


Establishing Western Australia as the centre for the production of high quality free range pork

GGRD-2015-0069

Prepared by
Pork Innovation WA Inc

February 2019

PIWA Pork Innovation WA

GOVERNMENT OF WESTERN AUSTRALIA

Department of
Primary Industries and Regional Development

Introduction

Pork Innovation WA Inc received a grant from the Western Australian Grower Group Research and Development Grants Program (Application GGRD 2015-0069-AGSC) to investigate means of establishing Western Australia as the centre for the production of high quality free range (FR) pork.

The aims and objectives of the project were to:

- Determine the drivers of demand for FR pork in WA.
- Define FR product characteristics and identify management strategies which can influence eating quality.
- Overcome productivity and efficiency drawbacks of FR systems by improving subsequent reproductive performance of sows affected by summer infertility and enhancing piglet survival and weaning weights.
- Assess the net benefits of the production findings from these studies and provide producers, investors, processors and retailers with current management and product information.
- Communicate findings to the supply chain.

This publication provides an overview of the information gained over the course of the project.

Figure 1. The label that identifies pork as APIQ✓® Free Range accredited.

What is free range pork?

There are a variety of FR accreditation schemes, however the Australian Competition and Consumer Commission (ACCC) conducted a review on the industry and stated that pork labelled 'free range' must be from pigs that are 'able to move about freely in an outdoor paddock on most ordinary days' (APIQ✓® Free Range) (ACCC 2015).

The Australian Pork Limited (APL) Free Range definition is:

Pigs are kept permanently outdoors for their entire life with shelter from the elements provided, furnished with bedding.

Free range pork production consists of outdoor paddocks, which include rooting and/or foraging areas, wallows (where state regulations and seasonal climates permit) and kennels/huts for shelter. The huts allow the animals to seek shelter from environmental extremes and provide additional protection for piglets.

The weaners, growers, and sows from which they have been bred have access to paddocks at all times for their entire life. Shelter, food and water must be provided and all pigs must be able to move freely in and out of the shelter and move freely around the paddocks, unless required to be confined for short amounts of time for routine husbandry or diagnostic procedures to be conducted.

All pigs raised under FR conditions must comply with the *Model Code of Practice for the Welfare of Animals – Pigs* to show compliance with state animal welfare regulations and use good land management practices as per the *National Environmental Guidelines for Piggeries*.

A desktop study was conducted in 2017 with the objective of gaining a greater understanding of product characteristics and market demand for Australian FR pork.

Who are free range pork consumers?

The typical FR pork consumer would largely be described as either "knowledgeable" or "caring". It was deduced that there is an expectation by consumers that quality will be maintained across the FR pork range. Hence, the supply chain needs to not only meet the FR pork specifications but also provide a quality product. In addition, consumers are becoming more sophisticated and their preferences are changing over time. It could be argued that demand for FR pork is increasing as people become aware of animal production practices and that this trend is likely to continue as more people have access to web-based information sources.

Is there a price premium for free range pork?

Retail price data is notoriously difficult to obtain but an observation of prices would suggest that consumers would be willing to pay a premium of between 10 and 27 per cent for FR pork in Western Australia (in 2017). It was also muted that supermarkets seek a range of meat products with benefits to them in being able to offer consumers the choice of "sow stall free" and FR pork.

Potential market opportunities for free range pork

It is expected that consumers will not readily alter their purchasing decisions with regard to FR pork because it falls into the "expensive" meat category. It is also likely that consumers will not readily switch between FR chicken and FR pork as the price of both tends to move in unison. However, it is thought that they will seek healthy, convenient food and so it might be pertinent for those involved with labelling to consider some of this detail. Further, given the consumer type that is likely to buy FR pork, it would be pertinent to make it clear that FR pork products are domestically produced in Australia.

The domestic market in Australia is the current focus for FR range pork produced in WA. It is also timely to consider international opportunities for this product. In terms of FR pork, Singapore would be the obvious market to explore further due to the already established ties there and possibly the growing population of "caring" consumers. However, there may also be opportunities to export premium Australian pork products to other countries such as Hong Kong and China.

Free range pork production in Western Australia in 2016 and 2017

An objective of this project was to establish the seasonal variation in supply of FR pork carcasses and how this differed to conventionally produced pork.

Abattoir data was collected from the 01 January 2016 to 31 December 2017 to provide an overall snapshot of the supply of pigs from FR compared to other production systems in Western Australia. Suppliers included were commercial farms whom were accredited as APIQ✓® Free Range in the 2016 and 2017 calendar years. The data were collected from Linley Valley Pork, Western Australia's export accredited, single species abattoir which processes the majority of pork in Western Australia (approximately 95%).

Figure 2 shows that over the two year period there was an increase in the total proportion of FR pigs slaughtered from 25 to 30%. There was also greater variability in the monthly supply of FR pigs during 2017 compared to 2016.

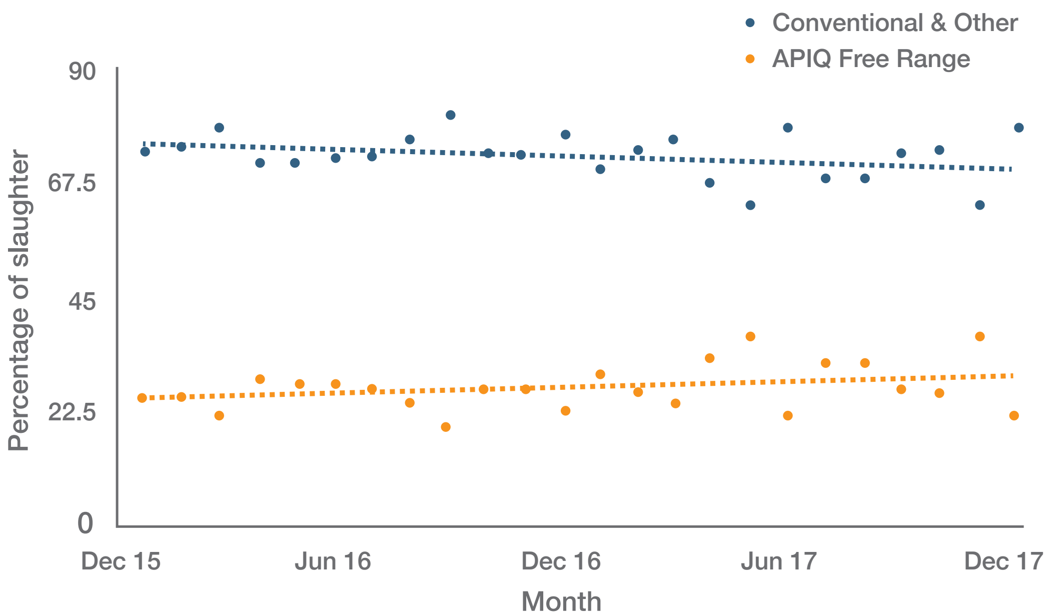

Figure 2. Percentages of pigs slaughtered in Western Australia for free range compared to other production systems from 01 January 2016 to 31 December 2017.

Overcoming heat stress in free range sows

An objective of this project was to overcome productivity and efficiency drawbacks of FR systems by improving subsequent reproductive performance of sows affected by summer infertility and enhancing piglet survival and weaning weights.

The extended exposure of sows in FR systems in WA to physiological heat stress can cause losses of 2 pigs/sow/year, indicating annual losses in excess of $50,000 in a 500 sow farrow-to-finish FR system. Further economic loss occurs due to lower milk production and reduced piglet growth during lactation. Therefore, addressing physiological malfunctioning caused by heat stress in FR sows is one of the most important influences on efficiency and welfare of FR pork production in WA. Several options were investigated in this project to try to reduce heat stress, including hut cooling and adjusting lactating sow nutrition.

Hut cooling

The objective was to test the concept that by providing a source of cooled air within the farrowing hut during summer conditions the lactating sow would find the environment more comfortable and choose to spend more time within the hut. This would be particularly important during the early lactation period when piglets are confined to the hut and potentially could allow greater suckling opportunities for the piglets. It could also reduce the impact of heat stress on the sow and therefore improve her subsequent reproductive cycle.

Solar powered snout coolers were identified as the most appropriate system to develop for the farrowing huts. The idea was to provide a zone of cooled air inside the hut that could be accessed voluntarily by sows to improve their own thermal comfort, whilst avoiding the risk of chilling the piglets.

The project was conducted in two parts:

1) **Preliminary study:** Conducted over 2 farrowing batches to test and refine the hut monitoring system and the hut cooling system, to determine the best location for the snout cooling tube ("snoutlet") and determine the appropriate temperature at which to initiate cooling.

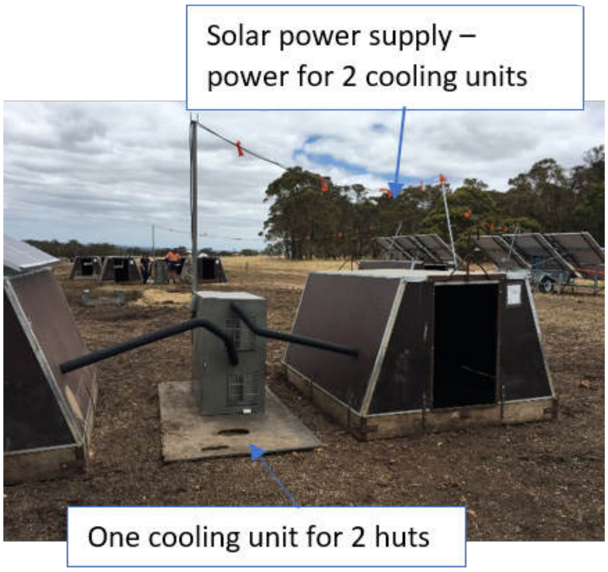

Figure 3. External view of cooled huts.

Figure 4. Position of snoutlet and direction of airflow.

2) **Proof of concept study:** Conducted over 3 farrowing batches to compare if snout cooling could positively impact on sow and piglet behaviours, numbers weaned and the sow's subsequent reproductive performance.

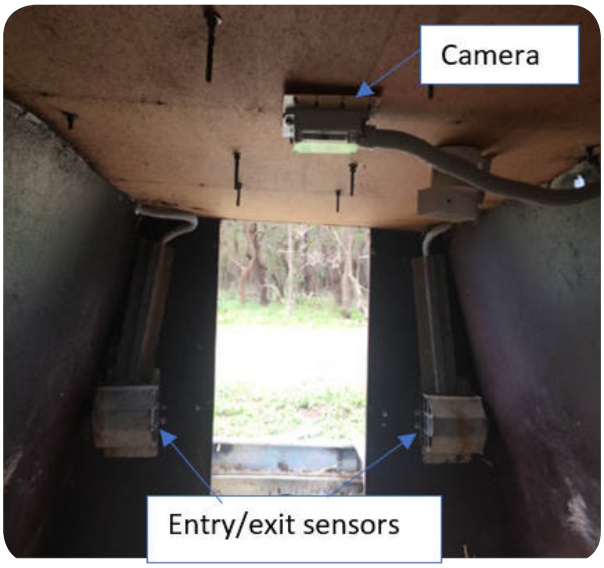

Figure 5. Internal fit-out of the hut.

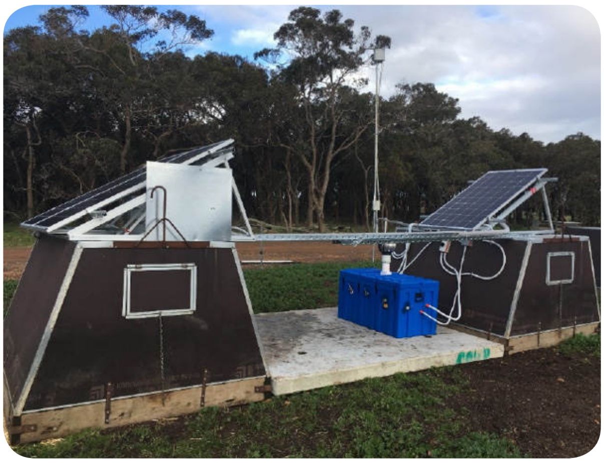

Figure 6. External view of huts showing solar panels, battery storage box and the remote communications tower in the background.

Figure 7: Camera view of the farrowing hut.

Monitoring the system

Simon Dutton, an engineering student from the University of Southern Queensland, developed the remote monitoring system through his honours project. The system comprised of a power source, communications and server, data processing and storage capability, sensors and software. Entry and exit sensors were installed to determine how long the sows spent in the huts during daylight hours. Cameras were also installed which allowed sow behaviour to be observed.

Two prototype solar powered, refrigerated cooling units were designed and built (Z. Cochran, Cool Sparky EC8759). Each provided cooled air to two huts.

What we did (main study)

The study was conducted in a farrowing paddock containing 11 farrowing huts, over 3 batches of sows.

- Data was collected from up to 4 cooled huts and 7 control huts per batch.
- For the cooled huts, fans initiated at an ambient temperature of 21°C, cooling initiated at 23°C.
- When the ambient temperature was between 23-30°C the air was chilled to 16-18°C. At higher temperatures the chilled air remained about 10°C cooler than ambient air**.
- Two cooled huts and two control huts were video monitored per batch to observe sow and piglet behaviour.
- Footage of pig activity within the hut was reviewed between 9am and 5pm, for the first 5 days after farrowing.
- Farrowing records, pre-weaning mortality, weaning records and subsequent mating and farrowing records were collected.

**To maintain the cooled air consistently at 16-18°C was not achievable as the cooled air was not being recycled through the cooling system and the power drain required from the batteries would have been too great.

Limitations of the project

The original project concept was to retro-fit off-the-shelf solar powered evaporative coolers to farrowing huts. The limitations of these coolers became evident, in particular that the coolers would require a high level of day to day maintenance which would not be practical within a commercial environment. Customised, low maintenance, refrigerated cooling units were designed and built. Working within the project budget meant that two units (and the appropriate solar power supply) were commissioned to provide snoutlets to 4 farrowing huts.

The behaviour information collected during this project is unique, as similar information has not been reported previously. A combination of constraints (economic, commercial and seasonal) resulted in low replicates of both monitored huts and cooled huts. Unfortunate timing of the project relative to the 2018 Australian pork industry downturn also meant that information relating to subsequent reproductive performance was limited, as a significant proportion of the sows were culled after weaning.

Results

Table 1. Farrowing performance.

	Snout cooling	Control		Treatment
	Average	Average	sed	P-value
Parity	2	2	0.426	NS
Total number born	10.8	13.6	1.64	NS
Number born alive	10.4	11.4	1.46	NS
Number born dead	0.4	2.1	0.59	0.009
% Born alive	95.6	85.9	3.93	0.02
Pre wean mortality	0.9	0.9	0.44	NS
Number weaned	10.5	10.7	0.71	NS
% Weaned*	91	92.5	3.72	NS
Change in sow body condition	4.4	3.5	0.56	NS

Parity was considered in the analyses as a covariate. *Calculated from total piglet number after fostering was completed.

Table 2: Sow behaviour.

	Snout cooling	Control		Treatment
	Average	Average	sed	P-value
Time outside of hut (mins)*	37.3	92.2	30.84	0.083
Number of suckling events*	10.9	9.7	1.19	NS

*Daily events between 9 and 5 pm.

Outcomes

- Observations confirmed that sows most commonly positioned themselves in the hut so that they were lying with their head facing the doorway (and tail to the back of the hut).
- The source of cooled air via the snoutlet did not alter the internal environment of the farrowing hut.
- The percentage of the litter born alive was higher for sows that farrowed in cooled huts.
- Percentage of the litter weaned, pre-weaning mortality and change in sow body condition during lactation was impacted by parity but not hut cooling.
- There was a trend for sows in the cooled huts to spend less time outside the hut during the first 5 days after farrowing (between 9am-5pm) – 37 minutes/day (cooled) versus 92 minutes/day (control).
- Behaviours, including total time spent outside of hut and the number of suckling events were variable across sows regardless of hut type and parity.
- Subsequent farrowing performance did not appear to be impacted by hut cooling.

Conclusions

The outcomes suggest that by providing a source of cooled air within farrowing huts the sow is positively impacted during farrowing (in terms of pigs born alive) and chooses to spend more time within the hut during the early lactation period (while piglets are confined). Litters within cooled huts may benefit in terms of survivability and growth rate as there is the potential for more suckling.

Even though the solar-powered snoutlet cooling system is not currently a commercially viable device the results of this study suggest that the concept of utilising snout cooling in farrowing huts during summer to manage the impact of heat stress on the sow does warrant further investigation.

Managing heat stress through lactating sow nutrition

Figure 8. Measuring sow body composition.

Figure 9. Sows feed the control diet on entry to the farrowing paddocks.

Table 3: Number of sows and paddocks per treatment.

	Control	EFA + Betaine
Number of sows	99	95
Number of paddocks	10	11
Sows/paddock	Range from 9 to 11	Range from 8 to 12

Previous research had shown that there was potential to manage the loss of reproductive performance due to heat stress by the dietary addition of:

1. Betaine:
    a. A methyl donor and osmotic regulator
    b. Addition shows significant improvements in the reproductive performance of breeding herds exposed to heat stress.

2. Essential fatty acids (EFA):
    a. These need to be supplemented in the diet as pigs have limited ability to synthesise their own EFA
    b. Play many important roles including the proper functioning of cells and are involved in immune function.

Our aim was to improve sow reproductive performance and piglet growth performance during summer months through supplementation of betaine and essential fatty acids to prevent the depletion of the sow's EFA body reserves and maintain cellular osmotic regulation during heat stress periods.

In our project:

- 194 sows from a commercial FR farm were used over two farrowing batches (Table 3).
- Sows were fed either a control diet (commercial lactation diet) or an experiment 'heat stress' diet (commercial lactation diet supplemented with alpha linoleic acid (100 g/day), linoleic acid (125 g/day) and betaine (2 g/kg)).
- The diets were fed to separate 'farms'.
- A red dye was added to the heat stress diet to ensure correct feed delivery on farm.
- Sows were fed the diets for 5 weeks from entry into the farrowing paddock until weaning.
- Piglets were weighed at weaning (approximately 3 - 4 weeks of age).
- Sow body condition was measured on entry and exit to the farrowing paddock.

- Blood samples were taken from selected piglets at weaning to measure the concentration of linoleic acid and alpha linoleic acid.

The daily maximum and minimum temperatures on-farm during January and February 2018 are given in Figure 10.

Outcomes from our project

- The sows did not like the 'heat stress' diet and feed intake was reduced which subsequently impacted on piglet performance and reproductive performance.
  - Was it because of the red dye? Possibly – however, food dye has previously been used in sow diets with no adverse impacts.
  - Was it because of the diet ingredients? Maybe.
- The plasma fatty acid profiles for the piglets showed the following differences (Table 4):
  - Linoleic acid, omega-6 polyunsaturated fatty acids and n6:n3 fatty acids were higher in piglets from sows fed the heat stress diet.
  - Omega-3 polyunsaturated fatty acids were lower in piglets from sows fed the heat stress diet.
- These differences were expected due to the differences in the fatty acid contents of the diets.

Conclusions

Unfortunately no conclusions can be drawn from this study as the sows had a reduced intake of the 'heat stress' diet compared to the control diet. Other research has consistently demonstrated the benefits of including betaine and EFA to reduce the impact of heat stress in sows. Therefore it is suggested that the idea be revisited for FR sows during summer months, on a smaller scale and on the same farm to reduce variability (differences in farm management practices) that may impact on the results.

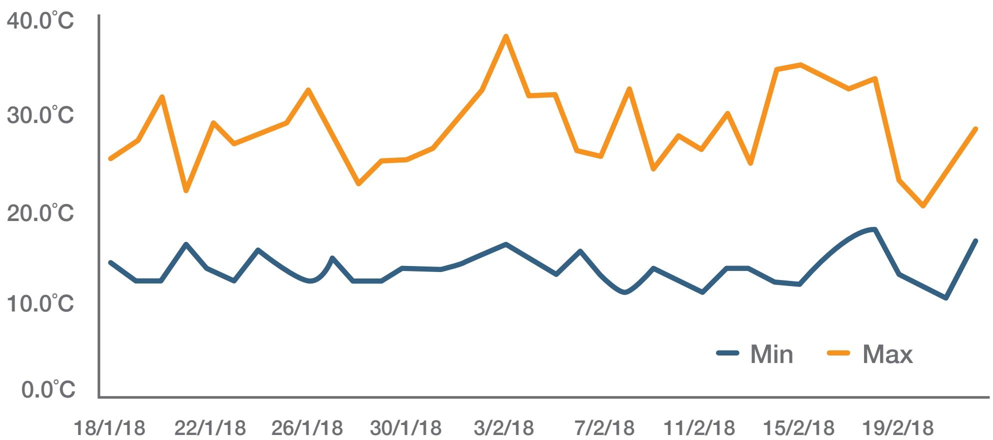

Figure 10: The daily maximum and minimum temperature on the farm in January and February 2018.

Table 4: Differences in plasma fatty acid profiles for piglets weaned from sows fed either the control or heat stress diet.

Plasma fatty acid profiles for piglets (g/100 g)	Control	Heat stress	SED	P-value
Saturated fatty acids	35.1	34.9	0.445	NS
Monosaturated fatty acid	24.0	22.4	0.579	0.014
n-6 Polyunsaturated fatty acid	32.5	34.8	0.435	<0.001
n-3 Polyunsaturated fatty acid	5.12	4.76	0.148	0.027
n-6:n-3	6.49	7.46	0.229	<0.001
Linoleic acid	23.8	26.1	0.487	<0.001
Alpha linoleic acid	1.15	1.22	0.053	NS

Pork quality:
free range vs. conventional

Studies have found differences in pork quality from pigs reared in FR and conventional environments, however, such differences are not always influenced favourably or consistently by FR production. To establish WA as the centre for production of FR pork and provide long term supply security, it's important to produce consistent, high quality product. The information and tools available to producers regarding the management of pigs in FR systems, specific to Australian conditions, are limited, in particular, strategies to ensure the production of optimal and consistent carcass and pork quality.

This component of the project aimed to establish the current characteristics and quantify variation of FR carcasses and compare the pork quality attributes from pigs raised in APIQ✓®-certified FR production systems against pork from pigs raised conventionally (indoors).

What we did

A conventional herd and a FR herd that came from the same genetic line and were fed a similar feeding program were selected. All pigs slaughtered over a two year period (2016-2017) were identified and carcass characteristics were compared. Between March 2017 and February 2018 20 entire male carcasses were randomly selected from each production system on a monthly basis for fresh pork quality analysis (Figure 11).

Figure 11. Preparing samples for analysis of drip loss.

Outcomes from our project

Carcass quality

- Carcass weights were more variable for FR pigs.
- The relationship between carcass weight and P2 depth differed between production systems (Figure 12).
  - Back fat depth was less sensitive to changes in live weight (and therefore carcass weight) for FR pigs compared to conventional pigs.
- There was an impact of season on P2 depth but not production system.
  - Overall, pigs from FR and conventional systems were very lean, well below the 12 mm market threshold.

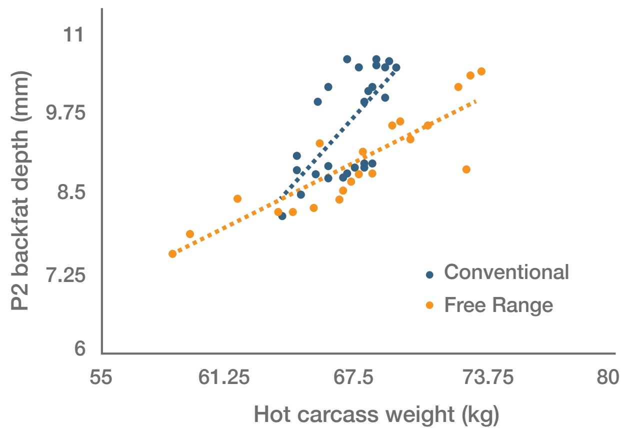

Figure 12: Relationship between hot carcass weight and P2 backfat depth for free range and conventional focus herds (monthly averages 2016-2017).

Pork quality results

- Chiller loss was significantly lower in FR carcasses.
  - Equivalent to an average of 0.5 kg less in a 68 kg carcass.
- Drip loss was higher from FR pork.
- In general, measurements of the pork quality attributes indicated that pork quality was similar between FR and conventional fresh pork, however there were subtle but consistent differences in pH and colour.
- pH was higher in FR carcasses 1 hour after slaughter and at 24 hours post slaughter (Figure 13).
  - Higher pH, particularly while the carcass is hot, has potential benefits for pork quality and eating quality attributes.
- There were subtle measurable differences in pork colour between FR and conventional pork. On average the colour difference was small and less likely to be noticed by consumers, except during Spring where FR pork was darker and the difference in colour was at a level that is detected by consumers.
- Fatty acid profiles and the percentage of intramuscular fat was similar for FR and conventional pork.
  - As the fatty acid profile is a primary contributor to flavour we expect that production systems in this study had very little impact on the flavour profile of the pork.
- There were no differences in the level of the boar taint compounds (androstenone and skatole) in fat tissue from FR and conventional entire male pigs.
  - There were carcasses from both production systems where the boar taint compounds occurred above the detection threshold.

Implications and follow up actions

- Determine potential management strategies specific to FR production systems to reduce/manage variability in carcass weight.
- Determine if packaging of fresh FR pork cuts requires review to improve presentation of the product (in response to higher drip loss ion FR pork).
- Establish colour parameters, prepare information (processor and customer oriented) to promote the quality parameters of FR fresh pork to increase awareness about the attributes (i.e. colour) specific to the FR product.

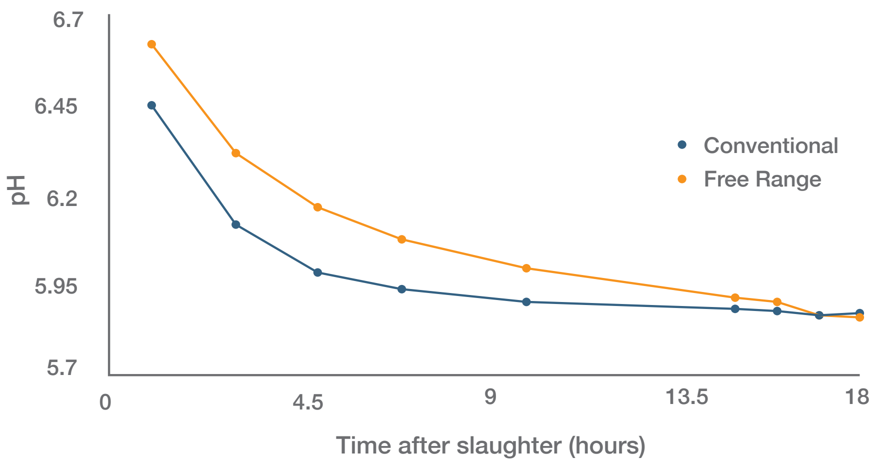

Figure 13: Average pH declines during chilling for free range and conventional carcasses. and conventional carcasses.

Bioeconomic assessment of strategies to counter heat stress in sows

The project also aimed to assess the net benefits of the production and pork quality findings. Due to the small number of 'cooled' huts and the inability to draw a conclusion from the nutrition experiment, data reviewed from the literature was used in the analysis.

What did we do?

The bioeconomic, simulation model, PIGS, was used to generate outcomes pertaining to a sow unit and a farrow-to-finish enterprise when different biological and economic constraints were imposed on these systems.

It was assumed that a cooling system design for farrowing huts improved physiological outcomes for the sow and favourably modified sow behaviour in hot conditions and enhanced piglet survival. It was expected that sows would spend more time in their huts and thus increase suckling frequency. The sows' improved thermal comfort would be expected to reduce restlessness and the risk of piglet overlay, increase feed intake and thereby milk production.

Further, it was assumed that the supplementation of essential fatty acids (EFA) and betaine in lactating sow diets will prevent depletion of EFA body reserves and maintain cellular osmotic regulation under heat stress. This was expected to improve one or more of the following: subsequent farrowing rate; the number of pigs born alive; milk production for enhanced pig survival; and weaning weights.

Outcomes

The results provided an indication of how the model can be used to generate outcomes and how parameter values can be altered to indicate the sensitivity of the results to such changes. Being a simulation model, there are many scenarios that could be generated to answer specific questions, however, the focus here has been on specific management activities to reduce heat stress for the sow. In addition, the ramifications of changing demand was considered in terms of the impact on pork price changes.

Even though the actual figures generated from the model may be of interest, they do not necessarily reflect a real situation. Hence, they should not be quoted out of context. Nevertheless, the comparison between figures for different options is justifiable because the assumptions are consistent.

With regard to the status quo, a standard option could be simulated for a farrowing enterprise that was reasonable in terms of economic and physical conditions in WA. In addition, it was possible to generate options to alleviate heat stress in sows through infrastructure changes, the use of essential fatty acids (EFA) or the use of betaine. The only parameter value that was not based on a medium long term average was the price of feed. It was deliberately forced down so that positive values for the economic criteria could be generated. It was then possible for comparisons to be made between the options. In the case of the status quo all options were economically viable based on the assumptions used in the model. As a consequence, a producer could consider the key parameters that could be expected to change given a treatment to alleviate heat stress and select an option that they considered most likely.

When considering likelihood or risk it is useful to look at the implications of changes and so the sensitivity analyses that were done are of interest. In all, the model indicated that the relevant parameters were sensitive to relatively small changes in value. Hence, to achieve positive outcomes it could be suggested that producers focus not only on increasing production but also on reducing risk through for example, production management.

The model results suggested that integrating treatments could be effective (Table 5). This being so it was possible to more accurately reflect the cost of feed in the model. This outcome reinforces the need for producers to focus on the activities that they have some control over or can work to lessening the risk associated with the production.

The results also emphasised the impact that the price of pork has on the profitability of pork production. Demand is difficult to estimate. Hence, FR producers should be aware of the market for their products and be prepared for fluctuations in price.

Table 5: Economic criteria vales generated by the PIGS model that allow comparison of alternative management options when treatments are considered together.

Option	Standard outdoor	Standard outdoor & hut cooling & betaine	Standard outdoor & hut cooling, EFAs & betaine
Farrowing rate (%)	80	82	84
Live piglets born/sow/farrowing	10	10.295	10.495
Pre-weaning deaths (hd)	1.5	1.46	1.44
Piglet LWT gain (ADG) kg/day	0.210	0.215	0.223
Piglet weaning weight (kg/hd)	6.23	6.35	6.53
Piglets weaned/sow/yr	21.5	22.4	23.0
Feed lactating sow ($/T)	270	270	425
Betaine costs: pre-gestation ($/hd/d)	0.00	0.042	0.042
Betaine costs: gestation ($hd/d)	0.00	0.061	0.061
Cost of hut ($/unit)	200	1,000	1,000
General labour ($/sow/day)	1.00	1.15	1.15
Management labour ($/hd/d)	0.10	0.175	0.175
Maintenance/repairs ($/hd/d)	0.10	0.15	0.15
Utilities ($/hd/d)	0.15	0.21	0.21
NPV (20 years) ($)	5,165	8,323	30,238
IRR (20 years) (%)	6.13	6.18	6.63
B:C ratio (20 years)	1.000	1.000	1.001
NVP/piglet weaned ($/hd)	0.03	0.05	0.16

These results provide a snapshot of the potential output from the model. They should be used with caution and should not be reported elsewhere without explaining the assumptions that have been used to generate them. However, they indicated that alleviating heat stress in sows should be considered by producers in FR systems in Western Australia.

Recommendations from the model

The following recommendations have been made:

1. Producers consider methods to alleviate heat stress in sows in their production systems;
2. Producers examine production risks in their systems and mitigate these risks;
3. Producers focus on the determinants of supply and demand for FR pork to mitigate price risk.

For further information about the Free Range project:

Pork Innovation WA

Emalyn Loudon
contact@piwa.com.au
0429 370 289

Dr Karen Moore
karen@klmconsulting.com.au

Dr Megan Trezona
mtrezona@craigmostyn.com.au

Dr Johanna Pluske
jpluske@bigpond.com

Acknowledgements

The funding and assistance provided by the following organisations is gratefully acknowledged.

Department of **Primary Industries and Regional Development**
GOVERNMENT OF WESTERN AUSTRALIA

CM Farms

LINLEY VALLEY PORK

Murdoch UNIVERSITY

This grant is administered through the Department of Primary Industries and Regional Development's Agribusiness Innovation Fund.

PIWA Pork Innovation WA