in biogas infrastructure. Of these, two producers own three of the registered CFI projects, four are currently in the application process for CFI registration and the other registered CFI project is owned by a producer yet to begin construction of the biogas plant.

To drive the uptake of biogas at Australian and New Zealand piggeries, the CRC for High Integrity Australian Pork (Pork CRC) is funding a Bioenergy Support Program headed by Dr Stephan Tait at the AWMC, University of Queensland. The program promotes biogas energy, supports pork producers with site-based feasibility assessments for biogas, provides technical information and resources to streamline adoption based on case study data from demonstration sites in Australia and New Zealand and identifies and promotes opportunities for targeted research to further benefit the pork industry. The support program has had

contact with more than 150 pork producers either directly or through pork industry facilitated forums and seminars. Support has covered a wide range of production sizes and systems and adoption of biogas has been shown to be economically feasible at many sites, with a significant positive return on investment over 10 years. Other activities of the Bioenergy Support Program have included scope definition for producers negotiating with regulators and local councils, fostering the build-up of a supplier base by providing direct support to suppliers on piggery biogas projects and doing engineering 'health checks' on system designs and projected biogas flows. The program also offers a laboratory analytical service, such as measurements of biogas composition to help appropriately size engine generators.

A Masters Research project through the support program by Alan Skerman, Principal Environmental Engineer of DAFF Queensland, based in Toowoomba, is developing cost-effective biogas cleaning options for on-farm use to increase the life of biogas infrastructure. Scrubbing medium regeneration field trials are ongoing at a piggery demonstration site and specialised laboratory testing equipment is being established

at DAFF Qld for testing of alternative scrubbing media products.

The research team at the AWMC has also been granted federal funding of about \$332,000 to develop feasible anaerobic processing technology for solid straw manures (spent litter) to give additional clean power and high value fertilisers and further reduce emissions from pork production. Pork CRC and APL are supporting this three year project. Additionally, Pork CRC has invested in research at the AWMC to better understand inhibition and stimulation of methane production in covered piggery lagoons, to further enhance methane production for beneficial use and value-add to the industry.

Life cycle assessments of Australian pork supply chains suggest that the majority of greenhouse gas emissions for production are methane emissions from effluent treatment and that capturing and using biogas onsite can reduce on-farm emissions by as much as 60-80%. This suggests that the industry goal of on-farm emissions of around 1kg CO₂e/kg pork produced is achievable and that the Australian pork industry has the potential to have the lowest global warming potential of pork production worldwide.

Figure 14 – Biogas returns – Breakdown

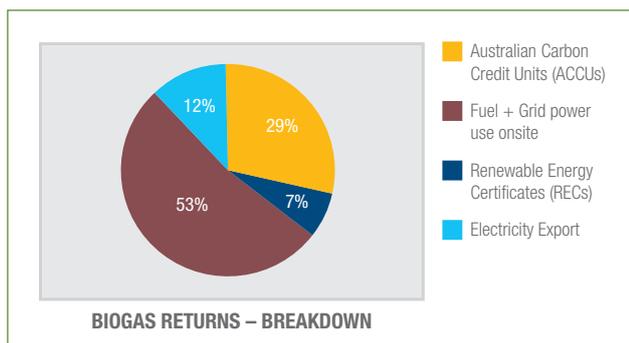


TABLE 10 - PIGGERY SCENARIOS FOR BIOGAS ENERGY

SCENARIO*	BIOGAS ENERGY*	AVERAGE DAILY ENERGY USE*	COMMENTS
100-sow farrow-to-finish conventional	170kW.h/day electricity + 180kW.h/day heat	120kW.h/day total	Supply of biogas energy can exceed demand
500-sow farrow-to-finish conventional	840kW.h/day electricity + 880kW.h/day heat	600kW.h/day total	Supply of biogas energy can exceed demand
500-sow specialised breeder unit (growers offsite) conventional	280kW.h/day electricity + 290kW.h/day heat	500kW.h/day total	Supply of biogas energy only meets energy demand if also heating with hotwater
500-sow-equivalent grow-out unit (progeny only) conventional	400kW.h/day electricity + 440kW.h/day heat	100kW.h/day total	Lots of manure, lots of biogas, little energy demand

*These scenarios were extrapolated from typical observations and may not reflect the specifics of a particular site.

Education Program

STUDENT	LEVEL	TITLE	SUPERVISOR	INSTITUTION
Jing Hoon Tan	Honours	Optimising particle size distribution	P Sopade	University of Queensland
Alan Skerman	Masters	Low cost biogas scrubbers and purification media	S Tait & S Heubeck	University of Queensland / DAFF QLD
Ryan Cheng	PhD	Exploitation of wastewater grown microalgae for the production of biogas and feedstocks	H Fallowfield	Flinders University
Megan Hawley	PhD	Advanced integrated treatment of pig slurry for algal biomass production and improved pig health	H Fallowfield	Flinders University
Dr Stephan Tait	Post-doc	Bioenergy support program	D Batstone	University of Queensland



Jing Hoon Tan



Alan Skerman



Ryan Cheng



Megan Hawley



Dr Stephan Tait

Improving Sow Reproduction

Program 5 was established to accommodate unfinished projects from the previous Pork CRC that could not fit into the four program structure of the CRC for HIAP, but will still deliver outcomes of importance to the Australian pork industry.

This program supports research to enhance the reproductive efficiency of the Australian pork industry by providing a better means of detecting pregnancy, increasing litter size and ultimately, pig volume.

THE FOUR MILESTONES FOR THIS PROGRAM ARE:

R5.1.1 COMPLETE INVESTIGATIONS OF RAPIDLY DETERMINING PREGNANCY IN SOWS WITHIN DAYS OF MATING AND PATENT THE RESULTING TECHNOLOGY

R5.1.2 COMPLETE INVESTIGATIONS OF PREDICTING THE LITTER SIZE OF PREGNANT SOWS. TEST OUTCOME ON COMMERCIAL UNITS

R5.2.1 COMPLETE INVESTIGATIONS ON THE POTENTIAL OF PROGESTERONE IMPLANTS TO ENHANCE PREGNANCY AND LITTER SIZE IN SOWS AND PATENT THE RESULTANT TECHNOLOGY

R5.2.2 COMPLETE INVESTIGATIONS ON THE EFFECTS OF NUTRITION, SEASON AND MANAGEMENT STRATEGIES ON SOW REPRODUCTION. INCREASE PREGNANCY RATES AND LITTER SIZE IN THE AUSTRALIAN SOW POPULATION



OF THE EIGHT PROJECTS, ONE – 5A-105 – WAS COMPLETED IN 2011/12, SIX IN 2012/13, WITH THE LAST (5A-107) TO BE COMPLETED BY JUNE, 30, 2014.

PROJECT ID (PREVIOUS PROJECT NUMBER)	PROJECT TITLE	PROJECT LEADER	COLLABORATIVE PARTNERS
5A-101 (2D-121)	Improving sow reproductive output through dietary manipulation in late lactation	P Hughes	SARDI & University of Adelaide
5A-102 (2D-122)	Reducing stillbirth & pre weaning mortality rates through better gestation feeding	P Hughes	SARDI & University of Adelaide & APFG
5A-103 (2D-125)	Determining the effects of season on timing of ovulation and luteal function	W van Wettere	University of Adelaide
5A-104 (2D-127)	Pre-farrowing prediction of litter size: towards improving sow metabolic status during the peri-partum period	W van Wettere	University of Adelaide
5A-105 (2D-128)	Improving embryo quality in pluriparous sows	P Langendijk	SARDI
5A-106 (2D-130)	Improving reproductive performance in pigs	S O'Leary	University of Adelaide, SARDI & APFG
5A-107 (2D-131)	Dietary ractopamine supplementation	W van Wettere	University of Adelaide, APFG & Elanco Animal Health
5A-108 (2H-108)	Impact of temperature on sow productivity	W van Wettere	University of Adelaide & CHM

Research Highlights

PROJECTS 5A-102, 5A-104 & 5A-105: SOW FEEDING STUDIES DURING GESTATION

Results from these projects, led by researchers at SARDI and University of Adelaide, provided solid evidence that increasing feed intake of gestating sows in early pregnancy can increase reproductive performance and that by increasing feed, less dominant sows get adequate nutrition. These results have particular relevance to group housed sows where aggression after mixing can result in the more submissive animals not receiving adequate feed, which have been shown to have a subsequent adverse effect on welfare and litter size. Pork CRC research has showed that towards the end of pregnancy, the increasing feed in late gestation, even for sows with big litters, had little or no beneficial effect on sow or piglet performance.

The results from these gestation feeding projects in Program 5 culminated in the production by Pork CRC and APL of the manual, Feeding Pregnant Sows in Group Housing Systems that has been distributed to all pork producers in Australia, to assist them in establishing feeding strategies for their dry sows, particularly as they transfer to group housing systems. The manual incorporates much of the information which emerged from these projects in Program 5.

PREGNANCY DIAGNOSIS SOON AFTER MATING

Currently, pregnancy is routinely determined in mated sows and gilts by an ultrasound scan performed by trained personnel at about 4-5 weeks after mating. Accurate diagnosis of pregnancy earlier than 4-5 weeks after mating will enable pork producers to identify non-pregnant animals that may be subsequently mated or

culled to improve overall non-productive days, a key measure of reproductive efficiency in commercial pork production. Project 5A-106, led by Sean O'Leary of University of Adelaide has investigated non-invasive methods of early pregnancy detection in pigs. The project has established that the important pregnancy hormones in the pig, oestrone sulphate and pregnane, can bind to a suitable antibody conjugate on prepared nitrocellulose strips to enable the accurate detection of pregnancy. The technology is a similar concept to the human pregnancy test where human chorionic gonadotropin is complexed in a similar fashion to a test strip.

An analysis of a large plasma sample set collected from previous Pork CRC projects has verified that this assay can accurately differentiate pregnant from non-pregnant animals as early as day 19 after mating.

The project has currently moved to a commercialisation project that will aim to duplicate the sensitivity of laboratory assays onto the test strips that detect the two hormones.

5

**PROJECT 5A-103:
DETERMINING THE
EFFECTS OF SEASON ON
TIMING OF OVULATION
AND LUTEAL FUNCTION**

Dr Will van Wettere,
University of Adelaide

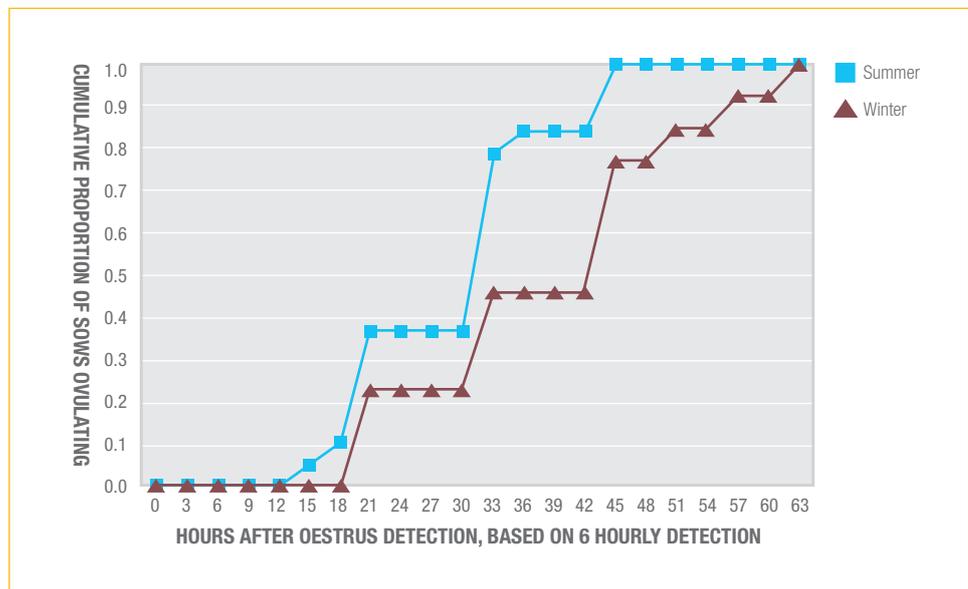
Results of studies in the previous Pork CRC revealed that post-ovulatory progesterone profiles differed between summer and winter. This project provided some interesting data regarding the effect of season on luteinizing hormone (LH) release around ovulation and the timing of ovulation as well as confirming the seasonal pattern of progesterone secretion after ovulation.

Specifically, basal LH was lower in summer compared to winter and levels of progesterone increased more rapidly from 72 hours post-oestrus detection onwards. However, from a commercial point of view, the major outcome from this study was the earlier ovulation relative to oestrus detection that was observed in summer compared to winter. Specifically,

sows weaned during summer ovulated approximately 10 hours earlier during oestrus than those weaned in winter, resulting in alterations in the interval from insemination to ovulation (Figure 15).

It could, therefore, be suggested that this alteration in the timing of ovulation and hence inseminations occurring outside the optimal period relative to ovulation (i.e. 0 – 12 hours pre-ovulation) could be partly responsible for the reduced fertility and fecundity of sows mated during summer. An extensive field trial is planned in a commercial herd during the summer of 2013/14 to examine a different insemination strategy for sows to determine whether insemination 12 hours earlier in summer months will improve the fertility of sows and help alleviate the effects of seasonal infertility.

Figure 15 – Timing of ovulation (Cumulative proportion) after first detection of oestrus for sows weaned during summer (square, ■) and winter (triangle, ▲), based on oestrus checking occurring at 6 hourly intervals.



6 Nutritional manipulations to enhance the performance and feed efficiency of growing pigs

Program 6 was established to accommodate unfinished projects from the previous Pork CRC that did not fit into the four program structure of the CRC for HIAP, but will deliver outcomes of importance to the Australian pork industry.

The research outcomes will enhance the performance and feed efficiency of growing pigs, specifically the two projects were designed to establish the extent chemosensory factors or components of ingredients might be used in diet formulations to manipulate feed intake and to investigate how nutrient asynchrony may contribute to sub optimal nutrient utilisation and pig performance.

THE TWO MILESTONES FOR PROGRAM 6 ARE:

R6.1.1 COMPLETE INVESTIGATIONS OF THE EXTENT DIFFERENT TASTANTS INFLUENCE THE FEED INTAKE OF GROWING PIGS. INGREDIENTS AND ADDITIVES (ORGANIC ACIDS, FLAVOURS AND TASTANTS) COMMONLY USED IN PORK PRODUCTION WILL BE RANKED ON THEIR PREFERENCE BY PIGS AND PREFERENCE TABLES FOR INDIVIDUAL INGREDIENTS/MATERIALS AND COMBINATIONS OF THESE WILL BE PREPARED AND MADE AVAILABLE TO NUTRITIONISTS AND THE WIDER INDUSTRY

R6.1.2 INVESTIGATE AND ESTABLISH THE EXTENT NUTRIENT ASYNCHRONY AFFECTS THE GROWTH PERFORMANCE OF PIGS UNDER COMMERCIAL SITUATIONS. THE RESEARCH WILL ESTABLISH HOW DIFFERENT INGREDIENTS AND PROCESSING TECHNOLOGIES AFFECT THE RATE AND SITE OF NUTRIENT AVAILABILITY IN THE SMALL INTESTINE AND THE EXTENT NUTRIENT ASYNCHRONY MIGHT AFFECT THE PERFORMANCE OF PIGS UNDER COMMERCIAL SITUATIONS

Nutritional manipulations to enhance the performance and feed efficiency of growing pigs continued

6

PROJECT ID (PREVIOUS PROJECT NUMBER)	PROJECT TITLE	PROJECT LEADER	COLLABORATIVE PARTNERS
6A-101 (1B-116)	Peripheral chemosensing and feed intake in pigs	E Roura	University of Queensland
6A-102 (2G-110)	Influence of nutrient asynchrony on finisher growth performance and feed efficiency	C Collins	Rivalea Australia, DAFWA

PROJECT 6A-101: PERIPHERAL CHEMOSENSING ON FEED INTAKE IN PIGS

Dr Eugeni Roura, University of Queensland

The sensitivity of pigs for the 4 basic hedonic tastes (bitter taste has not been assessed) was initially evaluated using sugar, citric acid, mono-

sodium glutamate (MSG) and salt (NaCl) and the results are shown in Table 11. The preference thresholds refer to the lowest concentration tested which resulted in significant ($P < 0.05$) preference over water compared to 50% (neutral value). Porcine primary tastes thresholds are remarkably close to identification thresholds in humans, with the exception of

sugar and citric acid, which are both significantly lower for pigs than humans. Consequently, based on preference thresholds, pigs seem to have an acute sense for tasting sweeteners and acids.

TABLE 11 – PORCINE PREFERENCE THRESHOLDS OF THE 4 PRIMARY NON-BITTER TASTES (SWEET, UMAMI, SOUR AND SALTY) EVALUATED BY DC TRIALS COMPARED TO HUMAN IDENTIFICATION THRESHOLDS.

COMPOUND	THRESHOLDS (mM)		PREF. VALUE IN PIGS (%) ¹
	HUMAN	PIG	AVERAGE
Sucrose	10	6	54
MSG	0.8	3	55
Citric acid	0.9	0.38	59
NaCl	10	18	54

¹ Refers to the lowest preference value significantly different than 50%.

However, the results seem to indicate that the concept of sensory-motivated intake is complementary to the widely used concept of preference. Sensory-motivated intake refers to the capacity of a compound to stimulate drink based on sensory cues in a non-thirsty status such as in piglets offered water ad libitum. Sensory-motivated intake threshold is referred to as the lowest concentration tested which results in significantly higher ($P < 0.05$) intake compared to water. In general, high preference index seems to be linked to high intake. However, several compounds appear to be preferred over water but may lack the capacity to motivate

any significant increase in drinking in a non-thirsty status.

When the intake of all the compounds tested in the project was compared at a constant low equimolar concentration (e.g. 1 mM) it was shown that tartaric, citric and phosphoric acids have a tremendous chemosensing potential. Consumption of these three acids at 1 mM was significantly higher than water, a result not seen in any other of the taste-active compounds investigated at that concentration. It was also interesting that Na Saccharin, MSG, NaCl or Sugar at 1 mM did not trigger any significant sensory-motivated consumption

compared to water. The results showed that Na Saccharin, MSG and NaCl only resulted in significant ($P < 0.05$) motivational intakes on or above 3, 9 and 20 mM concentrations respectively.

A commercialisation project has been commissioned jointly with the University of Queensland, CHM and a SME (BEC Feed Solutions) to develop products to enhance feed intake in weaned piglets.



Intellectual Property Management

A key driver for investment by Pork CRC is that outputs from its investments and activities will be used by industry to add value to individual commercial enterprises and Australia.

This concept of 'Utilisation' encompasses and drives a culture of:

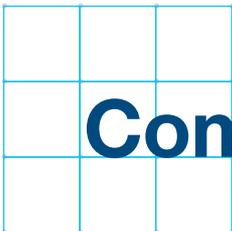
- designing projects which ask “who will use the outputs, how will they be used and how can the project be designed to maximise usability of those outputs?”
- including an Industry Adoption/Commercialisation strategy as a part of the project design or as an early milestone (within six months of project commencement) as a decision tool to identify the potential type of intellectual property that will be embodied in the project outputs, the path most likely to provide Australia and end users with the greatest benefits and why this path was chosen.
- recognising that most projects will produce outputs that will be most effectively utilised if the IP is in the public domain and encouraging widespread adoption and dissemination of research outcomes.

Building on the successes of the CRC for an Internationally Competitive Pork Industry, Pork CRC intends using these methods to maximise adoption and utilisation of research outcomes:

- Technical alerts/updates from the different Sub Program leaders on project outcomes and their commercial implications.
- *The Participant* newsletter.
- Technical visits to participants, as appropriate.
- Presentations at participant and industry conferences, trade shows and events, including Pork CRC annual conference, APSA and PPPE.
- Workshops, refresher courses and road-shows.
- Articles in industry journals and publications and the wider media, as appropriate.

As this is the second year of operation of Pork CRC, no registered IP is held. However, Pork CRC has spent this time establishing policies and procedures to ensure IP with revenue generating potential is identified early, then properly managed and protected and that a strategy is in place to achieve a successful commercial outcome, in accordance with the National Principles of IP Management for publicly funded research.

A Commercialisation and Adoption Committee has been established to oversee these functions and make recommendations to the Board regarding the commercialisation of IP generated by Pork CRC.



Communications

INTERNAL COMMUNICATION ACTIVITIES

Internal communications of activities and outcomes and on strategic direction are achieved via:

- *The Participant*
- Annual stakeholders' meeting.
- Six board meetings annually
- Pork CRC Board meets at least three times a year, at participant organisations, to provide Board members with direct communication with participants, researchers and students training within the organisations.
- Opportunities created regularly for participant and other industry stakeholders to address Board and Executive Management on matters affecting Pork CRC.
- Annual Program review – involves all program and subprogram leaders and members of R&D Committee.
- R&D Committee meetings – at least twice annually and covers all essential participants.
- Regular teleconferences and meetings held between

Pork CRC and Program teams & leaders.

- Attendance and presentations at Participant organisations and meetings.

EXTERNAL COMMUNICATION ACTIVITIES

A regular, strategic flow of media releases received good uptake and publicity through 2012/13 at state, national and international levels. Headlines and issue dates were:

- **STRATEGIC PROJECT FUNDING BY PORK CRC BOARD** (9/7/12)
- **PORK CRC ENCOURAGING INNOVATION** (17/8/12)
- **POSITIVE PIG WELFARE OUTCOMES** (27/8/12)
- **PORK CRC PROFESSIONAL PATHWAY PAYS** (13/9/12)
- **GROUP PLANNING FOR GROUP HOUSING** (31/10/12)
- **MUTTON ADDED TO PORK CRC BOARD** (20/11/12)
- **BERKSHIRE TRITICALE A GROWING GRAIN OPTION IN 2013** (12/12/12)

- **PORK CRC LINKING PORK PRODUCERS ACROSS THE TASMAN** (21/3/13)

- **PORK CRC INVITES HONOURS STUDENTS AND INNOVATION PROPOSALS** (3/4/13)

- **PREGNANT PAUSE IN HOW TO FEED GROUP HOUSED SOWS** (30/4/13)

The Participant, an e-newsletter written for and targeted at Essential and Other Participants of Pork CRC, was published and distributed in July (Issue #2), August (Issue # 3), September (Issue # 4), February (Issue #5) and June (Issue #6).

As Dr Campbell said in his welcoming words in Issue # 1, "*The Participant* is your roadmap into Pork CRC and our vehicle for keeping all valued Pork CRC participants regularly informed on where we've been and where we're going."

Dr Campbell contributed his informative, producer focused monthly *Pork CRC Initiatives* column to the national pork tabloid, *Australian Pork Newspaper (APN)*, reflecting on CEO activities and highlighting and detailing Pork CRC research outcomes likely to particularly benefit producers.



Very often published on the front page, the column is illustrated with graphs, tables and images to add value and attract reader attention. Headlines and issue dates were:

- **REFRESHING COURSE OF ACTION FOR GROUP HOUSING** (APN JULY 2012)
- **US AND CANADIAN CHANGE RATES WORTH WATCHING** (APN AUGUST 2012)
- **PROGRESSIVE PORK CRC DECISION MAKING** (APN SEPTEMBER 2012)
- **SHAPING UP FOR A GLOBAL SHAKE UP** (APN OCTOBER 2012)
- **GROUP HOUSING MAY SHELTER US AS GLOBAL CONFUSION REIGNS** (APN NOVEMBER 2012)
- **PORK CRC ACTIVELY MEETING CHALLENGES** (APN DECEMBER 2012)
- **PROMISING PORK CRC PREDICTIONS** (APN JANUARY 2013)
- **AUSSIE PORK PRODUCERS COMING OFF THE BENCH** (APN FEBRUARY 2013)
- **REFRESHING REVISION OF SOW NUTRITION** (APN MARCH 2013)
- **PORK CRC PROGRAM REVIEW HIGHLIGHTS** (APN APRIL 2013)
- **WAY OUT WEST AND ALL THE FUN OF THE FAIR** (APN MAY 2013)
- **DOES SIZE REALLY MATTER** (APN JUNE 2013)

A well-received communications initiative commenced in 2012/13 in Australian Pork Newspaper (APN) was a series of features on Pork CRC

Program Leaders and Pork CRC supported students, plus It's a Gas, a column promoting Pork CRC's Bioenergy Support Program, led by Dr Stephan Tait of University of Queensland.

Pork CRC Program Leader features in the reporting period were:

- Ray King, Prog. 1 (APN AUGUST 2012)
- Brian Luxford, Prog 2 (APN OCTOBER 2012)
- Darryl D'Souza, Prog 3 (APN NOVEMBER 2012)
- Rob Wilson, Prog 4 (APN DECEMBER 2012)
- George Foxcroft, Sub Prog 1A (APN JANUARY 2013)
- Pat Mitchell, Sub Prog 2A/B (APN MARCH 2013)
- Karen Charlton, Sub Prog 3B (APN APRIL 2013)
- John Black, Sub Prog 4B (APN MAY 2013)
- Paul Hemsworth, Sub Prog 1C (APN JUNE 2013)

Pork CRC Student features were:

- Megan Verdon, Uni of Melbourne (APN JULY 2012)
- Sarita Guy, Uni of Sydney (APN OCTOBER 2012)
- Henny Akit, Uni of Melbourne (APN NOVEMBER 2012)
- Jing Hooi Tan, Uni of Qld (APN DECEMBER 2012)
- Alice Weaver, Uni of Adelaide (APN DECEMBER 2012)
- Phil Markham, Uni of Melbourne (APN MARCH 2013)
- David Lines, Industry Placement, APFG (APN JUNE 2013)

It's a Gas columns in 12/13 were:

- **THE BUSINESS OF BIOGAS** (APN JULY 2012)
- **BIOGAS OPTIONS NOW ON THE TABLE** (APN AUGUST 2012)
- **KEEPING A SAFE WATCH ON BIOGAS** (APN SEPTEMBER 2012)
- **PORK CRC MASTERING BIOGAS** (APN DECEMBER 2012)
- **PUT YOUR FOOT ON THE GAS WITH CARBON FARMING INITIATIVE** (APN APRIL 2013)

APN also covered extensively, Pork CRC media releases and other Pork CRC related news, as did the Pork Journal, the industry nationally distributed bi-monthly magazine.

The Pork Journal, and APN, are the major source of industry news for Australian pork producers.

Internationally circulated e-newsletters continue to cover Pork CRC communications materials, while raising the profile of Pork CRC internationally. This heightens recognition among the international pork R&D and academic community, which is an important part of the very internationally collaborative CRC HIAP.

Dr Campbell and Pork CRC supported researchers and program leaders were regularly interviewed in the media on emerging R&D issues and events. Dr Campbell continues to be a preferred media 'go to' spokesperson on all pork R&D related matters.

Media monitoring via Meltwater and 'in-house' by Pork CRC Communications Manager,

Brendon Cant, reflected a high level of positive coverage in print and electronic media.

Pork CRC activities with communications potential are identified, packaged and strategic associations and links made with media and industry, to give Pork CRC valuable 'traction' and exposure to influential audiences and stakeholders.

Examples include raising Pork CRC's profile within Federal and State Government Departments and within Pork CRC participant organisations.

An expanded and refined website increasingly featured project profiles and links were always made with media materials and the website to drive traffic to www.porkcrc.com.au

Conferences and events supported by Pork CRC were, where possible, attended and covered, pictorially and editorially, by Pork CRC Communications Manager, Brendon Cant.

In the reporting period, this included his attendance at:

- Pork CRC Stakeholders meeting, Melbourne, November 2012.
- CRCA Communications meeting, Canberra, November 2012.
- Pork CRC Sow Housing workshops, Toowoomba & Melbourne, October 2012
- Victorian Pig Fair, Bendigo, April 2013
- *E coli* researcher forum, Bendigo, April 2013

OVERALL STRATEGIES TO ENSURE EFFECTIVE INTERNAL AND EXTERNAL COMMUNICATIONS

Effectively communicating, internally and externally, the activities and outcomes of CRC HIAP, has developed as early outcomes from CRC HIAP programs have become available. As the reporting period reflects Pork CRC's second year, our communications strategy has largely revolved around reinforcing the new direction, the new brand and the four programs of Pork CRC. Every opportunity has been taken to ensure consistent messages are delivered nationally and internationally that Pork CRC is all about developing a differentiated, high integrity Australian pork product. Strategically, this has involved integrating that message, whenever possible, within all communications activities delivered for each of the four programs. Considerable emphasis has been placed on informing and 'educating' external communication mediums (e.g. national and international news outlets) of the new Pork CRC identity, including brand and logo. An enhanced website has assisted the process, along with limited use of social media platforms.

During the reporting period, Pork CRC held and participated in a range of extension activities, all of which involved communicating CRC outcomes and directions. They included road shows, Victorian Pig Fair (where the sow feeding manual was launched by Dr Campbell), APL delegates' meetings in Melbourne, Brisbane and Adelaide, SA Pork Day, Australian Pig Veterinarians meeting (supported speakers on Pork CRC outcomes), tour of NZ by Dr Campbell and

Prof Paul Hughes (November 2012), face-to-face meetings between the Program leader for Program 3 and Woolworths, Rivalea and CHM supply chains on eating quality pathways outcomes.

ATTENDANCES

APL/Pork CRC Roadshows

- Perth – 50
- Roseworthy – 46
- Longford – 21
- Shepparton – 41
- Young – 50
- New Zealand Seminars – 59

Sow Workshops

- Vic – 80
- QLD – 62

Vic Pig Fair

- Student workshop – 12
- Seminar series – 110

E.coli workshops

- Vic DPI (Researcher Forum) – 40
- Vic Pig Fair – 150



Dr Jae Kim, DAFWA, Dr Stephan Tait, University of Queensland and Dr Sean O'Leary, University of Adelaide, attended the Pork CRC/APL Perth Roadshow in August 2012.



Financial Statements

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Directors' Report

Your Directors present their report, together with the financial statements of the Group, being Pork CRC Limited ('the Company') and its controlled entities ('the Group'), for the financial year ended 30 June 2013 and the auditor's report thereon.

DIRECTORS

The following persons were Directors of the Company during the financial year and are at the date of this report, except as otherwise stated:

■ **Dr John Keniry AM, BSc (Hons), PhD, FRACI, FTS, FAICD – Independent Chairman**

Dr Keniry has extensive experience as director and chairman of a number of public and private sector organisations. He is presently the Commissioner for Natural Resources in NSW, and is also Chairman of Sheep CRC Limited, Sydney Institute of Marine Science and the Australian Wool Exchange. He has previously held Board positions on the Pig R&D Corporation, the Industry Research and Development Board and was a member for six years of the Prime Minister's Science, Engineering and Innovation Council.

■ **Ms Kathryn Adams BSc.Agr (Hons), LL.M, M.Bus, M.Env. Stud, Grad Dip Leg Pract, FAICD**

Kathryn is an Agricultural Scientist and a lawyer. She has extensive experience in industry focussed R&D investment for agribusiness having held senior executive and Board positions in the public and private sectors, including CEO of 2 R&D Corporations and Director of the Queensland Horticulture Institute. She was the first Registrar of Plant Breeder's Rights in Australia and an Executive Director with the Queensland EPA. After retiring she became a part-time Senior Research Fellow with the Australian Centre for Intellectual Property in Agriculture (ACIPA) at Griffith University and is on a number of agribusiness Boards.

■ **Professor Robert van Barneveld B.Agr.Sc. (Hons), PhD, RAnNutr, FAICD**

Prof Robert van Barneveld holds a range of positions within the pork industry and other primary production sectors. Prof van Barneveld is a Non-Executive Director of the Ridley Corporation, Chairman of Porkscan Pty Ltd, a Director of Sunpork Pty Ltd, Sunpork Fresh Foods Pty Ltd, Swicker's Kingaroy Bacon Factory Pty Ltd, Barneveld Nutrition Pty Ltd, the BECAN Consulting Group Pty Ltd. In addition, he is Deputy Chair of the Autism CRC Ltd. In addition to working as a Consultant Research Scientist and Nutritionist, Prof van Barneveld acts as General Manager of the CHM Alliance Pty Ltd.

■ **Ms Sandra Di Blasio BA (Acc), CPA, GAICD (appointed 13 November 2012)**

Ms Di Blasio commenced her working career in the public service as an auditor and then for a major chartered accounting firm both in Adelaide and Sydney. Her most recent role was with BT Financial Group (Westpac) as Head of Operational Risk. She is currently on a number of boards and chairs many finance, audit and risk sub committees. Her board roles include industries such as education, IT, research and disability. Her professional experience extends across government, private sector and not for profit.

■ **Mr Brian Halstead BE (Hons), BEc, CPA – Independent Director (retired 13 November 2012)**

Mr Halstead has held the positions of Past Chairman Peer Support Foundation, Freightcorp, Past Director – Greening Australia NSW, Unilever Australia Ltd and Unilever New Zealand and Commercial Director EOI Division, Director and Trustee Unilever Aust Superannuation Fund.

■ **Mr Rod Hamann RDA(Ag)**

Mr Rod Hamann currently holds the positions CEO and Managing Director of Australian Pork Farms Group Limited plus Director of Big River Pork Abattoir. He retains Directorships for Auspork Limited and PorkScan Pty Ltd. He also sits as a member of the South Australian government appointed Pig Industry Advisory Group, the latter charged with recommending state based research projects to the SA Agriculture Minister. He is a Delegate for the peak pork industry body – Australian Pork Limited – while also being part of the Pork Executive of Pork SA, The State Based Producer Representative Group.

■ **Professor Simon Maddocks BAgSci (Hons), PhD, FAIAST, FAICD**

Professor Maddocks currently holds the position of Director Science Partnerships at the South Australian Research and Development Institute (SARDI). He is Chairman of the Governing Board of the Menzies School of Health Research, based in Darwin and Deputy Chairman of the Menzies Foundation in Melbourne. He has extensive experience in research, education, management and governance, and has held previous Board positions with the Salinity CRC and Pest Animal Control CRC. He is a member of the national Primary Industries Standing Committee (PISC) Research, Development and Extension Committee.

■ **Mr Dennis Mutton BSc.(Hons), Grad Dip Mgt, JP, FAICD, FAIM – Independent Director (appointed 13 November 2012)**

Mr Dennis Mutton is an experienced Board Chair and Director and an Independent consultant in resource planning and development, leadership, strategic management and regional development. He is Chair of BioSA and the Native Vegetation Council SA. He is also a member of the Premier's Science and Industry Council SA, the Australian Landcare Council and a Director of WPG Resources Ltd. He is the previous Chair of the Grape and Wine Research and Development Corporation and the Council of Rural R&D Corporations. He has had a distinguished career in the South Australian Public Service and industry including as Chief Executive of Primary Industries and Resources SA, the Department of Environment and Natural Resources and the Woods and Forests Department.

■ **Professor John Pluske BSc(Agric)(Hons), PhD (WA)**

Professor John Pluske is located at Murdoch University. Professor Pluske is a nutritional digestive physiologist with particular expertise in the nutrition and growth and development of the young and growing pig. He has extensive managerial experience in the University environment.

■ **Mr Kenton Shaw BAppSci, GradDip ManMgt**

Kenton is currently General Manager – Agricultural Operations for Rivalea Australia, having held the role since 2007. A graduate of the University of Queensland, Kenton began employment at Corowa in 1989. He progressed through the organisation; working in various leadership roles across the diverse production systems within the group throughout Southern NSW & Victoria. He is a member of the Victorian Farmers Federation Pork Committee and an Australian Pork Ltd delegate. While responsible for all pig production and more recently; Feed milling at Rivalea, a major focus is on implementing sustainable production systems that enhance animal welfare & meet the needs of the public while ensuring long-term viability of the organisation & industry.

■ **Mr Andrew Spencer B.Ag.Sc (Melb.), GAICD**

Mr Spencer currently holds the position of Australian Pork Limited's CEO which he took up in 2005 after a twenty year career in agribusiness, both in Australia and internationally. A large part of that time was spent in the agricultural chemical industry where he held marketing and general management roles in Australia, Germany and South Africa. In 2000, Mr Spencer moved to France to work in the agricultural biotechnology and seeds markets, particularly in global cotton, canola and rice cropping segments. Andrew comes from an agricultural upbringing. His family had cattle, sheep and cropping farms, resulting in his choice to complete a degree in Agricultural Science.

■ **Mr Chris Trengrove – Independent Director**

A New Zealand pork producer, Mr Trengrove was a Director of NZ Pork for 15 years, and was Chairman for nine years. For the past 30 years he has owned and managed a 450 sow outdoor piggery, in partnership with wife Judith, having previously spent a decade in banking. For five years he chaired the R&D Committee of NZ Pork and served for five years on the Massey University/NZ Pork Consultative Committee.

■ **Dr Hugh Wirth AM KSJ BVSc Hon DVSc (Melb) MRCVS FAVA MAICD – Independent Director**

Dr Hugh Wirth has spent his professional life in mixed veterinary practice. He is currently honorary president of RSPCA Victoria. He is the former national president of the RSPCA and the World Society for the Protection of Animals and is still a member of the Boards of these organisations. He has also held a range of positions within the veterinary profession. Since 1980 Dr Wirth has been appointed to a large number of national and state government and industry animal welfare advisory committees covering many animal species. He is currently a member of the Australian Animal Welfare Advisory Committee (AusAWAC) and the Victorian Animal Welfare Advisory Committee.



The number of directors' meetings (including meetings of Board Committees) and number of meetings attended by each of the directors of the Company during the financial year are:

DIRECTOR		BOARD OF DIRECTORS	RESEARCH AND DEVELOPMENT COMMITTEE	COMMERCIALISATION AND ADOPTION COMMITTEE	AUDIT COMMITTEE	REMUNERATION COMMITTEE	NOMINATION COMMITTEE
Dr John Keniry	Eligible	5	2	–	–	1	2
	Attended	5	2	–	–	1	2
Ms Kathryn Adams	Eligible	5	–	4	–	–	1
	Attended	5	–	4	–	–	1
Prof Robert van Barneveld	Eligible	5	2	4	–	–	2
	Attended	4	2	3	–	–	2
Ms Sandra Di Blasio *	Eligible	2	–	–	3	–	–
	Attended	2	–	–	3	–	–
Mr Brian Halstead	Eligible	3	–	–	2	–	–
	Attended	3	–	–	2	–	–
Mr Rod Hamann	Eligible	5	2	–	–	1	2
	Attended	5	2	–	–	1	2
Prof Simon Maddocks	Eligible	5	–	4	–	–	–
	Attended	5	–	4	–	–	–
Mr Dennis Mutton **	Eligible	2	1	–	3	–	–
	Attended	2	1	–	3	–	–
Prof John Pluske	Eligible	5	2	–	–	–	–
	Attended	5	2	–	–	–	–
Mr Kenton Shaw	Eligible	5	–	4	5	–	–
	Attended	5	–	4	4	–	–
Mr Andrew Spencer	Eligible	5	–	4	–	1	2
	Attended	5	–	3	–	1	2
Mr Chris Trengrove	Eligible	5	2	4	–	–	–
	Attended	5	2	4	–	–	–
Dr Hugh Wirth	Eligible	5	2	–	–	–	–
	Attended	5	1	–	–	–	–

* Ms Sandra Di Blasio attended 1 Board meeting and 2 Audit Committee meetings prior to being appointed as a director of the Company.

** Mr Dennis Mutton attended 1 Board meeting and 1 Research and Development Committee meeting prior to being appointed as a director of the Company.

COMPANY SECRETARY

Mr Geoff Crook BSc (Hons), FCA, GAICD

Mr Geoff Crook was appointed to the position of Company Secretary following incorporation of the Company on 6 April 2011. Mr Crook previously held the roles of Business and Finance Manager with the CRC for an Internationally Competitive Pork Industry, Finance and Compliance Manager with the Grape and Wine Research and Development Corporation and Chief Financial Officer and Company Secretary of an ASX listed software company.

PRINCIPAL ACTIVITIES AND OBJECTIVES OF THE COMPANY

The Company's objectives are focussed on enhancing the Australasian Pork Industry by providing new and novel technologies that assist the industry to ensure production:

- is efficient and ethical without the need for sow confinement in stalls or crates or widespread use of antibiotic medications
- delivers key nutrients safely, enhancing the health and well-being of consumers
- utilises innovative feed sources and effluent management systems resulting in emissions of less than 1 kg of CO₂ per kg of pork produced
- contributes significantly to Australia's economic growth and food security without drawing on the ecological capital of other parts of the world.

The Company achieves these objectives by investing in appropriate research and development projects and disseminating the results of those projects to the Australasian Pork Industry.

Further details of these activities can be found in the Company's published Annual Report.

PERFORMANCE MEASUREMENT

The Company measures its performance against detailed milestones agreed in its funding agreement with the Commonwealth, and against uptake of research outcomes by industry.

Progress against these milestones is reported to the Commonwealth annually.

MEMBERSHIP

The Company is limited by guarantee, with membership restricted to Essential Participants of the CRC for High Integrity Australian Pork.

12 Essential Participants have been admitted as members of the Company.

In the event of a winding up where there are insufficient assets to pay all liabilities, members are required to contribute \$10 each which would result in total additional funds of \$120.

SIGNIFICANT CHANGES IN THE STATE OF AFFAIRS

On 1 January 2013, the Company became the sole member of Australasian Pork Research Institute Ltd and so gained control of Australasian Pork Research Institute Ltd and PIGIP Pty Ltd from that date.

This created a Consolidated Group, which had a consolidated surplus of \$228,552 for the year. This surplus included an amount in respect of Australasian Pork Research Institute Ltd's net assets acquired of \$105,253.

During the year, the Company continued operating the CRC for High Integrity Australian Pork. Further details of the activities of the CRC can be found in the Annual Report.

MATTERS SUBSEQUENT TO THE END OF THE FINANCIAL YEAR

There are no material matters arising subsequent to the year end that would require disclosure or adjustment to the financial statements.



DIRECTORS' BENEFITS

No Director of the Company has received, or has become entitled to receive, a benefit, other than a remuneration benefit included below, because of a contract that the Director, a firm for which the Director is a member, or an entity in which the Director has a substantial financial interest, has made during the year ended 30 June 2013 or at any other time with the Company or a body corporate that was related to the Company, when the contract was made or when the Director received, or became entitled to receive, the benefit.

	COMPANY	
	2013 \$	2012 \$
Director's fees – cash	160,421	120,333
	160,421	120,333

The directors' fees shown are the cash benefits paid to the independent directors in their capacity as directors. The directors nominated by the participants do not receive any remuneration or benefit directly from the Pork CRC in their capacity as directors, as the respective participants can claim an in kind contribution for the time spent as a director. These contributions are included in the related party in kind contributions disclosed in Note 14.

INDEMNIFICATION AND INSURANCE OF OFFICERS

To the extent permitted by law, the Company has agreed to indemnify every person who is or has been a director or company secretary of the Company against any liability (other than for legal costs), together with reasonable legal costs in defending against such a liability, incurred by that person as a director or secretary of the Company or its controlled entities.

During the year the Company has paid premiums of \$5,705 (2012: \$5,705) in respect of directors' and officers' insurance cover.

LEAD AUDITOR'S INDEPENDENCE DECLARATION

The lead auditor's independence declaration is set out on the following page and forms part of the Directors' Report for the financial year ended 30 June 2013.

This report is made in accordance with a resolution of the Directors:

Dr John Keniry
Chairman

Adelaide, 26 September 2013

Ms Sandra Di Blasio
Director



Lead Auditor's Independence Declaration under Section 307C of the Corporations Act 2001

To: the directors of Pork CRC Limited

I declare that, to the best of my knowledge and belief, in relation to the audit for the financial year ended 30 June 2013 there have been:

- i] no contraventions of the auditor independence requirements as set out in the Corporations Act 2001 in relation to the audit; and
- ii] no contraventions of any applicable code of professional conduct in relation to the audit.

KPMG

Darren Ball
Partner

Adelaide, 26 September 2013

KPMG, an Australian partnership and a member firm of the KPMG network of independent member firms affiliated with KPMG International Cooperative ("KPMG International"), a Swiss entity.

Liability limited by a scheme approved under Professional Standards Legislation.

Statements of Comprehensive Income

For the year ended 30 June 2013

	NOTE	CONSOLIDATED GROUP	COMPANY	
		2013 \$	2013 \$	2012 \$
Revenue	2	25,895,536	25,865,212	12,829,638
Expenses				
Research programme costs		(24,100,238)	(24,100,238)	(10,703,051)
Employee expenses	3	(939,235)	(939,235)	(1,154,640)
Other expenses	4	(873,532)	(825,739)	(827,804)
(Deficit) / surplus from operating activities		(17,469)	-	144,143
Financial income		141,618	139,968	117,274
Financial expenses		-	-	(675)
Net financing income		141,618	139,968	116,599
Net assets acquired	15	105,253	-	-
Surplus before income tax		229,402	139,968	260,742
Tax expense		(849)	-	-
Surplus for the period		228,553	139,968	260,742
Other Comprehensive Income		-	-	-
Total Comprehensive Income for the period		228,553	139,968	260,742

The above Statements of Comprehensive Income should be read in conjunction with the accompanying notes set out on pages 82 to 95. The consolidated Group was established during the year. As such there are no comparative figures to disclose.

Statements of Changes in Equity

For the year ended 30 June 2013

	CONSOLIDATED GROUP		COMPANY	
	ACCUMULATED SURPLUS \$	TOTAL EQUITY \$	ACCUMULATED SURPLUS \$	TOTAL EQUITY \$
Balance at 1 July 2011	-	-	(143,469)	(143,469)
Surplus for the period	-	-	260,742	260,742
Balance at 30 June 2012	-	-	117,273	117,273
Balance at 1 July 2012	117,273	117,273	117,273	117,273
Surplus for the period	228,553	228,553	139,968	139,968
Balance at 30 June 2013	345,826	345,826	257,241	257,241

The above Statements of Changes in Equity should be read in conjunction with the accompanying notes set out on pages 82 to 95.
The consolidated Group was established during the year. As such there are no comparative figures to disclose.

Statements of Financial Position

As at 30 June 2013

	NOTE	CONSOLIDATED GROUP	COMPANY	
		2013 \$	2013 \$	2012 \$
Current Assets				
Cash and cash equivalents	6	3,736,161	3,551,989	4,477,689
Trade and other receivables	7	712,170	687,411	341,116
Investments	8	1,000,000	1,000,000	–
Total current assets		5,448,331	5,239,400	4,818,805
Non-Current Assets				
Deferred tax	5	4,020	–	–
Plant and equipment	9	5,153	5,153	7,085
Total non-current assets		9,173	5,153	7,085
Total assets		5,457,504	5,244,553	4,825,890
Current Liabilities				
Trade and other payables	10	1,716,900	1,614,767	1,222,931
Employee benefits	11	331,418	331,418	328,780
Unearned income	12	2,995,677	2,973,444	3,006,082
Total current liabilities		5,043,995	4,919,629	4,557,793
Non-Current Liabilities				
Employee benefits	11	22,683	22,683	15,824
Unearned income	12	45,000	45,000	135,000
Total non-current liabilities		67,683	67,683	150,824
Total liabilities		5,111,678	4,987,312	4,708,617
Net assets		345,826	257,241	117,273
Equity				
Accumulated Surplus		345,826	257,241	117,273
Total equity		345,826	257,241	117,273

The above Statements of Financial Position should be read in conjunction with the accompanying notes set out on pages 82 to 95.

The consolidated Group was established during the year. As such there are no comparative figures to disclose.

Statements of Cash Flows

For the year ended 30 June 2013

	NOTE	CONSOLIDATED GROUP	COMPANY	
		2013 \$	2013 \$	2012 \$
Cash flows from operating activities				
Cash receipts from Government and Participants		6,425,537	6,408,472	7,447,220
Cash paid to suppliers, researchers and employees		(6,507,119)	(6,474,140)	(2,962,951)
Cash generated from operations		(81,582)	(65,668)	4,484,269
Interest received		141,618	139,968	117,274
Net cash provided by operating activities		60,036	74,300	4,601,543
Cash flows from investing activities				
Investments	8	(1,000,000)	(1,000,000)	–
Cash acquired as part of business combination	15	198,436	–	–
Acquisition of plant and equipment	9	–	–	(7,729)
Net cash used in investing activities		(801,564)	(1,000,000)	(7,729)
Cash flows from financing activities				
Loans from Australasian Pork Research Institute Ltd		–	–	(445,550)
Interest paid		–	–	(675)
Net cash used in financing activities		–	–	(446,225)
Net (decrease)/increase in cash and cash equivalents		(741,528)	(925,700)	4,147,589
Cash and cash equivalents at 1 July		4,477,689	4,477,689	330,100
Cash and cash equivalents at 30 June	6	3,736,161	3,551,989	4,477,689

The above Statements of Cash Flows should be read in conjunction with the accompanying notes set out on pages 82 to 95.

The consolidated Group was established during the year. As such there are no comparative figures to disclose.

Notes to the financial statements

Pork CRC Limited ["the Company"] is a public company domiciled in Australia. The consolidated financial statements of the Group as at and for the year ended 30 June 2013 comprise the Company and its subsidiaries (together referred to as the 'Group' and individually as 'Group entities'). The Group is a not for profit entity.

The financial report was authorised for issue by the Directors on 26 September 2013.

The accounting policies set out below have been applied consistently to all periods presented in these consolidated financial statements, and have been applied consistently by Group entities.

2013 is the first year of the consolidated Group which was established on 1 January 2013.

Certain comparative amounts have been reclassified to conform with the current year's presentation.

Note 1 Significant Accounting Policies

(A) STATEMENT OF COMPLIANCE

The Company has early adopted AASB 1053 Application of Tiers of Australian Accounting Standards and AASB 2010-2 Amendments to Australian Standards arising from Reduced Disclosure Requirements for the financial year beginning on 1 July 2011 to prepare Tier 2 general purpose financial statements.

The financial statements are Tier 2 general purpose financial statements which have been prepared in accordance with Australian Accounting Standards – Reduced Disclosure Requirements (AASBs) adopted by the Australian Accounting Standards Board (AASB) and the Corporations Act 2001 and consequently the financial report does not comply with International Financial Reporting Standards ("IFRS's") and Interpretations adopted by the International Accounting Standards Board ("IASB").

(B) BASIS OF PREPARATION

(i) Basis of measurement

The financial report is prepared on the historical cost basis.

(ii) Functional and presentation currency

The financial report is presented in Australian dollars, being the functional currency of the Company and its subsidiaries.

(iii) Use of estimates and judgements

The preparation of a financial report in conformity with Australian Accounting Standards as discussed in the Notes below, requires management to make judgements, estimates and assumptions that affect the application of accounting policies and the reported amounts of assets and liabilities, income and expenses.

The estimates and associated assumptions are based on historical experience and various other factors that are believed to be reasonable under the circumstances, the results for which form the basis of making the judgements about carrying values of assets and liabilities that are not readily apparent from other sources. Actual results may differ from these estimates.

The estimates and underlying assumptions are reviewed on an ongoing basis. Revisions to accounting estimates are recognised in the period in which the estimate is revised if the revision affects only that period, or in the period of the revision and future periods if the revision affects both current and future periods.

Information about critical judgements in applying accounting policies that have the most significant effect on the amounts recognised in the financial statements is as follows:

- Unearned income, included in note 12.

(B) BASIS OF PREPARATION (CONTINUED)

(iv) Changes in accounting policies

Following the gaining of control of two subsidiaries during the period (see Note 15), the Group has adopted new accounting policies in respect of income tax and consolidated accounts. These policies can be found in Notes 1(l) Income tax and 1(q) Basis of consolidation.

(C) PLANT AND EQUIPMENT

(i) Owned assets

Items of plant and equipment are stated at cost less accumulated depreciation (see below) and impairment losses (see note 1(f) Impairment). Where parts of an item of plant and equipment have different useful lives, they are accounted for as separate items of plant and equipment.

(ii) Subsequent costs

The Group recognises in the carrying amount of an item of plant and equipment the cost of replacing part of such an item when that cost is incurred if it is probable that the future economic benefits embodied with the item will flow to the Group and the cost of the item can be measured reliably. All other costs are recognised in the Statement of Comprehensive Income as an expense as incurred.

(iii) Depreciation

Depreciation is charged to the Statement of Comprehensive Income on a straight-line basis over the estimated useful lives of each part of an item of plant and equipment. The estimated useful lives in the current and comparative periods are as follows:

Office equipment	4 years
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The residual value, the useful life and the depreciation method applied to an asset is reassessed annually.

(D) RECEIVABLES

Receivables are stated initially at their fair value and subsequently measured at their amortised cost less impairment losses (see Note 1(f) Impairment).

(E) CASH AND CASH EQUIVALENTS

Cash and cash equivalents comprises cash balances, at call deposits and term deposits with an original maturity of 3 months or less. Bank overdrafts that are repayable on demand and form an integral part of the Group's cash management are included as a component of cash and cash equivalents for the purpose of the Statement of Cash Flows.

Notes to the financial statements

(F) IMPAIRMENT

The carrying amounts of the Group's assets are reviewed at each reporting date to determine whether there is any indication of impairment. If any such indication exists, the asset's recoverable amount is estimated (see Note 1(f) (i) Calculation of recoverable amount).

An impairment loss is recognised whenever the carrying amount of an asset or its cash-generating unit exceeds its recoverable amount. Impairment losses are recognised in the Statement of Comprehensive Income.

Impairment losses recognised in respect of cash-generating units are allocated first to reduce the carrying amount of any goodwill allocated to cash-generating units (group of units) and then to reduce the carrying amount of the other assets in the unit (group of units) on a pro rata basis.

(i) Calculation of recoverable amount

The recoverable amount of the Group's receivables carried at amortised cost is calculated as the present value of estimated future cash flows, discounted at the original effective interest rate (i.e., the effective interest rate computed at initial recognition of these financial assets). Receivables with a short duration are not discounted.

Impairment of receivables is not recognised until objective evidence is available that a loss event has occurred. Significant receivables are individually assessed for impairment.

Other financial assets not carried at fair value through profit or loss are assessed at each reporting date to determine whether there is objective evidence that they are impaired. A financial asset is impaired if objective evidence indicates that a loss event has occurred after the initial recognition of the asset, and that the loss event had a negative effect on the estimated future cash flows of that asset that can be estimated reliably.

The recoverable amount of other assets is the greater of their net selling price and value in use. In assessing value in use, the estimated future cash flows are discounted to their present value using a pre-tax discount rate that reflects current market assessments of the time value of money and the risks specific to the asset. For an asset that does not generate largely independent cash inflows, the recoverable amount is determined for the cash-generating unit to which the asset belongs.

(ii) Reversals of impairment

An impairment loss in respect of a receivable carried at amortised cost is reversed if the subsequent increase in recoverable amount can be related objectively to an event occurring after the impairment loss was recognised.

In respect of other assets, an impairment loss is reversed if there is an indication that the impairment loss may no longer exist and there has been a change in the estimate used to determine the recoverable amount. An impairment loss is reversed only to the extent that the asset's carrying amount does not exceed the carrying amount that would have been determined, net of depreciation or amortisation, if no impairment loss had been recognised.

(G) EMPLOYEE BENEFITS

(i) Defined contribution plans

A defined contribution plan is a post-employment benefit plan under which an entity pays fixed contributions into a separate entity and will have no legal or constructive obligation to pay further amounts.

Obligations for contributions to defined contribution pension plans are recognised as an expense in the Statement of Comprehensive Income as incurred.

(ii) Long-term service benefits

The Group's net obligation in respect of long-term employee benefits other than defined benefit plans is the amount of future benefit that employees have earned in return for their service in the current and prior periods; that benefit is discounted to determine its present value, and the fair value of any plan assets deducted.

The discount rate is the yield at the reporting date on government bonds that have maturity dates approximating the terms of the Group's obligations and that are denominated in the same currency in which the benefits are expected to be paid. The calculation is performed using the projected unit credit method.

(iii) Wages, salaries and annual leave

Liabilities for wages, salaries and annual leave that are expected to be settled within 12 months of reporting date, represent present obligations resulting from employee's services provided to reporting date, are measured as the undiscounted amounts based on remuneration wage and salary rates that the Group expects to pay as at reporting date including related on-costs.

Non-accumulating non-monetary benefits are expensed based on the net marginal cost to the Group as the benefits are taken by the employees.

(H) PROVISIONS

A provision is recognised in the Statement of Financial Position when the Group has a present legal or constructive obligation as a result of a past event, and it is probable that an outflow of economic benefits will be required to settle the obligation. Provisions are determined by discounting expected future cash flows at a pre-tax rate that reflects current market assessments of the time value of money, where appropriate, the risks specific to the liability.

(I) TRADE AND OTHER PAYABLES

Trade and other payables are initially measured at fair value and subsequently measured at amortised cost. Trade payables are non-interest bearing and are normally settled on 30 day terms.

(J) REVENUE

(i) Government grants and cash contributions from Participants

Government grants and cash contributions from Participants are recognised in the Statement of Financial Position when there is reasonable assurance that they will be received and the Group will comply with the conditions attaching to them. Grants and contributions that compensate the Group for expenses incurred are recognised as revenue in the Statement of Comprehensive Income on a systematic basis in the same periods in which the expenses are incurred. Grants that compensate the Group for the cost of an asset are recognised in the Statement of Comprehensive Income as other income on a systematic basis over the useful life of the asset.

Notes to the financial statements

(J) REVENUE (CONTINUED)

(ii) In-kind contributions from Participants

Contributions by Participants are recognised in the Statement of Comprehensive Income when the significant risks and rewards of ownership have been transferred in the case of contributed assets or in proportion to the stage of completion of the transaction at the reporting date for cash and services provided. The stage of completion is assessed by reference to surveys of work performed. No revenue is recognised if there are significant uncertainties regarding recovery of the consideration due, the costs incurred or to be incurred cannot be measured reliably, there is a risk of return of goods or there is continuing management involvement with the goods.

(K) NET FINANCING INCOME

Interest income is recognised in the Statement of Comprehensive Income as it accrues, using the effective interest method. The interest expense component of finance lease payments is recognised in the Statement of Comprehensive Income using the effective interest rate method.

(L) INCOME TAX

(i) Taxable status of Group entities

On 16 January 2012, the Company applied to the Australian Taxation Office (ATO) for a private ruling to confirm that the Company is income tax exempt on the basis of being a non-profit scientific institution. On 13 July 2012, the ATO confirmed that the Company is a non-profit scientific institution and as such the Company's constitution prohibits the distribution of income and assets to members. Accordingly, the Company results are not subject to income tax.

A review of the status of the exemption was carried out on 17 September 2013 confirming the continuing tax exempt status.

Australasian Pork Research Institute Ltd, a not for profit public company limited by guarantee and controlled by the Group from 1 January 2013, is an organisation that invests in Research and Development for the benefit of the Australian pork industry. This entity is a tax exempt scientific institution.

A review of the status of the exemption was carried out on 17 September 2013 confirming the continuing tax exempt status.

A 100% subsidiary of Australasian Pork Research Institute Ltd, PIGIP Pty Ltd, has been established to commercialise Intellectual Property developed by the Group, and is regarded as a taxable entity.

(ii) Income tax expense

Income tax expense comprises current and deferred tax. Current tax and deferred tax is recognised in profit or loss except to the extent that it relates to a business combination, or items recognised directly in equity or other comprehensive income.

Current tax is the expected tax payable or receivable on the taxable income or loss for the year, using tax rates enacted or substantively enacted at the reporting date, and any adjustment to tax payable in respect of previous years. Current tax payable also includes any tax liability arising from the declaration of dividends.

Deferred tax is recognised in respect of temporary differences between the carrying amounts of assets and liabilities for financial reporting purposes and the amounts used for taxation purposes. Deferred tax is not recognised for:

- temporary differences on the initial recognition of assets and liabilities in a transaction that is not a business combination and that affects neither accounting nor taxable profit or loss.
- temporary differences related to investments in subsidiaries and jointly controlled entities to the extent that it is probable that they will not reverse in the foreseeable future.

(L) INCOME TAX (CONTINUED)

(ii) Income tax expense(continued)

Deferred tax is measured at the tax rates that are expected to be applied to temporary differences when they reverse, based on the laws that have been enacted or substantively enacted by the reporting date.

Deferred tax assets and liabilities are offset if there is a legally enforceable right to offset current tax liabilities and assets, and they relate to income taxes levied by the same tax authority on the same taxable entity.

A deferred tax asset is recognised for unused tax losses, tax credits and deductible temporary differences, to the extent that it is probable that future taxable profits will be available against which they can be utilised. Deferred tax assets are reviewed at each reporting date and are reduced to the extent that it is no longer probable that the related tax benefit will be realised.

Additional income tax expenses that arise from the distribution of cash dividends are recognised at the same time that the liability to pay the related dividend is recognised. The Group does not distribute non-cash assets as dividends to its shareholders.

(M) GOODS AND SERVICES TAX

Revenues, expenses and assets are recognised net of the amount of goods and services tax (GST), except where the amount of GST incurred is not recoverable from the Australian Taxation Office (ATO). In these circumstances, the GST is recognised as part of the cost of acquisition of the asset or as part of an item of the expense.

Receivables and payables are stated with the amount of GST included. The net amount of GST recoverable from, or payable to, the ATO is included as a current asset or liability in the Statement of Financial Position.

Cash flows are included in the Statement of Cash Flows on a gross basis. The GST component of cash flows arising from investing and financing activities which are recoverable from, or payable to, the ATO are classified as operating cash flow.

(N) SEGMENT REPORTING

A segment is a distinguishable component of the Group that is engaged either in providing products or services (business segment), or in providing products or services within a particular economic environment (geographical segment), which is subject to risks and rewards that are different from those of other segments. The Group entities do not operate in multiple business or geographical segments.

(O) RESEARCH AND DEVELOPMENT

Expenditure on research activities, undertaken with the prospect of gaining new scientific or technical knowledge and understanding, is recognised in the Statement of Comprehensive Income as an expense as incurred.

Expenditure on development activities, whereby research findings are applied to a plan or design for the production of new or substantially improved products and processes, is capitalised if the product has sufficient resources to complete development. The expenditure capitalised includes the cost of materials, direct labour and an appropriate proportion of overheads. Other development expenditure is recognised in the statement of comprehensive income as an expense as incurred.

Capitalised development expenditure is stated at cost less accumulated amortisation and impairment losses (see note 1(f) Impairment).

Notes to the financial statements

(P) CAPITAL MANAGEMENT

The Company is limited by guarantee and accordingly there is no issued capital. There were no changes to the Company's approach to capital management during the year. The Company is not subject to any externally imposed capital requirements.

In the event of a winding up where there are insufficient assets to pay all liabilities, members are required to contribute \$10 each.

(Q) BASIS OF CONSOLIDATION

(i) Subsidiaries

Subsidiaries are entities controlled by the Group. The financial statements of subsidiaries are included in the consolidated financial statements from the date that control commences to the date control ceases.

The accounting policies of subsidiaries have been changed where necessary to align them with the policies adopted by the Group.

(ii) Loss of control

Upon the loss of control, the Group derecognises the assets and liabilities of the subsidiary, any non-controlling interests and the other components of equity related to the subsidiary. Any surplus or deficit arising on the loss of control is recognised in profit or loss. If the Group retains any interest in the previous subsidiary, then such interest is measured at fair value at the date control is lost. Subsequently it is accounted for as an equity-accounted investee or as an available for sale financial asset depending on the level of influence retained.

(iii) Transactions eliminated on consolidation

Intra-group balances and transactions, and any unrealised income and expenses arising from intra-group transactions, are eliminated in preparing the consolidated financial statements.

(iv) Business Combinations

Business combinations are accounted for using the acquisition method as at the acquisition date, which is the date on which control is transferred to the Group. Control is the power to govern the financial and operating policies of an entity so as to obtain benefits from its activities. In assessing control, the Group takes into consideration potential voting rights that currently are exercisable.

The Group measures goodwill at the acquisition date as:

- the fair value of the consideration transferred; plus
- the recognised amount of any non-controlling interests in the acquiree; plus
- if the business combination is achieved in stages, the fair value of the existing equity interest in the acquiree; less
- the net recognised amount (generally fair value) of the identifiable assets acquired and liabilities assumed.

When the excess is negative, a bargain purchase gain is recognised immediately in profit or loss. The consideration transferred does not include amounts related to the settlement of pre-existing relationships. Such amounts are generally recognised in profit or loss.

Transaction costs, other than those associated with the issue of debt or equity securities, that the Group incurs in connection with a business combination are expensed as incurred.

	CONSOLIDATED GROUP	COMPANY	
	2013 \$	2013 \$	2012 \$

Note 2 Revenue

Government grant	3,053,754	3,053,754	1,564,474
Participants in-kind contributions	19,015,836	19,015,836	8,202,383
Participants cash contributions *	2,578,225	2,578,225	2,050,268
Research project co-funding	1,120,651	1,120,651	629,733
Commercialisation income	33,009	–	–
Other Income	94,061	96,746	382,780
	25,895,536	25,865,212	12,829,638

* Includes \$650,000 (2012: \$650,000) of funding for research facilities.

Note 3 Employee expenses

Wages and salaries	806,371	806,371	811,740
Contributions to defined contribution plans	54,395	54,395	50,681
Other associated personnel costs	57,327	57,327	47,080
Increase in provision for employee leave	21,142	21,142	245,139
	939,235	939,235	1,154,640

Notes to the financial statements

	NOTE	CONSOLIDATED GROUP	COMPANY	
		2013 \$	2013 \$	2012 \$

Note 4 Other expenses

Accounting fees		4,229	4,186	25,600
Directors fees		160,421	160,421	120,333
Travel		158,063	158,063	130,897
Commercialisation costs		46,242	–	–
Office cost		39,000	39,000	39,000
Depreciation	9	1,932	1,932	644
Media and Communications		138,972	138,972	127,887
Adoption expenses		170,237	170,237	75,987
Establishment costs		–	–	93,625
Other		154,436	152,928	213,831
		873,532	825,739	827,804

Note 5 Income tax expense

<i>Deferred tax expense</i>				
Utilisation of tax losses		849	–	–
Total deferred tax expense		849	–	–
Total tax expense		849	–	–
<i>Movement in Deferred tax asset</i>				
<i>Opening Deferred tax asset balance</i>				
Initial recognition of tax losses on acquisition of subsidiary		4,869	–	–
Utilisation of tax losses		(849)	–	–
Closing Deferred tax asset balance		4,020	–	–

Note 6 Cash and cash equivalents

Bank balances		2,736,161	2,551,989	4,477,689
Term deposits with an original maturity of 3 months		1,000,000	1,000,000	–
Balance as per statement of cash flows		3,736,161	3,551,989	4,477,689

	CONSOLIDATED GROUP		COMPANY	
	2013 \$		2013 \$	2012 \$

Note 7 Trade and other receivables

Other receivables	556,606	529,885	330,816
Prepayments	129,496	129,496	10,300
GST receivable	26,068	28,030	–
	712,170	687,411	341,116

Note 8 Investments

Term Deposits	1,000,000	1,000,000	–
	1,000,000	1,000,000	–

Term deposits have an original maturity of 8 months at an interest rate of 4%.

Note 9 Plant and equipment

<i>Cost</i>			
Balance at 1 July	7,729	7,729	–
Acquisitions	–	–	7,729
Balance at 30 June	7,729	7,729	7,729
<i>Depreciation</i>			
Balance at 1 July	(644)	(644)	–
Depreciation charge for the year	(1,932)	(1,932)	(644)
Balance at 30 June	(2,576)	(2,576)	(644)
<i>Carrying amounts</i>			
At 1 July	7,085	7,085	–
At 30 June	5,153	5,153	7,085

Note 10 Trade and other payables

Trade payables and accruals	1,716,900	1,614,767	1,206,110
GST payable	–	–	16,821
	1,716,900	1,614,767	1,222,931

Notes to the financial statements

	CONSOLIDATED GROUP	COMPANY	
	2013 \$	2013 \$	2012 \$

Note 11 Employee benefits

<i>Current</i>			
Salary and wages accrued	87,821	87,821	99,465
Liability for employee leave	243,597	243,597	229,315
	331,418	331,418	328,780
<i>Non-Current</i>			
Liability for employee leave	22,683	22,683	15,824
	22,683	22,683	15,824

Note 12 Unearned income

<i>Current</i>			
Government grants	1,349,772	1,349,772	803,526
Participants contributions	1,220,755	1,220,755	791,480
Co-funding – Australasian Pork Research Institute Ltd	187,879	187,879	1,201,076
Co-funding – Other	237,271	215,038	210,000
	2,995,677	2,973,444	3,006,082
<i>Non-Current</i>			
Co-funding – Other	45,000	45,000	135,000
	45,000	45,000	135,000

Unearned income consists of government grant income and contributions received and not spent. This method of recognition aligns the grant income to the period the relevant expenditure is incurred.

Note 13 Operating leases

Leases as lessee			
Non-cancellable operating lease rentals are payable as follows (including GST):			
Within one year	16,087	16,087	16,087
One year or later but no more than five years	9,570	9,570	25,657
Later than five years	–	–	–
	25,657	25,657	41,744

The Company leases office equipment and vehicles under operating leases of 3 to 4 years in duration. Lease payments are fixed throughout the term of the lease. The total amount expensed (excluding GST) for lease payments during the year was \$14,625 (2012: \$15,049).

Note 14 Key management personnel disclosures

The following were key management personnel of the Company for the entire reporting period, unless otherwise stated:

Directors

- Dr John Keniry AM, BSc (Hons), PhD, FRACI, FTS, FAICD – Independent Chairman
- Ms Kathryn Adams BSc.Agr (Hons), LLM, M.Bus, M.Env.Stud, Grad Dip Leg Pract, FAICD.
- Prof Robert van Barneveld B.Agr.Sc. (Hons), PhD, RANutr, FAICD
- Ms Sandra Di Blasio BA (Acc), CPA, GAICD (appointed 13 November 2012)
- Mr Brian Halstead BE (Hons), BEc, CPA – Independent Director (retired 13 November 2012)
- Mr Rod Hamann RDA(Ag)
- Prof Simon Maddocks BAgSci (Hons), PhD, FAIAST, FAICD
- Mr Dennis Mutton BSc.(Hons), Grad Dip Mgt, JP, FAICD, FAIM – Independent Director (appointed 13 November 2012)
- Prof John Pluske BSc(Agric)(Hons), PhD (WA)
- Mr Kenton Shaw BAppSci, GradDip ManMgt
- Mr Andrew Spencer B.Ag.Sc (Melb.), GAICD
- Mr Chris Trengrove – Independent Director
- Dr Hugh Wirth AM KSJ BVSc Hon DVSc (Melb) MRCVS FAVA MAICD – Independent Director

Executives

- Dr Roger Campbell, Chief Executive Officer, Dip Ag Science, B.Agr.Sc, Masters, PhD
- Mr Geoff Crook, Company Secretary and Business Manager, BSc(Hons), FCA, GAICD

Notes to the financial statements

Note 14 Key management personnel disclosures (continued)

Key management personnel transactions with the Group

During the year the Group transacted with entities for which key management persons hold positions that result in them having control or significant influence over the financial or operating policies of these entities. The terms and conditions of the transactions with key management personnel and their related parties were no more favourable than those available, or which might reasonably be expected to be available, on similar transactions to non-key management personnel related entities on an arms length basis.

The key management personnel compensation incurred by the Company and the Group for the year was \$807,682 (2012 : \$817,976).

Net transactions with the Group by director related entities were as follows:

	2013	2013	2013	2012
	\$	\$	\$	\$
	IN-KIND CONTRIBUTIONS	CASH RECEIPTS / (PAYMENTS)	TOTAL	TOTAL
South Australian Research and Development Institute	984,845	(226,940)	757,905	293,745
CHM Alliance Pty Ltd	1,624,521	(278,606)	1,345,915	527,671
Murdoch University	441,041	(200,377)	240,664	521,003
Australian Pork Ltd	775,965	1,695,344	2,471,309	1,944,824
New Zealand Pork Industry Board	–	–	–	73,671
Australian Pork Farms Group Ltd	1,739,818	(222,109)	1,517,709	643,263
Rivalea (Australia) Pty Ltd	2,300,160	(648,589)	1,651,571	768,394
Ridley (Agriproducts) Pty Ltd	58,945	103,125	162,070	61,875
Australasian Pork Research Institute Ltd	–	(30,487)	(30,487)	2,030,482
PIGIP Pty Ltd	–	2,954	2,954	2,547
Porkscan Pty Ltd	31,500	(77,873)	(46,373)	–
Total	7,956,795	116,442	8,073,237	6,867,475

* Sam McIvor, the director related to New Zealand Pork Industry Board resigned as a director of the Company on 28 February 2012 and so no amounts are shown in the table above for the current period.

Note 14 Key management personnel disclosures (continued)

Outstanding balances at 30 June are as follows:

	2013	2013	2013	2012
	\$	\$	\$	\$
	AMOUNT DUE TO THE COMPANY	AMOUNT DUE FROM THE COMPANY	TOTAL RECEIVABLE/ (PAYABLE)	TOTAL RECEIVABLE/ (PAYABLE)
South Australian Research and Development Institute	–	(44,000)	(44,000)	(23,443)
CHM Alliance Pty Ltd	20,625	(102,328)	(81,703)	(71,921)
Murdoch University	–	–	–	(77,414)
Australian Pork Ltd	5,060	(101,740)	(96,680)	16,137
Australian Pork Farms Group Ltd	–	(9,625)	(9,625)	–
Rivalea (Australia) Pty Ltd	–	(132,000)	(132,000)	(12,375)
Ridley (Agriproducts) Pty Ltd	–	–	–	20,625
Australasian Pork Research Institute Ltd	–	–	–	(10,054)
Total	25,685	(389,693)	(364,008)	(158,445)

In addition, at the year end PIGIP Pty Ltd has an outstanding loan payable to Australasian Pork Research Institute Ltd in the amount of \$60,240 (2012: \$60,240)

Note 15 Net assets acquired on gaining control of subsidiaries

On 1 January 2013, the Company became the sole member of Australasian Pork Research Institute Ltd and so gained control of Australasian Pork Research Institute Ltd and PIGIP Pty Ltd from that date.

No consideration was payable in respect of this change in control.

The assets and liabilities acquired by the Group (recognised at fair value) are as follows:

Cash	198,436
Receivables	20,224
Payables	(113,407)
Net assets acquired	105,253

Note 16 Subsequent events

There are no material matters arising subsequent to the year end that would require disclosure or adjustment to the financial statements.



Directors' Declaration

In the opinion of the Directors of Pork CRC Limited ["the Company"]:

- a]** the financial statements of the Company, set out on pages 78 to 95, are in accordance with the *Corporations Act 2001*, including:
 - i]** giving a true and fair view of the Company's financial position as at 30 June 2013 and of its performance for the financial year ended on that date; and
 - ii]** complying with Australian Accounting Standards – Reduced Disclosure Requirements (including the Australian Accounting Interpretations) and the *Corporations Regulations 2001*; and
- b]** there are reasonable grounds to believe that the Company will be able to pay its debts as and when they become due and payable.

Signed in accordance with a resolution of the directors:

Dr John Keniry
Chairman

Ms Sandra Di Blasio
Director

Adelaide, 26 September 2013



Independent Auditor's Report to the Members of Pork CRC Limited

REPORT ON THE FINANCIAL REPORT

We have audited the accompanying financial report of Pork CRC Limited (the Company), which comprises the statements of financial position as at 30 June 2013, and the statements of comprehensive income, statements of changes in equity and statements of cash flows for the year ended on that date, notes 1 to 16 comprising a summary of significant accounting policies and other explanatory information and the directors' declaration set out on page 96 of the Company and the Group comprising the Company and the entities it controlled at the year's end or from time to time during the financial year.

DIRECTORS' RESPONSIBILITY FOR THE FINANCIAL REPORT

The directors of the Company are responsible for the preparation of the financial report that gives a true and fair view in accordance with Australian Accounting Standards – Reduced Disclosure Requirements and the *Corporations Act 2001* and for such internal control as the directors determine is necessary to enable the preparation of the financial report that is free from material misstatement whether due to fraud or error.

AUDITOR'S RESPONSIBILITY

Our responsibility is to express an opinion on the financial report based on our audit. We conducted our audit in accordance with Australian Auditing Standards. These Auditing Standards require that we comply with relevant ethical requirements relating to audit engagements and plan and perform the audit to obtain reasonable assurance whether the financial report is free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial report. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial report, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the entity's preparation of the financial report that gives a true and fair view in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by the directors, as well as evaluating the overall presentation of the financial report.

We performed the procedures to assess whether in all material respects the financial report presents fairly, in accordance with the *Corporations Act 2001* and Australian Accounting Standards – Reduced Disclosure Requirements, a true and fair view which is consistent with our understanding of the Company's and the Group's financial position and of their performance.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

INDEPENDENCE

In conducting our audit, we have complied with the independence requirements of the *Corporations Act 2001*.

AUDITOR'S OPINION

In our opinion the financial report of Pork CRC Limited is in accordance with the *Corporations Act 2001*, including:

- i] giving a true and fair view of the Company's and the Group's financial position as at 30 June 2013 and of their performance for the year ended on that date; and
- ii] complying with Australian Accounting Standards – Reduced Disclosure Requirements and the Corporations Regulations 2001.



KPMG



Darren Ball
Partner

Adelaide, 26 September 2013

KPMG, an Australian partnership and a member firm of the KPMG network of independent member firms affiliated with KPMG International Cooperative ('KPMG International'), a Swiss entity.

Liability limited by a scheme approved under Professional Standards Legislation.



Notes

Essential and Other Participants

Essential Participants



Other Participants

- Alltech Inc
- Animal Genetics and Breeding Unit
- Australasian Pig Science Association
- Biomin Singapore Pte Ltd
- Charles Sturt University
- CSIRO
- Department of Primary Industries NSW
- DSM Nutritional Products
- Elanco Animal Health
- Feedlot Services Australia Pty Ltd
- Feedworks Pty Ltd
- Flinders University
- The Hanor Family of Companies
- Intergrain Pty Ltd
- Landmark Nutrition Pty Ltd
- MBD Energy
- Nutreco Nederland B.V.
- Plant Research (NZ) Ltd
- Porkscan Pty Ltd
- RSPCA Australia Incorporated
- University of Minnesota
- University of Queensland
- University of South Australia
- University of Western Australia
- University of Wollongong
- Western Australian Agricultural Authority – DAFWA
- Woolworths Ltd
- Zinpro performance Minerals Inc
- Zoetis Australia Pty Ltd

www.porkcrc.com.au