Research Summaries

Project summaries from CRC for an
Internationally Competitive Pork Industry

Contents

Mission Statement

The CRC for an Internationally Competitive Pork Industry aimed to enhance the efficiency and cost competitiveness of the Australian pork industry, while maintaining environmentally sustainable agricultural practice, allowing the efficient production of innovative pork products from enhanced grain resources and with improved efficiency.

Outcomes

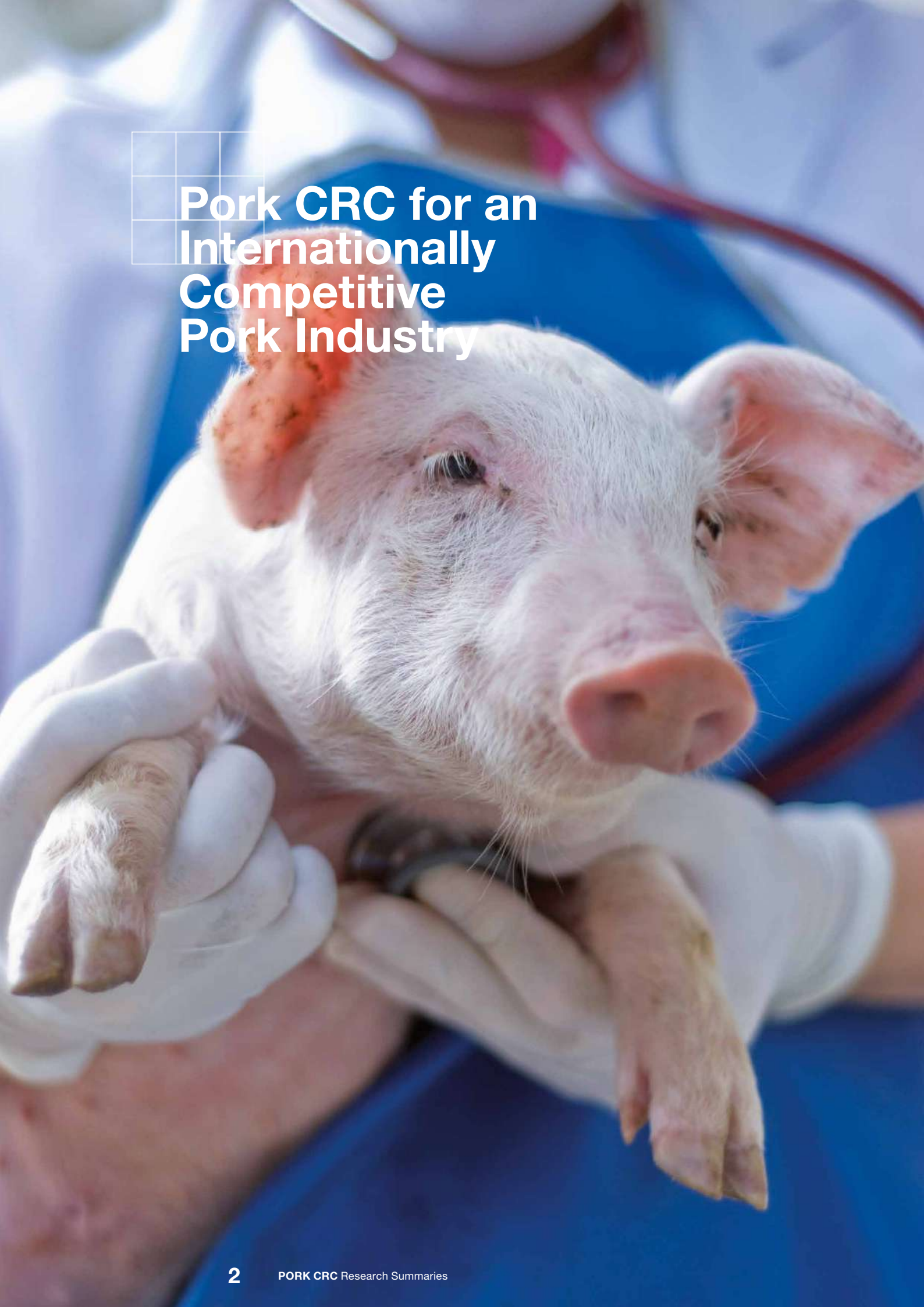
Across the three programs and some 13-sub programs, the Pork CRC reinvigorated research and development in pigs and pork and provided industry with new information and technologies that enhanced the efficiency and reduced the cost of production and demonstrated the quality of and the human health benefits of Australian pork.

Across Program 1 Pork CRC, researchers developed new Triticale, barley and pea varieties, continually enhanced the NIRS calibrations for rapidly determining the energy value of grains and eventually commercialised the technology (AusScan). They demonstrated the marked impact grain processing and grain particle size has on the feed efficiency of growing pigs and developed methods for assessing starch digestibility in grains.

Across Program 2 Pork CRC, researchers established the most cost effective strategies for using Paylean (Ractopamine) and Improvac, established the amino acid requirements for modern Australian genotypes and for modern genotypes offered diets containing Ractopamine. Requirements for male pigs vaccinated against boar taint were also established. They demonstrated the effects of combining fat (tallow) and NDF to improve feed efficiency and margin over feed cost in finisher pigs and the importance of Omega 3 and Omega 6 fatty acids on reproduction and progeny performance. They established the impact of Chromium and Lecithin on feed efficiency and carcass fatness in finisher pigs. Pork CRC researchers also demonstrated the positive effects of high energy diets for lactating gilts on subsequent reproduction and sow retention and the effect of including Ractopamine in the diet of lactating sows on subsequent reproduction. Research on feeding gestating sows turned common practice at the time on its head showing that high feeding levels in early gestation improved reproduction in younger sows and that feeding a higher level in late gestation had no effect on piglet birth weight or survival but reduced feed intake in lactation in all parities'. Overall Program 2 delivered industry a wealth of new information and technologies for enhancing reproduction, animal health and the performance and carcass characteristics of growing pigs.

In Program 3 Pork CRC, researchers demonstrated in many cases for the first time the benefits of pork on human health and wellbeing. These included weight loss, improvement in cardiac health and on the wellbeing of young women.

The projects supported across the three programs are all provided in tabular form. Where appropriate summaries of each project are provided under each sub program. A number of projects were completed under the CRC for High Integrity Australian Pork and these are identified in the project tables for each sub program. These summaries are provided under those for CRC for High Integrity Australian Pork. The final reports for both Pork CRCs are available on the Pork CRC web site (www.porkcrc.com.au).



Pork CRC for an Internationally Competitive Pork Industry

PROGRAMS

Investment across programs and subprograms are summarised in the following tables and where appropriate research summaries are provided for all projects.

1 Securing more reliable and consistent supplies of protein and energy for pig diets

2 Improving whole herd feed conversion efficiency

3 Enhancing capacity to deliver nutrients that promote health and well-being through pork

PROGRAM

1 Securing more reliable and consistent supplies of protein and energy for pig diets

Targets

- Reduce diet costs by 10% by 2012.
- Improve the Digestible energy (DE) content of grains by 1.0 MJ/kg by 2012.

Key Deliverables

Securing more reliable, more consistent protein and energy supplies for pig diets via innovative grain and pulse production, supply chain arrangements, quality assessment and co-production utilisation to:

1. Reduce variation in the annual costs of pig feed.
2. Reduce the cost of pig feed.
3. A wider range of feed ingredients available to more producers.
4. A closer match of diet and pig requirements.

SUBPROGRAM 1A	**INNOVATIVE GRAIN PRODUCTION FOR THE PIG INDUSTRY**
SUBPROGRAM 1B	**QUALITY ASSESSMENT OF FEED INGREDIENTS**
SUBPROGRAM 1C	**WIDER RANGE OF FEED INGREDIENTS FOR PIG PRODUCTION**

1

Subprogram 1A:
Innovative grain production for the pig industry

KEY DELIVERABLES

1] Commercial quantities of cereals (triticale and barley) and pulses (peas and lupins) that grow close to pork producing regions.

2] Cost effective agronomy and enhanced characteristics for pigs.

PROJECT ID	TITLE
1A–101	Enhancing quantities of high quality barley – Part 1
1A–102	Improved Triticale Production through breeding and agronomy
1A–103	Practical guidelines for the production and supply chain arrangements to deliver new and existing cereal and cultivars for the pig industry *(confidential)*
1A–104	Peas for a more reliable protein supply to the pork industry in the north
1A–105	Advanced development of Pea varieties for Australian Pork Production *(merged with 1A–108 – now 4B–102)*
1A–106	Enhancing supplies of high quality barley – Part 2
1A–107	Improved Triticale Production through Breeding *(now 4B–101)*
1A–108	Development of adapted field pea varieties for pork producing regions in northern and southern Australia *(now 4B–102)*
1A–109	Selection of feed wheat and (or) barley varieties for the Australian pig industry *(now 4B–103)*
1A–111	Dedicated feed grain production systems: An assessment of wheat, barley and triticale systems in Australia

Research Summaries for Subprogram 1A

PROJECT 1A–101: ENHANCING THE SUPPLIES OF HIGH QUALITY BARLEY – PART 1

Project Leader:
Dr Jerome Franckowiak

Project Participants:
Dept. of Employment, Economic Development and Innovation and Leslie Research Centre

Aims and Objectives

This project expanded the goals of the Barley Breeding Australia – North Region (BBA-North) barley breeding program located at the Hermitage Research Station, Warwick. Grain samples from BBA-North breeding trials were assessed for pig feed quality, selected crosses were fast tracked to produce pure lines, and regional variety trials (up to 12 sites) and agronomic studies were conducted. Bulk grain samples of elite varieties were provided for pig feeding trials. Rapid assessment of the feed value of barley samples from breeding and agronomic trials were conducted using near infra-red spectrometry (NIR) and appropriated calibrations.

Key Findings

1] The barley variety Shepherd was commercialised in 2008 and seed was available to growers in 2009. Recommended production and agronomy practices for Shepherd were distributed.

2] Breeding lines with consistently higher digestible energy (DE) levels and lower husk content were identified. One of them, ND19119-5 introduced from the USA, was recommended for release in 2010.

3] Good agronomic production practices were shown to produce more grain and improve the feeding value of barley. Maintenance of plump grain under heat/drought stress is a varietal trait.

4] Two populations of doubled-haploid barley lines were developed for future studies of pig feed quality attributes, foliar disease resistance, and agronomic traits.

5] NIR screening of samples will make breeding barley varieties with higher feed quality more feasible.

Application to Industry

The project provided valuable information on barley varieties for grain growers and pork producers. The information was made available to both industries and plant breeders.

PROJECT 1A–102 : IMPROVED TRITICALE PRODUCTION THROUGH BREEDING AND AGRONOMY

Project Leaders:
Professor Richard Trethowan and Dr Jeremy Roake

Project Participants:
University of Sydney and University of New England

Aims and Objectives

Triticale has become an important feed grain for pig diets. This project aimed to increase the value and supply of triticale to the pork industry through plant breeding and improved agronomy.

Key Findings

A new triticale variety, **Berkshire**, was released in 2009. In National Variety Yield Trials for NSW and northern Victoria in 2007 and 2008, **Berkshire** was 16% higher yielding than the standard variety Tahara. Compared to benchmark triticale varieties, the ileal DE and faecal DE of **Berkshire** was 0.71 MJ/kg and 0.25 MJ/kg greater, respectively.

The main recommendation from the agronomy package was that grain growers should optimise the fertilizer requirements for triticale, especially nitrogen to achieve satisfactory yields. Grain growers should aim for 11.5% grain protein, to ensure optimum yields are being achieved. This would increase the gross margins, and help increase triticale production.

Application to Industry

The project delivered a new high yielding high-energy triticale variety (Berkshire) which subsequently proved an ideal feed grain for pigs.

The agronomic information was communicated to growers and agronomists through the release of a small booklet on the agronomy for triticale.

1

Research Summaries for Subprogram 1A continued

PROJECT 1A–104: PEAS FOR A MORE RELIABLE PROTEIN SUPPLY TO THE PORK INDUSTRY IN THE NORTH

Project Leader:
Stephen Moore

Project Participants:
University of Sydney
Plant Breeding Institute
and Pulse Australia

Aims and Objectives

The major thrust of this project was to breed and identify germplasm suitable for production in the northern region. This germplasm would have a high and stable yield, be phenologically adapted to the range of environments in the region, be resistant or tolerant to the major disease risks which limit yield (and quality) potential and be of acceptable grain quality to pork producers.

Key Findings

The most significant achievement of this project has been the development of high yielding, adapted field pea germplasm. This has included the development and release of the new variety **"Maki"** in 2009 to supplement the existing variety "Yarrum". In addition, ongoing testing of newer germplasm produced a number of adapted lines, which are considered suitable for future release.

Application to Industry

The project delivered a new pea variety (Maki) and a wealth of information for grain/pulse growers.

PROJECT 1A–106: ENHANCING SUPPLIES OF HIGH QUALITY BARLEY – PART 2

Project Leader:
John Sturgess

Project Participants:
Plant Science,
Agric-Science Queensland
Dept. of Employment,
Economic Development
and Innovation, Queensland

Aims and Objectives

This project was designed to study management practices for production of barley and to expand the variety development goals of the Barley Breeding Australia – North Region barley breeding program and extend studies into southern Australia. Regional variety drill strip trials (up to 6 sites, including interstate) and agronomic studies were conducted, and grain samples from production experiments and BBA-North breeding trials were used to assess pig feed quality. Bulk grain samples of elite varieties were provided for pig feeding trials. Rapid assessment of feed value of barley samples from breeding and agronomic trials were conducted using near infrared spectrometry (NIR) and appropriated calibrations.

Key Findings

Key findings of the project were:

1] Using ABS data, the regional production of barley and location and size of pig production throughout the northern region was analysed in order to select sites for establishment of replicated barley drill strip trials which would be relevant to the preferred grain sourcing area for the pork industry.

2] Good agronomic production practices were shown to produce more grain and improve the feeding value of barley. Maintenance of plump grain under heat/drought stress is a varietal trait.

3] The barley variety Shepherd was commercialised in 2008 and seed was available to growers in 2009. Recommended production practices for Shepherd were distributed and refined in 2010.

4] Further encouragement on the growing of Shepherd was a focus of this project in 2009 and 2010.

5] Utilisation of NIR screening of grain samples and calculated estimates of feed quality will make breeding barley varieties with good feed quality more feasible.

6] Breeding lines with consistently higher digestible energy (DE) levels and lower husk content were identified. One of them, ND19119 introduced from the USA, was recommended for release.

7] However, because of inconsistent and often low yield, commercialization of ND19119 was not continued.

8] Breeding material was identified that could rapidly improve the drought/heat tolerance of barley grown in the Northern region.

Yield figures from 2010 NVT trials showed only average yields of Shepherd at most southern sites, and below average in WA. Shepherd is better performed than benchmark varieties in Northern NSW and Southern Queensland grain growing regions. The Victorian barley Hindmarsh was identified through strip trial research as having both a high DE and yield. Hindmarsh is better suited for Southern regions where it has become very popular.

Application to Industry

The project delivered a wealth of information on agronomic practices to increase the yield of barley and identified varieties with high-energy availability for pigs. The better yielding/ preferred varieties differ in the

North and South and in the northern regions wheat remains the preferred winter crop. The outcomes benefited grain growers and pork producers.

PROJECT 1A–111: DEDICATED FEED GRAIN PRODUCTION SYSTEMS: AN ASSESSMENT OF WHEAT, BARLEY AND TRITICALE SYSTEMS IN AUSTRALIA

Principal Investigator:
John Pluske

Project Participant:
Murdoch University

Background

A major objective of the Pork CRC is in securing more reliable and consistent energy (and protein) supplies for pig diets that will cause:

a] Reduced variation in the annual cost of pig feed.

b] Reduced total cost of pig feed.

c] A wider range of feed ingredients available to more producers.

d] A closer match of diet specifications to pig requirements.

Subprogram 1A, Innovative grain production, is targeted towards delivering commercial quantities of cereals (and pulses) of high yield and high energy content and acceptable nutritional characteristics for pigs, with cost effective agronomy, and appropriate marketing arrangements for grain and pig producers.

Methodology

A multidisciplinary approach combining qualitative and quantitative activities was combined to study the reasoning behind growing and using high energy feed grains. Activities included:

- A desktop search of the literature.
- A survey (semi-structured, interactive, open-ended interview approach) of 25 relevant stakeholders to record respondents' perceptions to issues such as the introduction in Australia of new high yielding, high energy grain varieties and possible marketing systems for dedicated feed grains; development of a gross margin model to understand economically rational behaviour of grain growers.
- Use of a feed formulation model to help understand economic decisions made by pig producers.

Key Findings

- High-energy grains are of value to some pig producers but depending on the price and availability of substitute energy sources, as well as handling capacity, this value varies amongst producers. Hence interest in high-energy grains is variable but important for some.
- For some diets selecting higher energy wheat lines may not be economically efficient due to a decreasing marginal value of energy at higher DE levels.
- Feed producers who have the ability to effectively segregate grain are in a better position to extract value from high energy grains than those who do not have this facility.
- If yield is similar, "dual purpose", high yielding grains are more attractive to the grain grower than dedicated feed grain varieties because of more market options.
- As the market place currently does not provide supply and demand signals to buyers and sellers then it is likely that increased communication amongst players wishing to participate in this market will be important, particularly with regard to grain standards.
- Yield remains the major trait for selection in plant breeding and this is the characteristic that will encourage growers to grow varieties suitable for feed. They may consider high energy grain varieties if they are high yielding and open up an additional market for them, although such a decision is likely to be contingent upon region.
- Specific agronomists and seed companies should be identified to promote new varieties of grains that are of value to the pig industry.
- In the foreseeable future, generally closed loop contracts may be difficult to implement.
- Seed price and EPR payments associated with a new variety may influence adoption decisions as both can negatively affect gross margins, particularly at lower yields.
- A premium for feed grains based upon $/MJ DE was considered by pig industry participants to be the most logical, although it will be extremely difficult to implement.

Application to Industry

The project provides information on the commercialisation/adoption of feed grain breeding projects. It also provides background information for similar research projects in the future.

1

Subprogram 1B: Quality assessment of feed ingredients

The objectives of subprogram 1B were to establish the reasons for differences in nutrient availability of grains, other ingredients, and rapidly identify such differences and to develop processing, and other strategies to increase the availability of energy and other nutrients from grains.

KEY DELIVERABLES

1] Adoption, implementation, enhancement and maintenance of NIRS calibrations for rapid measurement of the nutritional quality of cereals for pigs.

2] Rapid and objective analytical methods for the measurement of nutritional quality of pig feed ingredients (other than cereals).

3] Processing methods to increase the nutrient yield from target grains (eg enzyme applications).

PROJECT ID	TITLE
1B–101	NIRS calibrations for predicting the nutritional quality of feed ingredients for pigs
1B–102	Processing methods for improving the utilisation of cereal grains by pigs
1B–103	Canola Meal Value Chain Quality Improvement
1B–104	Enhancement of NIR calibrations for predicting the energy value of weather damaged grains *(Refer 1B–101)*
1B–105	Identification of the key attributes affecting starch content and availability in sorghum grain
1B–106	Canola Meal Value Chain Quality Improvement Stage 2
1B–107	Influence of hammer mill screen size and grain source (wheat or sorghum) on the growth performance of male grower pigs
1B–110	Commercial real-time application of NIR calibrations for the measurement of digestible energy
1B–111	Screening of new lines of cereal grains for inclusion in NIRS calibrations for predicting nutritional quality of feed ingredients for pigs *(Now 4B–105)*
1B–112	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 *(now 4B–106)*
1B–113	Effect of grain type, particle size and processing condition on growth performance characteristics in pigs
1B–114	Influence of increasing protease supplementation on two different types of sorghum
1B–116	Peripheral chemosensing and feed intake in pigs *(Now 6A–101)*
1B–117	Processing methods of grains – Extension *(Now 4B–107)*

Research Summaries for Subprogram 1B

PROJECT 1B–101: NIRS CALIBRATIONS FOR PREDICTING THE NUTRITIONAL QUALITY OF FEED INGREDIENTS FOR PIGS

Project Leader:
Dr Danny Singh

Project Participants:
Agri-Science Queensland, DEEDI, John L Black Consulting, University of Sydney, Plant Breeding Institute and Industry & Investment, Agriculture Institute, Orange NSW

Aims and Objectives

Two hundred and twenty four cereal grains have so far been included in NIR calibrations for predicting faecal and ileal DE content of grains for pigs (approx. 90 samples from PGLP and 134 Pork CRC). The original calibrations developed in the Premium Grains for Livestock Program (PGLP) contained just over 90 grains, including wheat, barley, triticale, sorghum and rice. Research in the Pork CRC projects, co-funded by GRDC, has more than doubled the number of grains in the calibrations. An emphasis was placed in the Pork CRC experiments to select grains that would increase the reliability of the calibrations for predicting accurately values for unknown samples.

Four experiments were conducted to determine feacal and ileal DE content of grains. The results from each experiment were used first to determine the accuracy with which the results could be predicted using the existing NIR calibrations. The results from each experiment were then added to all existing results to develop the next generation calibrations. The ability of the new calibrations to predict the results from previous experiments and the statistics for these calibrations were determined.

Approximately 25 new grains were selected because they were grown under dry conditions and were affected by drought or were sprayed with desiccant herbicides at intervals after flowering to simulate rapid, early finish to the growing season. Approximately 20 other grains were either selected because they were germinated naturally or artificially.

Key Findings

Both between and within grain types were highly significant for all faecal DE and ileal DE traits. Mean faecal DE value on, as received basis for sorghum was 14.5MJ/kg, wheat 13.8MJ/kg, barley 12.7MJ/kg and triticale 13.45MJ/kg. Similar values were obtained in the PGLP experiments. There was 1MJ/kg difference between the cereal grain types. The mean ileal DE on as received basis for sorghum, wheat and triticale were similar 12.5MJ/kg and barley had the lowest ileal DE of 10.6MJ/kg.

Inclusion of results from the Pork CRC experiments substantially improved the regression coefficient relating predicted to measured values (R^2), the accuracy expected for a predicted value (SECV) and the robustness or reliability of the calibration for predicting values for unknown samples (RPD). The R^2 values for predicting unknown samples increased from 0.79 to 0.91 for faecal DE and from 0.69 to 0.85 for ileal DE. With the fourth generation calibrations, there was little bias in the predictions with the slope of the relationship being near 1.0 and the intercept near 0.0.

Application to Industry

The project provided a wealth of information on the chemical composition of different grains and strengthened the NIRS calibrations for predicting the DE content of grains. The calibrations can be used by nutritionists, producers and grain grower to rapidly determine the energy value of grains and consequently their true value.

PROJECT 1B–102: PROCESSING METHODS FOR IMPROVING THE UTILISATION OF CEREAL GRAINS BY PIGS

Project Leader:
Professor Mike Gidley

Project Participants:
University of Queensland and John Black Consulting

Aims and Objectives

This project investigated the grain and processing factors that influence energy availability in pigs, and demonstrated a processing route to improve FCR.

Key Findings

Digestion rate is more affected by milling and heat processing than grain type:

a] Large particles are more slowly digested in proportion to their size squared.

b] Heat processing partially gelatinises starch & increases large particle digestion.

c] Removing large particles (by sieving and re-grinding) from mash feeds improves FCR for both sorghum (11%) and barley (8%). Effects for steam-pelleted feed are less (sorghum 5%; barley 3%) but still positive. FCR of re-ground sorghum or barley mash is at least as good as for conventional steam-pelleted feed.

d] Critical factors determining feed intake are the control of the rates of passage and digestion, with hormone and energy status signals integrated in the hypothalamus.

Application to Industry

The project developed a range of assays, which have been implemented and demonstrated that removing larger particles from ground grain significantly improves feed efficiency in pigs.

The information has be widely used by the Australian pork industry.

Research Summaries for Subprogram 1B continued

PROJECT 1B–103: CANOLA MEAL VALUE CHAIN QUALITY IMPROVEMENT

Project Leader:
John Spragg

Project Participants:
JCS Solutions Pty Ltd and NSW Department of Primary Industries

Aims and Objectives

This project was undertaken to determine the processes, which have the most influence on meal quality. Eight crushing plants within Australia, representing solvent extraction, expeller and cold pressing operations were invited to take part in the study. Samples were taken at all stages of the process from each processor and sent to laboratories to evaluate the influence of each stage of the process. All of the major chemical parameters, which may be of interest to feed manufacturers, were studied. All of the stages were replicated to make the study statistically sound.

Data was provided from the analysis of 249 samples.

Key Findings

The major factor affecting meal protein is canola seed protein and oil content. Expeller meal is lower in protein and higher in oil content. Residual oil in meal from expeller plants is more variable than meal from solvent plants. Lower canola meal crude fibre, ADF and NDF than in previous studies may correlate with plant breeding programs aimed at increasing oil and protein, which has resulted in less seed coat. The glucosinolate levels found for expeller and solvent meals were in the range 0.5 to 8.9 µmoles/g and are unlikely to have a negative effect on pig performance. Levels of sinapine (0.68–1.1%) are similar to those reported for Canadian canola meal. Similar levels were reported previously for Australian meals. Phytate phosphorus found within this study was higher than that found in previous studies and requires further clarification. Mineral analyses are in close agreement with Canadian data.

Both expeller and solvent meal processing systems are reducing meal protein quality for pig feeding applications. Processing results in a 15% loss of total lysine and a further 10% reduction in lysine availability.

Application to Industry

The final report is comprehensive and essential reading for nutritionist and canola seed processors. The final report has been widely distributed to crushers and nutritionists and has led to improvements in the nutritional quality of canola seed meal.

PROJECT 1B–105: IDENTIFICATION OF THE KEY ATTRIBUTES AFFECTING STARCH CONTENT AND AVAILABILITY IN SORGHUM GRAIN

Project Leader:
Dr John Black

Project Participants:
J L Black Consulting and GRDC

Aims and Objectives

Characteristics, which cause low starch digestibility, were investigated in 240 lines of sorghum.

Key Findings

Starch availability was positively related to waxy endosperm, large seed size, kafirin percentage and starch content. Starch availability was negatively related to protein content, N/S ratio, tannin content and seed colour.

An NIR calibration was established for predicting in-vitro starch digestibility.

Application to Industry

The most significant outcome from the project was the ability to select varieties for a new gene allele, which improved starch digestibility by > 15%.

PROJECT 1B–106: CANOLA MEAL VALUE CHAIN QUALITY IMPROVEMENT STAGE 2

Project Leader:
John Spragg

Project Participants:
JCS Solutions Pty Ltd and NSW Department of Primary Industries

Aims and Objectives

This project has provided support for the use of NIR technology in predicting reactive lysine as a measure of the quality of canola meal for pig feeding. 102 samples from commercially available canola meal were analysed for total and reactive lysine. Based upon previous research work, the objective was to develop an NIR calibration that could be used to asses canola meal quality and provide industry with a rapid analysis tool to determine the effects of heat processing upon meal quality.

Key Findings

The results of this project have confirmed that the measure of reactive lysine relative to total lysine provides a measure of meal quality. The NIR calibrations developed are sufficient to differentiate between high and low quality meals. Further work is being undertaken to further improve the calibrations prior to commercial release of the technology.

Data from this project, obtained in both Stage 1 and Stage 2, identifies that reactive lysine values are not correlated with total lysine. This finding is in agreement with the work completed by van Barneveld (2001) looking at canola meal and milk powder. Recent work by Redman et al (2008a and 2008b) looking at commercial samples of soybean meal and dried distillers grains with solubles has found that reactive lysine retains a set difference to total lysine, and they have concluded that total lysine is an equal measure of protein quality and potential heat damage. In contrast, the results from this project support the use of reactive lysine as a better measure of processing damage for canola meal.

Application to Industry

NIR calibrations for the total and reactive lysine contents of canola seed meal have been developed and commercialised. The calibrations enable diet formulations including canola meal to have improved accuracy and for crushers to evaluate the effectiveness of their processes.

PROJECT 1B–107: INFLUENCE OF HAMMER MILL SCREEN SIZE AND GRAIN SOURCE (WHEAT OR SORGHUM) ON THE GROWTH PERFORMANCE OF MALE GROWER PIGS

Project Leader:
Alicia Murphy

Project Participants:
Rivalea Australia

Aims and Objectives

864 male growers (Large White x Landrace, PrimeGro™ genetics) selected at 10 weeks of age and housed in-group pens of 18 pigs per pen. Pigs were selected over a six-week period, 8 pens per week with a start weight of 24.42 ± 0.11 kg (mean ± SE). Within replicate, pens were randomly assigned to a 2 x 2 factorial experiment, with the respective factors being hammer mill screen size (2 mm and 3 mm) and the predominate grain source in the diet (wheat or sorghum).

Key Findings

Reducing the hammer mill screen from 3mm down to 2mm reduced average particle size in all three grains (wheat: 639 and 552 µm; sorghum: 654 and 602 µm; barley: 676 and 639 µm respectively for the 3mm and 2mm screens). Durability of the pellet was superior when sorghum was excluded from the diet, regardless of screen size. Pellet quality of sorghum-based diets was improved by utilising the 3 mm screen size, thereby reducing the percentage of fines in the diet.

Over the entire experimental period there was a tendency for screen size to influence feed intake (1.41 and 1.45 kg/d respectively for the 2 and 3 mm screen size, P=0.078), although there were no impacts on daily gain or feed efficiency.

Sorghum inclusion did not significantly influence feed intake, but did reduce growth performance (738.4 and 707.3 g/d respectively for the wheat and sorghum based diets), resulting in a poorer feed efficiency during this time (FCR 1.95 and 2.02 respectively, P=0.029).

The effect of sorghum inclusion on feed efficiency was particularly evident during the initial 21 day feeding period when the grain was passed through the 2 mm screen due to the poorer pellet quality (increased fines and reduced durability), and therefore increased feed wastage.

In contrast, feed efficiency in the wheat based diets tended to improve when the screen size was reduced to 2 mm (FCR 1.89 and 2.00 respectively for the 2 mm and 3 mm screen size, P=0.062, sed 0.049).

Live weight at the end of the experimental period was not influenced by screen size (P=0.598), but tended to be lower when sorghum was included in the diet at 60 % (60.6 and 59.1 kg respectively for the wheat and sorghum diets, P=0.059). Mortality data indicated a trend for increased mortalities in the pigs offered the sorghum diets (x2 = 0.345, P=0.063), although this result was associated with a couple of pens with high numbers of Actinobacillus pleuropneumoniae (APP) related deaths.

Application to Industry

The results from this investigation suggest that the 3 mm screen size should be used if sorghum is to be included in grower pig diets through a hammer mill system in order to maximise pellet quality and reduce feed wastage. In contrast, the smaller screen size of 2 mm will maximise feed efficiency when wheat is the predominant grain source. It is also possible that further reducing average particle size would further improve growth performance of pigs fed wheat (or barley) based diets.

PROJECT 1B–110: COMMERCIAL REAL-TIME APPLICATION OF NIR CALIBRATIONS FOR THE MEASUREMENT OF DIGESTIBLE ENERGY

Project Leader:
Doug Pearson

Project Participants:
Feedworks and
Ridley Agriproducts

Aims and Objectives

Development and proceeding use of the NIRS AusScan® Digestible Energy calibrations has identified that there is significant variation between batches of cereals. The greatest benefit from application of these calibrations will be obtained through real-time analysis of cereals prior to incorporation into diets. An NIR-Online® X-One inline NIRS was installed at Ridley Agriproducts Murray Bridge feed mill on the cereal transfer line.

This line transports all cereals entering the mill to the hammer mill. The system-logged data for 12 months of mill operation from March 2010 through to March 2011, recording multiple parameters including results from the AusScan® calibrations for Pig Faecal Digestible Energy (FDE) and Ileal Digestible Energy (IDE).

Key Findings

Considerable variation of all parameters was seen across all the measured cereal types including Wheat, Barley, Triticale, Oats, Lupins and Peas. The cost of 1MJ/kg of cereal DE content is considered to be between $15 and $20/Metric Tonne. With the pig industry, striving for greater feed efficiency this highlights the need for better control of DE variability within finished feeds. Ideally, cereal DE content variations would be contained to within 0.5MJ/kg. Data logged by the NIR-Online® NIRS clearly showed that based on 1MT milled Wheat batches multiple batches over a 2 hour period would benefit from formulation adjustment.

Application to Industry

The project demonstrated/confirmed the variability in gain DE which occurs commercially and suggests the cost effectiveness and accuracy of diets could be improved by more frequent reformulation based on the predicted DE of the grains used.

Research Summaries for Subprogram 1B continued

PROJECT 1B–113: EFFECT OF GRAIN TYPE, PARTICLE SIZE AND PROCESSING CONDITION ON GROWTH PERFORMANCE CHARACTERISTICS IN PIGS

Project Leader:
Dr John Black

Project Participants:
John L Black Consulting, Better Blend Stock feeds, Centre for Nutrition and Food Sciences, The University of Queensland, Rivalea Australia Pty Ltd, NSW Industry and Investment

Aims and Objectives

To investigate the effect of removing the larger particles from ground sorghum and barley and pelleting the diet on the performance of weaner and grower pigs.

Re-ground and single grind samples of sorghum and barley were incorporated into a standard grower diet with grain representing 72% of the feed. Diets were fed either as a mash or after steam pelleting under typical commercial conditions. The diets were offered to young male weaner pigs at Rivalea or grower pigs at Wacol, Queensland

Key Findings

Re-grinding to remove the large particles significantly reduced the intake of the sorghum based mash diets with little effect on growth rate for both the weaner and grower pigs.

Consequently, there was a substantial improvement in feed conversion efficiency. Effects were particularly marked for mash feeds with re-grinding resulting in 22% and 10.5% improvement in the efficiency of feed use for sorghum offered, respectively, to weaner and grower pigs. Similarly, re-grinding of barley fed as a mash resulted in 15% and 8.3% improvement in efficiency of feed use for weaner and grower pigs, respectively. Regrinding of either sorghum or barley offered as a mash resulted in a lower FCR than pelleting grain based diets after a single grind.

Application to Industry

The project showed that there are large effects of reducing the size of large particles on the efficiency of feed use by young pigs offered either barley or sorghum based diets. These results are particularly important for pig enterprises offering mash feeds because removal of the large particles resulted in numerically better-feed conversion efficiency than traditional milling and pelleting of the diets. Nevertheless, pelleting of diets containing conventionally milled grain resulted in significant improvements in feed conversion efficiency compared with mash diets for all comparisons except barley based diets fed to grower pigs.

PROJECT 1B–114: INFLUENCE OF INCREASING PROTEASE SUPPLEMENTATION ON TWO DIFFERENT TYPES OF SORGHUM

Project Leader:
Dr David Cadogan

Project Participants:
Feedworks Pty Ltd and University of Queensland

Aims and Objectives

The performance young pigs offered sorghum based diets is up to 20% lower than for pigs offered wheat based diets (Premium Grains for Livestock Program, Final Report). A major reason for the difference is thought to be due to the encapsulation of starch granules within sorghum by a protein envelope consisting of relatively indigestible kafirin proteins.

An experiment was conducted to test the hypothesis that preliminary digestion of the kafirin envelope with a protease, Subtilisin, would improve the performance of young pigs offered sorghum based diets. The experiment was a 2 x 4 factorial array, with the treatments being sorghum type (White or Liberty cultivar and high kafirin red sorghum, the cultivar Buster) and Subtilisin protease dose (0, 50, 100 and 500ppm).

Key Findings

Overall, the unsupplemented sorghum diets depressed the performance of young male pigs and the highest dose rate of protease added to both the sorghum varieties improved feed efficiency to the levels of the wheat based diet. The two sorghums did respond differently to the increasing level of protease, with the most notable being the significant improvement in DE for the red sorghum, whereas the enzyme had no effect on the digestibility of the white sorghum. The results indicate the protease can reduce the nutritional barriers caused by the structural and storage proteins in sorghum, and improve feed efficiency to the level supported by wheat-based diets. Between 50 and 500 ppm of the protease appears the most cost effective dose rate. This however, would appear to vary with variety.

Application to Industry

The project demonstrated that sorghum did not support the same performance as wheat. Inclusion of the protease in the sorghum diets did improve growth performance. The enzyme is available commercially.

Subprogram 1C:
Wider range of feed ingredients for pig production

KEY DELIVERABLES

1] Identified potential for production of non-traditional or alternative protein and energy sources for pigs within existing grain production systems across Australia.

2] Assessment of the nutritional potential of novel protein and energy sources.

PROJECT ID	TITLE
1C–101	Evaluation of glycerine as a coproduct of biodiesel production for the pig industry
1C–102	The establishment of a viable pearl millet industry to support the Australian pork industry
1C–104	Evaluation of juncea meal for growing pigs

Research Summaries for Subprogram 1C

PROJECT 1C–101: EVALUATION OF GLYCERINE AS A COPRODUCT OF BIODIESEL PRODUCTION FOR THE PIG INDUSTRY

Project Leader:
Dr Jo Pluske

Project Participants:
SciEcons Consulting

Aims and Objectives

This project/report was based on a desktop review of the potential supply and use of glycerine as a feed ingredient in the Australian pig industry. While the focus of the review was on glycerine derived from production of biodiesel in Australia, the report shows that pig producers could use imported glycerine sourced from other biodiesel-producing countries.

Key Findings

1] The chemical properties of crude glycerine will vary depending on the feedstock source and the manufacturing process. Currently there is little knowledge concerning the variation in glycerine attributes and how it affects quality of animal feed. It is recommend that attempts be made to contact all known Australian biodiesel/glycerine producers to request representative glycerine samples that will be subsequently analysed, particularly for GE, oil, methanol, ash and minerals, including Na.

2] Feeding trials measuring growth performance, carcass specification and meat quality at different levels of glycerine inclusion in the diet should be conducted contingent upon the findings in recommendations 1 and 2. These studies should focus initially on grower and finisher pigs, but studies with weaner pigs could also be considered given the energy deficit encountered after weaning and glycerine's gluconeogenic capacity.

Application to Industry

The final report contains a wealth of information on biodiesel companies in Australia and on the chemical and nutrient content of glycerine and is an excellent background document.

The Biodiesel industry in Australia has not grown to the extent envisaged when this study was conducted and little glycerine is available at a price suitable for pig diets. Nevertheless, given the continual increase in grain prices in Australia glycerine may yet prove a useful ingredient for Australian pig diets.

Research Summaries for Subprogram 1C continued

PROJECT 1C–102: THE ESTABLISHMENT OF A VIABLE PEARL MILLET INDUSTRY TO SUPPORT THE AUSTRALIAN PORK INDUSTRY

Project Leader:
Michael Castor
and Dr Ray King

Project Participants:
MCA Goondiwindi Pty Ltd
and RHK Consulting Pty Ltd

Aims and Objectives

Pearl millet grain is an ideal feed for pigs, containing relatively high levels of energy as well as crude protein with a balanced amino acid profile that is worth a 5–15% premium over sorghum in least-cost pig diets. Pig feeding experiments have confirmed that very good growth performance can be achieved with the inclusion of pearl millet in diets of growing pigs. However, the major constraint to the establishment of the pearl millet industry to supply nutritional valuable grain to the Australian pork industry is the necessary agronomic requirements to produce satisfactory and economic yields of pearl millet in cereal growing regions of SE Queensland and Northern NSW. The project investigated the agronomic potential of pearl millet. During the first year of the project, which encompassed the summer growing season (October, 2007 to January, 2008), the commercially available hybrid pearl millet was compared to sorghum is four different locations in Southern Queensland and Northern NSW. In addition, various agronomic factors were evaluated in their effect on the yield of pearl millet in these comparative field studies.

Key Findings

The yield of pearl millet ranged from 1.1 to 2.2 tonne/hectare and was between 52% and 78% of the yield of sorghum at the four sites. The sowing costs of pearl millet are about $300/hectare and thus the minimum yield of pearl millet, just to cover sowing costs, is likely to be at least 1.5 tonne/hectare. The yield of hybrid pearl millet was consistently lower than sorghum grown under the same conditions in these trials. In addition, hybrid pearl millet seems to have a very flat yield response to changing environments, which is consistent with the previous Central Queensland data. This may indicate that the genetic ability of hybrid pearl millet is limiting yields in higher yielding situations.

Application to Industry

The results of the qualitative studies on the four co-operating properties in the first year of the project failed to indicate any potential whatsoever for pearl millet to achieve competitive yields to sorghum. It was also considered that the existing variety of pearl millet would not be competitive against other crops in most cropping locations, including the more marginal areas of Southern Queensland and Northern NSW. The project was terminated at the end of the first year with the following conclusion:

- The consistently low and relatively constant yield of pearl millet compared to sorghum makes the growing of the commercially available varieties of pearl millet presently economically unattractive for most grain growers.

The existing commercial varieties of pearl millet are unlikely to be a viable alternative summer crop for grain growers that wish to supply pearl millet as a feed ingredient to the Australian pork industry.

Pearl millet may be good for pigs but not for grain growers.

PROJECT 1C–104: EVALUATION OF JUNCEA MEAL FOR GROWING PIGS

Project Leader:
Dr Cherie Collins

Project Participants:
Rivalea Australia, RHK Consulting Pty Ltd and Smorgon Fuels Pty Ltd

Aims and Objectives

Juncea (Brassica juncea) has been bred as a crop for low rainfall regions in Australia, producing a seed with similar properties to that of traditional canola (Brassica napus). Increasing areas of the crop have been planted in the last 12 months, with approx. 13,000 ha planted across southern Australia in 2010. There is currently interest in the use of juncea oil for bio-diesel production, and as such, the remaining meal may be available for use in animal diets.

Given the similarity of juncea meal to traditional canola meal, there is the potential to utilise this product as an alternative vegetable protein source in pig diets.

70 entire male pigs (Large White x Landrace, PrimeGro™ Genetics) at 13 weeks of age (live weight 40.4 kg ± 0.41 kg) were housed in individual grower accommodation. At 14 weeks of age, all pigs were individually weighed and randomly allocated to one of five experimental diets:

1] Diet A: 0 % juncea meal

2] Diet B: 6 % juncea meal

3] Diet C: 12 % juncea meal

4] Diet D: 18 % juncea meal

5] Diet E: 24 % juncea meal.

Diets were formulated to contain 14.0 MJ digestible energy (DE) and 0.62 g available lysine/MJ DE, with juncea meal replacing canola meal at increasing concentrations in the test diets. Pigs were offered the allocated test diets ad libitum for a 35 day test period with feed intake and growth performance measured during this time.

Key Findings

Average glucosinolate concentration in the juncea meal was measured to be 15.9 µmoles/g air dry, with the results for the individual samples ranging from 13–19 µmoles/g air dry. During the initial 21 day feeding period, there were significant linear reductions in average daily feed intake ($P=0.029$) and growth rate ($P=0.011$) with increasing juncea meal concentration. In particular, pigs offered the diet containing 24 % juncea meal consumed 12 % less feed and grew 18 % slower than pigs offered the control diets (0 % juncea meal) during this time. Results over the entire test period showed a significant linear decline in feed intake with increasing juncea meal concentration ($P<0.001$) and growth rate with increasing Juncea meal in the diet.

Growth performance of the pigs offered up to 18 % juncea meal was however similar to the control animals over the entire test period.

Application to Industry

These and other results suggest that juncea meal may be safely included in commercial grower/finisher diets up to levels in which the total glucosinolate concentration in the complete diet does not exceed about 2.0 mmol/kg diet.

PROGRAM

2 Improving whole herd feed conversion efficiency

Target: Reduce Herd Feed Efficiency (HFC) from 4.3 to 3.6 over the life of the Pork CRC.

Key Deliverables

1. The capacity to routinely and accurately measure feed intake in individual animals and groups.
2. Products and management strategies that allow manipulation of feed intake/feeding efficiency in pigs.
3. Reduced reliance on antibiotics in production systems.
4. Cost effective nutrient and/or prophylactic treatments for the prevention of disease.
5. Products and/or strategies to improve production efficiency.
6. Reduction in sow culling rates.
7. Lower overall costs of production through more efficient reproductive performance.

SUBPROGRAM 2A	**INNOVATIVE FEED INTAKE MEASUREMENTS**
SUBPROGRAM 2B	**FEED INTAKE INNOVATIONS**
SUBPROGRAM 2C	**ALTERNATIVE HEALTH STRATEGIES – IMPROVE PRODUCTION/REDUCE MORTALITY**
SUBPROGRAM 2D	**IMPROVING SOW REPRODUCTION AND LONGEVITY**
SUBPROGRAM 2E	**ADVANCED REPRODUCTIVE TECHNOLOGIES**
SUBPROGRAM 2F	**PHYSIOLOGY AND GROWTH MANIPULATION**
SUBPROGRAM 2G	**NUTRITIONAL STRATEGIES FOR SOWS AND GROWER/FINISHER PIGS**
SUBPROGRAM 2H	**GROWER/FINISHER COST REDUCTION**

Subprogram 2A: Innovative feed intake measurements

KEY DELIVERABLES

1] A method for the practical and continuous measurement of feed disappearance to pigs in groups.

2] A method for the practical and continuous measurement of feed wastage in groups.

3] Novel methods for the measurement of actual feed consumed by individuals within a group.

4] Prediction of disease onset through the application of feed intake measurements.

PROJECT ID	TITLE
2A–101	Prediction of feed intake by individual pigs housed in groups using lithium chloride
2A–102	Novel and improved methods to determine individual feed intake of individual pigs in groups
2A–103	Practical and continuous measurement of feed intake and pig weight
2A–104	Evaluation of feeding strategies and measurement of feed consumption using the feedlogic system
2A–105	Development and evaluation of feeding strategies to improve feed conversion efficiency in growing pigs
2A–107	Exp 2 and 3 Lysine Requirements of Pigs from 20 to 100 kg liveweight
2A–108	Enhancing the efficacy of ractopamine with amino acid complexed zinc
2A–109	Determining the lysine requirements of immunocastrated male pigs

Research Summaries for Subprogram 2A

PROJECT 2A–101: PREDICTION OF FEED INTAKE BY INDIVIDUAL PIGS HOUSED IN GROUPS USING LITHIUM CHLORIDE

Project Leader:
Professor Robert Barneveld, CHM Alliance

Project Participant:
Rivalea Australia

Aims and Objectives

- Establish the optimum dietary inclusion levels of lithium chloride for pigs of different ages without compromising feed intake.
- Establish the time of blood sampling after ingestion that provides the best estimate of feed intake.
- Validate feed intake measurements determined using lithium chloride of individual pigs housed in groups.
- Apply lithium chloride feed intake measurements of individuals housed in commercial production systems.
- Compare feed intake measurements determined using lithium chloride with other markers such as bromide and antipyrine.

Key Findings

- A level of lithium chloride that was detectable without resulting in feed aversion was established.
- Feed intake of the individual animal was able to be well estimated when the diet was fed ad libitum, with the relationship between intake and plasma lithium highest at 36 hours post introduction.

Group-dynamics and feeding behaviour appeared to influence the ability to predict feed intake when animals were housed in groups, at best less than half the variation in feed intake was explained by plasma lithium concentration, but at more standard commercial stocking densities, this fell further. Group-dynamics and hierarchy effects were reflected in frequency of eating as well as time of eating.

Application to Industry

The technology has little application to commercial production.

PROJECT 2A–102: NOVEL AND IMPROVED METHODS TO DETERMINE INDIVIDUAL FEED INTAKE OF INDIVIDUAL PIGS IN GROUPS

Project Leader:
Dr Ian McCauley

Project Participant:
Department of Primary Industries Victoria

Aims and Objectives

The project was conducted to evaluate cheaper dual trough electronic feeders that could measure the feeding behaviour of individual pigs over the grower and finisher phases. The feeder was evaluated for its ability to measure feeding behaviour, its utility as a tool for determining productivity, and ability to monitor animals for illness and injury.

Key Findings

The analysis of the ability of the measurement of feeding duration of individual pigs generated by this system and the performance as measured by weekly weight gain, did not show that the RFID feeder system was an accurate predictor of individual performance. The high degree of variability in feeding behaviour both between pigs, and between days for an individual pig is indicative that feeding duration is not a good measure of feed consumption or feed utilisation. The system did however, identify pigs with poor performance warranting removal from experimental studies, and would similarly be the target of remedial action in commercial situations.

The project represents the first development of a system to monitor the feeding behaviour of individual pigs in groups utilising conventional feeders. As currently developed, the cost of the system and the limit of its ability to monitor for all but very poor performing pigs would hamper its widespread commercial adoption. This situation may change if significant improvements can be made to the design, and recommendation in this area have been made, or if the value of automated monitoring of welfare and morbidity is determined to have sufficient commercial value or is mandated by industry codes of practice.

Application to Industry

The feeders have no immediate application to industry but with modification may have in the future.

Research Summaries for Subprogram 2A continued

PROJECT 2A–103: PRACTICAL AND CONTINUOUS MEASUREMENT OF FEED INTAKE AND PIG WEIGHT

Project Leader:
Dr Thomas Banhazi, SARDI

Project Participants:
SARDI

Aims and Objectives

A large integrated project was designed and executed between July 2006 and December 2009 to facilitate the development of three key monitoring systems, namely the:

1] Development of image analysis based weighing system.

2] The development of a feed disappearance sensor.

3] Development of an environmental monitoring/control system.

Key Findings

Weighing System

Initially, web cameras were placed strategically in piggeries in order to capture images of live pigs from above. Dimensions such as the body area within the pigs' contour, body length, shoulder width and others measures were extracted from the images. The corresponding weights of these experimental pigs were also measured and a database of the pigs' shape, geometrical features and their corresponding weight was built in order to facilitate the development of predictive models.

The ability of the system to measure larger animals such as gilts/sows as well as very small animals, such as piglets was evaluated with promising results. In addition, a number of farm tests were undertaken at the Roseworthy research piggery and on three commercial farms to assess the precision of the program developed with, very good results (Banhazi et al., 2009).

Feed Sensor

A feed-sensor assessment facility (simulating farm conditions) was built at the Roseworthy campus (University of Adelaide) to enable the research team to simulate real feed delivery episodes and different experimental conditions.

A large number of separate trials conducted at the Roseworthy facility proved that the reliability and precision of the sensor was excellent under simulated field conditions and was not affected by change in humidity and/or feed composition.

An environmental monitoring system was developed and tested during the project.

Application to Industry

There are immediate commercial/technical and longer-term opportunities associated with the technologies developed. However, to realise these opportunities, further work will be required before these tools can be presented as commercial products to producers. The technologies were patented and remain in commercial development.

PROJECT 2A–104: EVALUATION OF FEEDING STRATEGIES AND MEASUREMENT OF FEED CONSUMPTION USING THE FEEDLOGIC SYSTEM

Project Leader:
Dr Karen Moore and Dr Bruce Mullan

Project Participants:
Department of Food and Agriculture WA

Aims and Objectives

The objectives were to:

1] Compare the performance and economics of three feeding systems involving a three-phase diet program a program where the diet was changed weekly and a single diet based on pigs at 60 kg. The diet strategies were employed between 22 kg and 133 days of age.

2] Determine the responses of male and female pigs to dietary lysine between 20 and 100 kg live weight.

3] Determine the effects of timing of the second Improvac vaccination on the incidence of boar taint and on animal performance. The timings investigated were zero, two, three, four and six weeks before sale/slaughter and all pigs started at 58 kg.

Key Findings

1] The different feeding strategies had no effect on overall growth performance or carcass characteristics but the more frequent phase feeding and single diet strategies reduced feed costs by approximately $2.40/pig.

2] The "requirements" for modern Australian genetics were determined. Between 20 and 50 kg, both sexes exhibited excellent performance and males had a higher requirement for lysine than females. Between 50 and 100 kg intact males exhibited superior performance than females on all dietary lysine levels tested and responded to a higher lysine level than females.

3] Reducing the time between the second Improvac vaccination and slaughter reduced carcass P2 at slaughter and tended to improve overall feed efficiency. Androstenone level was significantly lower for all Improvac treatments than the zero or control treatment but not affected by time between the second vaccination and slaughter. A similar effect was observed for skatole but it did not differ significantly across treatments.

Application to Industry

The results of the three studies provide crucial information on dietary and Improvac strategies to optimise the performance and profitability of grower-finisher pigs while maintaining eating quality (preventing boar taint). The final reports are essential reading for nutritionists and production managers.

PROJECT 2A–105: DEVELOPMENT AND EVALUATION OF FEEDING STRATEGIES TO IMPROVE FEED CONVERSION EFFICIENCY IN GROWING PIGS.

Project Leader:
Professor Robert van Barneveld

Project Participants:
CHM Alliance

Aims and Objectives

This project involved the installation and commissioning of a FEEDLOGIC feeding system within commercial facilities as well as Prattley weighing system to allow for the weighing of individual pigs, with subsequent experimental work being conducted post-establishment. Subsequent to the installation of the system, 5 experiments were conducted on behalf of the Pork CRC under this project agreement. The FEEDLOGIC feeding system allows for blending of two diets from 0 to 100 per cent and when combined with four silos to draw from, the system has the ability to deliver multiple feed combinations within the one environmental and period. The FEEDLOGIC system is used to deliver and record feed disappearance, removing the possibility of feeding the wrong diet, reducing labour costs and allowing for more randomised allocation within the facility. The five experiments conducted under this project were:

1] Review of nutritional requirements of a modern lean genotype I.

2] Review of nutritional requirements of a modern lean genotype II.

3] Efficacy of ractopamine and pST combinations on finisher pig performance.

4] Efficacy of cysteamine as an in-feed growth promoter under commercial conditions I.

5] Efficacy of cysteamine as an in-feed growth promoter under commercial conditions II.

Key Findings

Experiments 1 & 2 showed that modern lean genotypes appear to utilise lysine more efficiently at levels considerably higher than those employed currently. Whilst responses in growth rate were varied and showed no particular pattern across lysine levels, reduced feed intake and consequently improved feed conversion was seen as lysine levels were increased to around 11.5 to 12 g/kg total available lysine, whilst above this level of lysine inclusion performance reduced. Experiment 3 showed significant responses in performance efficiency to the use of ractopamine and porcine somatotropin. The use of ractopamine did not affect the feed consumption of the pig, however it did result in significant improvements in growth rate and subsequently feed conversion. Porcine somatotropin resulted in a non-significant additive growth rate response, but it had a significant effect on feed intake, reducing intake by 15%, and therefore a significant effect on feed conversion. Experiments 4 & 5 found that there was no significant response to the inclusion of cysteamine into the diet of finisher pigs.

Application to Industry

Pig producers and their nutritionists will be able to use this information to assist them in improving production efficiency. One example of the value generated by work in this facility is the improvements that are obtained by using ractopamine and porcine somatotropin in combination, Auspig analysis of these results showed an improvement in profitability of as much as $7.00 per pig.

The reports are essential reading for nutritionists and production managers/owners.

Research Summaries for Subprogram 2A continued

PROJECT 2A–107: EXP 2 AND 3 LYSINE REQUIREMENTS OF PIGS FROM 20 TO 100 KGS LIVEWEIGHT

Project Leader:
Dr Karen Moore

Project Participants:
Department of Food and Agriculture WA

Aims and Objectives

The aim of this project was to determine the optimal available lysine per MJ dietary energy ratios for entire male and female pigs from 20 to 100 kg liveweight. Two experiments were conducted, one from 20 to 50 kg and the other from 50 to 100 kg liveweight, to determine the lysine requirements of entire male and female pigs of the Australian PIC genotype. The available lysine to MJ digestible energy ratios examined from 20 to 50 kgs were 0.6, 0.7, 0.8, 0.9 and 1.0 g available lysine/MJ DE while from 50 to 100 kgs the ratios were 0.4, 0.5, 0.6, 0.7 and 0.8 g Av Lys/MJ DE. In both experiments, the pigs were housed in groups of 7 with the pigs weighed and voluntary feed intake recorded weekly.

Key Findings

- Entire males had a higher lysine requirement than females from 20 to 100 kg LW.
- Generally, it has been assumed that entire males and females have a similar lysine requirement from 20 to 50 kg liveweight and the difference in requirement found in this experiment suggests that potentially there may be some feed cost savings in separating male and female pigs in this weight range.
- The results from this project have established the lysine requirements for a current Australian genotype, which may be higher than the levels currently used by the Australian industry.

Application to Industry

The project established the lysine requirements of a modern Australian genotype between 20 and 100 kg live weight.

PROJECT 2A–108: ENHANCING THE EFFICACY OF RACTOPAMINE WITH AMINO ACID COMPLEXED ZINC

Project Leader:
Professor Robert van Barneveld

Project Participants:
CHM Alliance

Aims and Objectives

It was hypothesised that the response, in finisher gilts, to ractopamine can be enhanced through the inclusion of amino acid complexed zinc.

The treatments were:

A Control – –

B Control + ractopamine 7.5 ppm –

C Control + ractopamine 7.5 ppm + zinc 50 ppm

The treatments were imposed during the last two weeks of production.

Key Findings

There were no significant effects of treatment on growth performance though Ractopamine improved feed efficiency by 8%. Any impact of the additional Zinc on the immune system and performance may not have been detected due to the short duration of the study.

Application to Industry

The project provided no evidence that Availa Zinc enhanced the effect of Ractopamine on growth performance of female pigs.

PROJECT 2A–109: DETERMINING THE LYSINE REQUIREMENTS OF IMMUNOCASTRATED MALE PIGS

Project Leader:
Dr Karen Moore

Project Participants:
DAFWA and University of Melbourne

Aims and Objectives

The main aim of this project was to determine the optimal available lysine/MJ digestible energy ratio (g Av Lys: DE) of immunocastrates and how quickly their requirements change following the second vaccination with the immunocastration vaccine.

A dose titration approach was undertaken using five levels of available lysine to energy ratio from 0.32 to 0.75 g Av Lys: DE comparing the response of entire males and immunocastrated males for 6 weeks after the secondary immunisation.

Key Findings

Immunocastrates had a higher daily gain at lower lysine levels compared to entire males. They also had a higher feed to gain at higher levels of lysine compared to entire males. Entire males had a higher lysine requirement than immunocastrates over the six-week study period (60 kgs LW until slaughter). Lysine requirements of immunocastrates are similar to entire males for two weeks after the secondary immunisation and then decrease.

Application to Industry

The results of the project determined the lysine requirements for a current Australian genotype and provided a proposed feeding strategy to maximise performance whilst minimising feed costs.

The recommendation from the project was:

That immunocastrated male pigs remain on the same lysine levels as entire males until at least two weeks after the second immunisation. At this time, the available lysine to energy concentration in the diet may be decreased to 0.43 g Av Lys: DE.

Subprogram 2B: Feed Intake Innovations

KEY DELIVERABLES

1] Novel molecules and feed ingredients (e.g. grains, plant extracts and inherent plant compounds) that can be used to stimulate or supress feed intake.

2] Elimination of post-weaning growth checks and promotion of gut development through stimulation of feed intake.

3] Improved carcass quality through manipulation of feed intake in growing pigs.

4] Identification of gene markers, quantitative trait loci and genetic receptors for feed intake.

PROJECT ID	TITLE
2B–101(a)	Effect of dietary NDF content on growth rate and efficiency of finisher pigs
2B–101(b)	The effect of dietary fat concentration on the growth rate and feed efficiency of finisher pigs
2B–102(a)	Neonatal oxytocin treatment and milk feeding of pigs before and after weaning influences the expression of gastrointestinal hormones regulating feed intake throughout the gastrointestinal tract of the piglet
2B–102(b)	Using medium-chain triglycerides (MCT) to improve post-weaning performance
2B–102(c)	Determining the weaned pigs' responses to dietary medium-chain triglycerides (MCT) under conditions of mild challenge with enterotoxigenic Escherichia coli (ETEC)
2B–102(d)	Manipulation of Growth and Physiology in the Young Pig The responses of light and heavy pigs at weaning to dietary spray-dried porcine plasma
2B–103	Strategies to enhance the performance of pigs immediately after weaning
2B–106	Development of semi-moist extruded creep feeds to promote gastro-intestinal tract development, feed intake and subsequent weaning weights
2B–107	Arginine supplementation for pigs weaned at 21 days of age
2B–108	Nutritional strategies to limit the post-weaning growth check in young pigs

Research Summaries for Subprogram 2B

PROJECT 2B–101(A): EFFECT OF DIETARY NDF CONTENT ON GROWTH RATE AND EFFICIENCY OF FINISHER PIGS

Project Leader:
Dr Cherie Collins

Project Participant:
Rivalea Australia

Aims and Objectives

NDF, from the wheat by-product millmix, and supplemental fat have nutritional properties other than their chemical composition and digestible energy that enhance growth performance and efficiency in progeny.

The experiment was designed as a 2 x 6 factorial experiment with sex and dietary level of neutral detergent fibre (NDF) as factors. The two sexes were intact male and female pigs. There were 6 formulated levels of dietary NDF in the diet including 13%, 15%, 17%, 19%, 21% and 23% of the diet. All other nutrients were formulated to be equal across all treatments. The diet was formulated to contain 13.5 MJ of digestible energy and 0.52g of available lysine per MJ DE with the addition of a xylanase and phytase enzymes.

Key Findings

Feed efficiency was poorer for female than entire male pigs and tended to improve as the level of NDF increased with the effect diminishing as live weight increased. Carcass weight was not affected by treatment but P2 declined with increasing NDF level in the diet.

At the time of the study increasing the level of NDF in the diet reduced the cost of live weight gain in a linear fashion by 1.24 3.17 3.10 4.50 and 5.72 cents/kg compared to the basal diet containing 13% NDF. The economics did not take into account the potential difference in carcass value due to the reduction in P2 with increasing NDF.

Application to Industry

The results suggest that using millmix to increase the NDF content of finisher diets has the potential to improve the profitability of pork production.

Pigs appear to adjust to higher NDF levels over time and a level of 17–19% NDF from around 65 kg to sale at 100 kg is likely to provide the most cost effective strategy. The latter however will depend on feed ingredient costs.

PROJECT 2B–101(B): THE EFFECT OF DIETARY FAT CONCENTRATION ON THE GROWTH RATE AND FEED EFFICIENCY OF FINISHER PIGS

Principle Investigators:
Cherie Collins and Andrew Philpotts

Project Participant:
Rivalea Australia

Aims and Objectives

The hypothesis of this project was that the addition of fat to finisher diets may improve the utilisation of other nutrients and enhance the efficiency with which energy is used for growth.

A total of 1,296 pigs with an initial weight of 64 kg were used in a 2 X 6 factorial experiment to investigate the effects of sex (male and female) and six levels (1%, 2%, 3%, 4%, 5% and 6%) of supplemental dietary fat at the same dietary energy content (13.8 MJ DE/kg) on pig performance and carcass characteristics under commercial situations. Pigs were housed in groups of 9 and the diets were offered adlibitum for 35 days. The actual DE levels of the diets ranged from 13.6 to 14.1 MJ/kg with increasing dietary supplemental fat from 1 to 6%.

Key Findings

Increasing the level of fat (tallow) in the diet improved feed conversion efficiency throughout the 35 day experiment increased carcass weight and P2 fat thickness even when carcass weight was used as a covariate in the analysis of the data. For males increasing the level of fat added to the diet from 1% to 6% reduced feed: gain from 2.55 to only 2.31 and increased carcass weight from 74.9 to 77.3 kg and profit/pig by $4.10.

For females the responses were more moderate and the effects on profit were variable ranging from – $1.18 to + $1.47/pig.

The results suggest that adding fat to finisher diets enhances the efficiency of growth and for males in particular can markedly improve the efficiency with which feed (energy) is used for carcass growth resulting in improved profitability. For females the effects of increasing dietary fat on P2 fat thickness tends to reduce the potential for enhanced profitability though this will depend on the genetics involved and the price and grading system in which the pigs are sold.

Table 1 shows the possible advantage in cost of production that can be achieved from increasing fat level in the pig diet.

Application to Industry

Findings are novel and have significant economic implications. The final report was distributed to and discussed with Australian nutritionists.

Table 1: Cost analysis of increasing dietary fat for finisher pigs over a 35 day period (averaged for males and females)

FAT LEVEL %	1	2	3	4	5	6
Diet DE (MJ/kg)	13.6	13.7	13.8	13.9	14.05	14.2
Feed: gain	2.6	2.58	2.52	2.51	2.47	2.43
Carcass weight (kg)	74.2	74.9	75.4	75.4	75.4	75.8
P2 (mm)	8.8	8.9	9.1	9.4	9.2	9.2
Net improvement in margin ($/pig)	–	1.93	1.38	1.24	4.50	4.91

PROJECT 2B–102(A): NEONATAL OXYTOCIN TREATMENT AND MILK FEEDING OF PIGS BEFORE AND AFTER WEANING INFLUENCES THE EXPRESSION OF GASTROINTESTINAL HORMONES REGULATING FEED INTAKE THROUGHOUT THE GASTROINTESTINAL TRACT OF THE PIGLET

Project Leader:
Professor John Pluske

Project Participants:
Murdoch University and University of Melbourne

Aims and Objectives

The project used 83 piglets obtained at birth. The piglets were allocated to treatments in a 2 x 2 x 2 x 2 randomised block design. The respective factors were sex (male v female), injection (oxytocin v saline), pre-weaning dietary treatment (supplemented with skim milk during lactation vs. unsupplemented) and post-weaning dietary treatment (gruel v pellet). Piglets were euthanised at 10 days of age (n=15) or weaning at 21 days (n=38). Some piglets carried over into the post-weaning period were also subjected to euthanasia at 28 days of age (n=30). Samples from stomach, small intestine and hypothalamus were collected and snap frozen until real-time polymerase chain reaction analysis of gene expression in tissues were performed. PCR results were determined using the ΔCt method.

Key Findings

Oxytocin administration to piglets enhanced gastric leptin expression at 10 and 28 days of age. This enabled oxytocin to ameliorate but not overcome the post-weaning lag in growth and the possible promotion of immediate feed intake post-weaning. It was seen that female piglets were better equipped to handle the weaning process, as the greater expression of GLP-2 observed in the ileum of these pigs up until weaning indicates that intestinal development in females is more advanced allowing them to better adapt to a change in diet.

Application to Industry

Oxytocin injection may assist piglet's better transition weaning but the costs and labour involved would need to be considered.

PROJECT 2B–102(B): USING MEDIUM-CHAIN TRIGLYCERIDES (MCT) TO IMPROVE POST-WEANING PERFORMANCE

Project Leader:
Professor John Pluske

Project Participants:
Murdoch University

Aims and Objectives

To investigate the effects of medium-chain triglycerides on the performance of pigs after weaning.

Eighty-four weaned piglets were used in a completely randomised study with seven treatments:

1] Negative control diet (no antimicrobials)

2] Positive control diet (antibiotic + ZnO)

3] 0.625% MCT diet

4] 1.25% MCT diet

5] 2.5% MCT diet

6] 5% MCT diet

7] A diet with coconut oil at 5%.

There were 12 pigs/replicates per treatment. Pigs were fed the experimental diets for 14 days, and then a Phase 2 weaner diet for the following 14 days after which time the experiment ceased. Performance indices were calculated on weekly basis. A blood sample was collected from 6 'focus' pigs on days 7 and 14 of the experiment and plasma analysed for triglycerides, glycerol, NEFA and glucose levels, haematology indices and for growth hormone activity.

Key Findings

Results from this experiment did not demonstrate beneficial effects of MCT supplementation over and above that of the Positive Control diet, nevertheless suggesting that MCT could be used as a replacement product for antibiotics (olaquindox in this case) and ZnO. However the absence of diarrhoea during the experiment did not allow for a full evaluation of the antibacterial potential of MCT included in a commercial weaner diet.

Application to Industry

MCT may have potential to replace ZnO and antibiotics in weaner diets. However, the MCT used in the study was very expensive and a cheaper source would need to be sourced.

Research Summaries for Subprogram 2B continued

PROJECT 2B–102(C): DETERMINING THE WEANED PIGS' RESPONSES TO DIETARY MEDIUM-CHAIN TRIGLYCERIDES (MCT) UNDER CONDITIONS OF MILD CHALLENGE WITH ENTEROTOXIGENIC ESCHERICHIA COLI (ETEC)

Project Leader:
Professor John Pluske

Project Participants:
Murdoch University

Aims and Objectives

To investigate the effects of 3% MCT on the performance and health of piglets challenged with an ETEC after weaning.

The diets used in the experiment were:

1] Positive control diet (Olaquindox + ZnO)

2] MCT added at 0.5% to the diet

3] MCT added at 3% of the diet.

A challenge with an enterotoxigenic strain of E. coli was given to half of the pigs within each diet group. 72 newly weaned and individually housed male piglets were used in a split-plot arrangement. Challenge versus no-challenge with E. coli as the factor in the whole plot, and the three dietary treatments as subplots. Pigs were fed their experimental diets for three weeks after weaning and production indices calculated. Faecal swabs were taken from all pigs on days 0, 3, 5, 7, 9 and 11 of the experiment to determine the shedding of ß-haemolytic E. coli, and blood samples collected from half of the pigs per treatment on days 7 and 17 to measure blood metabolites and haematological parameters.

Key Findings

Results showed a significantly higher average daily gain in pigs fed 3% MCT or the antibiotic/ZnO diet compared to pigs on the 0.5% MCT diet, supporting the inclusion of 3% MCT in post-weaned pig diets. However and despite imposing a mild E. coli challenge, a reduction in E. coli shedding was not observed in pigs fed the higher level of MCT compared to those on the lower MCT level. This positive effect of the higher dietary MCT on the performance of the pigs could be a result of a beneficial effect of the MCT on other microbes in the gut, but possibly not on the E. coli.

Application to Industry

This experiment confirmed the previous activity showing that MCT can be used in a diet without antibiotics and ZnO, and not negatively influence production indices. The added cost of using MCT would need to be evaluated against the costs of other additives before being widely used in weaner diets by nutritionists, feed manufacturers and pig producers.

PROJECT 2B–102(D): MANIPULATION OF GROWTH AND PHYSIOLOGY IN THE YOUNG PIG

THE RESPONSES OF LIGHT AND HEAVY PIGS AT WEANING TO DIETARY SPRAY-DRIED PORCINE PLASMA

Project Leader:
Professor John Pluske

Project Participant:
Murdoch University

Aims and Objectives

Ninety-six pigs weaned at 21 days were used in a 2 x 2 factorial experiment. The respective factors being:

1] Light- (4.9 ± 0.67 kg LW) or heavy- (6.9 ± 0.73 kg LW) for-age pigs and

2] A diet containing SDPP (50 g/kg and 25 g/kg, for phase I and II, respectively) or a control diet not containing SDPP.

Each treatment had 8 replicates (pens) with 3 pigs per pen. Stage I diets were fed for the first week and Stage II for the following 2 weeks until the experiment ceased at 21 days after weaning. Pigs were weighed weekly and feed refusals daily to calculate performance indices. One pig per pen, randomly selected, was bled on days 7 and 14 to measure circulating levels of Igs, routine haematology indices and plasma urea nitrogen (PUN).

Key Findings

The inclusion of SDPP in the diet improved performance of both light- and heavy-for-age pigs during the first week after weaning. Such effects disappeared in the following 2 weeks and over the 3-week study pigs supplemented with SDPP tended to gain (20 g per day) more than the control pigs. Haematology indices as well as IgG, IgA and IgM levels in plasma were similar between treatments except for IgG, which was higher in the heavy control pigs than in the rest on day 14 of the experiment. Pigs fed the SDPP diet had lower PUN levels than the pigs on the control diet possibly indicating an increased efficiency of dietary protein utilisation as a result of SDPP supplementation.

Application to Industry

The inclusion of SDPP in weaner pig diets at 50 g/kg during the first week after weaning offers a means of improving performance of weaner pigs. Whether feeding SDPP at the levels used in this experiment protects the pig against post-weaning diarrhoea could not be determined from the results because pigs had only low and sporadic levels of diarrhoea.

PROJECT 2B–103: STRATEGIES TO ENHANCE THE PERFORMANCE OF PIGS IMMEDIATELY AFTER WEANING

Project Leader:
Dr Rebecca Morrison

Project Participants:
Rivalea Australia, DAFWA, CHM Alliance, Murdoch University

Aims and Objectives

The overall aim was to identify some of the risks for reduced feed intake and growth performance in the post weaning period and the development of strategies for increasing production and/or reducing the incidence of post-weaning diarrhoea. The more specific objectives of this project were to:

1] Identify the pre-and post-weaning risk factors that affect survival and lifetime growth performance.

2] Examine a number of nutritional and management strategies to improve pre- and post-weaning performance and survival.

Key Findings

The results showed:

1] That increasing weaning age per se had no positive effect on overall performance and actually reduced carcass weight at 152 days of age – but reduced P2.

2] That birth weight and weight at weaning are the two major factors affecting overall performance and profitability. Pigs at risk of poor pre and post weaning outcomes are those born less than 1.2 kg or with a weaning weight below 5.5 kg.

3] That using complex/expensive diets in the first two weeks after weaning increased the cost of production to 152 days of age by $3.00–$5.00/pig for pigs of average or heavy birth weight – and were only of value for pigs of light birth weight.

4] That reducing the protein content of the diets offered immediately after weaning reduced the incidence and severity of post weaning diarrhoea.

5] The benefits of the use of additional labour, artificial colostrum and supplementing with Arginine were not confirmed.

Application to Industry

The project provided a wealth of new information on the economics of managing pigs after weaning on whole of life performance. It is essential reading for nutritionists, veterinarians and production managers.

PROJECT 2B–106: DEVELOPMENT OF SEMI-MOIST EXTRUDED CREEP FEEDS TO PROMOTE GASTRO-INTESTINAL TRACT DEVELOPMENT, FEED INTAKE AND SUBSEQUENT WEANING WEIGHTS

Project Leader:
Professor Robert van Barneveld

Project Participants:
CHM Alliance, Rivalea Australia, APFG

Aims and Objectives

- Develop a basis for the production of extruded, shelf-stable, semi-moist (~15–20% moisture) creep feeds.
- Demonstrate an improvement in creep feed intake and post-weaning intake using a semi-moist feed relative to an existing commercial creep feed.
- Examine the influence of semi-moist creep feeds and subsequent increases in feed intake post-weaning on lifetime performance.
- Assess the influence of semi-moist creep feeding and diet composition on gut development, microbial communities in the gut and the incidence of disease.

Key Findings

- A set of production parameters for the manufacture of shelf-stable semi-moist feeds.
- A highly-palatable product that is suitable as a delivery device for less palatable ingredients, whether they be medications, supplements or poorer quality ingredients that may play a greater role in gut development.
- A semi-moist extruded creep feed containing high quality ingredients is a suitable replacement for slurry feeding of runt piglets. Whilst growth performance was not significantly enhanced, the clean, shelf-stable nature of the product was preferable to the on-farm production of supplemented slurries and resulted in greater levels of hygiene.
- Results showed that piglets offered the semi moist creep diet had fewer E coli carrying virulence genes than pigs on more conventional creep feeds.
- An excellent model for testing technologies across the Australian industry. The outcomes differed across production units and businesses.

Application to Industry

Production of a semi moist creep feed for smaller pigs at weaning and potentially all pigs the first week after weaning is being commercialised.

Research Summaries for Subprogram 2B continued

PROJECT 2B–107: ARGININE SUPPLEMENTATION FOR PIGS WEANED AT 21 DAYS OF AGE

Project Leader:
Dr Rebecca Morrison

Project Participant:
Rivalea Australia

Aims and Objectives

The aim of this project was to test the hypothesis that supplementing arginine at different rates ranging from 0 to 1% would increase the growth performance and survivability of newly weaned, 21 day old pigs.

Key Findings

There was no advantage of supplementing 21-day-old weaned pigs with additional arginine (above NRC requirements) in the diets for 12 days post-weaning.

Application to Industry

The lack of consistency in the data between the studies from Murdoch University and Rivalea Australia demonstrate the variation between experiments that can occur, which might be attributable to factors such as parity source of the piglets and hence the state of physiological 'maturity', which was not assessed. It also underscores the importance of an experimental approach whereby promising nutritional treatments/ strategies can be evaluated under commercial conditions following experimentation in research institutions. Arginine supplementation of weaner diets appears to have few commercial benefits.

PROJECT 2B–108: NUTRITIONAL STRATEGIES TO LIMIT THE POST-WEANING GROWTH CHECK IN YOUNG PIGS

Project Leader:
Dr Megan Edwards

Project Participants:
ACE Livestock Consultancy, Rivalea Australia, and University of New England

Aims and Objectives

The project comprised a PhD program conducted by Ms Megan Edwards and the thesis is available on the Pork CRC web site.

Four experiments were conducted under commercial conditions to assess the influence of various nutritional strategies on the intestinal and immune development, survivability and performance of young pigs in the pre- and post-weaning phases.

The nutritional strategies included an extruded creep feed product, amino acid supplementation, non-nutritional effects of creep feed, and the use of two nutraceutical products (spray-dried porcine plasma and a yeast derived protein meal).

In the latter three experiments, dam parity was considered as a factor, so comparisons between the progeny of primiparous (P0) and multiparous (P2, 3, and 4) sows were examined.

Key Findings

Of the strategies examined, inclusion of spray-dried porcine plasma was most effective at maintaining post-weaning feed intake and growth performance in the acute post-weaning period. These benefits were reflected in improved intestinal integrity, pancreatic digestive enzyme activity and colonic health.

Optimising the efficiency of nutritional strategies is likely best achieved through strategic application. Supplemental amino acids provided a cheap and effective nutritional tool specifically in young pigs, which faced a high risk of immunological challenge including the progeny of primiparous sows. In commercial herds dominated by young sow populations or in facilities where primiparous sows are housed independently, the use of yeast derived protein meals is recommended. Whilst the benefits of pre-weaning creep feed exposure and the use of spray dried porcine plasma appear to be beneficial across the entire grower period.

Application to Industry

The outcomes of all the studies have commercial implications both for the performance of pigs immediately after weaning and for their longer term health and survival.

Subprogram 2C: Alternative Health Strategies – improve production/reduce mortality

KEY DELIVERABLES

1] Nutritional, genetic, immunological and management solutions for the control of and/or reduction of disease and mortality in pigs as an adjunct to existing medication programs in all growth phases.

PROJECT ID	TITLE
2C–101	Management strategies to aid in the control of Proliferative Enteropathy (PE) ileitis
2C–102	Detection and strain typing of brachyspira hyodysenteriae to support swine dysentery eradication and control
2C–103	Evaluation of grower pig aerosol and sucker pigs app vaccination programmes
2C–104	Controlled exposure as a management tool for Glässer's disease
2C–105	A novel strategy for improved gut health and feed conversion
2C–106	Development of a serological ELISA test for detection of herds with swine dysentery
2C–107	Manipulating the environment in the porcine large intestine to help control swine dysentery (SD)
2C–108	The use of nucleotides, functional amino acids and vitamins to stimulate feed intake, enhance gut development and immunity in the pre- and post-wean piglet for lifetime growth performance
2C–110	Improving health of neonatal piglets by injecting immunoglobulins
2C–111	Bacteriophage to control Enterotoxigenic E coli *(Now 2C–101)*
2C–114	Evaluating the replacement of zinc oxide with an encapsulated zinc oxide product as a means of controlling post-weaning diarrhoea in piglets
2C–116	E. coli Probiotic Trial and Challenge Model *(Refer 2C–105)*

Research Summaries for Subprogram 2C

PROJECT 2C–101: MANAGEMENT STRATEGIES TO AID IN THE CONTROL OF PROLIFERATIVE ENTEROPATHY (PE) ILEITIS

Project Leader:
Dr Alison Collins

Project Participant:
NSWDPI

Aims and Objectives

- Determine if management strategies such as AIAO production, the type of housing, cleaning and disinfection of pens can significantly reduce the bacterial "load" of *Lawsonia intracellularis* in the piggery environment.
- Determine whether *L.intracellularis* can survive in pens previously occupied by pigs shedding *L.intracellularis* in their faeces, and transmit infection to naïve pigs introduced into these pens following various levels of cleaning and disinfection.
- Determine whether *L.intracellularis* can survive in ecosheds and be a source of infection to naïve pigs, following various levels of cleaning and disinfection between batches of pigs.
- Determine whether *L.intracellularis* can be completely eliminated from the pig.
- Determine if previously infected pigs can start to re-shed *L.intracellularis* under stressful conditions, and become a potential source of *L.intracellularis* infection to in-contact naïve animals.

Key Findings

- *L.intracellularis* can survive in faeces in empty pens for at least 2 weeks on concrete slatted flooring.
- Virkon-S is an effective disinfectant.
- Recovered pigs were not a source of *L.intracellularis* infection to naïve pigs, even if the pigs were immuno-suppressed.
- Antibiotic treatment of PE-affected pigs aided recovery, and prevented transmission of *L.intracellularis* infection from recovered to naïve in-contact pigs.
- Overall, a range of management techniques and new information on the aetiology of the disease was provided to industry to aid in the control of ileitis.

Application to Industry

The findings from the project were disseminated to industry through producer seminars, annual conferences, APSA, PPPE and meetings of veterinarians. Awareness and adoption survey results showed a high level of awareness and adoption of the outcomes.

If you are not aware of the outcomes – read the final report or contact Dr Collins.

PROJECT 2C–102: DETECTION AND STRAIN TYPING OF BRACHYSPIRA HYODYSENTERIAE TO SUPPORT SWINE DYSENTERY ERADICATION AND CONTROL

Project Leader:
Professor David Hampson

Project Participant:
Murdoch University

Aims and Objectives

The objectives were to:

1] Receive diagnostic samples from herds belonging to the Industry Partners, and from other Australian herds with swine dysentery (SD):

i] Subject the samples to culture and polymerase chain reaction (PCR) testing to identify Brachyspira hyodysenteriae, the aetiological agent of SD

ii] Test Australian B. hyodysenteriae isolates for their susceptibility to a range of antimicrobial agents

iii] Develop a new strain typing system for B. hyodysenteriae using multilocus sequence typing (MLST)

iv] To look for potential new reservoirs of B. hyodysenteriae that could threaten herd biosecurity.

2] During the study, 842 diagnostic samples were received and were subjected to selective anaerobic culture and to polymerase chain reaction (PCR) amplification for B. hyodysenteriae – 115 (13.7%) of the samples were PCR positive for B. hyodysenteriae, and 47 isolates of B. hyodysenteriae were recovered in pure culture. The PCR positive samples came from 16 of the 22 sources submitting samples.

Key Findings

Resistance to tylosin was almost universal amongst the isolates, while all isolates were susceptible to dimetronidazole. Unfortunately, the latter drug has been withdrawn for use for SD control in Australia. Resistance to lincomycin or tiamulin was observed in a number of isolates. Resistance to tiamulin has emerged since the last Australian survey was conducted in 2001. Most of the resistant isolates were recovered from Queensland, although one isolate from Victoria was resistant to both of these drugs, as well as to other antimicrobials. Most of the isolates appeared to be either susceptible or "moderately susceptible" to monensin and olaquindox, but interpretation of the data was difficult. Most isolates were susceptible to tetracycline and ampicillin.

A new multilocus sequence typing (MLST) method was developed for differentiating between B. hyodysenteriae isolates.

Faecal samples were collected from 222 feral pigs that had been trapped in three regions in the southeast of Western Australia. B. hyodysenteriae was detected by PCR in 18 (8.1%) of the pigs, from all three areas, and an isolate was obtained from a subset of 61 samples that were cultured.

Application to Industry

Overall, there should be concern about the increasing resistance to lincomycin and tiamulin, although it was reassuring to find that monesin still appears to be useful for inhibiting B. hyodysenteriae growth. Attempts should be

made to register this drug for more routine use in SD control in Australia.

The new multilocus sequence typing (MLST) method developed in the project will enable veterinarians to better understand which isolate might be affecting herds and enhance the management and potentially the eradication of SD.

PROJECT 2C–103: EVALUATION OF GROWER PIG AEROSOL AND SUCKER PIGS APP VACCINATION PROGRAMMES

Project Leader:
Dr Peter McKenzie

Project Participant:
Rivalea Australia

Aims and Objectives

The project was undertaken to develop a simple live Actinobacillus pleuropneumoniae vaccine that would be:

- Superior or equivalent to, the existing killed autogenous APP vaccines but at lower cost.
- Effective in large continuous flow pig production systems.
- Efficacious in the face of challenge with different APP serovars, together with other respiratory helper pathogens such as Mycoplasma hyopneumoniae and porcine circo virus associated disease (PCVAD).

Key Findings

A live autogenous vaccine was developed. The process-involved culture of the organism in a laboratory, shipping the vaccine to the farm site and storage at –80°C, diluting the live culture and vaccinating with a minimum dose of 105 cfu/ml by the intranasal route to pigs before weaning.

Application to Industry

Despite the early success in the field, the response to vaccination on farms over the following 12 months was variable. On four of six farms followed, growing pig mortality rates were reduced following vaccination. In the finishing pigs, only two of six farms showed an improvement in performance following use of the killed autogenous vaccine.

The efficacy of the vaccine appeared to decline over time and it was eventually withdrawn from the market.

PROJECT 2C–104: CONTROLLED EXPOSURE AS A MANAGEMENT TOOL FOR GLÄSSER'S DISEASE

Project Leader:
Dr Conny Turni

Project Participants:
Department of Employment, Economic Development and Innovation Queensland Primary Industries and Fisheries

Aims and Objectives

The objective of this project was to reduce production costs and improve herd feed conversion efficiency by offering a solution to farmers for the control of Glässer's disease. The solution was controlled exposure of piglets to a live strain of Haemophilus parasuis while they are still under the protection of maternal antibodies. Controlled exposure will give the piglets protection against the serovars on the farm but will also give cross-protection to other serovars. Therefore, if another serovar is introduced onto the farm, the results will not be catastrophic.

Key Findings

Even though the field trials (on 4 farms) only gave indications the method has efficacy, the knowledge gained during the trials is currently helping pig farmers. Major advances are a suite of diagnostic and support tools for pig veterinarians dealing with Glässer's disease.

1] A new improved PCR assay was developed. This Real Time PCR is much more sensitive and specific than the existing conventional PCRs. The method has been validated for direct application to systemic sites and lungs and is available for use.

2] A serovar profiling service has been developed and is now available. This service has now been provided for 23 farms successfully.

3] A H. parasuis genotyping service has been developed and is now available. This service can be used to understand on farm epidemiology. This genotyping (and an expanding database of genotypes) will greatly improve our understanding and hence our ability to control outbreaks.

Application to Industry

The outcomes enhance our diagnostic capacity and assist in the management and potentially the control of Glässer's disease. The services and diagnostics have been made available to industry and are widely used.

PROJECT 2C–105: PROBIOSIS – A NOVEL STRATEGY FOR IMPROVED GUT HEALTH AND FEED CONVERSION

Project Leader:
Dr Toni Chapman

Project Participants:
NSWDPI and International Animal Health Products

Aims and Objectives

The focus of the project was to provide the pork industry with a probiotic-based alternative to antibiotics in the management of pre- and post-weaning diarrhea (PPWD). Escherichia coli, and in particular enterotoxigenic E. coli (ETEC) are the dominant source of PPWD losses, and these were targeted in this project.

Once individual isolates were obtained, they were assessed on three main criteria (PART 2):

1] Safety judged by absence of markers for virulence and antibiotic resistance.

2] Antagonism to a selection of ETEC and other E. coli (direct inhibition).

3] Persistence within the same ecological niche that the ETEC would normally occupy (competitive exclusion).

A final selection of three candidates was made out of an initial panel of over 25,000 to create the experimental probiotic formulation called EP and this product was further tested in a number of animal trials.

Research Summaries for Subprogram 2C continued

Key Findings

The overall conclusion of this project was that properly formulated and trialled probiotic formulations (E. coli based or otherwise) have earned a place within the pork industry's arsenal in combating PPWD.

Application to Industry

The strategy needs to be tested commercially on a larger scale than was the case in the project. The technology however, seems to have potential as a replacement for antibiotics.

PROJECT 2C–106: DEVELOPMENT OF A SEROLOGICAL ELISA TEST FOR DETECTION OF HERDS WITH SWINE DYSENTERY

Project Leader:
Professor David Hampson

Project Participant:
Murdoch University

Aims and Objectives

- Develop a novel serological ELISA test that could be used to detect antibodies to *Brachyspira hyodysenteriae* (i.e. a herd test for swine dysentery).
- Demonstrate the use of the ELISA to diagnose and monitor the efficacy of control measures for swine dysentery in Australian herds.
- Sell the commercial rights to this technology and gain royalty payments for the Pork CRC and Murdoch University.

Key Findings

An ELISA test to detect the presence of *B hyodysenteriae* was developed. It successfully identified all 18 negative herds and correctly identified five of six infected herds. Hence, the test has a high specificity, and there were no false positives in the samples detected.

Application to Industry

Once commercialised the ELISA test will enable veterinarians to readily test herds for the presence of swine dysentery.

PROJECT 2C–107: MANIPULATING THE ENVIRONMENT IN THE PORCINE LARGE INTESTINE TO HELP CONTROL SWINE DYSENTERY (SD)

Project Leader:
Professor John Pluske

Project Participant:
Murdoch University

Aims and Objectives

1] To determine whether highly fermentative diets incorporating lupins and moderately fermentable fibre (as fructans from e.g. inulin) can prevent SD.

2] To examine in the potential protective effects of tubers of yacon, a plant that can be grown in Queensland and which contains over 60% (dry matter) of inulin-type fructans.

3] To reveal the underlying nature and mechanisms of the protective changes observed in two experiments associated with objectives 1 and 2 above.

Key Findings

1] Inulin at a level of inclusion of 80 g/kg of diet markedly reduced the relative risk of pigs developing SD under the dietary and challenge conditions used.

2] Lupins delayed the onset of SD compared to canola meal in the diet, under the dietary and challenge conditions used.

3] Pigs without SD have a different microbial community structure associated with certain (identifiable) bacteria, which could influence the colonisation of *B. hyodysenteriae* in the large intestine, and hence influence SD.

Application to Industry

The project demonstrated that dietary strategies (ingredients) can help reduce the incidence and severity of swine dysentery.

PROJECT 2C–108: THE USE OF NUCLEOTIDES, FUNCTIONAL AMINO ACIDS AND VITAMINS TO STIMULATE FEED INTAKE, ENHANCE GUT DEVELOPMENT AND IMMUNITY IN THE PRE- AND POST-WEANED PIGLET FOR LIFETIME GROWTH PERFORMANCE

Project Leader:
Dr Karen Moore

Project Participants:
Department of Agriculture and Food Western Australia

Aims and Objectives

This project examined the effect of the addition of nucleotides, inositol or glutamate, either individually or in combination, to weaner diets on gut development, immune function and lifetime pig performance.

Key Findings

The diets were fed for three weeks post-weaning and the pigs were subsequently monitored through until slaughter. There was no significant difference between the treatments in either post-weaning or lifetime performance. It is possible that the lack of a significant difference in growth performance is due to the optimum conditions in which the pigs were housed (individual pens), as compared to commercial practice. Measures of gut development and immune function were used in an attempt to identify the mechanisms by which each of these additives may be working to predict their value for pigs in less ideal environments. Improvements in gut histology and/or immune function were found with the addition of either inositol, glutamate or nucleotides, or the inclusion of all three.

Application to Industry

The project-demonstrated effects of the additives on GIT development but the changes were not reflected in growth performance. This situation is likely to differ under commercial conditions.

PROJECT 2C–110: IMPROVING HEALTH OF NEONATAL PIGLETS BY INJECTING IMMUNOGLOBULINS

Project Leader:
Dr Rob Smits

Project Participant:
Rivalea Australia

Aims and Objectives

Improving the health and viability of dystrophic (light and low vitality) piglets by intramuscular injection of plasma derived from slaughtered sows of the same farm was investigated.

In a series of studies, blood plasma from young parity sows at slaughter was collected and processed by a GMP facility at Bendigo, VIC, and stored at –20C. In the pilot study, neonatal piglets (n=81) were injected with 5 mL plasma on d 1 of age with plasma collected from sows of the same farm and health status (n=490) and compared to piglets left untreated (n=83). In a larger study, dystrophic piglets weighing between 0.8 to 1.3 kg at birth were injected with 10 mL plasma on either d 1 (n=200), or d 1 and 3 (n=209), and compared with piglets injected with a placebo (Hartmann's solution) on d 1 and 3 (n=203). In the final study, the transfer of antibodies from the plasma injection method was assessed. Sows destined for slaughter were vaccinated with either a tetanus toxoid vaccine (Equivac®) or a placebo (Hartmann's solution) two weeks prior to slaughter. The blood from each donor sow group was collected, plasma processed and stored before being injected into dystrophic piglets on d 1 and 3.

Key Findings

In the pilot study there was no difference in weight gain between d 1 to d 14 in the two groups (average of 162 g/d; P = 0.49), though there was a numeric reduction in mortality by d 14 in the plasma treated piglets (14 vs 17%; P = 0.41).

In the larger study, there was no significant difference in weight gain or mortality by d 7, 14 or 21. Mortality was numerically higher in piglets injected with plasma on d 1 and 3, particularly in the first week, compared to those injected with plasma on d 1 only or treated with the placebo. In the final study the antibodies specific to tetanus were higher in piglets treated with plasma from Equivac treated sows compared to the placebo sow plasma. This demonstrated that antibodies as IgG are transferred from plasma injected into piglets. Despite an increase in antibody transfer by the plasma injection method, there was no benefit to health or viability of neonatal piglets.

Application to Industry

The strategy has little or no industry applicability.

PROJECT 2C–114: EVALUATING THE REPLACEMENT OF ZINC OXIDE WITH AN ENCAPSULATED ZINC OXIDE PRODUCT AS A MEANS OF CONTROLLING POST-WEANING DIARRHOEA IN PIGLETS

Project Leader:
Dr Jae Kim

Project Participants:
DAFWA and
Murdoch University

Aims and Objectives

Recently, a microencapsulated zinc oxide product was released on the market and the lipid-coated ZnO has been claimed to decrease dramatically inclusion of ZnO from 2,500–3,000 ppm to 100 ppm to achieve the same effect on PWD. Therefore, the microencapsulated zinc oxide was evaluated as a solution for the environmental issue as well as controlling PWD.

An experiment with a split-plot design for which the whole plots were arranged in randomised blocks was conducted. Challenge versus no-challenge with ETEC (E. coli O149:K91:K88) were the factors in the whole plot, and the three dietary treatments (control, ZnO and encapsulated Zn) were used as subplots (n=12). 72 weaner pigs (castrate and female, 1:1) were used in a 3-week feeding experiment (housed individually, providing 12 replicates per treatment). The experiment assessed the incidence of PWD, monitored production indices (feed intake, daily gain, feed conversion ratio), and measured faecal zinc excretion levels and plasma zinc concentrations

Key Findings

Pig weights and average daily gain (ADG) were not affected by the dietary treatments or ETEC challenge. Feed intake tended (P = 0.092) to be lower in the first week after weaning and overall (P = 0.109) for the pigs challenged with ETEC. The FCR was not calculated for the first week after weaning due to the high number of negative values. Overall FCR was affected by diet as the pigs fed Shield-Zn had an improved FCR compared with the pigs receiving ZnO.

Diet significantly affected the incidence of PWD expressed as the mean percentage of days with diarrhoea during 14 days post-weaning (P < 0.001) whereas challenge with ETEC in this experiment failed to increase the incidence of diarrhoea. Pigs fed the control diet had a higher incidence of PWD compared with the pigs fed ZnO and Shield-Zn supplemented diets. As a consequence pigs fed a control diet required more antibiotic treatments during the first 2 weeks after weaning (P<0.001).

For faecal Zn Diet effect was significant (P<001) with control and Shield Zinc having similar faecal Zn levels and both dramatically lower than the ZnO treatment.

Application to Industry

The experiment was conducted with a relatively small number of pigs and under hygienic condition using only 1 ETEC strain. Therefore, the response might be different when pigs are exposed to less hygienic conditions and where multi-strains of pathogen might be present in the environment. A large-scale commercial validation study is required for confirmation of current findings.

Subprogram 2D: Improving sow reproduction and longevity

RESEARCH IN SUBPROGRAM 2D FOCUSED ON THREE BROAD THEMES

1] Improvement of lactation performance and weaning weight.

2] Improving sow longevity and lifetime performance.

3] Investigating the potential for a new approach to breeding management through inducing lactation oestrus.

PROJECT ID	TITLE
2D–101	Improving the performance of the progeny of gilts
2D–102	Supplementation of sow feed with omega 3 fatty acids to improve performance and health of piglets
2D–104	Management strategies to maximise sow longevity and lifetime performance
2D–105	Development of ovulation synchronisation protocols to facilitate artificial insemination breeding systems
2D–107	Do changes in steroid sensitivity and melatonin underpin seasonal infertility in pigs
2D–108	Improving reproductive performance during seasonal infertility: identification of “at-risk” sows and the role of oocyte quality
2D–109	Using GnRH analogues to address seasonal infertility in pigs
2D–110	Determining the effects of season on ovarian development and early pregnancy returns
2D–111	Measurement and comparison of feed intake and growth performance during lactation and wean-finish of giltprogeny pigs cross-fostered onto multiparous sows
2D–112	Nutritional manipulation of corpus luteum development during early pregnancy to increase embryo survival and litter size
2D–113	Induction of oestrus in lactating sows
2D–114	Using dietary betaine supplementation to alleviate summer infertility and improve litter size
2D–115	Physical and nutritional interventions to reduce sow lameness *(Now 1C–101)*
2D–116	Lactogenesis: late gestation diets and hormonal intervention
2D–117	The epidemiological and physiological investigation of milking disorders in sows and the relation to pre-weaning mortality and growth rates
2D–118	Improving lactation performance with pST
2D–119	Pregnancy and lactation interventions to increase progeny birth weight, growth and survivability
2D–120	Strategies to enhance oestrus induction in lactating sows *(Now 1A–101)*
2D–121	Improving sow reproductive output through dietary manipulation in late lactation *(Now 5A–101)*
2D–122	Reducing stillbirth & pre-weaning mortality rates through better gestation feeding *(Now 5A–102)*
2D–123	Dietary strategies to alleviate the impact of seasonal infertility within gilt pools
2D–124	Improving piglet performance through increased polyamine levels in sow milk
2D–125	Determining the effects of season on timing of ovulation and luteal function *(Now 5A–103)*
2D–126	Investigation of the galactagogue potential of Fenugreek in sows
2D–127	Pre-farrowing prediction of litter size: towards improving sow metabolic status during the peri-partum period *(Now 5A–104)*
2D–128	Improving embryo quality in pluriparous sows *(Now 5A–105)*
2D–130	Improving reproductive performance in pigs *(Now 5A–106)*
2D–131	Dietary ractopamine supplementation to improve the productivity of early parity sows *(Now 5A–107)*
2D–132	Supplementation of lactating sow diets with glutamine to improve milk yield and growth of piglets
2D–133	Parity and nutritional effects on seasonal infertility

Research Summaries for Subprogram 2D

PROJECT 2D–101: IMPROVING THE PERFORMANCE OF THE PROGENY OF GILTS

Project Leader:
Dr Yvette Miller

Project Participants:
University of Sydney, Rivalea Australia and NSW DPI

Aims and Objectives

To investigate the reasons gilt progeny perform poorer and are more susceptible to disease than sow progeny.

Key Findings

The first component of this project focused on attempts to improve the post-weaning growth performance of gilts by increasing their weaning weights with supplemental full-cream milk. The weaning weights of supplemented gilt litters was similar to non-supplemented sow litters, but the post-weaning medication and mortality rates of gilt progeny continued to exceed that of sow progeny. This result suggests there are weight-independent factors responsible for this relatively poor performance.

In summary, our research suggests that the three main risk factors identified as contributing to the poor growth and survival of gilt progeny are piglet birthweight, piglet milk intake and the immunity transferred from the gilt compared to that from older parity sows. Gilt progeny weighed on average 200g less at birth than sow progeny. Birthweight independently influenced piglet pre- and post-weaning growth and survival through to market. Heavier piglets drank more milk than their lighter counterparts did – most likely, due to increase suckling stimulus causing increased mammary gland growth. Sows produced more milk than gilts, independent of average piglet birthweight in the litter. Sow progeny are likely to transfer more antibodies specific to endemic pathogen to their progeny than gilt progeny due to their repeated exposure to these, and the production of memory immune cells.

Application to Industry

1] Under current conditions, gilt and sow progeny should be considered two separate populations. This is especially important when piglets are being blood sampled for optimal vaccination timing based on circulating concentrations of maternal antibodies.

2] Maximise the birthweight of gilt progeny through optimal nutrition during gestation.

3] Maximise gilt milk production by optimising the environmental conditions for milk production and maximising suckling pressure during lactation.

4] Increase frequency and quality of exposure of gilts to farm-endemic pathogens to maximise pathogen-specific immunity transferred to their progeny.

5] Consider fostering only large piglets to reduce within-litter variation.

6] Consider increasing suckling pressure (larger litters) on gilts and early in lactation for both gilts and sows to prime the mammary glands to maximise subsequent milk production.

Research Summaries for Subprogram 2D continued

PROJECT 2D–102: SUPPLEMENTATION OF SOW FEED WITH OMEGA 3 FATTY ACIDS TO IMPROVE PERFORMANCE AND HEALTH OF PIGLETS

Project Leaders:
Andrew Phillpotts and David Henman

Project Participant:
Rivalea Australia

Aims and Objectives

To investigate the effects of supplementing the sow's diet in late gestation and lactation or in lactation only on reproduction and piglet performance and survival when piglets received diets with or without salmon oil.

The experiment was a 3 x 2 factorial design. There were three sow treatments and two treatments imposed on the piglets during the weaner phase. The sow treatments were assigned as either:

- A – supplemented with salmon oil during the last 28 days of gestation (5g/kg of feed) and during lactation (3g/kg of feed)
- B – Supplementation from entry to the farrowing shed or
- C – nil supplementation during gestation and lactation periods.

At weaning progeny from the three sow treatments were split into two treatments and were fed a common diet plus or minus the addition of salmon oil (3g/kg). The rates were designed to provide a daily level of supplementation of approximately 18 g. Two hundred and thirty seven sows of mixed parity 4 weeks before farrowing were used in the study.

Key Findings

There was a tendency for sows supplemented with salmon oil in late gestation and in lactation to have a higher subsequent farrowing rate (88% vs 75%) and a higher litter size than those on the other two treatments. Including salmon oil in the sow diets and/or the weaner diet had only minor effects on weaner pig performance.

Application to Industry

The effects of Omega 3 and Omega 6 levels on sow reproduction remain to be established but the evidence suggests both can have positive effects. There appears to be little value however on birth weight or weaner performance of including higher Omega 3 levels in the sow or weaner diets.

PROJECT 2D–104: MANAGEMENT STRATEGIES TO MAXIMISE SOW LONGEVITY & LIFETIME PERFORMANCE

Project Leader:
Professor Paul Hughes

Project Participants:
CHM Alliance, SARDI, Rivalea Australia and University of Adelaide

Aims and Objectives

To investigate means of reducing sow wastage and increase sow longevity.

The effects of nutrition in late lactation and feeding strategies during gestation are covered under Projects 5A 101 AND 5A 102 respectively. The effects of including Ractopamine in the lactation diet is covered under Project 5A 107. The report on the web site investigated the effects of dietary lysine (standard (0.56g/MJ DE and high (0.9 g/MJ DE)) and litter size (suckling pressure 7 vs 12 piglets) on the lactational performance of gilts and on subsequent retention and reproduction. There were at least 240 gilts per treatment at the start of the study.

Key Findings

Diet had only a small effect on lactational performance and subsequent reproduction. Gilts, which reared the larger litter, lost more weight and P2 fat thickness in lactation and took longer to return to oestrus than gilts, which reared only seven piglets.

Increasing suckling pressure in the first lactation also reduced second parity litter size and individual piglet birth weight. Retention rate to litter 2 was not affected by treatment when all sows, which returned to heat, were taken into account (average 86%). When only sows, which returned to heat within 14 days, were investigated, retention rate was lower for those, which reared 12 piglets during their first litter.

Application to Industry

Final report is essential reading and shows that suckling pressure more than diet (amino acids) is a major factor affecting weight loss in lactation and subsequent reproduction but maybe not longevity.

Attention should be paid to maximising the intake of lactating gilts (sows) and another project (2G 102) did show that higher energy diets for lactating gilts did significantly increase retention rate to parity 2 and subsequent reproduction.

PROJECT 2D–105: DEVELOPMENT OF OVULATION SYNCHRONISATION PROTOCOLS TO FACILITATE ARTIFICIAL INSEMINATION BREEDING SYSTEMS

Project Leader:
Dr Sean O'Leary

Project Participant:
University of Adelaide

Aims and Objectives

- To increase litter size following natural mating and AI by reducing the variation of ovulation within sows and between sows in a herd.
- Develop a single injection of hormones with a single fixed time AI without the need for boar detection of oestrus.

Key Findings

- Through pilot study evaluation and literature searches, a new product was identified, Gonavet, that is currently undergoing registration for use in Australia.
- Identified that PMSG might not be necessary in older weaned sows, potentially saving some costs.

- Field studies demonstrated that litter size, but not farrowing rate could be improved.
- Commercial use of the technology will need to have minor changes depending on the herd's historical pattern of Weaning to Oestrus interval.

Application to Industry

The development of a reliable and cost effective means of inducing oestrus (without boar stimulation) in weaned sows will have a marked positive effect on reproductive efficiency and genetic gain in the Australian pork industry.

Subsequent research has been promising and using Gonavet the strategy appears within reach.

PROJECT 2D–107: DO CHANGES IN STEROID SENSITIVITY AND MELATONIN UNDERPIN SEASONAL INFERTILITY IN PIGS

Project Leader:
Dr David Kennaway

Project Participant:
University of Adelaide

Aims and Objectives

- Develop an ovariectomised, oestradiol-implanted model and investigate the mechanism explaining seasonal infertility based on LH and melatonin.
- Develop intervention strategies based upon melatonin implants to alleviate seasonal infertility in pigs.

Key Findings

An ovariectomised, oestradiol-implanted experimental model, that could test the responsiveness to melatonin, was established.

- Treatment with the melatonin implants failed to alter the timing of the release from the negative feedback effects of estradiol in oestrogen treated ovariectomised gilts.
- Treatment of gilts with melatonin from 18 weeks of age does not advance puberty in the absence of boar stimulation during the seasonal infertility period.

Application to Industry

The outcomes suggest melatonin has limited applicability to overcoming seasonal infertility.

PROJECT 2D–108: IMPROVING REPRODUCTIVE PERFORMANCE DURING SEASONAL INFERTILITY: IDENTIFICATION OF "AT-RISK" SOWS AND THE ROLE OF OOCYTE QUALITY

Project Leader:
Dr Christopher Grupen

Project Participant:
University of Sydney

Aims and Objectives

The initial work in the project involved retrospective analyses of the reproductive performance of some 13,122 sows and gilts from three herds affected by farrowing rate declines in summer. The initial evaluation investigated possible links between late pregnancy loss and factors such as parity, weaning to oestrus interval, lactation length, and the number of piglets weaned.

Subsequent studies examined the effect of season on ovarian properties in sows. The assessments included follicle distribution, follicular fluid steroid content and oocyte quality. First, sows culled for non-reproductive reasons were slaughtered in summer or winter 4 days after weaning. Next, sows classified as "pregnancy test negative" at day 35 post-mating were slaughtered following matings in summer or winter. Finally, sows classified as "not-in-pig" were slaughtered in summer or winter and grouped according to the season in which they were mated.

Key Findings

Across all three herds the probability of seasonal infertility increased with:

1] Increasing parity

2] Increasing weaning to oestrus interval

3] Decreasing lactation length

4] Decreasing litter size weaned.

Results obtained following ovary collections in two summers and the two corresponding winters showed two clear effects of season:

1] The concentration of progesterone in follicular fluid from both small and large follicles was about 50% lower in summer compared with winter.

2] The quality of oocytes recovered from large follicles, as measured by their capacity to develop to the blastocyst stage of embryonic development, was severely reduced in summer (21%) compared with winter (55%).

Application to Industry

This is the first study to demonstrate that oocyte quality in pigs is compromised during the summer months. The findings support the hypothesis that suppressed endocrinological control mechanisms during lactation in summer adversely affect oocyte quality at the post-weaning oestrus.

To avoid reductions in sow reproductive performance during the seasonal infertility period, recommendations for producers include practicing longer lactations, ensuring that the first oestrus after weaning is identified in a higher proportion of animals, and culling higher order parity sows earlier.

Research Summaries for Subprogram 2D continued

PROJECT 2D–109: USING GNRH ANALOGUES TO ADDRESS SEASONAL INFERTILITY IN PIGS

Project Leader:
Dr Sean O'Leary

Project Participant:
University of Adelaide

Aims and Objectives

This project investigated the use of three treatments to increase progesterone production in early pregnancy to reduce the impact of embryo mortality on pregnancy rate and litter size during periods of seasonal infertility.

Methodology and results

The ability to reduce seasonal infertility in gilts and sows by increasing progesterone in early pregnancy was evaluated in South Australia (n= 162) and in a field trial in central Queensland (n = 643) during periods of reported normal fertility and seasonal infertility. The treatments consisted of 50 µg of gonadotrophpin releasing hormone (GnRH) Gonavet, 1000 iu of pregnant mare's serum gonadotrophin and 750 iu of human chorionic gonadotrophin (PMSG/hCG) and a single dose of PG600 in South Australia and PMSG/hCG in Queensland. All treatments were given via intra-muscular injection on day 10; hCG was given on day 13 in the PMSG/hCG group.

Key Findings

- Clear seasonal infertility was not determined in S.A. or QLD piggeries.
- Treatment with PMSG/hCG increased progesterone production in early pregnancy resulting in an increase in total born in S.A. of approximately 2/pigs/sow/year but had no effect on litter size in QLD.
- Increasing progesterone production increases embryo survival in pigs.

Application to Industry

Further research is required before the commercial implications of increasing progesterone in early pregnancy can be established.

PROJECT 2D–110: DETERMINING THE EFFECTS OF SEASON ON OVARIAN DEVELOPMENT AND EARLY PREGNANCY RETURNS

Project Leader:
Dr William van Wettere

Project Participant:
University of Adelaide

Aims and Objectives

The project tested two hypotheses:

1] That betaine supplementation of pre-mating diets alleviates the negative impacts of high summer temperatures on ovarian development and reproductive performance.

2] That betaine supplementation of gestating sow diets will alleviate the negative effects of high ambient temperature on pregnancy failures and litter size.

Two studies were conducted in 2007 / 2008. The first study was conducted in winter 2007 and summer 2008, and used 168 gilts to determine the effects of betaine supplementation (2 g / kg feed) from 21 weeks of age until first mating on puberty attainment and potential litter size on day 30 of gestation. Gilts commenced boar exposure at 25 weeks of age and were mated at their first (pubertal) oestrus. Reproductive tracts were collected on day 30 of pregnancy, and the number of corpora lutea and viable embryo's counted. The second study was conducted on a large commercial facility, and determined the effects of supplementing sow gestation diets with betaine during summer on farrowing rates and litter size. In total, 450 sows (parities 1 to 7) were used in this study. Sows were mated between the 11th of January and 11th February 2008, and received either a standard gestation diet (n = 221) or a betaine supplemented gestation diet (n = 229) for the duration of their pregnancy. All sows were fed at the same level during gestation, with the betaine inclusion rate altered during gestation to ensure a daily intake of between 6.5 and 9.0 g / sow.

Key Findings

The results of the first study demonstrated that including betaine in the diets of replacement gilts for 4 weeks prior to, and during, boar exposure, resulted in a 2 day reduction in the interval to puberty (7.5 versus 9.6 days), and an increase in ovulation rate (14.1 versus 13.6). Comparisons between reproductive performance of gilts mated in the summer and winter also demonstrated a reduction in embryo survival in summer-mated gilts. Interestingly, a significant reduction in both ovulation rate and embryo number occurred in gilts mated during a period of prolonged high ambient temperature. However, this decrease in ovulation rate was not observed in gilts receiving supplementary betaine prior to mating. The results indicate that prolonged exposure to high ambient temperature can decrease potential litter size, and suggest that supplementing gilt diets with betaine at 2 g/kg feed prior to mating has the potential to reduce the negative effects of high ambient temperature on reproductive performance of gilts.

The results of study two showed that betaine supplementation of gestation diets increased the total number of piglets born and the number of piglets born alive by 0.6 and 0.5 respectively. Interestingly, the beneficial effect of supplementary betaine was highest in older (parity 3–7) sows. In addition, supplementing gestation diets with betaine in this experiment also tended to reduce the incidence of late pregnancy loss. Late pregnancy loss is a common manifestation of seasonal infertility, exerting a significant economic impact on breeding herd profitability.

Application to Industry

Betaine is commonly used in lactation diets during summer. These results suggest it also has a role in gestation diets particularly for older parity sows. The final report is essential reading.

PROJECT 2D–111: MEASUREMENT AND COMPARISON OF FEED INTAKE AND GROWTH PERFORMANCE DURING LACTATION AND WEAN-FINISH OF GILT PROGENY PIGS CROSS-FOSTERED ONTO MULTIPAROUS SOWS

Project Leader:
Dr Rob Smits

Project Participant:
Rivalea Australia

Aims and Objectives

- To determine if gilt progeny can perform better when cross-fostered onto older sows.
- Evaluate health and growth performance and FCR over lifetime.

Two hundred and forty gilts and sows (parity 3–7) were allocated after farrowing to one of six treatments: Gilts with birth progeny (GB); gilts with fostered gilt progeny (GG); gilts with fostered sow progeny (GS); sows with birth progeny (SB); sows with fostered gilt progeny (SG); and sows with fostered sow progeny (SS). The progeny were followed through to weaning and post-weaning growth, feed efficiency and mortality assessments were made until 21 weeks of age when they were slaughtered.

Key Findings

- No net improvement in weaner performance of progeny performance through litter swapping of gilt progeny onto sows and vice versa.
- No benefit of dams (either gilts or sows) rearing their own progeny compared to when the whole litter is fostered.

Application to Industry

Gilt progeny tended to grow slower and have a higher mortality than sow progeny but both factors were reduced when gilts progeny were fostered onto sows.

If gilt progeny have to be fostered, they should be moved to older parities that are suitable mothers, rather than fostered onto another gilt litter.

PROJECT 2D–112: NUTRITIONAL MANIPULATION OF CORPUS LUTEUM DEVELOPMENT DURING EARLY PREGNANCY TO INCREASE EMBRYO SURVIVAL AND LITTER SIZE

Project Leader:
Dr Pieter Langendijk

Project Participants:
SARDI and Rivalea Australia

Aims and Objectives

This project was designed to quantify progesterone secreted by the ovaries under different feed regimes during the first month of gestation, to assess the importance of this "local source" of progesterone for embryo survival. The effect of using different energy sources as opposed to cereals as main energy ingredient in gilt diets was also assessed.

In an initial trial, a surgical model was used (unilateral ovariectomy) in which one ovary was removed from 30 gilts prior to mating, to assess the effect on embryo survival in the uterine horn attached to this ovary. Removal of the one ovary made this horn rely solely on systemic progesterone, as opposed to the other, contralateral horn, which had a systemic supply as well as "local" supply of progesterone from the ovary still attached. In the horn with both systemic and local supply of progesterone, 1.3 more embryos (6.3 vs. 5) survived at d35 of pregnancy, indicating the significance of local transfer of progesterone (2.6 embryos in total for two horns). In addition, gilts on the high feed level had 11.3 embryos as opposed to 10.3 on the low feed level, and a better embryo survival between implantation (d15) and d35 of gestation. To quantify secretion of progesterone by the ovaries as affected by feed level, 20 gilts were surgically fitted with catheters in the vena cava, close to where the utero-ovarian vein drains into the vena cava, to enable sampling of blood close to the ovarian source. These gilts were fed either a high (2.8 kg) or low (1.5 kg) feed level during early gestation. First of all, this study showed that progesterone is secreted in a pulsatile fashion by the ovaries with concentration varying between 50 to 600 ng/ml in an individual sow, as opposed to a more stable concentration of around 20–30 ng/ml in the systemic concentration at this stage of gestation. At d6 and d9 of gestation, the high feed level resulted in a higher mean concentration and more pulses of progesterone in the vena cava, indicating a higher secretion rate of progesterone by the ovaries. Recovery of embryos at d10 of gestation also showed a higher embryo survival (92% vs 77%) on the high feed level.

Key Findings

The main finding across studies was that a high feeding level in early gestation had no adverse effects on sow reproduction. Indeed, sows/gilts with the highest growth rates in early gestation tended to have higher pregnancy and farrowing rates.

Application to Industry

The project showed that higher feeding levels in early gestation tended to improve reproduction and seriously questioned the long held belief that sows should be fed at low levels in early gestation.

PROJECT 2D–113: INDUCTION OF OESTRUS IN LACTATING SOWS

Project Leader:
Dr Jeff Downing

Project Participants:
University of Sydney and Rivalea Australia

Aims and Objectives

1] Trial the concept of oestrus induction in lactation under commercial practice.

2] Test the hypothesis that induction of oestrus during lactation and postponing weaning age to 35 days has no effect on subsequent mating and farrowing performance when compared with a cohort of sows weaned at 20 days after farrowing.

Research Summaries for Subprogram 2D continued

3] Test the hypothesis that postponing weaning to 35 days after farrowing will increase piglet weight at weaning and increase growth at 70 days of age when compared to a cohort of piglets weaned at 20 days after farrowing.

Key Findings

The study confirmed that the previous findings by Downing et al. (2007) were repeatable under commercial conditions. Induction of oestrus at 24–25 days after farrowing and postponing weaning age to 35 days had no effect on subsequent mating and farrowing performance. Out of 23 sows allocated to each treatment, 87% of sows were mated within a mean of 4.3 days resulting in a subsequent farrowing rate of 65% and an average of 11.3 piglets born alive per sow. Although postponing weaning age to 35 days increased mean piglet weight by 0.9 kg, this weight advantage was not maintained to 70 days of age.

Application to Industry

This was the second project on inducing oestrus in lactation. The technology was refined over time and eventually tested over 12 months on a commercial unit. The results showed that taken over a 12 month period the technology had few advantages over the conventional practice of mating sows after weaning.

PROJECT 2D–114: USING DIETARY BETAINE SUPPLEMENTATION TO ALLEVIATE SUMMER INFERTILITY AND IMPROVE LITTER SIZE

Project Leader:
Dr William van Wettere

Project Participants:
University of Adelaide, Rivalea Australia and Sun Pork Farms

Aims and Objectives

To investigate the effects of including betaine and/or Folate and Vitamin B12 in gestation diets on reproduction in sows mated in summer.

The aim of the final study was to determine whether supplementing gestation diets with betaine and / or folate + vitamin B12 would improve reproductive performance. 1079 sows (parities 2–9 at mating) across two farms received a standard gestation diet supplemented with either nothing (control); 3 g / kg betaine; 20 mg / kg folic acid plus 150 µg/kg vitamin B12; or 3 g / kg betaine plus 20 mg / kg folic acid plus 150 µg/kg vitamin B12.

Key Findings

To summarise, betaine supplementation increased litter size in older (parity 4 plus) sows ($P < 0.05$), whilst the addition of folic acid and Vitamin B12 decreased incidences of early (< day 35) pregnancy failure by 4% ($P < 0.05$) and increased the litter size of parity 2 and 3 sows ($P < 0.05$). Folic acid and Vitamin B12 supplementation decreased ($P<0.001$) plasma homocysteine by 2.2 and 2.8 µM, respectively, on days 3 and 107 of gestation, whilst betaine supplementation decreased ($P<0.05$) plasma homocysteine on day 3 only. We have previously demonstrated a relationship between elevated plasma homocysteine in early gestation and incidences of early pregnancy failure, suggesting a reduction in homocysteine may have been partially responsible for the observed improvement in pregnancy outcomes.

Application to Industry

The results suggest including betaine in gestation diets during summer can improve litter size in older parity sows though in this project the outcomes differed between farms. Inclusion of higher levels of folate and Vitamin B12 in gestation diets may reduce the incidence of early pregnancy losses.

PROJECT 2D–116: LACTOGENESIS: LATE GESTATION DIETS AND HORMONAL INTERVENTION

Project Leader:
Dr Pieter Langendijk

Project Participant:
SARDI

Aims and Objectives

To investigate the effects of feeding level and diet fibre level in late gestation on the lactational performance of gilts.

Study involved a standard gestation diet (13 MJ DE/kg) fed during the last four weeks of gestation at 2.5 or 3.5 kg/d. A third diet based on fibrous ingredients (oats, millrun, oat hulls and 7.7% tallow) was formulated to have the same DE as the standard diet. It was fed at 3.5 k/d in late gestation.

Litter performance was assessed over 21 days.

Key Findings

Feeding level in late gestation had more effect on lactation performance that ingredients included in the diet though the high fibre diet did significantly increase birth weight. Sows fed at the higher level in late gestation ate less feed in lactation (reduced by 12.1 % in sows fed the standard diet at 3.5 kg/d and by 24.4 % in sows fed the higher fibre diet at 3.5 kg/d). Sow body weight loss in lactation was highest for those fed the high fibre diet at 3.5 kg/d in late gestation followed by sows fed the standard diet at 3.5 kg/d in late gestation. Piglet performance over the 21-day lactation tended to be positively related to sow feed intake.

Application to Industry

The results show that high feeding levels in late gestation have minor effect on piglet birth weight but reduce lactation feed intake and increase sow body weight loss and are likely to adversely affect subsequent reproduction. They support flat feeding levls through gestation, which probably should not exceed 3.0 kg/day.

PROJECT 2D–117: THE EPIDEMIOLOGICAL AND PHYSIOLOGICAL INVESTIGATION OF MILKING DISORDERS IN SOWS AND THE RELATION TO PRE-WEANING MORTALITY AND GROWTH RATES

Project Leader:
Dr. J.J. Lievaart

Project Participants:
CSU and Rivalea Australia

Aims and Objectives

To investigate the incidence of and strategies to reduce milking disorders in sows.

Project involved a survey and studies to investigate more closely the cause of milking disorders and a study using Regumate to extend gestation length.

Key Findings

Both the data from the piggery involved in the project and the survey demonstrated that the problem of milking disorder and the subsequent impact on piglets is extensive. The survey indicated that in total 66% of the producers did register the clinical signs of sows gradually drying up in the days following farrowing and 43.5% recorded sows not bagging up properly in the days before farrowing. In total 70% of those producers indicated that the milking plays a major role in the pre weaning mortality and growth rates of the piglets.

The hypothesis that the milking disorder has a physiological basis was partly supported by the data on feed intake, difference in back fat score and NEFA concentrations in the blood. Affected sows do have a decreased appetite, an increased loss in body fat and a higher level of NEFA's.

The hypothesis that the milking disorder(s) has an endocrinological basis was supported by the data from the Regumate trial. A longer gestation period was associated with increased birth weight and a higher survival rate. Still we would not recommend the use of the Regumate as a regime to increase birth weight and survival rate because of the increased risk of stillborn, which is not acceptable.

Application to Industry

The project showed that monitoring sows in late gestation and early lactation for signs of illness or lactation failure is one of the best strategies for improving overall piglet survival and performance.

Regumate starting at day 108 of pregnancy did increase birth weight and piglet survival but also increased still birth rate and it use commercially for pregnant sows is not recommended.

PROJECT 2D–118: IMPROVING LACTATION PERFORMANCE WITH pST

Project Leader:
Dr Cherie Collins

Project Participant:
Rivalea Australia

Aims and Objectives

To investigate the effect of administering exogenous porcine somatotropin (pST) to lactating sows on lactational performance.

One hundred and twenty six sows (Parity 2 and 3, Large White x Landrace, PrimeGro™ Genetics) were selected over a six-week period. Sows were randomly allocated prior to farrowing to one of three treatment groups: Control – no injections; Extended lactation – 4mg pST per sow per day from the day of farrowing to weaning; Late lactation – 4mg pST per sow per day from day 14 to weaning. Piglets were weaned at an average age of 26.2 days. Individual piglet weights were recorded weekly as an indirect measure of sow milk yield.

Key Findings

- Average piglet growth rate to weaning was not improved with the use of pST (227.9, 210.9 and 222.0 g/d respectively for the control, extended lactation and late lactation treatment groups, P=0.20).
- Sows administered pST for the entire lactation period consumed less feed than the control animals (average daily feed intake 7.16, 6.63 and 6.96 kg/d respectively for the control, extended lactation and late lactation treatment groups, P=0.042).
- The use of pST did not prevent cases of milking failure from occurring (sows drying up before day 10 of lactation). Two cases of milking failure occurred – one in each of the pST treatment groups.

Application to Industry

The results did not support the use of pST during lactation as a strategy to improve litter performance under commercial conditions.

Research Summaries for Subprogram 2D continued

PROJECT 2D-119: PREGNANCY AND LACTATION INTERVENTIONS TO INCREASE PROGENY BIRTH WEIGHT AND GROWTH AND SURVIVAL TO WEANING

Project Leader:
Dr Kathy Gatford

Project Participants:
University of Adelaide, Rivalea Australia and Sun Pork Farms SA

Aims and Objectives

To improve piglet birth weight, survival, and performance to weaning.

Experiment 1 – Conducted in NSW in 2009–2010. Gilts and parity 2/3 sows (n=75/group) were treated with pST (2.5 mg/d in gilts, 4.0 mg/d in sows) from day 75 to 100 of pregnancy, and compared to untreated controls. Piglets were weighed at birth, d14 and weaning. Dams were followed for subsequent reproductive performance.

Experiment 2 – Conducted in South Australia in 2009. Sows (Parities 2–5) were fed a control lactation diet or a lactation diet supplemented with an additional 1% arginine. Sow weights, P2 backfat, feed intake and milk production at day 4, 14 and 21 of lactation were measured. Piglets were weighed at birth, day 1, 4, 14 and 21.

Key Findings

Experiment 1 – Maternal pST injections increased piglet birth weight (+96g, 6.4%, P=0.034) and weaning weight (+430 g, 5.7%, P=0.038) but ONLY in sows, with no effect on progeny weight in gilts. Removal rates of dams in pregnancy, lactation and after weaning, and next litter size were not affected by pST treatment.

Experiment 2 – Maternal arginine supplementation increased piglet weights in early-mid lactation, and average growth rates throughout lactation, but only in male piglets. This was not due to changes on milk yield in sows, which was similar in both groups despite lower feed intake in arginine-supplemented sows. Milk amino acid concentrations were increased in parity 2 and 4 sows, but decreased in parity 3 in arginine-supplemented sows. Weaning-oestrous interval was 1 day shorter in arginine-supplemented sows.

Application to Industry

Both strategies had positive effects on piglet performance with pST significantly increasing birth weight in older sows. pST is no longer available commercially in Australia and arginine supplementation of lactation diets needs to be revisited with more modern genotypes which have larger litter sizes.

PROJECT 2D–123: DIETARY STRATEGIES TO ALLEVIATE THE IMPACT OF SEASONAL INFERTILITY WITHIN GILT POOLS

Project Leader:
Dr William van Wettere

Project Participant:
University of Adelaide

Aims and Objectives

The project consisted of two studies to investigate the effects of either feeding a diet rich in non-starch polysaccharides (whole lupins) or less fermentable fibre (wheat bran) during the gilt rearing phase and prior to mating on indicators of reproduction.

- Would the treatments decrease circulating oestradiol concentrations, increase GnRH release and promote maturation of the follicle oocyte complex; and
- Improve puberty attainment and litter size during summer/autumn.

Study one was conducted in the summer of 2009/2010, using 54 Large White / Landrace cross terminal line gilts. Study two (conducted in the summer of 2010/2011) determined the effect of lupin fibre (35%) in pre-mating diets on puberty attainment and potential litter size on day 30 of gestation.

Key Findings

Study 1 demonstrated that including lupin fibre (35%) in pre-mating diets improved the proportion of oocytes able to complete meiosis in vitro by 17% compared to standard fed gilts. However, the addition of wheat bran to the diet exerted neither a positive or a negative effect on oocyte development in vitro compared to standard fed gilts.

The results of study two demonstrated no effect of lupin fibre on the timing of the pubertal response to boar contact or ovulation rate. However, gilts receiving the lupin based diet prior to mating possessed 2 more embryos than their standard fed counterparts (P = 0.054; 13.8 versus 11.8), resulting in a 16% improvement in embryo survival (0.92 versus 0.76).

Application to Industry

Further studies are required to:

1] Validate this effect on a commercial scale.

2] Determine whether the observed improvements in embryo survival translate into more piglets being born.

3] Identify additional fibre sources (preferably available throughout Australia) which improve litter size in female pigs.

PROJECT 2D–124: IMPROVING PIGLET PERFORMANCE THROUGH INCREASED POLYAMINE LEVELS IN SOW MILK

Project Leader:
Dr William van Wettere

Project Participant:
University of Adelaide

Aims and Objectives

To investigate the effect of orally administering polyamine to piglets on growth performance and pre weaning digestive system development.

There were two experiments. The first investigated oral dosing of spermidine and parity on pre weaning performance and intestinal development. The second investigated oral dosing of spermine and spermidine prior to weaning and parity on the performance of piglets to day 61.

Key Findings

In the first study, Spermidine improved the development of the small intestine and increased piglet weight at 14 and 24 days of age.

In the second study, dosing piglets with either polyamine improved the performance of piglets between days 14 and 18. This effect was observed in parity 1 sows only and there were no effects of the polyamine treatments at day 61.

Application to Industry

The results suggest Polyamines may have a role in improving the gastro intestinal development of piglets prior to weaning but larger studies are required to confirm the results and an alternative method of delivering the polyamines is required.

PROJECT 2D–126: INVESTIGATION OF THE GALACTAGOGUE POTENTIAL OF FENUGREEK IN SOWS

Project Leader:
Dr Pieter Langendijk

Project Participant:
SARDI

Aims and Objectives

The aim of the project was to test the potential of Fenugreek powder, supplemented to lactating sows, to increase milk production and piglet weight gain. Fenugreek is a herb and its seeds have (sometimes anecdotally) been reported to increase milk secretion in breastfeeding women.

Multiparous sows (n=43) served as controls, or were supplemented with 12 g/d or 24 g/d of ground Fenugreek seeds respectively. The Fenugreek was top-dressed. Fenugreek was supplemented in the second and third week of lactation, with piglet weight gain during the first week serving as a control.

Key Findings

Piglet weight gain in week 1 (180 g/d), in week 2 (237 g/d), and in week 3 (269 g/d) of lactation was not influenced by Fenugreek supplementation. Milk production was also estimated by a weigh-suckle-weigh procedure. In this procedure, piglets are separated from their dam, and allowed to suckle at 45 min intervals. Immediately prior and immediately following a suckling bout, piglets are weighed and the increase in weight serves as an estimate of milk volume consumed. The weigh-suckle-weigh procedure also did not point to any effect of the Fenugreek supplementation.

Application to Industry

The results suggest Fenugreek has little commercial potential for lactating sows.

Research Summaries for Subprogram 2D continued

PROJECT 2D–132: SUPPLEMENTATION OF LACTATING SOW DIETS WITH GLUTAMINE TO IMPROVE MILK YIELD AND GROWTH OF PIGLETS

Project Leader:
Professor Robert van Barneveld

Project Participant:
Sun Pork Farms

Aims and Objectives

There have been recommendations to include 1 % glutamine in the diets of sows in late gestation and lactation, and the diet of newly weaned pigs. However, the use of glutamine at this level is cost prohibitive. This project investigated the benefits that may be obtained in piglet performance during lactation when the gilt's diet is supplemented with a cheap and readily available source of glutamine.

Diets (14.5 MJ DE/kg, 0.80 g Av L/MJ DE) were offered to lactating gilts (n=50) throughout lactation (21 d). Gilts received one of three treatments:

1] Control diet.

2] Control diet + 1 % Glutamic acid.

3] Control diet + 1.15 % Glutamic acid donor.

Diets were offered on a step-up basis for the first 5 days of lactation, and then gilts were fed to appetite.

Key Findings

Lactation length and gilt feed intake did not differ significantly between treatments; although those gilts that received the control diet supplemented with 1 % glutamic acid ate, 9 % more feed across the lactation.

Piglet weight did not differ significantly at the start of lactation or at weaning. However, when treatments were compared on an average daily gain basis, piglets receiving the control diet supplemented with 1.15 % glutamic acid donor grew significantly faster (P=0.042, 172 *c.f.* 188 g/d) than either the control or 1% supplemented diet.

Application to Industry

This project investigated a cheaper source of glutamine that showed some potential to improve piglet growth performance, further validation of this potential should occur before recommendations on dietary inclusion are made.

PROJECT 2D–133: PARITY AND NUTRITIONAL EFFECTS ON SEASONAL INFERTILITY

Project Leader:
Professor Paul Hughes

Project Participants:
SARDI,
University of Adelaide
and Sun Pork Farms
South Australia

Aims and Objectives

To test the theory that higher feeding levels in early gestation would reduce the incidence and severity of summer infertility.

A single study was conducted using 1,383 females (440 gilts, 261 parity 1 sows & 682 parity 2+ sows) at a large commercial piggery. These females entered the study 1–4 days after breeding when they were transferred into gestation housing equipped with electronic sow feeders (ESFs). The gilts & sows had their body condition scored (BCS 1, 2 or 3) prior to allocation to treatment, which was on this BCS basis. Within each parity group approximately equal numbers of females were fed 1.9kg/d, 2.3kg/d & 2.7kg/d of a standard dry sow diet (DE = 13 MJ/kg, CP = 14.6% & Av. Lys. = 0.55%) for the first 4 weeks of gestation. The animals were mated in either January–March or July–August 2011. Farrowing rate & litter size data were then retrieved from the commercial herd recording scheme.

Key Findings

The data showed that early gestation feeding did not affect overall, farrowing rate or subsequent litter size. Season did not significantly alter farrowing rate but subsequent litter size was significantly reduced following breeding in the Summer/early Autumn period. Subsequent litter size, but not farrowing rate, was significantly higher for parity 2+ sows compared to parity 0 & 1 sows.

However, when the interaction between parity, nutrition & season was investigated a clear effect of early gestation feeding, but not season, was seen in parity 1 sows. This suggests that higher feeding in early gestation for parity 1, but not parities 0 or 2+ sows, increases farrowing rate but decreases subsequent litter size (total born).This possibly reflects a positive effect of the higher feeding level on rescuing the pregnancies of sows carrying smaller litters.

Application to Industry

The results are somewhat confusing but suggest that overall higher feeding levels in early gestation probably have little effect on summer infertility. Nevertheless, higher feeding levels are now commonly practiced in early gestation, which may reflect a change in genetics and housing over time.

Subprogram 2E: Advanced reproductive technologies

KEY DELIVERABLES

1] Novel genetic and reproductive tools and technologies enhancing reproduction efficiency, including enhancing placental efficiency.

2] Embryo freezing.

PROJECT ID	TITLE
2E–101	Genetic associations between voluntary feed intake of females, finisher performance, and sow longevity
2E–105	Development of a commercial embryo freezing protocol for the conservation, transportation and importation of pig genetics
2E–107	Male factors and early pregnancy loss
2E–108	Development of in vitro embryo production systems as a breeding tool for the pig

Research Summaries for Subprogram 2E

PROJECT 2E–101: GENETIC ASSOCIATIONS BETWEEN VOLUNTARY FEED INTAKE OF FEMALES, FINISHER PERFORMANCE, AND SOW LONGEVITY

Project Leader:
Dr Kim Bunter

Project Participants:
AGBU and Rivalea Australia

Aims and Objectives

The project generated a unique and comprehensive data set. Around 3500 pedigreed and performance tested gilts from two large maternal lines were individually recorded for feed intake and efficiency at selection, followed by serial recording for sow condition attributes (weight and fatness) during gilt development and throughout gestation and lactation (N~2200). Accompanying production traits, reproductive performance, and lactation feed intake, sow health and ultimately sow longevity traits were recorded. This data was subsequently used to estimate both genetic (via pedigree) and non-genetic associations between traits, and identify possible paths (through management and breeding) towards improving sow longevity. In particular, the focus was on establishing the importance of lactation feed intake (or traits recorded around lactation) on sow performance and longevity, and the role historical selection plays on sow attributes during this part of her lifecycle.

Key Findings

Genetic parameters indicated that selection for lean growth potential placed breeding sows more at risk of premature culling in early parities through correlated changes to sow body composition (increased weight, reduced fat) combined with increased litter demands during both gestation and lactation. This scenario could be further exacerbated by concurrent selection for larger litters because, in many production systems, sows are not fed to meet differential requirements during gestation, and their ability to adapt. Further intake during lactation can be restricted by management or environmental limitations (season, feed delivery schedules, sow size, farrowing outcomes, and health).

While phenotypic associations were as expected, from the genetic perspective, lactation feed intake was relatively less important than sow fatness, and positively correlated with sow size. Overall, breeding goals for maternal lines could benefit from using additional information on sow attributes. Potentially useful (heritable and variable) selection criteria include lactation feed intake, sow IGF-I recorded at weaning, and weight loss during lactation.

Application to Industry

This research was an essential step towards enabling breeding companies to understand better the complex mechanisms that lie behind observed reductions in sow longevity. Potential selection criteria and management strategies are discussed.

Research Summaries for Subprogram 2E continued

PROJECT 2E–105: DEVELOPMENT OF A COMMERCIAL EMBRYO FREEZING PROTOCOL FOR THE CONSERVATION, TRANSPORTATION AND IMPORTATION OF PIG GENETICS

Project Leader:
Dr Luke Beebe

Project Participant:
University of Adelaide

Aims and Objectives

To develop an embryo freezing protocol which conformed to protocols developed by the International Society of Embryo Transfer for the international transfer of embryos.

Key Findings

This project developed a porcine embryo cryopreservation protocol that complies with International Embryo Transfer Society requirements and produces acceptable results. It is reasonably simple to perform and does not require expensive equipment or complex laboratory facilities, and could be used for the importing or exporting of pig embryos with no further modification.

The vitrification protocol including all the modifications was used to cryopreserve and then recover porcine blastocysts, which were then transferred into six pseudo-pregnant recipients (average 26 cryopreserved embryos transferred per recipient). Of these six, five maintained pregnancy and farrowed 26 piglets (average litter size 5.2), which are acceptable pregnancy rates and litter sizes for the transfer of cryopreserved embryos.

Application to Industry

The protocol can be used for freezing and exporting or importing porcine embryos. However appropriate quarantine measures for handling embryo donors and embryo recipients still need to be developed as well as approval by AQIS (or similar) regarding these and the method developed before it can be used commercially.

PROJECT 2E–107: MALE FACTORS AND EARLY PREGNANCY LOSS

Project Leader:
Dr Peter Chenoworth

Project Participant:
Charles Sturt University

Aims and Objectives

The project provided an opportunity to apply modern andrological technologies to better understand the causes of male-related losses in the Australian pig industry and provide insights to their management.

Numerous semen and sperm factors were investigated for their effects on sow reproduction (pregnancy, litter size and sill birth rate).

Key Findings

The following recommendations were made based on the results of the project:

1] Quality assurance should be reinforced and maintained in boar studs. This should include the use of best laboratory practices in determining boar semen motility and concentration, as well as in preventing contamination.

2] Greater awareness of the importance of appropriate (17–20 C) temperature maintenance in shipped semen. This could be facilitated by improved designs of semen shipping containers.

3] More emphasis needs to be placed upon the routine morphological monitoring of boar sperm. This should include awareness of the significance of defects such as retained cytoplasmic droplets.

4] Routine assessment of sperm DNA/Chromatin integrity should be encouraged, especially as simple and rapid techniques (e.g. DiffQuik staining) are now available.

5] Educational programs should be established to facilitate all of the above.

Application to Industry

The final report provides comprehensive information on male related factors affecting the reproduction of sows. The information has been included in a laboratory manual and made available to boar studs and breeding companies.

PROJECT 2E–108: DEVELOPMENT OF IN VITRO EMBRYO PRODUCTION SYSTEMS AS A BREEDING TOOL FOR THE PIG

Project Leader:
Professor Mark Nottle

Project Participant:
University of Adelaide

Aims and Objectives

The aims of the project were to:

1] Develop a non-surgical embryo transfer catheter.

2] Demonstrate acceptable pregnancy rates using IVP embryos produced using abattoir ovaries and non-surgical embryo transfer.

3] Develop non-surgical oocyte collection using laparoscopic aspiration.

4] Demonstrate proof of concept i.e. piglets born using oocytes collected from live animals using laparoscopic aspiration, in vitro embryo production and non-surgical embryo transfer.

Key Findings

1] A catheter was developed and trialled using embryos obtained surgically from live animals, as well as in vitro produced embryos.

2] Six transfers were performed with in vitro produced embryos. Of the 4 transfers performed successfully (correct insertion of catheter good quality embryos), 1 transfer (25%) resulted in a pregnancy but the sow returned on d28. 12 transfers were performed with in vivo derived embryos. Of the five transfers performed successfully (correct insertion of the catheter, good quality embryos), 2 transfers (40%) resulted in pregnancies, which resulted in litters of 3 piglets each.

3] A prototype for the laparoscopic aspiration of ovarian follicles in situ was developed.

4] This aim was not completed due to technical difficulties associated with the development of the embryo transfer catheter, which delayed the project.

Application to Industry

The project was the first step in developing a new breeding tool whereby all the oocytes are collected from the ovary, grown and fertilised in vitro with sexed semen, frozen and then transferred non-surgically.

Subprogram 2F: Physiology and growth manipulation

KEY DELIVERABLES

1] Commercial means of manipulating the performance and carcass characteristics of growing pigs.

2] Nutrition strategies to enhance endogenous growth hormone levels in growing pigs.

3] Strategies to manipulate the pre-natal development of pigs.

PROJECT ID	TITLE
2F–101	Effects of fatty acids and feeding strategies on the performance and carcass composition of growing pigs
2F–102	Evaluation of omega fatty acids supplementation as a nutritional approach to improve productivity and longevity in gilts and sows
2F–103	The effects of exogenous pST administration and feeding ractopamine in early pregnancy on the birth weight and growth performance of gilt and sow progeny
2F–104	Improving feed conversion efficiency and carcass composition in barrows
2F–106	Nutritional manipulation of the somatotropic axis in grower and finisher pigs
2F–108	Effect of nano-chromium on growth performance carcass characteristics and glucose metabolism of finishing pigs
2F–109	Field evaluation of the benefits of fish oil dietary supplementation to multiparous sows fed during lactation and early pregnancy on fertility

Research Summaries for Subprogram 2F

PROJECT 2F–101: EFFECTS OF FATTY ACIDS AND FEEDING STRATEGIES ON THE PERFORMANCE AND CARCASS COMPOSITION OF GROWING PIGS

Project Leader:
Dr Ron Newman

Project Participants:
University of Sydney
and Rivalea Australia

Aims and Objectives

To improve the efficiency of pork production two strategies were investigated.

Strategy 1

Twenty entire male pigs were allocated randomly to individual pens. The pigs were fed either *ad libitum* or entrained to a bi phasic feed pattern consisting of two 60-minute feeding periods (0900–1000 h and 1600–1700 h) per day for 49 days. Body weight and feed intakes were determined weekly and carcass composition was assessed by computed tomography.

Strategy 2

Experiment 1 Thirty pubertal gilts were allocated to one of 3 treatment groups (n=10/group) and fed experimental diets 2 weeks prior to mating containing either 3% n-6 PUFA, n-3 PUFA or saturated fatty acids. These diets were fed during the 1st and 2nd trimesters and throughout lactation. During the 3rd trimester, the dietary fat concentration was increased to 5%. At weaning forty seven female weaner pigs were randomly allocated to single pens and fed either n-6 PUFA (n=19), saturated fatty acids (n=9) or n-3 PUFA (n=19). These diets were maintained throughout their production cycle.

Experiment 2 The methodology was essentially similar for experiment 1, however a larger cohort of animals (n=70) was used and this experiment conducted in a commercial environment. On day 23, half of the progeny fed the n-3 and n-6 PUFA were fed tallow (saturated fatty acids) to determine any carry over effect of the PUFA diets fed prior to wean.

Key Findings

The outcomes were quite profound. Pigs on the biphasic feeding strategy grew at the same rate as those fed adlibitum but ate 8% less feed, were 10% more feed efficient (2.39 vs 2.63 feed:gain) and had a 2.6 mm lower P2 fat thickness and 16% less body fat than their adlibitum fed counterparts.

High Omega 6 levels in gestation tended to adversely affect reproduction though caution is needed in interpreting the results because of the small number of animals involved. Progeny performance was also adversely affected by high dietary Omega 6 levels.

Application to Industry

The results have commercial implications and continue to be followed up.

Research Summaries for Subprogram 2F continued

PROJECT 2F–102: EVALUATION OF OMEGA FATTY ACIDS SUPPLEMENTATION AS A NUTRITIONAL APPROACH TO IMPROVE PRODUCTIVITY AND LONGEVITY IN GILTS AND SOWS

Project Leader:
Dr Rob Smits

Project Participant:
Rivalea Australia

Aims and Objectives

The objective of this project was to provide scientific evidence in a commercial genotype on the response to omega 3 fatty acids from dietary supplementation with fish oil.

Five experiments were conducted to investigate the response to omega 3 fats EPA and DHA in gilts and sows. In gilts, the experiments were designed to address duration of feeding on responsiveness (3 vs 6 weeks pre-mating), level of supplementation (3 g fish oil/kg vs 10g/kg) and the effects on ovulation rate and embryo survival. In older sows, the effect of supplementation at 3 g fish oil/kg on ovulation and embryo survival was evaluated. Concurrent studies investigated the dietary response on fatty acids in the follicular fluid, in-vitro oocyte development and gene expression in follicular cells. The last experiment evaluated the response to long-term supplementation on sow retention over the first two parities.

Key Findings

Omega 3 supplementation at 3 g fish oil/kg diet during lactation and post-weaning increased embryo survival and consequently potential litter size in older sows, but not in pubertal gilts. Dietary supplementation at 3 g/kg fed to gilts tended to improve embryo survival, but the background level of fertility was high and further levels of improvement may have been limited. The use of omega 3's EPA and DHA were also shown to reduce significantly, lameness and mortalities due to feet and leg issues over the first two parities. This study is the first to provide data that supports the view that dietary omega 3 fatty acids can be used as a nutraceutical to reduce inflammation.

Application to Industry

The project has provided valuable information on ovulation rates and embryo survival in commercial sows. It has refined techniques for in-vitro oocyte development, embryo maturation and metabolism and gene expression.

At the time the project was conducted the cost of supplementing the diet with 0.3% semi purified fish oil was $2.35/sow during lactation and $8.75/sow during gestation.

The strategy would be cost effective in lactation if subsequent litter size is increased. In gestation the producer would need to replace 2–3% fewer sows for the strategy to break even.

PROJECT 2F–103: THE EFFECTS OF EXOGENOUS pST ADMINISTRATION AND FEEDING RACTOPAMINE IN EARLY PREGNANCY ON THE BIRTH WEIGHT AND GROWTH PERFORMANCE OF GILT AND SOW PROGENY

Project Leader:
Dr Kathy Gatford

Project Participants:
University of Adelaide and Rivalea Australia

Aims and Objectives

To investigate the effects of administering pST or feeding Ractopamine during different periods of gestation on embryo development, birth weight and progeny performance.

Researchers evaluated effects of maternal pST injections or feeding ractopamine from day 25 to 50 of pregnancy on foetal and placental growth and muscle fibre development in the foetal pig at day 50 of pregnancy, and compared responses in gilts and sows (Study 1). Subsequently they evaluated effects of maternal pST injections from day 25 to 50 or day 25 to 100 in gilts and sows, on maternal reproductive performance in the treatment pregnancy and lactation, and at the subsequent mating, and on progeny size at birth,

postnatal growth; finisher feed consumption and efficiency, and carcass characteristics. In the latter study, there were over 100 sows/gilts per treatment.

Key Findings

This research demonstrated that significant increases in birth weight and postnatal growth were obtained under commercial conditions when pregnant pigs were injected daily with pST from day 25 to 100 of pregnancy. Increases were greater in sow progeny than in gilt progeny. Carcass weights were increased by 3.3 kg on average in progeny of dams injected with pST from day 25 to 100 of pregnancy. Responses were larger in sow litters, but this was partly offset by increased post-weaning cull rates, and strategies to minimise this might be needed (e.g. pST from first litter onwards to maximise foot and leg strength, increased lactation feed intakes or holding over to avoid culling highly productive sows with large litter weight gains in lactation).

Application to Industry

At the time the project was conducted the effects of pST treatment from day 25 to 100 of gestation was cost effective – it increased birth weight particularly in sows and improved post weaning growth performance. However, the strategy is labour intensive, pST is no longer available commercially, and alternative strategies need to be explored/developed.

PROJECT 2F–104: IMPROVING FEED CONVERSION EFFICIENCY AND CARCASS COMPOSITION IN BARROWS

Project Leader:
Dr Peter Wynn

Project Participants:
Charles Sturt University, Rivalea Australia and Windridge Farms

Aims and Objectives

The gonadal steroids testosterone and oestrogen both potentiate the synthesis and release of growth hormone (GH) releasing factors from the hypothalamus and also play a role in their activity on the pituitary GH secreting cells. It was hypothesised that the programming of the hypothalamic-pituitary GH secretary axis with these steroids at farrowing may improve the lifelong productivity of treated piglets through an increase in the sensitivity of the GH secretary axis. Anabolic steroids are unlikely to be registered for veterinary use in the pig industry, and so alternative molecules were investigated. The non-steroidal selective androgen receptor modulators (SARM's) have been developed for the treatment of hypogonadal conditions in humans as an alternative to testosterone analogues as they retain their androgenic influence without causing prostate cancer.

Pfizer Animal Health kindly provided significant quantities of 2 SARM's, CE-284821 and PF-03207245-00, which were highly androgenic and not converted to oestrogen, which is the case with endogenous testosterone. In all, 5 studies were conducted with castrate male piglets in which the impact of neonatal injection of testosterone propionate (which mimics the native molecule and is convertible to oestrogen). This was compared to the effect of dihydrotestosterone (not convertible to oestrogen) and the most promising SARM (also not convertible to oestrogen), CE-284821, on growth performance to weaning: a group of entire animals was always used as a positive control.

Key Findings

In experiment 1, in which the SARM was not included, testosterone propionate administered at 8mg/kg bodyweight gave significant improvement in growth performance to weaning which was associated with an elevation in circulating levels of the metabolic indicator IGF1. In experiment 2 this experimental design was replicated and animals carried through to slaughter. No production responses were observed, nor were GH secretary profiles different in the testosterone-programmed piglets post-weaning.

None of the three other studies yielded a significant

Research Summaries for Subprogram 2F continued

result with the same molecule used in study 1, Testosterone propionate; however, there was a trend for higher productivity in 2 of these 3 studies with this molecule in both male castrate and female piglets. Neither the SARM's, CE- ii 284821 or PF-03207245-00, nor dihydrotestosterone gave any response in either growth or circulating IGF1.

Application to Industry

The outcomes suggest the strategy has little commercial relevance for the Australian pork industry.

PROJECT 2F–106: NUTRITIONAL MANIPULATION OF THE SOMATOTROPIC AXIS IN GROWER AND FINISHER PIGS

Project Leader:
Dr David Miller

Project Participants:
Murdoch University

Aims and Objectives

Porcine somatotropin (pST) has been used in the pig industry for many years to improve daily weight gain, feed efficiency and backfat, through its actions on promoting lean growth. However, there is growing interest in providing other options to stimulate lean growth. This project looked at two nutritional strategies to stimulate the endogenous somatotropic system; medium chain fatty acid oil (MCFA) supplementation and cysteamine hydrochloride (CSH) supplementation.

The research objective of Phase 1 of the project was to compare the effectiveness of 4 levels (0%, 1%, 3% & 6%) of dietary MCFA supplementation in the diets of Large White x Landrace grower/finisher male pigs from week 10 to week 22 post-partum on:

a] increasing circulating somatotropin concentrations; and

b] increasing growth and feed efficiency.

In Phase 2, 64 Large White x Landrace female pigs, of approximately 60 kg live weight, were allocated to one of three treatments; control diet (n = 22), MCFA diet (optimum dose from Phase 1: 6%; n = 21) and CSH diet (70 mg/kg in feed; n = 21) for a period of approximately 4 to 5 weeks. Blood samples for metabolic analyses were collected from a subset of animals (n ≈ 6 per treatment) 3 weeks into the treatments.

Key Findings

Findings from Phase 1 showed that there was a significant effect of MCFA supplementation, particularly at the highest level of 6%, in terms of stimulating the somatotropic system, but no effect on weight gain or feed intake. In Phase 2, although there was no stimulation of endogenous somatotropin, and no effect on weight gain or feed intake, by either the MCFA or CSH treatments, there was a decrease in backfat depth (19% MCFA; 14% CSH) indicating that there was an improvement in lean meat yield.

Application to Industry

One may never be able to stimulate somatotropin to sufficient levels with dietary MCFA or CSH to compare with a pST injection; however, a small benefit in lean growth, that has welfare and labour benefits, might be attractive to some growers/consumers given the importance of P2 fat thickness on pig price in Australia.

PROJECT 2F–108: EFFECT OF NANO-CHROMIUM ON GROWTH PERFORMANCE CARCASS CHARACTERISTICS AND GLUCOSE METABOLISM OF FINISHING PIGS

Project Leaders:
T.Y Hung and
Professor Frank Dunshea

Project Participant:
University of Melbourne

Aims and Objectives

To investigate the effects of different forms of Chromium picolinate on the performance of pigs fed diets with different levels of fat.

96 finishing gilts (initial weight 51.9±1.20 kg) were stratified on weight into 4 blocks of 8 pens of 3 pigs and then within each block each pen was randomly allocated to 8 treatment groups in a 2×4 factorial design. The respective factors were dietary fat (25 or 100g/kg) and dietary Cr (0, 400 ppb normal size Cr picolinate (CrP), 400 ppb 1µm Cr picolinate (µCr), or 400ppb 100 nm Cr picolinate (nCr).

Key Findings

Cr supplementation positively affected growth rate and feed efficiency in the first 21 days of the study but had no significant effect on animal performance between days 0 and 47.

Cr increased final weight marginally and carcass weight.

The carcass weight effect was due to a highly significant effect of Cr on dressing percentage. The effect was most pronounced with micro Cr on the lower fat diet and for normal Cr on the higher fat diet. Similar effects were seen for carcass P2 that was significantly reduced by Cr supplementation of both diets and unaffected by dietary fat content. The lowest P2 fat thickness was for the micro Cr and nano Cr on the lower and higher fat diets respectively.

Application to Industry

The results suggest Cr supplementation of finisher diets is likely to have positive effects on dressing percentage, carcass weight and carcass P2 fat thickness and warrants commercial consideration.

PROJECT 2F–109: FIELD EVALUATION OF THE BENEFITS OF FISH OIL DIETARY SUPPLEMENTATION TO MULTIPAROUS SOWS FED DURING LACTATION AND EARLY PREGNANCY ON FERTILITY

Project Leader:
Dr Rob Smits

Project Participant:
Rivalea Australia

Aims and Objectives

The aim of the project was to assess the effect on reproductive performance when commercially housed multiparous sows were offered Omega 3 (fish oil) supplemented diets pre-mating, post-mating or both.

Project conducted during winter and spring, 1,216 commercial sows ranging in parity from weaned parity 1–7 were fed a lactation diet either a lactation diet either with 3 g/kg fish oil or an unsupplemented control diet during 20 day lactation and post-weaning up to mating. 860 of these sows were then used in a 2 x 2 factorial design and fed either an unsupplemented control gestation diet or a supplemented (6 g/kg) gestation diet with fish oil for 28 days in early pregnancy. Fish oil replaced tallow. The incidence of post-weaning oestrus, farrowing rate and subsequent litter size was recorded.

Key Findings

The subsequent litter size was significantly increased (12.6 vs. 11.7 total born; $P<0.05$) in sows fed the fish oil supplemented diets through lactation, post-weaning and early pregnancy compared to sows fed unsupplemented diets. Diets fed during either lactation or post-weaning, or during early pregnancy alone produced intermediate results. The response was more pronounced in older parity sows (weaned parity 4–7). There were no effects of supplementation on the resumption of oestrus and sow retention to remating. Farrowing rate was similar between treatments (83.1%).

Application to Industry

Feeding diets supplemented with fish oil is a strategy that could improve declining productivity from the ageing sow herd.

Subprogram 2G:
Nutritional strategies for sows and grower/finisher pigs

KEY DELIVERABLES

1] Nutritional strategies and dietary recommendations for cost effectively improving growth performance.

2] Nutritional strategies and their recommendations for improving reproductive performance.

PROJECT ID	TITLE
2G–102	Increasing the dietary energy of diets fed to first-litter sows on lactation performance and subsequent reproduction
2G–103	Evaluation of an in-feed appetite suppressant as a means to manipulate feed intake of pigs
2G–104	(NE) defines lean and fat deposition better then digestible energy
2G–105	Cost effective formulation of vegetable-protein based diets
2G–106	The response to increasing dietary lysine on lactation and subsequent reproductive performance of first-litter (gilt litter) sows
2G–107	The use of high fibre diets to manipulate carcass tissue distribution in finisher pigs, with particular emphasis on reducing belly fat
2G–108	Bi-phasic feeding to improve pig performance and body composition
2G–109	Commercial validation of a single diet verses phase feeding in grower – finisher pigs
2G–110	Influence of nutrient asynchrony on finisher growth performance and feed efficiency *(Now 6A–102)*

Research Summaries for Subprogram 2G

PROJECT 2G–102: INCREASING THE DIETARY ENERGY OF DIETS FED TO FIRST-LITTER SOWS ON LACTATION PERFORMANCE AND SUBSEQUENT REPRODUCTION

Project Leader:
Dr Rob Smits

Project Participant:
Rivalea Australia

Aims and Objectives

First-litter sows (gilt litters) have an energy demand for milk production, reproduction and maternal growth. Improving lactation and subsequent reproductive performance is important in these sows as they comprise between 20–30% of the herd; piglet birth weight and hence weaning weights are 10–15% below sows; and poor retention of young sows leads to costly sow replacements and poor HFC (15 c/kg COP). This project consisted of a single experiment, which evaluated the energy response to increasing levels from 13.0–15.3 MJ DE/kg on lactation, sow longevity and subsequent reproductive performance.

Over summer, 285 pregnant gilts (day 109) were allocated to one of 5 diets increasing in energy content (13.0, 13.6, 14.2, 14.7 and 15.3 MJ DE/kg). Sows were offered diets to appetite from day of farrowing and litters were equalised to an average of 10.6 within 24 hours. Litters were weighed at birth, after fostering, day 14 and at weaning (26 days). Sows were weighed and P2 measured after farrowing and at weaning to determine lactation weight and fat loss. Sow feed intake was measured during lactation. The sows were weaned and re-mated at their post-weaning oestrus and returned to the production herd and diets. Subsequent second litter size (parity 2) was recorded.

Key Findings

1] Sow retention was improved with lactation energy content above 14.2 MJ DE.

2] Sow appetite was unaffected by increasing dietary energy content allowing for a linear increase in energy intake.

3] Lactation performance and weaning weights did not respond to energy intake, suggesting other constraints on gilt milk production.

4] Sow weight loss was reduced by increasing energy content, but not fat loss, suggesting that body protein loss was reduced.

5] Overall productivity/sow was improved by 10% when feeding energy levels above 14.0 MJ DE.

Application to Industry

The effects on sow reproduction and retention were huge and supported higher/high energy diets for lactating gilts.

Reducing sow replacement rates due to inadequate energy intakes by 5% equates to a saving of 15c/kg COP. In sow herds where body condition is an issue, feeding high-energy diets throughout the herd and the year is likely to improve sow lifetime performance.

PROJECT 2G–103: EVALUATION OF AN IN-FEED APPETITE SUPPRESSANT AS A MEANS TO MANIPULATE FEED INTAKE OF PIGS

Project Leader:
Dr Rick Carter

Project Participants:
Kemin Australia Pty Ltd and Rivalea Australia

Aims and Objectives

To control, or at least reduce the feed intake of the finisher pig through means of appetite suppression, we can thus control the energy intake of the animal and more effectively aim at maximum lean deposition without allowing excess energy being directed to undesirable fat deposition.

A specific patented proteinase inhibitor (P12) which sustains the presence of cholecystokinin was used in this short duration 'proof of concept' experiment to evaluate its capacity to suppress feed intake in finisher pigs.

Key Findings

The proteinase inhibitor had no consistent effect on feed intake or animal performance.

Application to Industry

The results suggest the technology has little commercial potential for controlling the feed intake of pigs.

Research Summaries for Subprogram 2G continued

PROJECT 2G–104: (NE) DEFINES LEAN AND FAT DEPOSITION BETTER THEN DIGESTIBLE ENERGY

Project Leader:
Dr David Cadogan

Project Participants:
Feedworks and
Rivalea Australia

Aims and Objectives

- To demonstrate how formulating using Net energy produces a more consistent carcass weight and quality.
- Diet manipulation to reduce carcass fat while maintaining lean gain.
- Provide the industry recommendations to concentrate on carcass gain indicators rather than live weight.
- Diet manipulation to incorporate diet formulation and additives that maximise dietary net energy.

Key Findings

While Digestible Energy (DE) predicted Feed Conversion Ratio (FCR), Net Energy (NE) predicts fat deposition, better reflects lean gain and NE changes are reflected in dressing yield.

NE changes did not reflect changes in liveweight and feed efficiency, and the improvement in cost of production was not evident and only marginal at best. The major incorrect assumption is that feed efficiency is not a major factor in the cost of production and that savings in feed are related to changes in diet cost. Both factors have to be considered.

Application to Industry

The project did not support the use of NE in commercial diet formulations though it should be noted that NE is the chosen system in Europe and in many other major pork producing countries and should continually be revisited for Australia.

PROJECT 2G–105: COST EFFECTIVE FORMULATION OF VEGETABLE-PROTEIN BASED DIETS

Project Leader:
Dr Brenton Hosking

Project Participant:
Queensland Department of Primary Industries and Fisheries

Aims and Objectives

To establish the effects of exogenous Phytase on the ileal and faecal digestibility of nutrients in barley and sorghum based diets formulated with different phytate levels.

The project also investigated grain type on the digestion kinetics of 55 kg pigs.

The first experiment was conducted on one barley variety (Gardiner) and two sorghum varieties; one containing low condensed tannins (Liberty) and the second (Bonus) with medium levels (albeit low compared to the tannin levels in the older cultivars), to produce 12 treatments, designated as:

1] Grain type

2] Phytate level (0.25% and 0.35% Phytate Phosphorus)

3] Phytase (0 and 150 ppm).

Key Findings

There was a significant effect of grain type on the ileal digestibility of P, Ca, fat, DE and all the amino acids except for lysine, arginine, serine and glycine. The white sorghum produced lower P and Ca digestibility compared to the other two grains, and the red sorghum had inferior fat and ileal amino acid digestibility. The presence of phytase improved P, Ca and amino digestibility ($P=0.05$). Barley and Red Sorghum were the most responsive to phytase in terms of ileal EAA digestibility, whereas the white sorghum showed little to no response, with interactions on methionine, threonine, Isoleucine, leucine, valine, histidine, arginine serine and glycine ($P<0.05$).

Phytate level only influenced ileal P digestibility ($P<0.05$).

Phytase significantly improved the faecal digestibility of P, Ca, potassium, nitrogen, threonine and fat; however, it had no effect on DE.

The results for the kinetics of digestion for sorghum and barley based diets were inconclusive.

Application to Industry

There is little information on the “uplift” of nutrients by phytase for barley and sorghum. The project provides a wealth of information for nutritionist and suggests that barley is more responsive to phytase than sorghum. The final report is essential reading for nutritionists.

PROJECT 2G–106: THE RESPONSE TO INCREASING DIETARY LYSINE ON LACTATION AND SUBSEQUENT REPRODUCTIVE PERFORMANCE OF FIRST-LITTER (GILT LITTER) SOWS

Project Leader:
Dr Rob Smits

Project Participants
Rivalea Australia

Aims and Objectives

The aim of the project was to evaluate the response to increasing levels of dietary lysine and other amino acids in first litter sows on lactation performance, sow weight loss over lactation and subsequent reproductive performance and sow retention on a commercial farm over summer.

437 lactating parity 1 sows were used in a commercial piggery at Rivalea, Corowa, during the summer. There were five lactation diets formulated to increasing lysine (total) and protein levels: 6.2 g/kg, 8.7 g/kg, 10.9 g/kg, 13.3 g/kg and 15.6 g/kg. Diets were formulated at 14.7 MJ DE/kg and all amino acids were balanced to lysine. Dietary crude protein ranged from 16% to 27%. Diets were fed to gilts as they entered the farrowing shed (12 days) and throughout a 20-day lactation. Litters were equalised to an average litter size (11) and litter weight (17.6 kg) within 24 hours of birth. Sows were fed 3 kg/day prior to farrowing and the day after farrowing. Thereafter they were fed to appetite. Feed intake was recorded. Sows and litters were weighed between farrowing and weaning, back fat P2 recorded and subsequent litter performance and farrowing rates measured.

Key Findings

There was no linear response to increasing dietary lysine on lactation performance, sow lactation weight and P2 loss, the weaning to oestrus interval or subsequent litter size.

Litter gains were low overall and typical of other commercial herds in summer. The herd was affected by pre-weaning piglet scours and lactation failure, which was found to be unrelated to dietary lysine treatment. Sow feed intake was negatively related to increasing dietary lysine content. A high proportion of weaned sows were remated and subsequent farrowing rates were unaffected by dietary lysine. There tended to be positive response in parity 2 litter size when lysine fed in the previous lactation was increased from 8.7 g/kg to 10.9 g/kg or higher.

Application to Industry

The recommendation is that parity 1 sows should be fed a diet in lactation formulated to high energy and 11 g lysine/kg (0.62 g av. Lys/MJ DE) to allow adequate protein intake for sow longevity. Feeding sows a higher lysine diet can reduce overall feed intake, and will not improve milk production and litter gains when other factors, such as health, are limiting performance.

PROJECT 2G–107: THE USE OF HIGH FIBRE DIETS TO MANIPULATE CARCASS TISSUE DISTRIBUTION IN FINISHER PIGS, WITH PARTICULAR EMPHASIS ON REDUCING BELLY FAT

Project Leader:
Dr Megan Trezona

Project Participants:
Department of Agriculture and Food WA

Aims and Objectives

The objective of this project was to use dietary interventions to manipulate the composition of the belly primal without negatively affecting growth performance and carcass quality. Two experiments were conducted; the first investigated the effect of dietary energy level and the inclusion of straw (10%)in finisher diets, and the second the inclusion of straw, lucerne and lupin hulls in finisher diets (all at 10%).

Key Findings

Overall, there was no effect of treatment on belly primal composition and very little difference in growth performance, or the quality and composition of the carcass. P2 backfat depth was significantly higher for pigs fed a low energy diet without straw (14.2 mm) compared to those fed a high energy commercial diet with or without straw (12.6 and 12.0 mm, respectively) and a low energy diet with straw (12.8 mm). The results suggest that the addition of straw to the low energy diet contributed to reduced fat deposition at the P2 site, indicating that the straw had a direct effect on the pig rather than an indirect effect via dilution of dietary nutrients. Although the objective of manipulating tissue distribution within the carcass was not met, the similarity in growth performance and carcass quality between treatments suggests that straw, lucerne and lupin hulls may be used as alternative ingredients in finisher diets.

Application to Industry

The project demonstrated the extent fibrous materials can be included in finisher diets without affecting growth performance or carcass characteristics. The decision to use any or all of the materials tested will depend on their price relative to alterative ingredients.

Research Summaries for Subprogram 2G continued

PROJECT 2G–108: BI-PHASIC FEEDING TO IMPROVE PIG PERFORMANCE AND BODY COMPOSITION

Project Leader:
Dr Ron Newman

Project Participants:
University of Sydney and Rivalea Australia

Aims and Objectives

To confirm earlier findings (Project 2F–101) that bi phasic feeding has performance and cost advantages over adlibitum feeding for grower finisher pigs. The two feeding systems were investigated in individual pens and in-group pens fitted with electronic feeders or single round commercial feeders (one/pen).

Biphasic feeding consisted of allowing pigs access to feed for two one-hour periods daily.

Key Findings

The study conducted in individual pens tended to confirm the results of the original experiment in that pigs on the bi phasic feeding treatment ate less feed and tended to be more efficient than those fed adlibitum were.

In the group-housed studies, Biphasic fed pigs generally grew at a similar rate to their adlibitum fed counterparts but used less feed and tended to have a higher dressing percentage.

In the electronic feeder study, there were behavioural problems on the bi phasic feeding treatment with the more dominant animals blocking access to the feeders for the less dominant animals in the pen.

Application to Industry

The results demonstrate the potential of a biphasic feeding strategy to improve the cost effectiveness of grower-finisher pigs and raise questions on the efficiency of nutrient use with adlibitum feeding. However, further thought is needed on how to implement such a system commercially. The latter is likely to require modification of feeders and even feeder space. Nevertheless, the outcomes are promising and warrant further investigation.

PROJECT 2G–109: COMMERCIAL VALIDATION OF A SINGLE DIET VERSES PHASE FEEDING IN GROWER – FINISHER PIGS

Project Leader:
Tony Edwards

Project Participants:
ACE Livestock Consultant and Sun Pork Farms South Australia

Background

In 2009, Karen Moore and Bruce Mullan reported on a CRC project, which involved a comparison of 3 different feeding strategies for female Grower/Finisher pigs. Comprised a conventional 3 phase programme, a blend feeding programme with the diets changing weekly and a single diet from 20–100 kg. L. Wt. pitched at 60 kg requirement for female pigs nominated by AUSPIG. The surprising outcome of this trial was that there were no significant differences between any of these treatments in terms of growth rate, feed efficiency or final carcass characteristics. Further, the single diet treatment resulted in a lower cost per kilogram liveweight gain by about 3c/kg. The current project undertook to validate these findings under commercial conditions.

This project attempted to mimic the previous study as closely as was practicable (same three treatments using the same dietary specifications) but with greater numbers (960), both male and female pigs housed at commercial stocking densities, and a fourth treatment of a standard commercial feeding programme. Overall performance was quite respectable for commercially housed pigs with an average daily gain and FCR of 893 g/d and 2.43 respectively for the 25–103 kg liveweight range.

Key Findings

Up to 60 kg, live weight the pigs on the Single Diet exhibited retarded growth due to the obvious shortfalls in amino acid supply (0.58 gm Avail. Lysine/MJ DE). In this same period the best performance was recorded on the highest lysine treatment (3 PHASE programme involved 0.75 gm Avail. Lysine/MJ DE up to 50 kg and then 0.60 gm/MJ DE to 80 kg liveweight). In the second half of the trial (60–103 kg. L. Wt) the Single Diet programme delivered the best performance, and was the highest lysine treatment in this phase. The feeding programmes involving the lowest lysine levels in this latter period (3 PHASE treatment at 0.5 gm Avail. Lysine/MJ DE and the blend feeding treatment 0.50–0.48 gm Avail. Lysine/MJ DE) not only recorded the poorest growth but also showed a marked deterioration in feed conversion efficiency.

Overall, there were few differences in the performance or carcass traits of pigs across the treatments and the single diet strategy tended to have the lowest feed costs – confirming the results of the previous project.

Application to Industry

The single diet strategy has potential to reduce milling costs and feed usage for grower finisher pigs. However, questions remain around the amino acid adequacy of the finisher diets used for the other tree treatments. It is possible that the better performance of pigs on the single diet after 60 kg was due to the higher amino acid content of the diet and that diets offered pigs on the other treatments during this period may have been “deficient” in lysine and other amino acids. The possibility is being investigated.

Subprogram 2H: Grower/Finisher cost reduction

KEY DELIVERABLES

1] Nutrition and management strategies to reduce grower/finisher costs.

2] Defining the most cost effective use of growth promoting technologies.

3] Establishing the optimum nutrient requirements for modern genetics and how these are modified by growth enhancement technologies.

PROJECT ID	TITLE
2H–101	Strategies to reduce sorting variability
2H–102	Influence of dietary protein source on the metabolic modifiers Ractopamine and pST during the finisher period
2H–104	Improving the response to Paylean with the novel use of pST
2H–106	Growth potential and meat quality of different pig genotypes
2H–109	The use of *Berkshire* triticale in weaner pigs
2H–110	Defining the optimum dose and timing of paylean application in finishing pigs
2H–111	The effect of dietary energy density on paylean responses in finishing pigs
2H–113	Determining the lysine to energy requirement of female pigs from the Australian Pig Improvement Company (PIC) genotype when fed a diet containing Ractopamine
2H–115	Effect of sodium bromide on feed intake of finisher pigs over summer
2H–116	Influence of Soya bean lecithin on carcass weight and dressing percentage
2H–117	Lecithin and carcass quality in finishing pigs

Research Summaries for Subprogram 2H

PROJECT 2H–101: STRATEGIES TO REDUCE SORTING VARIABILITY

Project Leader:
Dr Cherie Collins

Project Participant:
Rivalea Australia

Aims and Objectives

To establish the effect of birth weight on the lifetime performance of pigs.

Piglets born to a subset of gilts and sows were identified individually and weighed within 24 hours of birth. Piglets were classified as light (birth weight (BW) ≤ 1.3 kg), medium (BW 1.4–1.6 kg) or heavy (BW ≥ 1.7 kg) at birth. At weaning (average age 26.8 days ± 0.08 days), 120 pigs per week for 5 weeks were selected based on BW category and individually weighed. Pigs were weaned into group weaner accommodation of the same sex and BW category and growth performance measured on a pen basis. At 13–14 weeks of age, pigs were transferred to electronic feeder pens. Pigs were housed in groups of 30 pigs per pen of the same sex (mixed BW) with each pen containing three electronic feeders. Individual weight, feed intake, feed efficiency, P2 back fat depth and leg fat depth was assessed periodically on each animal through to sale at sorted weights as they reached a target of 90 kg live weight.

Key Findings

- Weaner period: light BW pigs consumed less feed than the medium or heavy BW pigs (P<0.001) and grew slower than the heavy BW pigs (P=0.016).
- From 14 to 17 weeks of age, there was a tendency for the heavy BW pigs to gain weight faster than those born light (P=0.095), and to utilise feed for weight gain more efficiently (FCR 2.48, 2.44, 2.16 for the light, medium and heavy BW pigs respectively, P=0.057).
- Live weight at 19 weeks of age was influenced by BW, with the average weight of the light BW animals 6.5 kg less than the heavy BW pigs.
- Light BW pigs were fatter at slaughter (carcass P2 depth 7.3, 6.9, 6.7 mm respectively for the light, medium and heavy birth weight pigs, P=0.001).
- Birth weight had a significant influence on survivability, with the light BW pigs more likely to die or removed from the group between weaning and the close out of the finisher period.

Application to Industry

The results from this study confirm that pigs born at weights below 1.3 kg display reduced lifetime growth rates, an increased likelihood of illness and/ or mortality and are fatter at slaughter. The challenge for producers is to employ management strategies that cost effectively assist in improving the performance and health status of this group of animals.

PROJECT 2H–102: INFLUENCE OF DIETARY PROTEIN SOURCE ON THE METABOLIC MODIFIERS RACTOPAMINE AND PST DURING THE FINISHER PERIOD

Project Leader:
Dr Cherie Collins

Project Participant:
Rivalea Australia

Aims and Objectives

- To determine the impact of dietary vegetable protein source on the response of finisher pigs to Ractopamine. The vegetable protein sources investigated were soybean meal, canola meal, lupins and peas.
- To assess the impact of an intermittent Ractopamine feeding strategy on the growth performance, feed efficiency and carcass composition of pigs when Ractopamine supplementation begins during the late grower period.
- pST was not investigated in the project.

Key Findings

- Dietary vegetable protein source did not influence the growth and efficiency response to Ractopamine during the finisher period. As such, there is no evidence to suggest that the use of canola meal as the sole vegetable protein source in nutritionally adequate diets will limit the finisher response to Ractopamine.
- A lack of response to RAC during the grower period meant that an evaluation the intermittent RAC feeding strategy could not be achieved.

Application to Industry

The result of experiment 1 provides nutritionists with the confidence to use canola meal in finisher diets containing Ractopamine. In experiment 2, the lack of response to RAC during the grower period was however an interesting outcome for producers to take into consideration.

PROJECT 2H–104: IMPROVING THE RESPONSE TO PAYLEAN WITH THE NOVEL USE OF PST

Project Leader:
Dr Cherie Collins

Project Participants:
Rivalea Australia and University of Melbourne

Aims and Objectives

The growth and efficiency response of finisher pigs to dietary RAC is highest during the first 2 weeks of feeding and declines thereafter. The aim of this project was to determine if a one-off dose of pST to finisher pig's mid-way through a RAC feeding program could enhance receptor sensitivity and help maintain the response to RAC through to pre-sale weights.

97 female pigs (PrimeGro™ Genetics) selected at 17 weeks of age and transferred to individual finisher accommodation. Pigs were offered a commercial grower

diet for seven days while they acclimatised to the individual pens. At 18 weeks of age, pigs were individually weighed and randomly allocated to one of five experimental treatments. They consisted of A: Control finisher diet, no RAC for 28 days; B: RAC finisher diet for 28 days; C: RAC finisher diet for 28 days plus one dose of 10 mg pST at day 14; D: RAC finisher diet for 28 days plus one dose of 10 mg pST at day 14 and again at day 21, E: Control finisher diet for 28 days plus daily pST injection (5 mg/d) from day 14 to day 28. The RAC finisher diet was formulated to contain 7.5 ppm RAC (Paylean™, Elanco Animal Health). Individual pig weights and feed intake were recorded weekly to the end of the 28-day test period. Pigs were slaughtered in a commercial abattoir and carcass information obtained.

Key Findings

Pigs offered the RAC finisher diet consumed more feed (2.39 and 2.53 kg/d for the control and RAC treatments respectively, P=0.009) and tended to grow faster (1.01 and 1.07 kg/d respectively, P=0.11) than pigs offered the control finisher diet during the initial 14 days of the test period. There was no impact of dietary RAC on feed efficiency during this time. Rate of gain and feed efficiency were not improved over the entire test period when pigs fed the RAC diet were administered pST at either day 14 or at day 14 and day 21. There was no impact of the RAC/pST strategy on carcass weight or dressing percentage.

Application to Industry

The results from this project do not provide any evidence that the novel use of pST can maintain the growth performance response to RAC during the finisher period. However, the lack of a normal response to the standard RAC finisher program is of concern and makes it difficult to interpret the impact of the novel strategy. Further investigation may be warranted with an alternative genotype that is known to respond to RAC supplementation when housed in individual pens.

PROJECT 2H–106: GROWTH POTENTIAL AND MEAT QUALITY OF DIFFERENT PIG GENOTYPES

Project Leader:
Dr Patrick Morel

Project Participant:
Massey University, NZ

Aims and Objectives

To compare the performance and carcass traits of two PIC USA sire lines (337 and 356) and sex (male and female). Genetics from overseas (Europe and USA) can be imported into NZ – as frozen semen.

Pooled boar semen of PIC genotypes (i.e., 337 and 356) was used to inseminate females of the PIC line C46 on a commercial pig farm located in the North Island, New Zealand. The day after birth, 133 pigs were individually tagged. At 5–6 weeks of age 16 females and 16 males pigs from each boar genotype were selected (15.4 ± 2.6 kg; live weight ± standard deviation) and transported at the Massey University Pig Biology Unit. The pigs were kept in pens of either eight males or eight females (4 animals from each genotype per pen) and individually fed the diets as slurry twice daily. Water was available at all times. After a one-week adaptation period, the recording of daily feed offered and refused and weekly live weight started.

The pigs were fed two diets. The first diet (MinLP) was limiting in energy but not limiting in amino acids, thus in this experimental phase the capacity of the pigs to partition energy between body fat and body protein (minimum lipid to protein ratio, MinLP) was driving growth (Weis et al. 2004). This diet was fed restricted and the amount of feed offered per day (kg) was calculated as (LW × 0.26 + 9.1) / 13.85. Once the pigs' LW was ≥ 49.5 kg their diet was changed to the second diet (PdMax), which was limiting in neither energy nor amino acids and was fed twice daily up to appetite. In this phase of the study, the pig maximum protein deposition potential (PdMax) was limiting growth. The pigs remained on the PdMax diet until being slaughtered.

Key Findings

The pigs exhibited exceptional performance (under near ideal conditions) achieving feed: gain values of less than 2:1 in PdMax period and as low as 1.67 overall. Males exhibited better growth performance than females and the 337 genotype tended to out perform the 356 genotype though for some traits there was an interaction between sex and genotype.

There was an interesting interaction between sex and genotype for P2 fat thickness. 337 females had lower back fat than all other pigs and lower than 356 females while males of both genotypes had the same P2 (9.0 mm).

Application to Industry

The results provide some information on the performance capabilities of PIC genotypes from the USA. They were generally excellent. It is not possible to compare the performance of these animals with the genetics available in Australia but the results do enable genetic companies here to have some bench mark data and targets to try and achieve.

Research Summaries for Subprogram 2H continued

PROJECT 2H–109: THE USE OF *BERKSHIRE* TRITICALE IN WEANER PIGS

Project Leader:
David Henman

Project Participant:
Rivalea Australia

Methodology

Berkshire triticale was developed by Pork CRC and the plant breeders rights are owned by Pork CRC. Berkshire was selected for it agronomic characteristics and it relatively high digestible energy content for pigs. The project compared the performance of weaner pigs offered diets based on wheat, a blend of triticale and Berkshire triticale.

One hundred and eighty male pigs were allocated at weaning (26 days) to a dietary program based on wheat, a mixed triticale or *Berkshire* triticale as the main grain source. Pigs were housed in 10 pens of 6 for each treatment program. The live weight and feed intake and resulting feed efficiencies were recorded over two periods (0–20 days and 20–40 days). All grain varieties assumed a digestible energy content of 14.4MJDE/kg and the protein was measured at 13±0.3%.

Key Findings

There was no significant difference in response of the pigs to any of the grain varieties although the highest growth rate and best-feed conversion were seen on the *Berkshire* triticale. This indicates that the triticale has similar digestible energy content to wheat and that the selection of *Berkshire* triticale for improved digestible energy content is having the intended outcome.

Application to Industry

The project confirmed the excellent feeding value of Berkshire triticale for pigs. Scientists involved in the genetic selection of new varieties of triticale can use this information in improve the selection of future varieties of triticale.

PROJECT 2H–110: DEFINING THE OPTIMUM DOSE AND TIMING OF PAYLEAN APPLICATION IN FINISHING PIGS

Project Leader:
Tony Edwards

Project Participants:
ACE Livestock Consulting and Sun Pork Farms South Australia

Aims and Objectives

Paylean has been shown to have positive economic benefits for carcass yield in finishing pigs. This project set out to evaluate a series of exposure times and doses of Paylean with the view of achieving a clearer definition of the optimum commercial application of the product.

Two experiments were conducted to evaluate a series of exposure times (2, 3 or 4 weeks) and doses (5, 7.5 or a combination of 5+10ppm of Paylean). 2240 female finisher pigs were used across both experiments. Each experiment utilised 56 pens of 20 pigs, assessing 7 treatments groups. Pig growth performance was monitored for a 6-week period from 60 to 100kg liveweight, with treatment groups applied for the final four weeks prior to slaughter. Growth performance and carcass characteristics (carcass weight, backfat (at the P2 position) and carcass yield) were assessed.

Key Findings

The initial experiment appeared to be compromised by erratic dispensing and/or a health issue within the herd. The expected responses to Paylean were not observed. The second trial appeared to be compromised by a mechanical error with the feed dispensing system. The primary objective of the project to define the optimal dose and timing for the commercial application of Paylean was not achieved.

Application to Industry

The limited conclusions that could be drawn from the studies were:

1] Paylean increases carcass weight and improves feed conversion efficiency.

2] Carcass weight improvements were greatest after 3–4 weeks of application despite the spike in growth rate occurring during the initial week of application.

3] Response to Paylean can be variable due to health or other interfering factors.

PROJECT 2H–111: THE EFFECT OF DIETARY ENERGY DENSITY ON PAYLEAN RESPONSES IN FINISHING PIGS

Project Leader:
Tony Edwards

Project Participants:
ACE Livestock Consulting Pty Ltd and Sun Pork Farms South Australia

Aims and Objectives

One aspect of Paylean application that has not previously been studied in isolation is the effect of dietary energy density on the response to Paylean. There is now a need to establish the responses to Paylean under a range of energy densities to determine the economic optimum dietary energy level. The experiment involved the evaluation of 3 energy levels with or without Paylean. The 3 energy levels chosen were 13.4 MJ DE/kg (current commercial recommendations for Paylean diets), 14.2 MJ DE/kg and 15.0 MJ DE/kg. All diets were formulated to contain 0.58 g of available lysine/MJ DE. This design allowed the response to energy density per se to be extracted independently, and then the response to Paylean at each energy level to be evaluated also. The level of Paylean applied was 7.5 ppm.

960 commercial grow-out pigs [(Landrace x Large White) x TS] were drawn from a regular consignment of approximately 1200 pigs

placed in the grow-out facility at approximately 25 kg live weight and 9 weeks of age and grown out on the standard commercial programme to 75 kg live weight. These pigs were placed in 48 pens of 20 pigs utilising a common feeder between each 2 pens. This then yielded 48 groups for growth rate evaluation but only 24 groups for feed intake and FCR calculations.

Key Findings

Increasing energy density resulted in only a minor increase in overall energy intake as the pigs compensated by lowering their intake. This minor elevation in energy intake resulted in a modest increase in growth but with no apparent shift in energetic efficiency. Adding Paylean to the diets had no effect on feed intake but increased carcass weight by around 2.0 kg on average across all 3 energy levels with no effect on P2 backfat. There was an interaction between energy density and Paylean inclusion, whereby the response to Paylean increased as energy density increased. Over the 28-day study, Paylean improved feed efficiency by approximately 7%. Increasing the DE content of the diet from 13.4 to 14.2 MJ/kg improved feed: gain by 5%. Further increasing DE to 15 MJ/kg improved feed; gain 9.6%.

Application to Industry

The inference from this project is that the response to Paylean will only be maximised, if supported by a higher energy base diet. As energy density was raised largely by added tallow in this experiment, there is the possibility that the response was, to added fat rather than energy density per se. This differentiation may require further research.

The final report is essential reading for nutritionists and production managers.

PROJECT 2H–113: DETERMINING THE LYSINE TO ENERGY REQUIREMENT OF FEMALE PIGS FROM THE AUSTRALIAN PIG IMPROVEMENT COMPANY (PIC) GENOTYPE WHEN FED A DIET CONTAINING RACTOPAMINE

Project Leader:
Dr Bruce Mullan

Project Participants:
Department of Agriculture and Food WA and University of Melbourne

Aims and Objectives

Pork CRC and collaborating institutions have shown the benefits to feed conversion efficiency and growth rate of including ractopamine in the diet of finisher pigs. However, the extent ractopamine might alter the pig's response to dietary lysine remains unclear. The experiment conducted in this project investigated the responses of female pigs over 28 days starting at 75 kg to five levels of dietary available lysine: DE (0.4 to 0.72 g/MJ DE) and two ractopamine levels (zero and 7.5 ppm).

Key Findings

The results supported the benefits of ractopamine on feed efficiency (0.2 points) and growth rate (approx. 100 g/day); presumably by an improvement in lean meat deposition since there was no change in depth of backfat, when ractopamine was included in the diet. The performance of control and ractopamine supplemented pigs improved with increasing dietary lysine with control animals reaching a plateau at approximately 0.56 g available Lysine: MJ DE. This response was similar to that reported previously at the same facility using the same genotype by Moore and Mullan (2010). Pigs fed the diets containing ractopamine not only exhibited superior growth rate and improved feed conversion efficiency but their responses to lysine, especially in terms of feed efficiency, appeared to continue to higher levels than that required to support near maximum performance in the controls.

Application to Industry

These results provide industry confidence in the value of including ractopamine in the diet of finisher pigs. The outcomes will also help nutritionists and producers assess the optimal level of dietary lysine that they should be formulating for when feeding female pigs diets that either contain ractopamine or not.

Research Summaries for Subprogram 2H continued

PROJECT 2H–115: EFFECT OF SODIUM BROMIDE ON FEED INTAKE OF FINISHER PIGS OVER SUMMER

Project Leader:
Dr Cherie Collins

Project Participants:
Rivalea Australia

Aims and Objectives

The aim of this study was to determine if sodium bromide (NaBr) could be used to improve feed intake of entire male, female and Improvac vaccinated male pigs during summer.

792 pigs (Large White x Landrace, PrimeGro™ Genetics) were selected at 17 weeks of age (average weight 64.6kg ± 0.24 kg) and housed in pens of 9 pigs of the same sex. Pens were randomly allocated to a 2 x 3 factorial experiment with the respective factors being dietary NaBr (0 or 0.04 g/kg) and sex (female, entire male and Improvac male). Diets were formulated to contain 0.52 g available lysine/ MJ digestible energy (DE) and 13.8 MJ DE/ kg. Pen weights were recorded at Day 0, 14 and 35 and pen feed intake (FI) measured by feed disappearance during this time. Pigs were slaughtered in a commercial abattoir at the conclusion of the 35-day test period.

Key Findings

- Pigs offered the NaBr diet consumed more feed (2.39 and 2.47 kg/d for the control and NaBr treatments respectively, P=0.020) over the entire 35 day test period. While this response was consistent across the three sexes, the magnitude of the response was however insufficient to increase growth rate during this time (ADG 0.852 and 0.872 kg/d respectively for the control and NaBr treatment groups, P=0.27).
- There was no impact of NaBr supplementation on carcass weight, P2 or dressing percentage.

Climatic conditions during the test period (Summer 2010/11) were mild, with only 6 days in which the maximum temperature exceeded 35^{0}C. It is unclear if a greater response may have been obtained under more typical summer conditions.

Application to Industry

NaBr appears to have potential to increase the feed intake of grower-finisher pigs but dose rate studies are required to better evaluate the material as an appetite enhancer.

PROJECT 2H–116: INFLUENCE OF SOYA BEAN LECITHIN ON CARCASS WEIGHT AND DRESSING PERCENTAGE

Project Leader:
Dr Cherie Collins

Project Participants:
Rivalea Australia and University of Melbourne

Aims and Objectives

The project tested the hypothesis that dietary lecithin increases carcass weight and dressing percentage of pigs housed in groups. In addition, a further assessment of meat quality was made.

256 pigs (Large White x Landrace, PrimeGro™ Genetics) at 17 weeks of age transferred to finisher accommodation (pens of 8 pigs of the same sex). Pens were randomly allocated to a 2 x 2 factorial experiment with the respective factors being dietary lecithin supplementation (0 or 5 g/kg) and sex (female and Improvac vaccinated male). Diets were pelleted and fed *ad libitum* from 17 weeks of age through to slaughter at 22 weeks of age. Pigs were slaughtered in a commercial abattoir and individual hot standard carcass weight (HSCW) and fat depth at the P2 site measured. Twenty-four hours after slaughter, a subset of 64 carcasses (2 pigs per pen) were followed through the boning room for collection of the loin (*longissimus dorsi*). Colour (L*, a*, b*), pH and iron content measures were obtained on each of the loins.

Key Findings

- Pigs offered the lecithin diet utilised feed for weight gain more efficiently than pigs offered the control diet (FCR 2.96 and 2.79 kg/kg respectively for the control and lecithin treatment groups, P=0.006). This improvement was due to a small (non-significant) reduction in feed intake coupled with a similar rate of gain over the entire test period.
- There was no impact of dietary lecithin supplementation on final live weight, carcass weight, P2 back fat depth or dressing percentage.
- There was no impact of lecithin supplementation on the meat quality measures assessed (pH, colour and iron content of the loin).

Application to Industry

The results from the project do not support the use of lecithin in the diet of finisher pigs at 5 g/kg to improve carcass weight, dressing percentage, muscle colour or iron content of the loin. The results do however suggest that lecithin may be a worthwhile component in finisher diets containing high levels of added fat (tallow) to improve the efficiency of feed utilisation. The diets used in this study contained 4.6% added tallow and 6.3% total fat.

PROJECT 2H–117: LECITHIN AND CARCASS QUALITY IN FINISHING PIGS

Project Leader:
Tony and Megan Edwards

Project Participants:
ACE Livestock consulting and Sun Pork Farms South Australia

Aims and Objectives

Both dressing percentage and feed efficiency during the finisher phase can affect the profitability of pig production. Naturally, derived feed additives, like soy-derived lecithin may provide simple and safe tools to enhance the profitability of pig production. Lecithin has been recognised as a feed additive with emulsifying properties, which can improve total tract digestibility of diets high in animal fats (Kim et al. 2008).

Soy-Lecithin was also demonstrated to improve the feed efficiency of finisher pigs in Pork CRC project 2H–116.

The experiment was conducted under commercial conditions at the Brinkley Research facility, where 960 pigs were housed in 48 pens (20 pigs per pen). A 3 x 2 factorial design was applied. Pigs were segregated by sex (480 female and 480 entire male) and allocated to one of three dietary treatment groups. Each pair of pens shared a common feeder. The experimental unit for the growth rate and carcass data was the pen (n=48), whilst the feeder (n=24) served as the experimental unit for feed intake and feed conversion data. The levels of supplementary lecithin were applied to a high-energy finishing base diet (14.5 MJ DE/kg including 4% added fat. The three levels of lecithin applied were 0, 0.5 and 1.0%. The lecithin product utilised was ADM Ultralec (Archer Daniels Midland Co., Decatur, Illinois, USA – See appendix II). Treatments were applied from 60kg live weight until slaughter.

Key Findings

Supplemental lecithin did not influence the growth performance or feed conversion of pigs ($P > 0.05$). Nor did supplemental lecithin influence the carcass weights, dressing percentage or back fat thickness of pigs ($P > 0.05$).

Application to Industry

The project results do not support the use of Lecithin in finisher diets to improve growth performance or carcass characteristics. The reason the results differed for feed efficiency in this and Project 2H–116 remain to be established but both were conducted in commercial conditions.

PROGRAM

3 Enhancing capacity to deliver nutrients that promote health and well-being through pork

Program 3 aimed to increase the value and versatility of pork products resultsing in:

1. An increase in the range of viable pork products and market opportunities for the Australian industry.
2. Demonstrated benefits from consumption of pork products for consumers.

SUBPROGRAM 3A	**IMPLEMENT NUTRITIONAL AND GENETIC STRATEGIES TO PRODUCE PORK AND PORK PRODUCTS WITH FUNCTIONAL FOOD PROPERTIES**
SUBPROGRAM 3B	**ENHANCING THE IRON CONTENT OF PORK TO PROMOTE HUMAN HEALTH BENEFITS**

3

Subprogram 3A:
Implement nutritional and genetic strategies to produce pork and pork products with functional food properties

KEY DELIVERABLES

1] Fresh pork products desired by consumers based on the natural human health benefits of pork.

2] Fresh pork products, ready for retail with specific nutritional attributes relative to daily requirements of consumers (e.g. selenium, iron and bioactives).

PROJECT ID	TITLE
3A–102	Nutritional strategies to increase the selenium and iron content in pork and promote human health
3A–104	Fresh pork and cardiometabolic health
3A–105	The effects of pork on satiety
3A–106	Pork meat as a dietary strategy for the treatment of iron deficiency in young women
3A–107	The role of Australian pork in improving thiamine status, heart disease risk factors and glucose control in people with type 2 diabetes
3A–108	Nutritional manipulation of iron level in finisher pigs and fresh pork
3A–109	Soya bean lecithin to improve tenderness and health active properties of pork
3A–110	Inclusion of lupins in the diet of finisher pigs to reduce the level of cholesterol *(Now 3C–102)*
3A–111	A comparison of regular consumption of fresh lean pork, beef and chicken on body composition and energy intake
3A–112	Fatty acid composition, cholesterol- and intramuscular fat- content of loin muscles from finisher pigs fed soy lecithin supplement
3A–113	Skatole and androstenone content of pork fat from finisher pigs fed chicory inulin or organic iron supplement

Research Summaries for Subprogram 3A

PROJECT 3A–102: NUTRITIONAL STRATEGIES TO INCREASE THE SELENIUM AND IRON CONTENT IN PORK AND PROMOTE HUMAN HEALTH

Project Leader:
Dr Eric Ponnampalam

Project Participants:
Victorian DPI, Feedworks Pty Ltd and University of Melbourne

Aims and Objectives

Determine Se and Fe bio-availability and incorporation into pig plasma, muscle and visceral tissues.

- To determine the bio-availability of Se and Fe from pork in a rat model.
- Apply molecular techniques and histological/ immunohistological examination to determine tumour progression and development.
- To develop and validate analytical methods that are capable to extract, identify and determine levels of the major and important forms of selenium in mammalian tissue, these being selenomethionine and selenocysteine.

Key Findings

Dietary Se supplementation of pigs increased the Se content of pork in a linear manner compared with control and non Se-diet treatments.

- Selenium enriched pork was found to be effective in preventing pre-neoplastic lesions in rats, an early biomarker of colorectal cancer.
- Demonstrated that the bioavailability and efficacy of muscle-bound selenium resulted in reduced incidence of early stage bowel cancer compared with supplementing rats with inorganic or organic Se.
- This observation is significant as the incidence of colorectal cancer is a significant problem in Australia and other Western populations.
- Se supplementation of pigs did not impact on growth performance, carcass characteristics or meat quality attributes.
- Supplementing diets with organic iron did not alter muscle iron levels which were found to be significantly higher in the muscles from female compared to male pigs.

Application to Industry

The project provided preliminary evidence that selenium enriched pork reduced the incidence of an early biomarker of colorectal cancer.

This work was a proof of concept study and only included early stage cancer development in the rat. Further work is required to identify both the level and duration of Se pork consumption required for prevention of early stage colonic cancer as well as other forms of cancer, including prostate, in rat and human studies. Also, it may be of interest to determine whether there are other forms of organic Se that can be included as a supplement into pig diets to maximise the Se content of pork muscle from supplemented pigs.

PROJECT 3A–104: FRESH PORK AND CARDIOMETABOLIC HEALTH

Project Leader:
Dr Karen Murphy

Project Participants:
Nutritional Physiology Research Centre, University of South Australia

Aims and Objectives

This project investigated the effect of regular consumption of lean fresh pork on cardiometabolic health including body composition and risk factors for diabetes and cardiovascular disease.

A dietary intervention trial with 144 overweight/obese men and women who were low pork consumers (ate less than one pork meal per week) and were randomised to increase their consumption of lean pork or, alternatively, remain on their customary diet for 6 months. Men and women on the pork diet were provided with 1050g/wk and 750g/wk, respectively, of lean fresh cuts of steak, sausages, diced, mince and stir fry to incorporate into their diet. Cardiometabolic outcomes were measured at baseline and then at 3 and 6 months.

Key Findings

Volunteers assigned to the pork diet increased their pork intake 10 fold by substituting pork for other meats in their diets, mainly beef and chicken. On average male volunteers in the pork group consumed 946g per week (135g/d) while female volunteers in the pork group consumed 682g (97g/d) per week.

There was no significant effect on any risk factors for diabetes or cardiovascular disease. More importantly, compared with those who remained on their customary diet, there were improvements in weight ($P \leq 0.01$), body mass index ($P < 0.02$) and waist circumference ($P \leq 0.03$), body composition, including reductions in % body fat ($P \leq 0.04$), fat mass ($P \leq 0.04$) and abdominal fat ($P \leq 0.01$) after only 3 months. There was no change in lean mass indicating that the reduction in weight was due to loss of fat mass.

Application to Industry

Lean fresh Australian pork included in the diet may improve body composition without adversely affecting risk factors for diabetes and cardiovascular disease.

The project results demonstrated clear health benefits (weight loss) from including lean pork in the diet of obese adults.

Research Summaries for Subprogram 3A continued

PROJECT 3A–105: THE EFFECTS OF PORK ON SATIETY

Project Leader:
Dr Karen Charlton

Project Participant:
University of Wollongong

Aims and Objectives

The aim of the project was to demonstrate that the consumption of a pork meal has a greater effect on acute satiety than comparative meals using animal protein sources, namely beef and chicken.

Thirty non-smoking pre-menopausal women aged 19–45 years, with a Body Mass Index range of 19.2–38.3 kg/m2 were recruited for the study. On three test days, fasting participants attended a research centre and consumed, in random order, one of three meat-containing meals (pork, chicken, and beef) that were matched in energy (kJ), total protein content, palatability, and appearance. A within-subjects design was employed whereby each participant served as her own control. The primary outcome measures were:

1] Amount of food consumed at a subsequent ad libitum buffet lunch meal

2] Amount of food consumed and macronutrient selection for the rest of the day

3] Visual Analogue Scale (VAS) ratings for hunger and satiety

4] Hormonal appetite and satiety signals.

Key Findings

No difference was found between meat groups for either energy intake, or for macronutrient profile (% energy from protein, fat or carbohydrate) of food consumed at the buffet lunch, following test meal breakfast consumption.

Participants also consumed comparable quantities of food over the rest of the day on each of the three test meal days, indicating no test meal effect on later food choice. Subjective VAS scores did not differ between test meals. With the exception of a difference in PYY between chicken and pork meals (P = 0.027), no significant differences were found for any of the appetite hormone levels investigated (CCK, ghrelin, insulin) after consumption of pork, beef or chicken.

Application to Industry

In an obesogenic environment where high protein diets are seen to provide opportunity for better satiety and weight loss, this study positions pork in a healthy diet as being equal to lean beef or chicken in terms of its effect on satiety and release of appetite-related intestinal hormones and insulin. Where previously consumers may have only thought of red meat and chicken in terms of these benefits, pork is seen as equally effective.

PROJECT 3A–106: PORK MEAT AS A DIETARY STRATEGY FOR THE TREATMENT OF IRON DEFICIENCY IN YOUNG WOMEN

Project Leader:
Professor Samir Samman

Project Participants:
School of Molecular Bioscience, University of Sydney, Department of Statistics, Macquarie University and Boden Institute of Obesity, Nutrition and Exercise, University of Sydney

Aims and Objectives

The aim of the project was to determine if an increase in the intake of pork meat over a period of 3 months would affect the nutritional status of iron, zinc, vitamin B6, vitamin B12, and the feeling of wellbeing in young women.

Healthy young women were randomly assigned to a control diet (CG), a pork containing diet (PG) or a control diet with iron supplementation (SG) for 12 weeks. Sixty-five women aged 24.6 ± 4.4 y (mean ± SD) completed the trial.

Key Findings

Serum ferritin concentrations were increased significantly (P=0.001) in subjects assigned to SG as compared to the other groups, as assessed by repeated-measures ANOVA. At week 12, haemoglobin concentrations were significantly higher in PG and SG as compared to individuals in CG. Plasma zinc concentrations at the end of the intervention were similar to baseline concentrations for individuals in the CG and PG but were decreased significantly (P (P<0.05) in SG. Plasma-, erythrocyte-folate, serum vitamin B6 and serum vitamin B12 concentrations were not significantly affected by the intervention, although the concentrations of vitamins B6 and B12 tended to increase in PG. Responses to the Health Survey Short Form (SF36) showed a significant improvement in the scores for "vitality" in SG as compared to subjects assigned to CG or PG. In those consuming pork, the score for "bodily pain" was more favourable than scores in CG and SG. No significant relationships were observed between health concept scores and biomarkers of nutritional status.

Application to Industry

Consumption of pork meat by young women maintained haemoglobin levels to the same extent as low-dose iron supplementation, and enhances the feeling of wellbeing.

PROJECT 3A–107: THE ROLE OF AUSTRALIAN PORK IN IMPROVING THIAMINE STATUS, HEART DISEASE RISK FACTORS AND GLUCOSE CONTROL IN PEOPLE WITH TYPE 2 DIABETES

Project Leader:
Dr Jennifer Keogh

Project Participant:
CSIRO – Human Nutrition

Aims and Objectives

The rising prevalence of obesity and type 2 diabetes (T2D) has seen increased interest in the use of higher protein, lower carbohydrate (HP) diets for weight and diabetes management. However, HP diets have been typically

associated with increased red meat consumption, of which there is some evidence albeit inconclusive that higher red meat consumption may increase the risk of developing cardiovascular disease (CVD) and T2D and iron intake may be related to the development of T2D.

This clinical trial assessed the efficacy of a comprehensive 16-week weight reduction program high in pork with resistance exercise (EX) in improving thiamine concentrations, diabetes control and markers of CVD risk.

83 men and women with T2D (age 56.12±7.53 yrs, BMI 35.4±4.6 kg/m2) were randomly assigned to an isocaloric, energy restricted diet (~6–7 MJ/day) of either high carbohydrate (HC; carbohydrate: protein: fat, 55:20:25) or high protein, high pork (HP; 40:35:25), with or without Ex (3 d/wk). Body weight and composition, cardiometabolic markers and erythrocyte thiamine pyrophosphate (ETP) were assessed pre- and post-intervention.

Key Findings

59 participants completed the study. There was a significant time x group effect (P≤0.04) for body weight, fat mass and WC. The HP+EX had the greatest reduction for these parameters. Across the groups there was an overall reduction (P<0.001) in lean mass (2.0±2.3 kg), blood pressure (–15/8±10/6 mmHg), fasting glucose (–2.1±2.2 mmol/L), insulin (–4.7±5.4 uM/L), HbA1c (–1.25±0.94 %), triglycerides (–0.47±0.81 mmol/L), total cholesterol (–0.67±0.69 mmol/L) and LDL-cholesterol (–0.37±0.53 mmol/L). There was no significant difference between groups (P30.17, time x group interaction). Overall, compared to the HC diet, the HP had greater improvement in ETP levels (HC -25±53 nmol/L vs HP 4±50 nmol/L (P=0.04).

Application to Industry

A higher intake of lean pork as part of a high protein dietary plan lifestyle program, when combined with resistance exercise training may provide advantages for weight loss and improvements in body composition in overweight and obese patients with type 2 diabetes. It also provides evidence that a lifestyle program that indicates pork may offer additional nutritional advantages for promoting thiamine status over a HC diet. This evidence suggests lean pork is a valuable alternative source of protein with higher protein lifestyle patterns for weight management in type 2 diabetes.

PROJECT 3A–108: NUTRITIONAL MANIPULATION OF IRON LEVEL IN FINISHER PIGS AND FRESH PORK

Project Leader:
Dr Eric Ponnampalam

Project Participants:
Victorian DPI,
Murdoch University
and Melbourne University

Aims and Objectives

To determine whether:

- Dietary Iron (Fe) supplementation of finisher pigs increases total iron content of pork muscle.
- The addition of inulin (a complex carbohydrate) to the diet changes the incorporation of Fe into pork muscle.
- The muscle Fe content in male pigs can be increased to the level similar to that of females.

Key Findings

- Haem iron content and redness of pork can be increased by addition of inulin from chicory at 5% into the finisher diet.
- Potential to improve average daily gain and carcass lean content in pigs by dietary inulin supplementation.

Muscle iron content was found to decline quite markedly and to very low levels with live weight, which is contrary to expectations. The muscle iron levels reported at 100 kg live weight were also lower than in the previous study conducted at Werribee.

Application to Industry

The project results suggest the inclusion of inulin in finisher diets may improve growth performance but this needs to be validated in a larger commercial project.

PROJECT 3A–109: SOYA BEAN LECITHIN TO IMPROVE TENDERNESS AND HEALTH ACTIVE PROPERTIES OF PORK

Project Leader:
Professor Frank Dunshea

Project Participants:
University of Melbourne
and Rivalea Australia

Aims and Objectives

The aim of the project was to test the hypothesis that dietary lecithin would improve pork eating quality by reducing chewiness and hardness and in doing so may improve other aspects of carcass and meat quality. In addition, the hypothesis that dietary lecithin would improve meat tenderness by reducing collagen content and collagen cross-linking by measuring the gene expression of collagen precursors and enzymes involved in collagen synthesis and degradation was also tested.

Thirty-six Large White x Landrace (PrimeGro™ Genetics) gilts were randomly allocated at 16 weeks of age (62.9±0.56 kg, mean± SE) to finisher diets containing either 0, 4, 20 or 80 g/kg soybean lecithin (ADM Australia Pty Ltd). The pigs were housed individually and had ad libitum access to feed and water for 6 weeks (103.2±1.67 kg).

Key Findings

Dietary lecithin reduced pork hardness in a dose-dependent manner though decreasing collagen synthesis. While lecithin improves the fatty acid profile of pork, these changes may not be sufficient on their own to justify use of dietary lecithin. An interesting finding is that dietary lecithin may improve carcass weight and dressing percentage, particularly in females.

Research Summaries for Subprogram 3A continued

Application to Industry

The chemical and physical improvements in pork quality associated with lecithin need to be confirmed and we need to know if they can be detected as improved pork eating quality by consumers. The effects on dressing percentage and carcass weight also need to be confirmed as does the improvement in feed efficiency observed in an associated study. Lecithin appears to have commercial application but its effects on performance and eating quality are somewhat inconsistent.

PROJECT 3A–111: A COMPARISON OF REGULAR CONSUMPTION OF FRESH LEAN PORK, BEEF AND CHICKEN ON BODY COMPOSITION AND ENERGY INTAKE

Project Leader:
Dr Karen Murphy

Project Participant:
University of South Australia

Aims and Objectives

This was a 9 month cross-over intervention project, where 49 overweight adults were randomly assigned to consume up to 1kg of either pork, chicken or beef/wk, in the form of steak or (chicken) breast, diced, mince and stir fry, ad libitum and without energy restriction. At baseline and then at 3, 6 and 9 months weight, body mass index, waist/hip circumference and measures of body composition including % body fat, abdominal fat and lean mass using dual energy x-ray absorptiometry was assessed.

Key Findings

Results showed that regular consumption of lean pork was equally healthy as beef or chicken consumption. After statistical analyses using random effects GLS regression, there was no difference between the pork, beef or chicken diet for weight or any other index of adiposity. Similarly, there was no difference in energy intake or macro or micronutrient intakes.

Volunteers reported that pork was the preferred meat to chicken (P=0.229) and had significantly greater satisfaction than beef (P=0.018). The most enjoyed type and cut of meat was pork steak.

Application to Industry

Pork was as healthy as chicken or beef and was the protein most preferred by volunteers.

PROJECT 3A–112: FATTY ACID COMPOSITION, CHOLESTEROL- AND INTRAMUSCULAR FAT- CONTENT OF LOIN MUSCLES FROM FINISHER PIGS FED SOY LECITHIN SUPPLEMENT

Project Leader:
Dr Eric Ponnampalam

Project Participant:
Future Farming Systems Research Department of Primary Industries Victoria

Aims and Objectives

An experiment was undertaken with pigs fed a diet supplemented with soy lecithin by Professor Frank Dunshea at the University of Melbourne Dookie campus animal facilities. Pork muscle samples (longissimus dorsi) were collected from pigs at 24 h post-slaughter during this study. These muscle samples were transferred to the Department of Primary Industries, Werribee Centre, in November 2010 for the determination of fatty acid composition and cholesterol content. Samples were supplied with ID, but no information on treatment codes.

Key Findings

The results have been filed and available for researchers to understand the effects of lecithin on the fatty acid composition of pork muscle.

Application to Industry

Yet to be reported but results available to researchers.

PROJECT 3A–113: SKATOLE AND ANDROSTENONE CONTENT OF PORK FAT FROM FINISHER PIGS FED CHICORY INULIN OR ORGANIC IRON SUPPLEMENT

Project Leader:
Dr Eric Ponnampalam

Project Participant:
Future Farming Systems Research Department of Primary Industries Victoria

Aims and Objectives

This project was undertaken by the Victorian Department of Primary Industries to provide quantitative analysis of pork fat samples collected from an experiment conducted at DPI Werribee pig research facilities in pigs fed chicory inulin or organic iron as a dietary supplement. The experimental design and the outcomes on growth performance, blood parameters and muscle composition have been reported previously to Pork CRC Pty Ltd under the DPI VIC project agreement CMI-102740 (MIS-08578): Nutritional Manipulation of Iron level in Finisher Pigs and Fresh Pork.

Key Findings

There was an inulin × sex interaction such that inulin reduced (P<0.06) skatole content in males (0.031 vs 0.025 mg/ kg fat tissue) while in female pigs (0.025 vs 0.034) the levels were increased.

Similarly, there was an interaction between inulin and iron supplementation that inulin with organic iron reduced (P<0.03) skatole concentration (0.041 vs 0.020 mg/ kg fat tissue) but not with organic iron without inulin (0.026 vs 0.027) supplementation. Neither inulin nor organic iron had a main effect on androstenone concentration including their (inulin or organic iron) interactions. The results suggest that dietary inulin, with or without organic iron, may lower the skatole content of pork in male pigs. This might have been due to the digestion and absorption process associated with chicory inulin fibre in the large intestine and warrants further investigation.

Application to Industry

Inulin reduced the skatole level in male pigs but increased it in females. Neither inulin nor organic iron affected androstenone levels in male or female pigs.

Further research is required to establish the real value of inulin for the Australian pork industry.

Subprogram 3B: Enhancing the iron content of pork to promote human health benefits

KEY DELIVERABLES

1] Improve the level and bioavailability of iron in pork through dietary iron supplementation.

2] Strategies to enhance the uptake and deposition of iron in pigs to increase the iron content of pork.

3] Investigate pig production systems that enhance the iron content of pork.

4] Use of nutrigenomics to increase the levels of iron in pork through cellular modulation.

PROJECT ID	TITLE
3B–101	Does hypoxia or erythropoietin (EPO) promote iron storage in pork?
3B–102	Genetic parameters and breed differences for iron content in pork
3B–103	Enhancing the Iron Content of Pork to Promote Human Health Benefits *(Now 3C–104)*

Research Summaries for Subprogram 3B

PROJECT 3B–101: DOES HYPOXIA OR ERYTHROPOIETIN (EPO) PROMOTE IRON STORAGE IN PORK?

Project Leader:
Dr Peter G. Allingham

Project Participants:
CSIRO Livestock Industries, Queensland Bioscience Precinct, and School of Veterinary Science, Faculty of Science, University of Queensland

Aims and Objectives

The objective of this project was to perturb iron metabolism and affect iron stores in muscle by hypoxia or by administration of EPO. To that end, pigs were exposed to either intermittent (nightly) hypoxia in a purpose-built chamber over 8 weeks at a simulated altitude of 3800 m (~13% O2) or received a low dose of EPO intravenously every second day for 8 days. Pigs in both studies were at or near market weight at slaughter (70–90 kg).

Key Findings

Whilst there was a demonstrable increase in red blood cell number, haemoglobin concentration and packed cell volume (haematocrit) due to intermittent hypoxia at 28d and 56d of treatment as predicted, there was no increase in iron content in the muscles of pigs.

In contrast, serial injection of EPO over 8d resulted in a 20% increase in iron content of skeletal muscles concomitant with the predicted increase in red cell number, haemoglobin and haematocrit. However, it was apparent that the response to EPO had been limited by availability of iron as evidenced by the mobilisation of iron from both the liver and spleen. This was despite access to dietary iron in excess of 400mg/day.

Application to Industry

The hypoxia study confirmed the refractory nature of pig muscle to dietary supplementation of iron. Nonetheless, there was evidence that iron supplementation influenced iron stores in the liver and spleen and circulating levels of serum iron suggesting there had been a differential effect on partitioning and mobilisation of iron resources. There was also evidence to suggest that fortification of the diet with iron had altered the dressing percentage of the pig suggesting there had been a reduction in the weight of viscera of these pigs without compromising the weight of saleable meat.

Serial injection of EPO is not considered a commercial strategy for increasing the level of iron in pork. Nonetheless, there was proof of the concept that it is possible to perturb iron metabolism in pigs and increase the iron content of their muscles. This work lays the foundation for increasing the effect of EPO and through further research raises the possibility of manipulating the networks underpinning iron metabolism to provide a commercially viable approach to achieve the desired increase in muscle iron level.

Research Summaries for Subprogram 3B continued

PROJECT 3B–102: GENETIC PARAMETERS AND BREED DIFFERENCES FOR IRON CONTENT IN PORK

Project Leader:
Dr Susanne Hermesch

Project Participants:
AGBU and Rivalea Australia

Aims and Objectives

The aim of this study was to obtain genetic parameters for haemoglobin levels in blood and iron content in pork and to estimate genetic correlations between these measures of iron and meat quality and performance traits.

Key Findings

Iron content in pork was moderately heritable (0.34 ± 0.07) and genetic correlations with haemoglobin measures ranged from 0.39 ± 0.24 to 0.58 ± 0.13 indicating its potential use as a selection criterion for increasing iron levels in pork. However, heritabilities for haemoglobin were low, ranging from 0.04 ± 0.2 to 0.18 ± 0.04 and the on-farm haemoglobin measure may require refinement-using experiences from other Australian studies that have used the HemoCue® device successfully on farm to measure haemoglobin levels in pigs (i.e. Payne, 2009).

Application to Industry

Current selection practices are not expected to affect iron content in pork, given that no significant genetic correlations between performance and haematological traits were found. Therefore, the exact causes of the observed reduction in iron levels of pork over time remain unknown.

www.porkcrc.com.au