Pork Production With Entire Male Pigs and Immunocastrates

An Australian Perspective

D.N. D’Souza, R.J.E. Hewitt, R.J. van Barneveld

SunPork Group, Murarrie, Queensland, Australia
This presentation

• Australian pig production
• Entire male pigs
  • Issues (boar taint incidence, welfare, eating quality)
• Immunocastration
  • Australian R&D
• Industry adoption and market acceptance

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Australian pork industry

Breeding herd size: ~275,000 sows
Annual slaughter: 5.3M pigs

Conventional housed ~ 87%
Outdoor housed ~13%

15 Producers ~50% of production
400 producers ~90% of production
1,800 producers ~10% of production

Pork consumption: ~ 27kg
Fresh ~ 11kg
Processed ~ 16kg
(Imported processed ~70%)
Per capita consumption, demand for pork increasing

ABARES, 2017

Nielsen Homescan Data 2017
## Cost of production  (cost/kg HSCW, 75kg carcase)

<table>
<thead>
<tr>
<th>Cost Area</th>
<th>Low Range</th>
<th>High Range</th>
<th>Average</th>
<th>Average (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freight</td>
<td>$0.09</td>
<td>$0.14</td>
<td>$0.12</td>
<td>0.08</td>
</tr>
<tr>
<td>Feed costs</td>
<td>$1.50</td>
<td>$1.70</td>
<td>$1.60</td>
<td>1.02</td>
</tr>
<tr>
<td>Labour</td>
<td>$0.40</td>
<td>$0.45</td>
<td>$0.42</td>
<td>0.27</td>
</tr>
<tr>
<td>Utilities</td>
<td>$0.08</td>
<td>$0.12</td>
<td>$0.09</td>
<td>0.06</td>
</tr>
<tr>
<td>Repair and maintenance</td>
<td>$0.06</td>
<td>$0.12</td>
<td>$0.09</td>
<td>0.06</td>
</tr>
<tr>
<td>Genetics</td>
<td>$0.07</td>
<td>$0.10</td>
<td>$0.08</td>
<td>0.05</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>$0.12</td>
<td>$0.25</td>
<td>$0.20</td>
<td>0.13</td>
</tr>
<tr>
<td>Facility</td>
<td>$0.06</td>
<td>$0.12</td>
<td>$0.08</td>
<td>0.05</td>
</tr>
<tr>
<td>Technical services</td>
<td>$0.06</td>
<td>$0.08</td>
<td>$0.07</td>
<td>0.05</td>
</tr>
<tr>
<td>Consumables</td>
<td>$0.04</td>
<td>$0.12</td>
<td>$0.06</td>
<td>0.04</td>
</tr>
<tr>
<td>Corporate and administration</td>
<td>$0.04</td>
<td>$0.06</td>
<td>$0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>Finance</td>
<td>$0.02</td>
<td>$0.05</td>
<td>$0.03</td>
<td>0.02</td>
</tr>
<tr>
<td>Cull sow value</td>
<td>$0.10</td>
<td>$0.12</td>
<td>$0.11</td>
<td>0.07</td>
</tr>
<tr>
<td><strong>TOTAL COSTS</strong></td>
<td><strong>$2.64</strong> (€1.67)</td>
<td><strong>$3.43</strong> (€2.19)</td>
<td><strong>$3.00</strong></td>
<td><strong>€1.93</strong></td>
</tr>
</tbody>
</table>

![Graph showing cost over time](chart.png)

APL, 2017
Feed cost extremely high due to drought
This presentation

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➢ SunPork Group
Entire male pig production – focus on efficiency

- Ceased surgical castration late 1970s
- Relatively low slaughter weight (HSCW) ~55kg (±10kg)
- Enhance growth performance and efficiency
- Carcase trade
- Domestic markets only
- Payment on backfat and weight

Now:
- Growth and efficiency focus continue
- Slaughter weights have increased marginally ~76kg (up to 100kg)
- Domestic and export markets (and value-add products)
- Mainly boxed sub-primal and cuts trade, with some carcase trade
- Payment still on backfat and weight (rather than LMY or SLMY)
But we have created a few issues!

- Entire male pig (boar taint)
- <1% IM fat
- Inconsistent ageing period (2-5 days)
- Cooked 'well done' (>75°C)
High incidence of boar taint

Sensory thresholds

>25% of pigs above sensory thresholds

(Hennessy et al. 1997)

(D’Souza et al., 2011)
Poor correlation between boar taint risk and carcase weight

\[ R^2 = 0.0055 \]

Androstenone µg/g vs. Hot carcass weight (kg)

\[ R^2 = 0.0043 \]

Skatole µg/g vs. Hot carcass weight (kg)

(D’Souza et al., 2011)
Carcase weight strategies don’t work

Fail rate: % Quality Grade <3
(1 = Unsatisfactory; 2 = Below average; 3 = Average; 4 = Above average; 5 = Excellent)

D’Souza et al. (Unpublished); Pork CRC Final Report (2013) 3Z-110
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# Cost of production (cost/kg HSCW 75kg carcase)

<table>
<thead>
<tr>
<th>Cost Area</th>
<th>Low Range</th>
<th>High Range</th>
<th>Average</th>
<th>Average (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling costs – freight, levies</td>
<td>$0.09</td>
<td>$0.14</td>
<td>$0.12</td>
<td>0.08</td>
</tr>
<tr>
<td>Feed costs – inc mill and delivery</td>
<td>$1.50</td>
<td>$1.70</td>
<td>$1.60</td>
<td>1.02</td>
</tr>
<tr>
<td>Labour</td>
<td>$0.40</td>
<td>$0.45</td>
<td>$0.42</td>
<td>0.27</td>
</tr>
<tr>
<td>Utilities – electricity, water, gas</td>
<td>$0.08</td>
<td>$0.12</td>
<td>$0.09</td>
<td>0.06</td>
</tr>
<tr>
<td>Repair and maintenance</td>
<td>$0.06</td>
<td>$0.12</td>
<td>$0.09</td>
<td>0.06</td>
</tr>
<tr>
<td>AI/breeding stock/selection fees</td>
<td>$0.07</td>
<td>$0.10</td>
<td>$0.08</td>
<td>0.05</td>
</tr>
<tr>
<td>Pharmaceutical costs(vacc; treatments, etc)</td>
<td>$0.12</td>
<td>$0.25</td>
<td>$0.20</td>
<td>0.13</td>
</tr>
<tr>
<td>Facility costs inc depreciation, licences, rates</td>
<td>$0.06</td>
<td>$0.12</td>
<td>$0.08</td>
<td>0.05</td>
</tr>
<tr>
<td>Vet/nutrition/consultants/audits</td>
<td>$0.06</td>
<td>$0.08</td>
<td>$0.07</td>
<td>0.05</td>
</tr>
<tr>
<td>Consumables, straw, etc</td>
<td>$0.04</td>
<td>$0.12</td>
<td>$0.06</td>
<td>0.04</td>
</tr>
<tr>
<td>Other misc costs incl corporate</td>
<td>$0.04</td>
<td>$0.06</td>
<td>$0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>Finance costs</td>
<td>$0.02</td>
<td>$0.05</td>
<td>$0.03</td>
<td>0.02</td>
</tr>
<tr>
<td>Adjustment for Cull sow value</td>
<td>$0.10</td>
<td>$0.12</td>
<td>$0.11</td>
<td>0.07</td>
</tr>
<tr>
<td><strong>TOTAL COSTS</strong></td>
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<td>$3.00</td>
<td>€1.93</td>
</tr>
</tbody>
</table>

- **Immunocastration**: $0.05 - 0.09 (€0.03 - 0.06)
Immunocastration and aggression

**Note:**
*General observations indicate that there is an increase in leg damage in entire male pigs*

Cronin et al. (2003)

Approx. 15% of entire male carcases had moderate to severe skin scratches

Scratch damages scale:
1 - None
2 - Carcass covered less than 20%
3 - Carcass covered 20% - 60%
4 - Carcass covered above 60%

(Karaconji al. 2011)
Global Literature review

Compilation of large database containing over 250 published and non-published datasets on effects of production, processing and cooking parameters on pork eating and technological quality.

<table>
<thead>
<tr>
<th></th>
<th>Entire male</th>
<th>Female</th>
<th>Immunocastrate</th>
<th>Surgical castrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall liking*</td>
<td>48.37</td>
<td>50.34</td>
<td>57.60</td>
<td>53.61</td>
</tr>
<tr>
<td>IMF %</td>
<td>1.82</td>
<td>1.92</td>
<td>2.21</td>
<td>2.34</td>
</tr>
</tbody>
</table>

*0 - dislike extremely to 100 - like extremely

Channon et al., 2011
Entire male pigs have highest fail rates (Australian data)

<table>
<thead>
<tr>
<th></th>
<th>Entire male</th>
<th>Female</th>
<th>Surgical castrate</th>
<th>Immunocastrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Fail rate</td>
<td>21.5</td>
<td>19.8</td>
<td>17.7</td>
<td>16.9</td>
</tr>
</tbody>
</table>

Average incidence for 6 studies and across different supply chains

Fail rate: % Quality Grade <3 (1 = Unsatisfactory; 2 = Below average; 3 = Average; 4 = Above average; 5 = Excellent)

>14,000 consumer assessments

Channon et al., Pork CRC Program 3
### Sensory fail rates for pork

<table>
<thead>
<tr>
<th>Study</th>
<th>Entire males</th>
<th>Females</th>
<th>Surgical castrates</th>
<th>Immunocastrates</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channon et al. (2016)</td>
<td>23.0</td>
<td>19.1</td>
<td>17.7</td>
<td></td>
<td>0.005</td>
</tr>
<tr>
<td>Channon et al. (2018a)</td>
<td>17.8</td>
<td></td>
<td></td>
<td>15.7</td>
<td>0.19</td>
</tr>
<tr>
<td>Jose et al. (2013)</td>
<td>23.8</td>
<td></td>
<td></td>
<td>19.4</td>
<td>0.19</td>
</tr>
<tr>
<td>Channon et al. (2015)</td>
<td></td>
<td>19.6</td>
<td></td>
<td>15.8</td>
<td>0.004</td>
</tr>
<tr>
<td>Channon et al. (2018b)</td>
<td>21.9</td>
<td></td>
<td></td>
<td>18.7</td>
<td>0.031</td>
</tr>
<tr>
<td>Channon et al. (2018c)</td>
<td></td>
<td>19.1</td>
<td></td>
<td>18.5</td>
<td>0.75</td>
</tr>
<tr>
<td>Moore et al. (2017)</td>
<td>29.8</td>
<td></td>
<td></td>
<td>20.7</td>
<td>0.007</td>
</tr>
</tbody>
</table>
## Critical quality control points for pork

**Commercial issue**

Finding the most appropriate ‘pork eating quality pathway’ to reduce fail rate ~10%?

<table>
<thead>
<tr>
<th>Critical Control point</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breed</td>
<td>**</td>
</tr>
<tr>
<td>Sex</td>
<td>***</td>
</tr>
<tr>
<td>Age and slaughter weight</td>
<td>*</td>
</tr>
<tr>
<td>Nutrition</td>
<td>**</td>
</tr>
<tr>
<td>Housing</td>
<td>*</td>
</tr>
<tr>
<td>On-farm handling</td>
<td></td>
</tr>
<tr>
<td>Transport</td>
<td>**</td>
</tr>
<tr>
<td>Lairage / pre-slaughter handling</td>
<td>**</td>
</tr>
<tr>
<td>Time off feed</td>
<td>**</td>
</tr>
<tr>
<td>Stunning</td>
<td>*</td>
</tr>
<tr>
<td>Stimulation</td>
<td>**</td>
</tr>
<tr>
<td>Carcass processing</td>
<td>****</td>
</tr>
<tr>
<td>Product preparation</td>
<td>*****</td>
</tr>
<tr>
<td>Consumer preparation</td>
<td>*****</td>
</tr>
</tbody>
</table>

† & **Low risk/impact, *** Medium risk/impact, ***** High risk/impact

Taverner, 2001
Eating quality pathway – increase demand for pork

Guaranteeing the quality and integrity of pork – An Australian case study
# Australian Pork Limited, P.O. Box 7877, Eagles, ACT 2036, Australia
## Faculty of Veterinary and Agricultural Sciences, The University of Melbourne, Parkville, VIC, 3052, Australia
### School of Agriculture, Food, and Environment, The University of Melbourne, Parkville, VIC, 3052, Australia
## Australian Research and Development Corporation, Wattle Centre, Parliament House, Acton, ACT, 2601, Australia

Contents lists available at ScienceDirect
Meat Science
journal homepage: www.elsevier.com/locate/meatsci

Review

Value

<table>
<thead>
<tr>
<th>Term</th>
<th>df</th>
<th>Denominator df</th>
<th>t value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1</td>
<td>6.5</td>
<td>2295.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Gender</td>
<td>3</td>
<td>116.2</td>
<td>3.28</td>
<td>0.021</td>
</tr>
<tr>
<td>Ageing period</td>
<td>5</td>
<td>19.9</td>
<td>0.85</td>
<td>0.52</td>
</tr>
<tr>
<td>Cut type x cooking method</td>
<td>6</td>
<td>3065.8</td>
<td>122.70</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Endpoint temperature</td>
<td>1</td>
<td>3523.5</td>
<td>4.68</td>
<td>0.004</td>
</tr>
<tr>
<td>Moisture infusion</td>
<td>1</td>
<td>5193.1</td>
<td>95.15</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Electrical stimulation</td>
<td>1</td>
<td>377.9</td>
<td>7.40</td>
<td>0.007</td>
</tr>
<tr>
<td>Hanging method</td>
<td>1</td>
<td>211.7</td>
<td>6.67</td>
<td>0.011</td>
</tr>
<tr>
<td>Ultimate pH</td>
<td>1</td>
<td>1104.5</td>
<td>4.40</td>
<td>0.038</td>
</tr>
<tr>
<td>Gender x temperature</td>
<td>3</td>
<td>3600.4</td>
<td>5.95</td>
<td>0.001</td>
</tr>
<tr>
<td>Age x Temperature</td>
<td>3</td>
<td>5145.0</td>
<td>5.75</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cut type x cooking method: endpoint temperature</td>
<td>0</td>
<td>2074.7</td>
<td>5.31</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Moisture infusion: loin roast/stir fry vs. other cuts</td>
<td>1</td>
<td>2075.0</td>
<td>12.44</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Electrical stimulation: roast vs. other cuts</td>
<td>1</td>
<td>3001.0</td>
<td>8.06</td>
<td>0.008</td>
</tr>
</tbody>
</table>

*Non-moisture infused loin roast sample from a non-electrically stimulated, Achilles hung entire male carcase aged for 1 day with ultimate pH of < 5.5 cooked to an endpoint temperature of 70°C

Overall liking

- Entire male: 0.00
- Female: 2.1
- Physical castrate: 3.5
- Immunocastrated male: 2.4

Value at 70°C

- Overall liking: 52.4
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➢ SunPork Group
Retail share of fresh meat trade

- Coles: 26.2%
- Woolworths: 33.0%
- Aldi: 8.3%
- IGA: 7.4%
- Other: 4.3%
- Butchers: 20.8%
Immunocastration

• The biggest shift, retailers have recognised the issues with entire male pig production
• Immunocastration now accepted by all retailers
• Most immunocastrate pigs sold on contracts
• Entire male pigs do incur a penalty ($0.03-$0.10/kg)
• Surgical castration is <1% of entire male pigs (not sustainable)
• In the absence of other viable technologies, use of boar taint vaccine continues to increase
• Current adoption is >60% of entire male pigs, and growing!
Welfare based approval

Boar taint vaccine permitted by Royal Society for the Prevention of Cruelty to Animals (RSPCA) Australia

Castration
5.2 Physical (surgical) castration is not permitted.
5.3 Where the risk of ‘boar taint’ is high, immunological castration\(^3\) is permitted.
Australian industry takes position on boar taint vaccine

Australian pork industry supports the choice for use of the boar taint vaccine on the basis that:

- It improves welfare of entire male pigs
- RSPCA approved
- It eliminates boar taint
- It improves carcase and product quality
- It is accepted by consumers
- No other viable alternative to the boar taint vaccine
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Immunocastration: SunPork Group Markets

Breeding herd size: ~42,000 sows
Annual slaughter: 0.97M pigs
18% of Australian production
PIC Australia: Genetics >50% of industry

Major retail 55%
Independent retail 7%
Export 10%
Wholesale 20%
Food service 8%

<table>
<thead>
<tr>
<th>Customers</th>
<th>Retail</th>
<th>Wholesale</th>
<th>Export</th>
<th>Foodservice</th>
</tr>
</thead>
</table>
| • Woolworths  
• Coles  
• Costco  
• Metcash  
• Independents | • Butchers  
• Traders  
• Further manufacturers | • Singapore processors  
• Hong Kong supermarkets  
• SE Asia and Pacific | • Pubs and clubs  
• Fine dining |

<table>
<thead>
<tr>
<th>Products</th>
<th>Retail</th>
<th>Wholesale</th>
<th>Export</th>
<th>Foodservice</th>
</tr>
</thead>
</table>
| • Fresh boxed pork  
• Value added pork | • Carcase  
• Fresh & frozen boxed pork  
• Value added pork | • Carcase  
• Fresh boxed pork  
• Value added pork  
• Offal | • Fresh boxed pork  
• Value added pork |
# Carcass requirements per market

<table>
<thead>
<tr>
<th>Sex</th>
<th>Costco</th>
<th>Wholesale</th>
<th>Export</th>
<th>Woolworths</th>
<th>Coles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female IC</td>
<td>Female IC</td>
<td>Female IC</td>
<td>IC</td>
<td>Female IC</td>
<td></td>
</tr>
<tr>
<td>Backfat P2 (mm)</td>
<td>&lt;15</td>
<td>&lt;12</td>
<td>&lt;12</td>
<td>&lt;12</td>
<td>&lt;12</td>
</tr>
<tr>
<td>Weight (HSCW; Kg)</td>
<td>90 - 110</td>
<td>70 - 90</td>
<td>70 - 90</td>
<td>65 - 85</td>
<td>65-75</td>
</tr>
<tr>
<td>Source (Farms)</td>
<td>QLD, SA</td>
<td>QLD, NSW, SA</td>
<td>QLD, NSW, SA</td>
<td>QLD</td>
<td>SA</td>
</tr>
</tbody>
</table>
Altering timing of immunocastration – optimise production

Carcase fat:
Surgical castrate > Immunocastrate > entire male pig

Improvac® flexibility allows us to manage this;
1. Prevent backfat increases associated with immunocastrates
OR
2. Increase intramuscular fat in heavier slaughter weight markets
## Managing immunocastrates: Control backfat

<table>
<thead>
<tr>
<th>Time post-last vaccination (weeks)</th>
<th>0</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>6</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed intake</td>
<td>2.43</td>
<td>2.56</td>
<td>2.75</td>
<td>2.78</td>
<td>2.91</td>
<td>0.024</td>
</tr>
<tr>
<td>ADG (g)</td>
<td>1112</td>
<td>1108</td>
<td>1102</td>
<td>1159</td>
<td>1181</td>
<td>0.157</td>
</tr>
<tr>
<td>FCR</td>
<td>2.18</td>
<td>2.32</td>
<td>2.50</td>
<td>2.40</td>
<td>2.46</td>
<td>0.095</td>
</tr>
<tr>
<td>Slaughter wt (kg)</td>
<td>105.4</td>
<td>105.1</td>
<td>104.4</td>
<td>107.4</td>
<td>108.9</td>
<td>0.025</td>
</tr>
<tr>
<td>Carcase wt (kg)</td>
<td>70.1</td>
<td>68.5</td>
<td>67.7</td>
<td>70.6</td>
<td>71.8</td>
<td>0.086</td>
</tr>
<tr>
<td>P2 Backfat (mm)</td>
<td>11.6</td>
<td>11.4</td>
<td>12.7</td>
<td>12.6</td>
<td>13.8</td>
<td>0.057</td>
</tr>
<tr>
<td>Androstenone (ug/g)</td>
<td>0.91</td>
<td>0.11</td>
<td>0.11</td>
<td>0.10</td>
<td>0.13</td>
<td>0.001</td>
</tr>
<tr>
<td>Skatole (ug/g)</td>
<td>0.05</td>
<td>0.04</td>
<td>0.03</td>
<td>0.04</td>
<td>0.04</td>
<td>0.420</td>
</tr>
</tbody>
</table>

Lealiifano et al., 2009
Assuring boar taint free pork

(1) Test every male carcase

Evaluating the performance of sensory quality control: The case of boar taint

Lisa Meier-Dinkel, Jan Gertheiss, Simone Müller, Raffael Wesoly,, Daniel Mörlin

Exemplarily evaluated. Using the panel average score, sensitivity and specificity of sensory analysis ranged from 61 to 69% and 77 to 85%, respectively. Performance of individual assessors varied highly (sensitivity: 47 to 86%; specificity: 45 to 88%) and correlated to olfactory acuity to the compounds. According to receiver operating characteristic-curves, the
Assuring boar taint free pork

(2) Monitoring for socio-sexual behaviour

Two stage verification with corrective actions;

(i) On farm behavioural inspection for socio-sexual behaviours after 7-10 days post second vaccination
   ➢ At risk animals vaccinated again

(ii) Lairage ante-mortem inspection for socio-sexual behaviours
   ➢ At risk animal are identified and segregated post-slaughter
Export markets

• Biggest markets are Singapore and Hong Kong

• No issues with offal – accepted by all markets

• Currently export female (only) carcases to Singapore
  ➢ This issue relates to visibility of testicle cut lines on carcase
  ➢ Cannot be used in traditional wet markets (premium grade)

• No issue with immunocastrates for boxed product in Hong Kong or other export markets
Take home messages

➢ Entire male pig production does negatively impact welfare, carcase and eating quality

➢ Immunocastration has helped to address these entire male pig issues

➢ Market acceptance of immunocastration is not an issue in the domestic market (retail, food service or processed segments)

➢ Some acceptance issues in export markets but these predominantly relate to carcase trade

➢ Consumer acceptance of immunocastration does not appear to be an issue
Thank you

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Pork Production With Entire Male Pigs and Immunocastrates

An Australian Perspective

D.N. D’Souza, R.J.E. Hewitt, R.J. van Barneveld

SunPork Group, Murarrie, Queensland, Australia