Department of Primary Industries

Industry insights- Pork production

Supporting document

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Australian pork production

Introduction

Pigs produce the food known as pork. Pork is eaten as a freshly cooked meat or processed and preserved to make bacon, ham, sausages, and smoked pork. Pigs are also referred to as swine.

Pigs have been a part of Australian agriculture since 1788. Over the years, many breeds have been introduced. Better housing, nutrition, marketing and processing have improved the NSW and Australian industries. Pigs historically were a secondary enterprise on Australian farms, eating excess by-products from butter and cheese manufacture and kitchen scraps. Their diet was extended to include home-grown grain, which allowed the industry to expand further. Pigs are omnivores.

Pig breeds grown in Australia include Large White, Yorkshire and Landrace. These breeds have pale pink skin, white hair and are called white breeds. Other breeds include the coloured breeds of Large Black, Berkshire, Duroc and Hampshire.

Most of the commercially produced pigs grown in Australia are crossbred, which means that the animal's ancestors were different breeds that were selectively crossed and bred. Crossbred animals tend to perform better than their parents, especially in growth rates and fertility. The agricultural term used to describe this is hybrid vigour.

Pork production in Australia and New South Wales

The pork industry in Australia is the smallest of the livestock industries but is the only one competing with imports, mainly from Denmark, the USA, Canada and the Netherlands. About two-thirds of processed pork products (which includes ham, bacon and smallgoods) are made from imported pork. The fresh pork market is all Australian. A small amount of pork is exported to Singapore, New Zealand and other Asian markets.

The sow is the productive unit for the piggery. Most farms are described in terms of the number of sows. In NSW, 72% of sows are farmed on just over 2% of the state's farms, which have 500 or more sows that produce the majority of the state's pork. Only 7% of sows are farmed on 81% of the state's farms having 50 or fewer sows. This is the highest proportion of small-scale pig farms in Australia.

Six abattoirs process pigs in NSW, but their locations mean long freight journeys for many pigs. The two export-licensed abattoirs are: Booyong Service Processing, at Booyong, near Lismore, and Rivalea, at Corowa. The abattoirs at Cowra, Wollondilly and Frederickton are domestic-licensed abattoirs. Hawkesbury Valley Meats at Wilberforce also kills a small number of pigs.

The Australian pork industry employs more than 20 000 people and contributes approximately $2.8 billion to the economy. About 1500 pig farmers produce around 4 million pigs annually, accounting for 2.13% of total Australian farm production.

The major areas of pig production are south-eastern Queensland, especially the Darling Downs; southern NSW; northern and western Victoria; south-eastern SA; and southwestern WA. Traditionally, pigs have been farmed in major grain-growing areas and in some dairy areas (see Figure 1). Recently, however, the industry appears to be re-locating to grain growing areas near abattoirs.

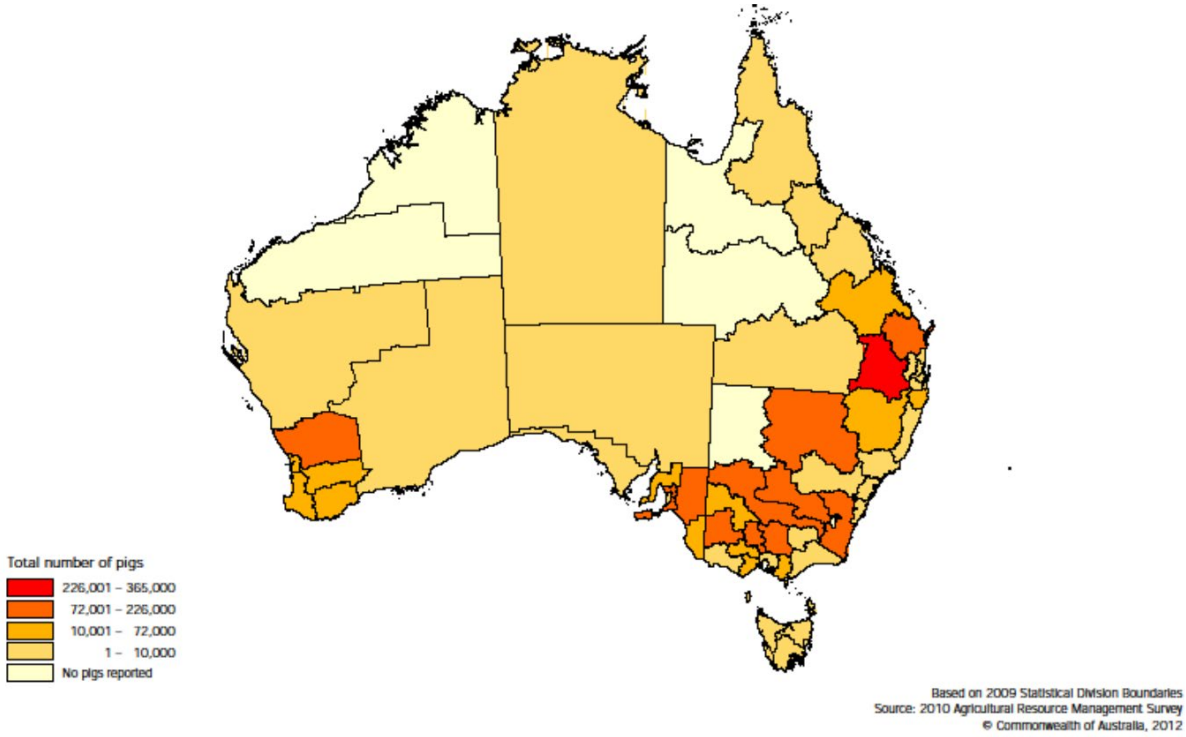


Figure 1 Location of pig population Source: ABARES, 2010 Agricultural Management Survey

Local pork producers compete with imported products, having to cope with world pricing for grain and fuel; higher labour and processing costs; a fluctuating A$; and a more difficult local market than our competitors due to the dominance of Coles and Woolworths.

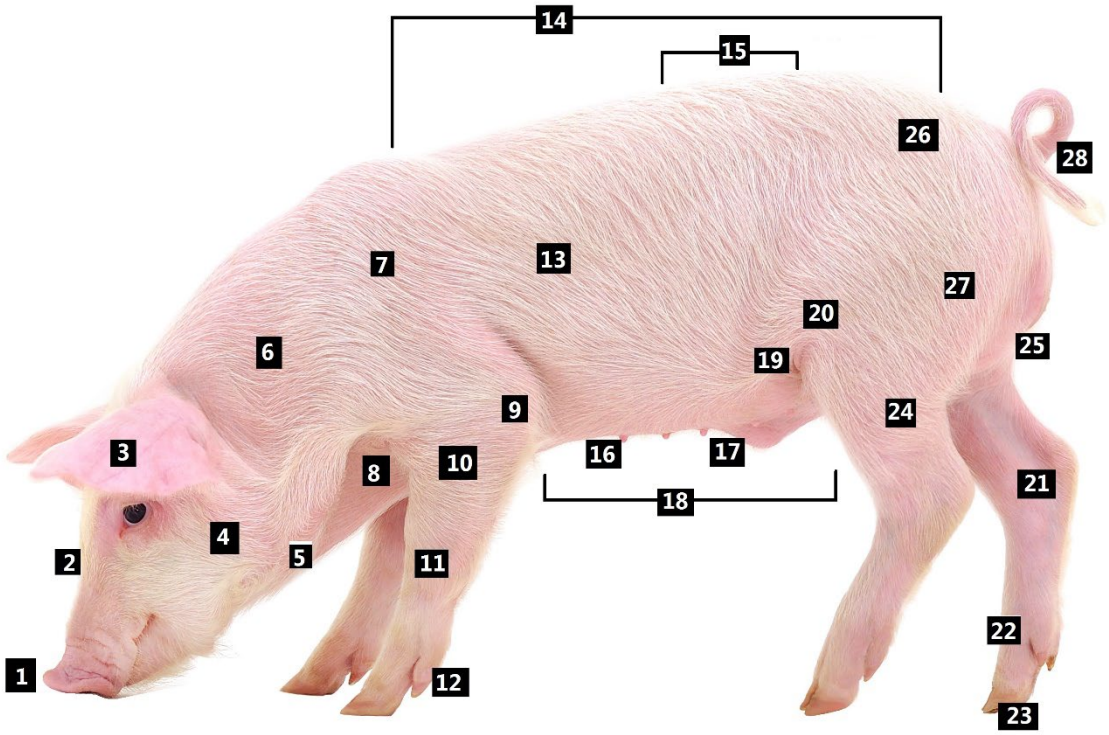
The total number of Australian pig farmers has been declining since 1960, when there were around 50 000 producers, but herd size was fewer than 20 sows.

Today there are 1386 producers remaining, and herd size averages around 170 sows.

In general, production is relatively stable, but profits have been hit with competition with imports, drought, low pork prices, high grain prices, fewer processing facilities and a fluctuating Australian dollar.

Pig anatomy

Label the parts of the pig using the [NSW DPI 'Pork Production'] poster.



1	8	15	22
2	9	16	23
3	10	17	24
4	11	18	25
5	12	19	26
6	13	20	27
7	14	21	28

Pig breeds

There are eight pure breeds of pigs in Australia. Three of the eight pure breeds used in commercial pork production are: Landrace, Large White and Duroc (used for crossbreeding). The remaining five breeds – Tamworth, Wessex Saddleback, Hampshire, Berkshire and Large Black - tend to supply niche markets. Their popularity varies according to their commercial value. Some of these breeds are quite rare. All the breeds were originally imported into Australia.

Pure bred pigs have become rare in Australia and internationally due to intensive pig farming, away from free-range production in the 1960s. This has meant that many of the 'old' (traditional) breeds of pure-bred pigs were no longer suitable for commercial production. Pure breeds were considered to grow too slowly and put on too much back fat or had undesirable skin colours for consumers. Intensive farming focuses on efficiency and profit, so later maturing pure breeds were only used in crossbreeding programs. Today, pigs in commercial production are hybrid (crossbred) varieties.

Another factor leading to the decline in pure bred pigs is biosecurity. There are no imports of live pigs, pig embryos or pig semen permitted into Australia today due to international diseases such as African Swine Flu. This has closed the genetic pool and limited breed improvement.

1. **Use the NSW DPI 'Pork Production' poster to identify pig breeds important to Australian production. Research the origin and features of each breed pictured to complete the following table.**
   Suggested references include:

- 'Australian pig breeds', Australian Pig Breeders Association Limited
- 'Pig breeds in Australia', NSW DPI
- 'Breeds of pigs- Duroc', NSW DPI
- 'Breeds of pigs- Landrace', NSW DPI
- 'Breeds of pigs- Large White', NSW DPI
- 'Pig Breeds', Livestock of the world
- 'Breeds of Livestock – Swine breeds', Department of Animal Science, Oklahoma State University

<table>
<tr><td rowspan="4"> </td><td>Breed:</td></tr>
<tr><td>Origin:</td></tr>
<tr><td>What genetics (breeds) were used to develop this breed?</td></tr>
<tr><td>Breed characteristics: (Skin colour, ears, frame size and length etc.)</td></tr>
<tr><td colspan="2">Uses and performance/carcass characteristics:</td></tr>
</table>

Breed:

Origin:

What genetics (breeds) were used to develop this breed?

Breed characteristics: (Skin colour, ears, frame size and length etc.)

Uses and performance/carcass characteristics:

Breed:

Origin:

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Uses and performance/carcass characteristics:

Breed:

Origin:

What genetics (breeds) were used to develop this breed?

Breed characteristics: (Skin colour, ears, frame size and length etc.)

Uses, performance and carcass characteristics:

Breed:

Origin:

What genetics (breeds) were used to develop this breed?

Breed characteristics: (Skin colour, ears, frame size and length etc.)

Uses, performance and carcass characteristics:

<table>
<tr><td rowspan="3"> </td><td>Breed:</td></tr>
<tr><td>Origin:</td></tr>
<tr><td>What genetics (breeds) were used to develop this breed?</td></tr>
<tr><td colspan="2">Breed characteristics: (Skin colour, ears, frame size and length etc.)</td></tr>
<tr><td colspan="2">Uses, performance and carcass characteristics:</td></tr>
</table>

Pork processing, marketing and value adding

2. **Define value-adding and include an example of a value-added pork product.**

_____

_____

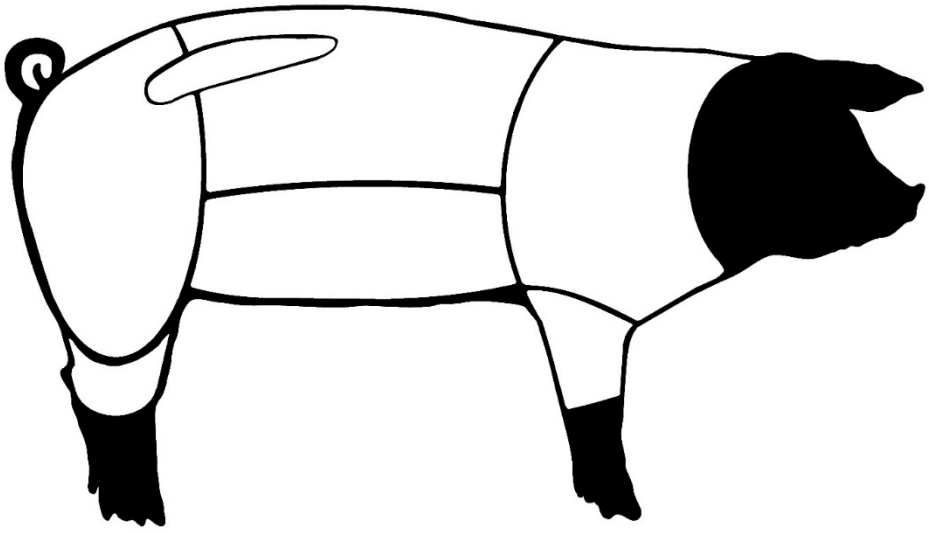
_____

_____

3. **Watch "Australian pork carcass breakdown", Inspired by Australian Pork, 2019.**

Australian Pork Carcass Breakdown

4. **Use the NSW DPI 'Pork Production' poster to label the six carcass locations**



5. **Use the NSW DPI 'Pork Production' poster to complete the table by listing pork cuts.**

Carcass location	Pork cuts
1. Leg	
2. Hock	
3. Loin	
4. Tenderloin	
5. Belly	
6. Forequarter	
Miscellaneous	

6. **Common sale methods for market pigs include: Direct selling to butchers; direct consignment or contract to abattoirs; online auctions and saleyard auctions. Use research to find out more about each sale method and complete the following table.**

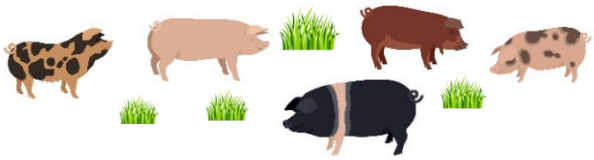
Marketing method	Description of marketing method	Advantages of method	Disadvantages of method
Direct sales			
Direct consignment or contract			
Online auction and saleyard auctions			

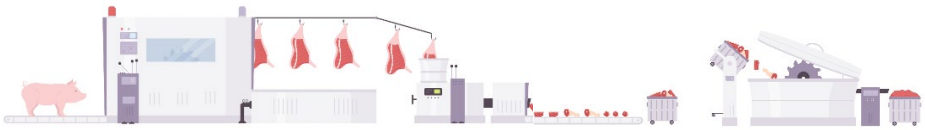
7. **Pork production and marketing chain-**

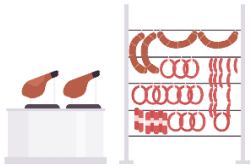
Match the missing titles to the descriptions to explain what is happening at each step of the pork production and marketing chain. Use the '[NSW DPI Pork production' poster] for assistance.

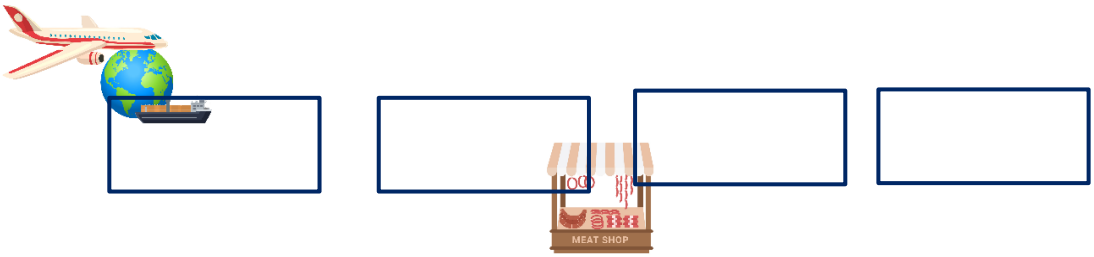
Title		Description
		Farms range from small family owned to large scale corporate owned operations. Pig enterprises include specialist breeding farms (farrow-to-wean); specialist finishing farms (grow out facilities) or a combination of both (farrow-to-finish). Managers precisely manage pigs in terms of nutrition, genetics, reproduction, welfare and health and disease to increase the quantity and quality of product and to meet market specifications. Sale methods of market pigs include: Direct selling to butchers, retailers or consignment to abattoirs, online auctions or saleyard auction.
		Market pigs and pork products are transported from the farm to a processing facility, to retailers and consumer, all throughout the production chain.
Processors		First stage in pork processing e.g. abattoir. Carcasses are classified according to market specifications. Carcasses can be broken down to fresh pork cuts, frozen or vacuum sealed and delivered to sellers. They can also be sold to butchers and smallgoods producers, as whole carcasses, so individual retailers can develop their own cuts and food styles to suit their customers. Or, they can be sold directly to the consumer.
		Second stage in pork processing. Secondary processing involves the processing of pig meat cuts into value added products such as bacon, ham and smallgoods through curing, cooking and smoking.
Wholesale/ retail		Products are distributed to specific overseas consumers and markets.
		Sells/ supplies pork product to resellers who in turn sell directly to the consumer.
		For example, butcher or supermarket, restaurant
	Company owned food enterprise or food service	These businesses may be vertically integrated: from production to processing then to retail outlet or export market. Or the processor can be linked to a chain of retail outlets and sources pig meat to specifications for these outlets.
	Direct marketing	Farmers/producers have great involvement in the marketing of their pork via farmers markets or community agriculture schemes - usually limited to small scale or niche production systems.
		The consumer purchases a pork product for consumption. Branding, marketing and promotional campaigns help sell to consumers and new markets. Consumer demands drive all stages of production and processing.

8. **Use the following images and the [‘Pork Production’ poster] to create a pork production and marketing chain.**
Include:
• A title and description at each step of the chain, explaining what is occurring (use above table for assistance with descriptions)
• Arrows linking each step to the next









Specifications and markets

Australian pork competes not only with other meats (beef, lamb, chicken etc.), but also with the vast imports of pork from other countries. Supplying pork that meets the demands our domestic and international customers (export markets) is crucial in ensuring that Australian producers remain competitive.

Meeting market specifications is also important to the profitability of pig enterprises. A thorough understanding of different markets enables farmers to match their property, seasonal conditions, management systems, calendar of operations and stock to meet the needs of their target market. Regardless of the chosen market, a consistent supply of suitable stock benefits everyone: the producer, processor and consumers.

Producers manage their breeding and nutrition programs, and continually improve their stock to ensure their pigs meet the specifications. Table 1 lists and explains major and minor specifications for pork.

Major market specifications
• Fat- (fat depth at P2 site). Fat specifications are usually in the range of 8mm to15 mm of backfat at the P2 site (see figure 2). These specifications can vary, depending on the market. Pork carcasses outside the specifications - too fat or too thin are penalised by receiving less money per kg. • Weight- (hot carcass weight). Producers are paid $/kg carcass weight. Pork carcasses outside the specifications (too fat, too heavy, too light or inadequate fat), are penalised by receiving less money. • Lean muscle- Influenced by genotype, sex, breed and nutrition. • Age- younger animals are better eating in terms of tenderness, fat. Age influences carcass weight and available markets. Market pigs are turned off very quickly, (this is the time from farrowing to finishing a market pig for sale). • Quality assurance- Consumers and food processors demand a high-quality and safe product from contaminants, disease and produced under high standards of animal welfare. This is achieved through Australian Pork Industry Quality Assurance Scheme APIQ✓® accreditation.
Minor market specifications
• Breed- European white breeds such as Large White, Landrace and Yorkshire and crossbreeds of these are used for commercial production due to their growth for age and skin colour. • Genetics- Genotype determines the animal's potential to deposit lean muscle relative to fat which is the main influence on carcase quality. Low backfat has a high level of heritability. Stress prior to slaughter such as through transport causes rapid decline in carcass quality (Pork Stress Syndrome). • Meat and skin colour- too pale, too dark and two-toned pork is undesirable to the consumer. Black and coloured skin is undesirable to consumers. • Sex- The carcase quality of entire male pigs is better than that of castrates or females because entire males have higher lean meat:fat ratios. Pork tenderness, juiciness and flavour is unaffected by sex. Boar taint:- unfortunately, 10 - 15% of entire male pigs produce pork that has a smell or 'boar taint' when cooked due to hormones. Australian consumers don't mind consuming uncastrated males due to possible boar taint but Asians in Australia and overseas discriminate against pork from entire male pigs due to possible taint. • Intramuscular fat- Duroc and Berkshire breeds have higher levels of intramuscular fat (IMF) than faster growing 'white' European breeds such as Large White, Landrace and Yorkshire. Higher IMF produces greater eating quality- juiciness and tenderness. • Fat quality- The firmness or softness of fat tissue is influenced by the proportion of saturated and unsaturated fatty acids present. Softer fat is more desirable. Entire male pigs have softer fat than castrates and gilts. Soft (unsaturated) fat levels in the animal can be manipulated through diet.

Table 1 Major and minor specifications for pork

9. **List the major market specifications for Australian pork.**

_____

_____

10. **Pick 2 major pork specifications and describe how a producer could manipulate their management to meet the specifications.**

_____

_____

_____

_____

11. **List the minor market specifications for Australian pork.**

_____

_____

12. **Pick 2 minor pork specifications and describe how a producer could manipulate their management to meet the market requirements.**

_____

_____

_____

_____

Specific markets

The percentage of lean (muscle) and depth of backfat in relation to carcase weight determines carcase quality. Producers are currently paid on the basis of:

- hot carcass weight. Hot carcass weight (HCW) is the weight of the unchilled carcass in kg after the head, hide and internal organs have been removed and
- fat depth at the P2 site, which is located 65 mm from the midline of the carcase over the last thoracic rib (see Figure 2).

Pigs are sold in a range of carcass weights but the most common is the bacon carcass - 60 to 85 kg dressed weight. Pigs are paid for using a grid system with carcass weight and fat specified. Fat specifications are usually in the range of 8mm to15 mm of back fat at the P2 site, but this may vary depending on the market.

Pork carcasses outside the specifications - too fat, too heavy, too light or too thin are penalised by receiving less $/kg carcass weight.

The dressing percent for a pork carcass is around 70 to 75%. It may seem high compared to other animals, but is a result of carcasses being 'skin-on', unlike other animals where the skin is removed.

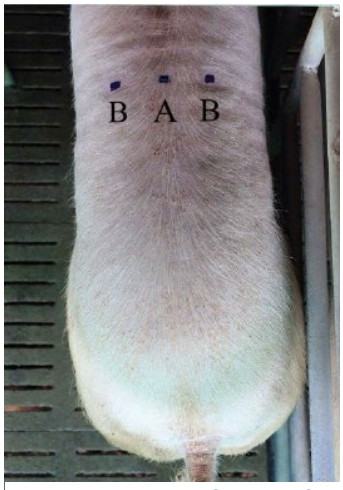


Figure 2 Position for backfat thickness measurement in live pigs. (A) body midline (B) P2 position (6-8 cm away from body midline at the last rib level) (Tummaruk and Roongsitthichai, 2014)

Market	Specifications
Oven pig	(from weaner pigs), these are whole carcass pigs of carcass weight 15 to 25 kg (liveweight 20-35kg) - favoured by some Asian and Pacific Islander consumers
Porker	grower pigs weighing between 60-80 kg liveweight (dressed weight 45-60kg)
Baconer	finisher pigs with a liveweight greater than 80 kg (dressed weight 60-85kg)
Backfatter	Animal too large for baconer market (dressed weight >90kg) Usually mature cull boars or sows

Pig contracts are divided into 'porker' contracts and 'baconer' contracts. Porkers are lighter pigs generally used for fresh pork, while baconers are heavier pigs used for cured meats- bacon, ham and smallgoods.

Asian pork exports: Australian pork is exported to Asia. The main Asian markets only accept pork from female and surgically castrated or immunocastrated pigs (see page 67), due to fears of boar taint.

Find out more at: 'Managing the eating quality of pork - What the producer can do'

13. **Place an 'X' on the following image, to identify the P2 site for measuring fat depth.**

14. **Define hot carcass weight (HCW).**

_____

_____

15. **Dressing percentage = (carcass weight ÷liveweight) ×100**
Use this equation to calculate questions 15a)-c)

    a) **An animal has a HCW 50kg and liveweight of 69kg. Calculate the dressing percentage.**

    _____

    _____

    _____

    b) **An animal has a dressing percentage of 70% and liveweight of 65kg. Calculate the HCW (kg) round answer to the nearest kg.**

    _____

    _____

    _____

    c) **An animal has a dressing percentage of 75% and HCW 74kg. Calculate the liveweight.**

    _____

    _____

    _____

16. Complete the table listing specific pig market weight specifications.

Market	Liveweight	HCW
Oven pig		
Porker		
Baconer		
Backfatter		

Exports and imports

Producers in the Australian pork industry supply two domestic markets:

- The fresh meat market (which is largely protected from international competition due to Australia's strict biosecurity legislation), and
- The processing market (which competes with international producers)

Around 40 per cent of domestic pig meat is sold as fresh pork. A number of Australian producers supply fresh and processed pork to overseas markets.

All fresh pork sold in Australia is grown in Australia by our Australian farmers!

However, about two thirds of processed pork (ham, bacon, cured pork and smallgoods products) is made from frozen pork imported from Denmark, the Netherlands, Canada and the United States (Australian Pork, 2015). Make sure to buy fresh pork or pork products with the following labels to support Australian farmers and pork production.

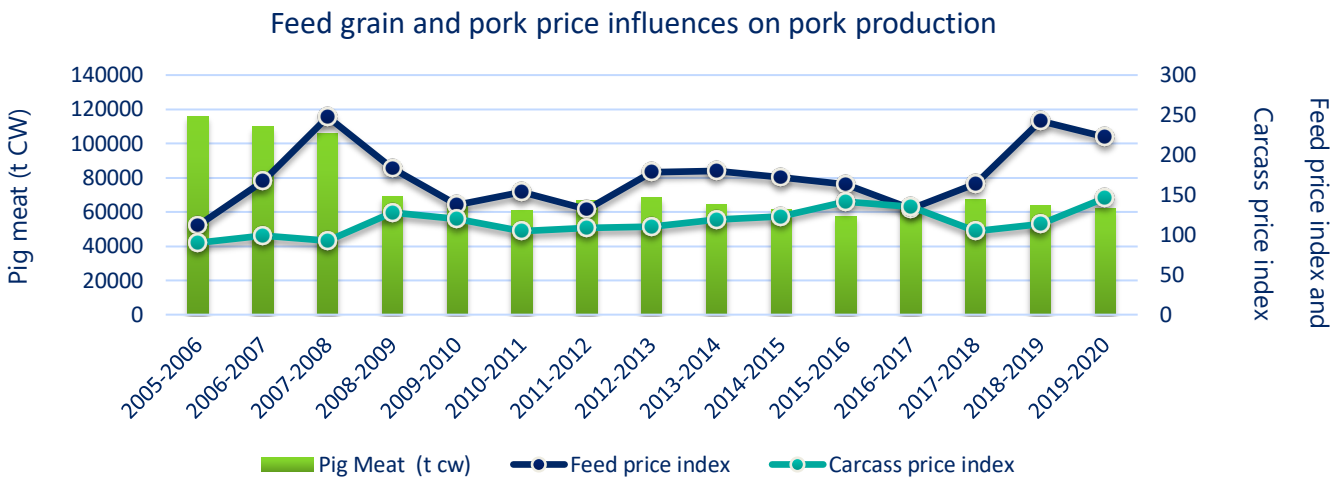
Although quarantine restrictions mean imported pork does not compete directly with domestic production in the fresh meat market in Australia, imports and global pork prices affect the prices of fresh meat. This occurs because our production can go to either the fresh or processed market, so price changes in one market can lead to domestic supply shifting between markets.

The Australian pig meat industry has been under pressure since imports were first permitted from Canada and Denmark in the mid-1990s. This pressure has further increased as free trade agreements have become established.

17. **Explain why it is important to buy Australian made, grown and produced pork products.**

18. **Table 2 shows the influence feed grain and pork price have on production. Explain the trend.**

Table 2 Source: [NSW DPI, Pork Performance and Data Insights, 2020]



19. Tables 3 and 4 show NSW pork imports and Tables 5 and 6 show NSW exports in 2014-2020. Complete parts a) – h) using the tables.

Table 3 NSW Pork imports ($m) 2014 vs 2020

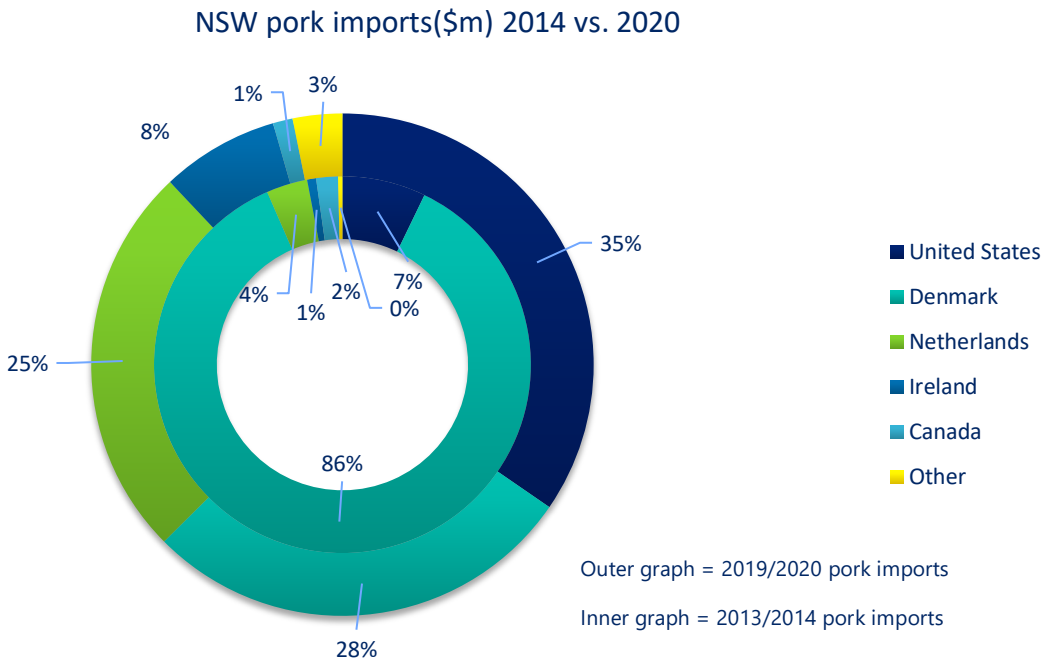


Table 4 NSW Pork imports ($m), Source: IHS Global Trade Atlas (GTA) (2020)

Year	United states	Denmark	Netherlands	Ireland	Canada	Other
2013-14	$51,893,898	$50,934,448	$41,657,776	$11,181,626	$4,683,950	$8,001,671
2014-15	$39,601,931	$82,330,832	$20,624,972	$5,029,765	$17,726,117	$7,673,229
2015-16	$34,130,028	$70,321,393	$20,035,552	$8,112,073	$9,178,573	$10,012,797
2016-17	$44,346,425	$70,592,330	$32,725,497	$8,938,894	$4,308,554	$8,879,491
2017-18	$35,041,711	$67,131,763	$33,672,023	$6,385,577	$2,780,708	$9,532,023
2018-19	$51,893,898	$50,934,448	$41,657,776	$11,181,626	$4,683,950	$8,001,671
2019-20	$79,576,641	$64,331,994	$58,402,455	$17,438,679	$2,928,812	$7,329,574

a) List the 5 main countries importing pork into Australia in 2020.

_____

_____

b) Where does the majority of imported pork in Australia come from in 2020?

_____

_____

c) Contrast the growth in import revenue and market share between 2014-2020 for:

- **United States**

_____

_____

- **Denmark**

_____

_____

- **Netherlands**

_____

_____

Table 5 NSW pork exports ($m) 2014 vs. 2020

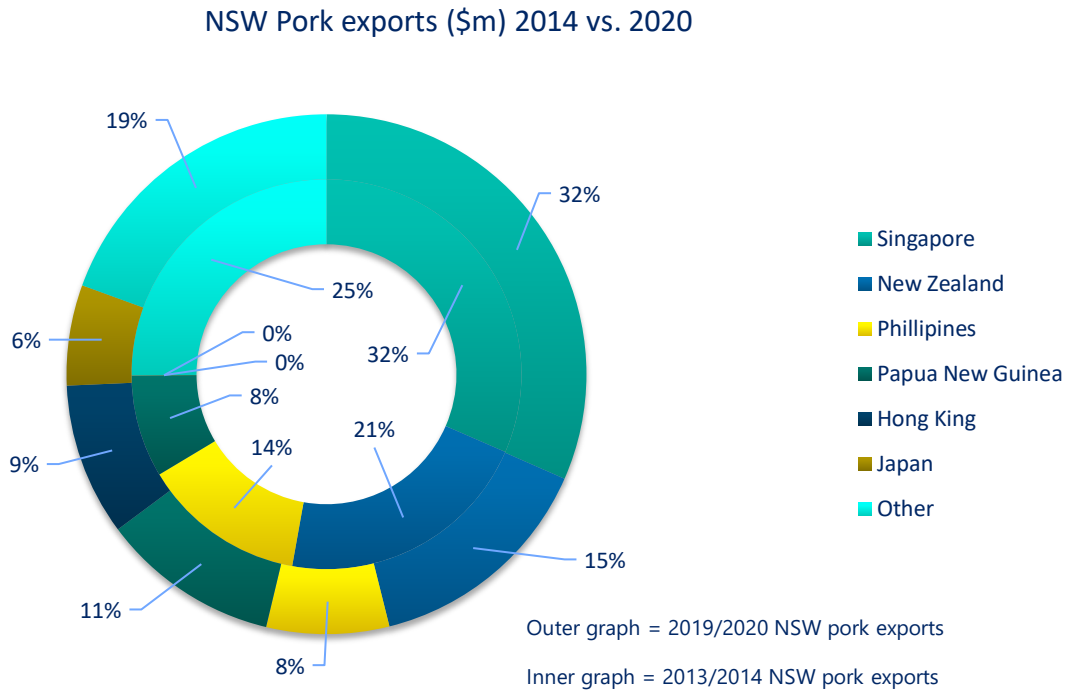


Table 6 NSW Pork imports ($m), Source: IHS Global Trade Atlas (GTA) (2020)

Year	Singapore	New Zealand	Philippines	Papua New Guinea	Hong King	Japan
2013-14	$6,630,569	$4,477,768	$2,856,819	$1,787,440	0	$3,122
2014-15	$5,083,669	$4,210,086	$1,825,655	$2,495,737	0	$2,270
2015-16	$8,261,335	$7,650,478	$2,087,750	$1,854,530	$758,285	$1,926
2016-17	$12,298,526	$4,751,341	$3,121,380	$2,811,932	$1,527,079	$241,829
2017-18	$11,379,703	$6,320,193	$2,911,539	$4,356,617	$2,126,673	$244,087
2018-19	$9,422,578	$4,818,669	$3,916,213	$3,291,920	$1,711,051	$1,758,531
2019-20	$7,361,517	$3,383,820	$1,777,298	$2,584,789	$2,209,296	$1,457,912

d) List the 5 main export markets for Australian pork in 2020.

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e) What was the main export market for Australian pork in 2020?

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f) Contrast the growth in import revenue and market growth between 2014-2020 for:

- **Singapore**

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- **New Zealand**

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- **Hong Kong**

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g) Do you think there is opportunity for Australian pork producers to increase domestic supply of pork to meet or domestic demands and reduce pork imports? Why or why not?

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h) What are some of the external factors that might influence pork production in Australia and our import and export markets?

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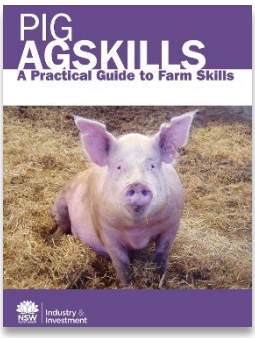


Practical activity- moving pigs

Adapted from Pig Agskills available in hardcopy or as an eBook. Find this activity and more at the Tocal online bookshop.

Aim: To move pigs safely with high animal welfare standards

Background: Pigs are large animals and can be determined if they don't want to do something. If you have pigs at your school you will need to develop skills to move them from time to time in a safe and calm manner.

Understanding what affects the ways that pigs interpret their environment makes it easier to move pigs. The stockperson should always keep themselves and the pig/s calm, safe, and the pig/s doing what they ask.

Some tips to remember:

- Pigs have 310° vision, so can be easily distracted or alerted by anything around them.
- When setting up yards- it's best to have solid sided chutes, ramps and pens that prevent animals being distracted, or frightened.
- When moving pigs, the stockperson should walk behind but slightly to one side of the pig.
- The stockperson should aim to block the pig's vision, which both reduces animal stress and prevents them trying to escape. A solid portable panel should be used.
- Pigs dislike and will balk at, or refuse to cross over, obstacles such as drains, hoses, puddles, shadows, different coloured concrete or a change in the ground surface and texture.
- Pigs have sensitive hearing and will balk at loud or unfamiliar noise.
- Pigs prefer to move from a dimly lit area to a brightly lit area, (providing the light does not provide too much glare in their eyes).
- Pigs are very intelligent and social herd animals so are easier to move in a group than singularly, but are difficult to move in a large group.

Materials:

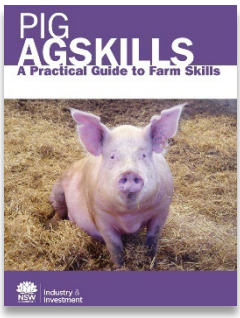
- Portable panel or board to block pigs' vision
- Obstacles removed, gates set, and noise minimised
- Any necessary Personal Protective Equipment.

What to do:

- Moving one pig- move a small group and draft the selected pig at the destination to minimise the time it is on its own.
- Moving large groups of pigs- it may be more efficient to move them as several small groups (depending on walkway dimensions)
- Be patient! Positive behaviours such as patting, stroking, resting a hand on the pigs back, talking quietly and calmly, along with slow, deliberate and predictable movements will train your pigs to be calm and relaxed whenever handled and will always get the best results. NEVER- hit, slap, push, shout and make fast sudden movements when handling pigs.

Animal welfare

- For details on approved activities and Animal Welfare for pigs in schools go to the NSW Animal in Schools -Pig page.



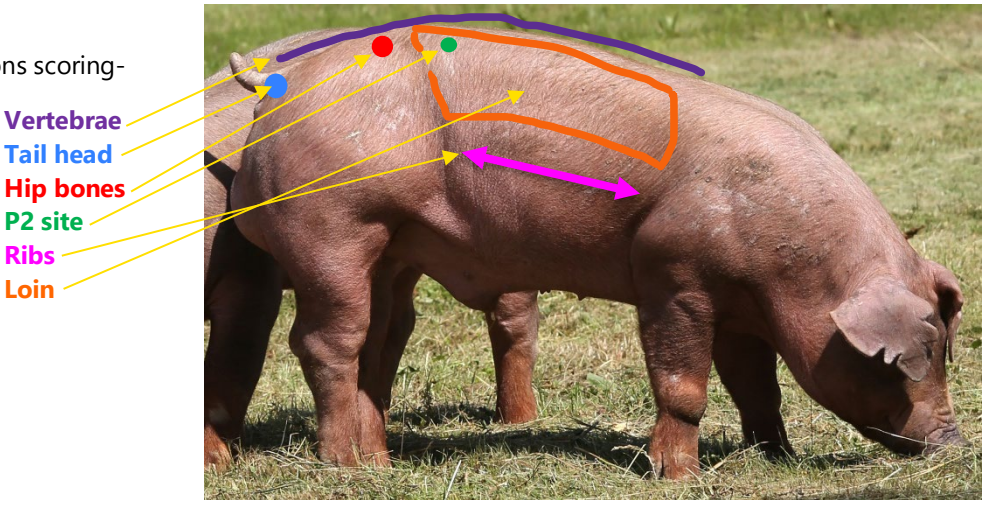
Practical activity- condition scoring pigs

Adapted from Pig Agskills available in hardcopy or as an eBook. Find this activity and more at the Tocal online bookshop.

Aim: To assess and score pig body condition.

Background: Condition scoring (CS) is carried out to determine muscling and fat cover and used in selecting pigs, for example for market, along with other management practices such as checking or changing rations, checking overall pig health etc.

Sites for conditions scoring-



Body condition scoring is a subjective measurement. It scores animals from 1 (emaciated) to 5 (overly fat) and combines both visual appraisal of the animal and feel. Visual appraisal is not good enough; handling the pig is essential to get an accurate assessment of its condition. If bones protrude at scoring sites, then body condition is given a condition score of 1-2. If bones are impossible to feel it has a body CS of 5.

Sows- the ideal body CS of a sow at farrowing is CS 3-3.5 and at weaning CS 2.5. The demands of lactation results in most sows losing condition. Nutrition must be managed for the sow throughout lactation, so she does not fall below CS 2.

In practice very few extreme (CS 1 or 5) scores are found in well managed pig herds. Most sows should fall into the middle score range between CS 2-4. Older dry sows may reach CS 4 when not in lactation.

Welfare- The Australian Model Code of Practice for Animal Welfare-Pigs requires that immediate action must be taken to restore body condition of pigs that fall below CS 2. This would include providing extra feed and often a veterinary consultation. If this fails, the animal should be culled. Animals with CS 2 often have additional health problems.

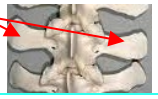
Ultrasound- Manual assessment of condition score can be subjective. Accurate results depend on the skill of the handler. A more objective measurement method involves using scales to weigh the pig (kg) and using an ultrasound to measure backfat (mm).

What to do:

- Identify the pigs:
  - ✓ Backbone (vertebrae)
  - ✓ Hip bones
  - ✓ Pin bones
  - ✓ Tail bones
  - ✓ Loin
  - ✓ Ribs
  - ✓ P2 site

- Gently touch/feel the pig in these areas using your fingers and flattened hand to feel the bones, loin, ribs, vertebrae and P2 site.
- Make an CS assessment using the Table 7 as a guide
- Record your results for each pig individually

Table 7- Condition score descriptions for pigs

Condition score (CS)	Description	Visual	Hip/pin bones, tail head	Loin	Vertebrae	Ribs
1	Emaciated		Hip/pin bones very prominent and angular Deep cavity around the tail head	Loin very narrow Sharp edges on transverse spinal process** Flank very hollow	Prominent and sharp throughout the length of the backbone	Individual ribs very prominent and angular
** Transverse spinal process- small bony projections on the right and left side of each  vertebrae						
2	Thin		Hip/pin bones obvious but some slight cover Cavity around tail head	Loin- narrow. Only slight coverage to the edge of transverse process Flank rather hollow.	Prominent	Rib cage- less apparent. Difficult to see individual ribs
3	Ideal		Hip/pin bones covered No cavity around tail	Edge of spinal transverse process covered and rounded	Visible over the shoulder. Some cover further back along the vertebrae	Covered but can be felt
4	Fat		Hip/pin bones only felt with fir pressure No cavity around	Edge of spinal transverse process only felt with firm pressure	Felt only with firm pressure	Rib cage not visible. Very difficult to feel any ribs.
5	Overly fat		Hip/pin bones impossible to feel Root of tail set deep in surrounding fat	Impossible to feel transverse process bones. Flank- full and rounded.	Impossible to feel vertebrae	Impossible to feel ribs

Animal welfare: For details on approved activities and Animal Welfare for pigs in schools go to the NSW Animal in Schools -Pig page.

Swine production systems

There are three main systems in Australian pork production:

- Intensively housed (indoors),
- Outdoor bred (breeding sows are run outdoors, and growing pigs are housed indoors) and
- Free range (all pigs are run outdoors all the time).

Intensively housed indoor systems

- Intensive housed systems in the pork industry are very efficient in terms of resource use.
- These systems are leaders among the Australian livestock industries in methods to reduce the carbon footprint of production.
- Intensive producers are under attack from animal welfare lobbyists because animal welfare is seen as poor by the general public.
- Intensively systems can turn off baconers (75–85 kg carcass) in 10-months from conception in the sow to slaughter of the offspring (gestation 115 days, lactation 28 days, and wean-to-finish 20–22 weeks).
- Efficient farms aim to produce 2.4 litters per sow per year.
- This system allows for technology for maximum efficiency such as electronic sow feeders, ear tag readers, which can record animal health, behaviour and manipulate a ration to the individual animal.
- This type of housing protects the animals from climate variations, predators and sunburn. Indoor systems allow pigs of similar ages and sizes to be housed together in small, medium and large groups.

Outdoor production systems including free range and outdoor bred

- Viewed as being more welfare friendly than intensive indoor systems, but this depends on human management.
- Sows are not confined throughout gestation, so piglet mortalities can be high.
- White pigs are susceptible to sunburn, so small-scale farmers use coloured breeds, such as Berkshire, Tamworth, Large Black, Hampshire and Wessex Saddleback sows. These breeds have not been as heavily selected for high growth performance as the Large White, Landrace and Duroc breeds, which form the major commercial lines. Outdoor breeders rely heavily on crossbreeding, and white boars are popular to add growth, improve carcasses and have white skinned progeny.
- Free range and outdoor bred systems have become increasingly popular over the past 15 years. NSW has the highest proportion of small-scale farmers using outdoor production systems.
- Have higher biosecurity risks due to Australian feral pigs spreading endemic diseases, such as brucellosis (*Brucella suis*) and leptospirosis, which are also contagious to humans (zoonotic diseases).
- Outdoor systems are not as efficient as intensive systems in terms of resource use, environmental impact and production.
- Small-scale growers and free-range producers tend to target niche markets, and pigs produced for sale range from weaners to baconer weight.

Follow these links to investigate different pig housing systems:

Watch: Indoor systems Housing pigs- current approaches.	Watch: Free range systems "Maximising quality on an Australian Pig Farm- Free range'
Watch: 'Free Rangers', Landline	Watch: Indoor housing system 'Hyde Park Pig farm's 700 sow integrated pig unit'

20. Use the NSW DPI Pork Production poster to complete the table on production systems in Australia.

System	**Free range**	**Bred free range**	**Indoor housing**
Description			

Carry out research to answer questions 21-24. A great site to start your research is Australian Pork factsheet '*Get the Facts on your pork industry*'

21. Describe the features of Australian pig, indoor housing production systems.

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22. **Describe the features of Australian deep litter pig production systems.**

23. **Describe the features of Australian free-range pig production systems.**

24. **Describe the features of Australian outdoor bred pig production systems.**

Animal welfare

Animal welfare refers to the state of the animal. Welfare is covered by other terms such as animal care, animal husbandry, and humane treatment. Good animal welfare requires disease prevention and appropriate veterinary care, shelter, management and nutrition, a stimulating and safe environment, humane handling and humane slaughter or killing *(*Animal Health, Australia*)*.

Animal welfare guidelines, legislation, animal welfare measurements and enforcements differ between and within countries globally.

In Australia, the federal government has responsibility for trade and international agreements that involve animal welfare issues. This includes having legislation that covers the import, export, processing and welfare of animals and animal products. The Australian government's federal animal welfare regulations require that farmers deliver an acceptable standard of care for their animals. State and territory animal welfare agencies manage and enforce these regulations.

NSW Department of Primary Industries (NSW DPI) manages and enforces animal welfare policies and frameworks for NSW, including Prevention of Cruelty to Animals Act 1979, the Exhibited Animals Protection Act 1986 and the Animal Research Act 1985.

Australian agriculture and farmers are world leaders in animal welfare. The overwhelming majority of Australian farmers take great pride in breeding and producing animals and animal products for various markets to a high-quality level and follow and adopt animal welfare practices for the following reasons:

- Farmers genuinely care and take pride in looking after the animals in their charge to the best of their abilities.
- Stressed animals are not productive. Other than genuinely caring for their animals, loss in production leads to loss of profit.
- To keep the good reputation of high-quality Australian livestock production.
- To meet consumer and community expectations and trust of Australian animals being farmed with high animal welfare standards.

Even though Australian agriculture boasts a good reputation of high animal welfare, there are cases of poor animal welfare. Developing an understanding and empathy toward farming and livestock production from the paddock to plate is important. We must realise that individual cases of poor animal welfare, while upsetting and unjust, do not reflect the practices of the whole industry and all producers**.**

Social media, urbanisation, non-factual media reports and the disconnection between farms, farming and consumers are all changing the balance from scientifically-based animal welfare to attitudes driven by consumer perception. This is a serious issue for pig farmers, as perception on animal welfare is beginning to impact on how farmers farm.

Examples of welfare practices in agriculture which involve debates on ethics include live animal export, caged egg production in poultry, using farrowing crates in piggeries, mulesing sheep and removing young calves from dairy cows to name a few.

Consider the animal welfare issue of using farrowing crates in the pork industry. Farrowing crates are used to house lactating sows and their litters. They are designed to protect piglets from being laid on by their mothers. They ensure maximum survival of the piglets and ease of assistance to sows in difficulty at farrowing. They also ensure greater health and disease monitoring of the sow and her piglets.

Points for:	Points against:
• Lying on piglets is the major cause of death in the first 3 days after birth. • Newly farrowed sows can be very protective of their litter, and this can pose WHS hazards for stock attendants. • Sows can weigh 150 to 250kg, they are big animals. If they lie on piglets, it results with death. • Farrowing crates ensure maximum survival of the piglets and ease of assistance to sows in difficulty at farrowing. • Farrowing crates ensure greater health and disease monitoring of the sow and her piglets	• Farrowing crates confine a sow throughout lactation (about 25 days). • Critics of farrowing crates state deprivation of the sow's nest building instincts and restricted movement as the major problem with their use.

Research around the world is investigating better options. However, no system currently protects piglets as well as the farrowing crate. The trade-off for piglets' survival is sow confinement during lactation (about 25 days). Across the world, farmers are happy to adopt a scientifically proven replacement system, but nothing as effective is available.

New farrowing pen designs have options to restrict sow movement during the first week after farrowing or allow the sow to be locked in a feeder stall. The Pork Cooperative Research Centre funds many projects to establish better housing options for pigs while maintaining productivity.

Animal Welfare in the Pork industry

Model Code of Practice

Australian pork producers follow a Model Code of Practice. The Model Code of Practice for the Welfare of Pigs outlines minimum standards for the welfare of pigs on farms and includes regulations such as minimum space allowances in indoor systems, space requirements in gestation stalls. The Code provides a foundation for animal welfare legislation, and has been regulated in each state, making it legally enforceable.

The Code is intended as a guide for all people responsible for the welfare of pigs under both intensive and extensive systems. The Code emphasises that, whatever the form of husbandry, managers, and others responsible for the day-to-day needs of pigs have a responsibility to care for animals under their control. It details the responsibilities of those involved with the care of pigs, including their accommodation, food, water and management.

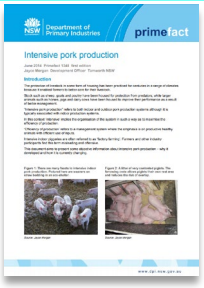
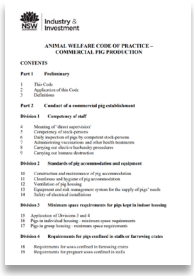
Find out more by following this link '[Husbandry, Model Code of Practice]', Pork Australia.

Housing

The housing of pigs, particularly sows, has been a controversial topic. The Australian pork industry has taken a world-leading position by voluntarily committing to phasing out sow stalls, meaning that sows will not be confined in stalls from five days after they are last mated until one week before farrowing, when they are moved into farrowing accommodation. Read on to learn more about this initiative and the different terms used in the pork industry to describe the different types of housing.

Find out more by following this link '[Animal welfare, Housing']', Pork Australia.

Read the following publications to learn more about legislation and codes of practice in the pork industry surrounding animal welfare.

			
Read: 'Intensive pork production', NSW DPI Primefact. Topics include: History, Animal welfare – perception versus reality; What about media images of the pork industry? Efficiency is not a dirty word; Who will feed the world?	Read: 'NSW Pork Industry Overview 2015', NSW DPI. This publication covers the Pork industry situation; Industry body roles; Industry legislation; Issues affecting industry production.	Read: 'NSW Code of Practice- Commercial pig production' NSW DPI. This Code outlines the principles that everyone involved in commercial pig production in NSW must use to protect the welfare of the animals in their care.	Read: 'Responsible pig ownership', NSW DPI. This Primefact aims to highlight the key legal requirements for pig ownership and farming in Australia

Watch these videos to observe animal welfare in intensive systems in Australia and around the world.

Aussie Pig farmers; Nothing to Hide

Fawley Farms: Pig Farm Documentary

Modern pig farming technology

Australia's Great Southern Piggery

Outdoor pig farm in New Zealand

25. Select an animal welfare issue for Australian pork production systems.

In this activity, you will conduct research to:

Evaluate one management practice in Australian pork production, in terms of animal welfare outcomes.

Topics you could investigate include:

- **The use of mating stalls**
- **Pig transport**
- **Castration**
- **Ear notching**
- **Teeth clipping**
- **Indoor housing systems**
- **Free range housing systems**
- **The use of sow stalls and farrowing crates**

For assistance in preparing your evaluation, use the following template.

Evaluate: make a judgement based on criteria, determine the value of	
Description of feature/issue:	
Points for (advantages):	*Points against (disadvantages):*

Criteria:
Judgement (of each point/issue against the criteria):

Pig diseases and biosecurity

Biosecurity

Biosecurity is the protection of the economy, environment and community from the negative impacts of pests and diseases, weeds and contaminants. Biosecurity involves preventing new threats from entering Australia; controlling outbreaks when they do occur and controlling the spread of pests, diseases, weeds and contaminants already present in Australia.

Click on the image to find out more!

Globalisation, urbanisation and climate change are increasing the risk of a biosecurity breach in Australia at a national, state, district and individual property level. The Australian Government has regulatory responsibility for Biosecurity border and pre-border activities, while state and territory governments are responsible for post-border activities such as surveillance, prevention and response. While robust response plans are in place to combat outbreaks, preventing pest, disease and weed entry in the first place is shared from the national level all the way to the state, regional and personal level. Everyone has a role in biosecurity and it is a shared responsibility.

Australia's geographic isolation allows Australia to be free from many diseases, pests, weeds and contaminants of serious global significance. Freedom from these exotic pests and diseases is a vital part of the future profitability and sustainability of Australian agriculture. Biosecurity allows us to preserve and access unique and essential international and domestic markets.

Biosecurity in pork production

Producers play a key role and have a general biosecurity duty in protecting Australian plant and livestock industries from pests, weeds and diseases. All pig owners have a duty of care to manage their own pigs. Farm biosecurity involves a set of measures designed to protect a property and prevent the entry and spread of biosecurity threats.

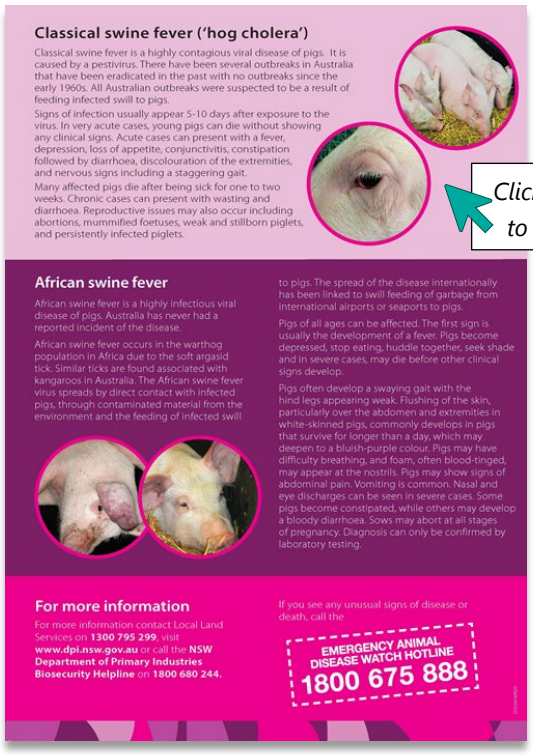
There are a range of pests and diseases present both internationally and in Australia, that threaten the health and productivity of pigs. Common endemic diseases include: enzootic pneumonia, pleuropneumonia, mange, and swine dysentery. They pose constant challenges to Australian pig producers and industry, causing millions of dollars in losses each year though deaths, decreased growth and reduced reproductive rates. Control measures such as vaccines, antibiotics and other chemicals further add to the cost to industry and producers. Minimising the level of disease within the herd (both nationally and on a farm) can dramatically reduce costs, while increasing profitability and animal welfare.

Exotic diseases which pose great potential risk to the Australian pork industry include:

- Japanese Encephalitis
- African swine fever (ASF)
- Foot and Mouth Disease (FMD)
- Classical swine fever (Hog cholera)
- Aujeszky's disease
- Porcine reproductive and respiratory syndrome (PRRS)
- Postweaning multisystemic wasting syndrome (PMWS)

Biosecurity is the best form of defence against both endemic and exotic diseases. Eradication and recovery from an exotic disease outbreak would not only be costly, but the long-term prosperity of the Australian

pig industry could be damaged if a foreign disease became established. International market access for Australian pork products is increasingly dependent on the absence of certain diseases from Australia.



Click on the images to find out more!

How do diseases of pigs spread?

Infectious agents can be spread by pig to pig contact; illegal importation and disposal of contaminated meat products; semen and embryos; aerosol contamination of people and their clothing and equipment. Veterinary equipment, transport vehicles, contaminated feed and water, biting insects and wildlife vectors are all methods by which infectious agents can be moved from property to property and pig to pig.

Examples of ways in which pig owners implement high levels of biosecurity include:

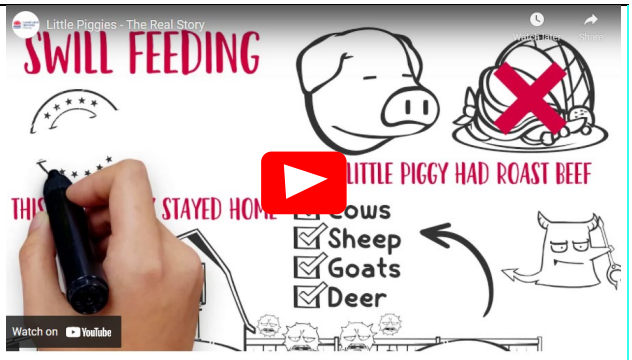
- NO swill feeding or feeding pigs prohibited matter- ensure pigs do not have access to prohibited pig feed or contaminated food scraps. Swill feeding is illegal in Australia.
- Prevent contact with neighbouring properties- applying buffer zones between properties and piggery units or management zones. These reduce the risk of airborne contamination.
- Separation from other animals- Pigs on farm are protected through pig proof fences (feral pig proof); separated from other grazing livestock cross contamination; with stringent rodent, pest and insect control reduction strategies.
- Introduction of new stock and quarantining- Introduced pigs present the greatest risk of introducing new diseases to a herd. Pig producers buy replacement animals directly from herds with a higher or comparable health status, or only introduce new genetic material through artificial insemination from Australian boars. Any new breeding stock are quarantined for 6 – 8 weeks by separation from the herd. No genetic material or live pigs can be imported into Australia.
- Controlled access- Farms have rigid procedures and rules to minimise risk from visitors, staff, vehicles, and equipment coming onto the site. All these could potentially bring pest, disease or contaminants with them.
- Disease identification and reporting- Staff should be trained to recognise signs of disease in the herd and to report any unusual signs or unexplained deaths immediately. Mortality and disease records must be kept. If something unusual or unexpected happens and infectious disease is suspected, veterinary advice should be sought as soon as possible to allow for rapid recognition of any possible disease incursions.

- Pig identification and movement documentation- All pig owners in NSW must have a property identification code (PIC) identifying the property of birth, or the place where pigs are kept. All properties that sell pigs must have a tattoo brand and/or ear tag that link to the PIC.
- Identification- identification of pigs going for sale or slaughter is an essential part of monitoring for diseases and chemical residues. All pigs consigned for sale at a saleyard, slaughter at an abattoir or disposal must be identified by either a tattoo brand or ear tag prior to leaving their property of origin. Pigs over 25 kg body weight must be tattooed and pigs below this weight must be ear tagged.
- National vendor declaration- All pig movement off farm must be accompanied by a PigPASS national vendor declaration (NVD). *PIGPass is essential for everyone who owns a pig*, whether it is a pet pig, a backyard or hobby farmer, or a large commercial producer.
    - See the Notifiable animal pests and diseases in NSW Primefact.
    - See the NSW DPI Pig health and diseases and Australian Pork Limited's Biosecurity resources.

Good farm biosecurity strengthens regional biosecurity, which in turn supports national biosecurity. If a new pest or disease becomes established on farm, it can affect the business by:

- Increasing costs (for treatment, monitoring, production practices, additional chemical use and labour)
- Reducing productivity (in yield and/or product quality)
- Loss of domestic and international markets.

'African Swine Fever: Australia's pork industry in high alert', Landline



'Pigs and swill feedings- The real story', LLS

'APL- Biosecurity at your Piggery', Australian Pork Industry Quality Assurance

'PIGPass Traceability at work', Australian Pork Limited

Click on the images to find out more!

26. Define biosecurity:

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27. Why is biosecurity a shared responsibility?

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28. List the 9 ways pig producers can manage pigs to sustain high levels of farm biosecurity.

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29. **Choose an endemic or exotic pig disease to further research. For your chosen disease conduct research to create a disease awareness brochure of fact sheet that could be provided to pig producers.**
In your report include the following:
    - **Disease common name**
    - **Disease scientific name**
    - **Description of the disease (include animal/s affected)**
    - **Description of how it spreads**
    - **List symptoms (include images where appropriate)**
    - **Describe how the disease can be treated**
    - **List where the disease is found around the world (include a map if possible)**
    - **Describe how the disease affects production, the environment or the economy.**
    - **Summarise the biosecurity duty regarding this disease (How can you prevent the spread of this disease in pork production?)**

Helpful websites:

- NSW DPI Pig Health and Disease
- African swine fever
- Foot and Mouth Disease (FMD)J
- Japanese Encephalitis
- Classical swine fever
- Aujeszky's disease
- Porcine reproductive and respiratory syndrome (PRRS)
- Postweaning multisystemic wasting syndrome (PMWS)

Click on the images to find out more!

Swine digestive anatomy and physiology (Monogastric digestion)

Pigs along with humans, poultry, fish, horses, rabbits, mice, cats and dogs are all monogastrics. Monogastrics are classified as animals which have one simple, single-chambered stomach, as opposed to ruminant animals, which have four-chambered stomachs.

Monogastrics can be further categorised as carnivores, herbivores and omnivores. Each of the three monogastric systems (carnivore, herbivore and omnivore) have modifications to digest their diet (for example, pig vs. horse vs. poultry all have modifications). All monogastric animals, however, require a high-quality source of protein and amino acids from the diet (unlike ruminants).

Anatomy

Pigs are omnivorous monogastrics. Organs within the pig's digestive tract are connected in a continuous musculo-membranous tube from the mouth to the anus. Major components of the swine digestive system include:

- Mouth
- Oesophagus
- Stomach
- Pancreas (accessory organ)
- Liver (accessory organ)
- Gall bladder (accessory organ)
- Small intestine (duodenum, jejunum and ileum)
- Large Intestine (caecum)
- Rectum/anus

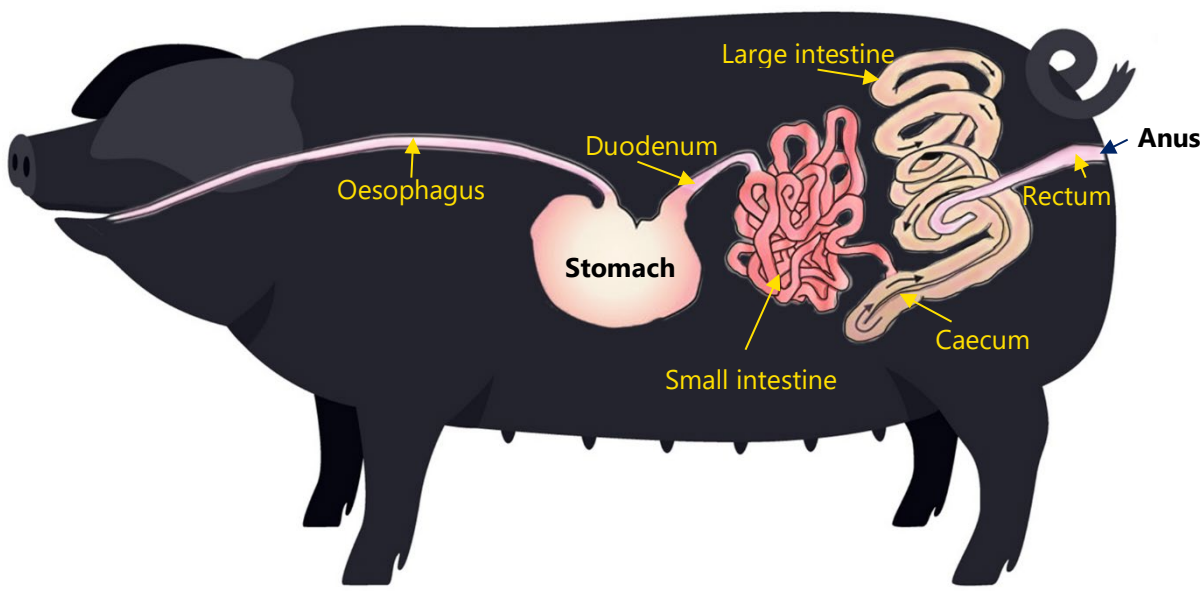
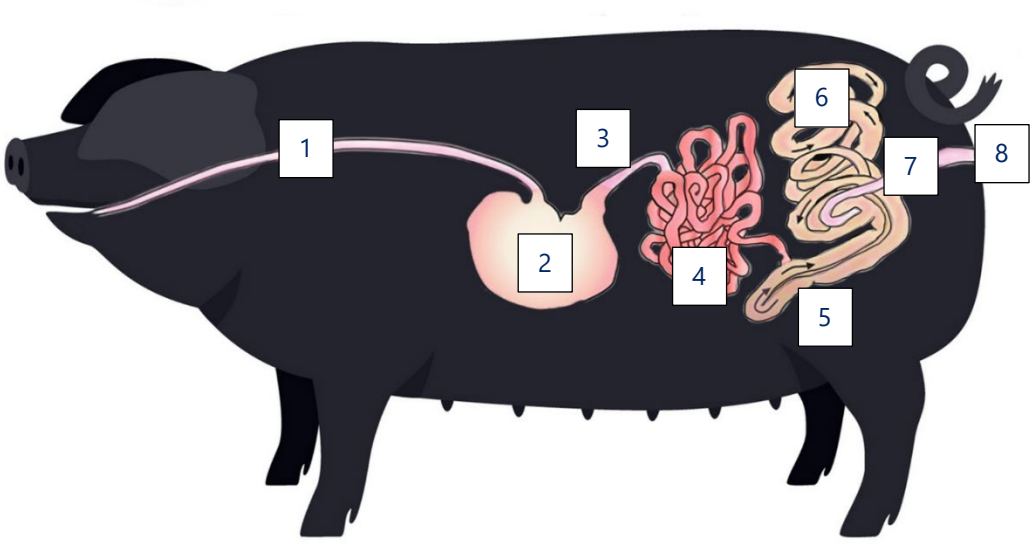


Figure 3 Monogastric digestive tract (pig)

30. Use Figure 3 to complete the table by labelling the parts of the monogastric pig digestive tract.



Digestive organ name	
1.	5.
2.	6.
3.	7.
4.	8.

Digestive physiology of the pig

Digestion is the breakdown of food throughout the digestive tract. As food passes through the digestive tract it is broken down into smaller units (nutrients). The nutrients from the food are absorbed into the blood and any leftovers are passed out of the body as urine and faeces. Different parts of the digestive tract carry out different functions in the digestion and absorption process.

The monogastric digestive system of the pig is very efficient as compared to other livestock (ruminants). The feed conversion ratio (FCR) is a value that shows the efficiency with which the animal transforms the feed consumed to body mass (meat). (FCR = weight of feed ÷ weight gained. Low FCRs indicate high efficiency. See the following table for FCRS for different livestock. For example, if an animal had an FCR of 1, this means that for every 1kg of food it consumes, it gains 1kg body mass. If an animal has an FCR of 10, for every 10kg food consumed it gains 1kg body mass.

Table 8 General Food Conversion Ratios for livestock

Swine	Beef cattle	Poultry (chickens)	Sheep	Fish
2.7-5.0	6.0-10.0	1.7-2.0	4.0-5.0	1.2

Organ functions in the pig digestive tract:

- Mouth- (physical and chemical breakdown). The mouth consumes and physically breaks down the size and increases the surface area of food through the grinding action of teeth. Chemical breakdown occurs as the feed is mixed with saliva. Saliva is produced and secreted from salivary

glands. Saliva contains enzymes including amylase. Amylase begins breaking down carbohydrates (starch) into maltose.

- Oesophagus- a muscular tube connecting the mouth to the stomach. Movement though the oesophagus is carried out by peristalsis, which involves the contraction and relaxation of muscles in the oesophagus to move the food.
- Stomach- (physical and chemical breakdown). The stomach is a muscular organ responsible for storage, initial breakdown of nutrients, and the passage of food into the small intestine. The stomach churns food, allowing stomach secretions to mix with the food and increase chemical breakdown. Chemicals secreted include:
    - Hydrochloric acid, which lowers the pH in the stomach to 1.5-3.0 pH. The low pH kills bacteria in the feedstuff
    - Digestive enzymes- Pepsinogen. Pepsinogen is broken down by hydrochloric acid forming Pepsin. Pepsin breaks down proteins.

  Food then passes from the stomach into the small intestine.

- Small Intestine- (chemical breakdown and absorption). The small intestine is the major site of nutrient absorption and is divided into three sections. The duodenum, the jejunum, and the ileum.
    - Duodenum- (first section of the small intestine) approximately 12 inches long. Contains ducts which links the accessory organs the pancreas, liver and gallbladder and their secretions essential to digestion. High levels of digestion of proteins, fats and carbohydrates occurs in the duodenum.
    - Pancreas- secretes insulin and glucagon in response to glucose levels in the body. It also secretes digestive enzymes and sodium bicarbonate which is essential in neutralising the acid secretions from the stomach which would otherwise cause small intestinal cell damage. The digestive enzymes secreted by the pancreas breakdown proteins, fats and carbohydrates.
    - Liver- secretes bile which is stored in the gall bladder and secreted into the small intestine via the duodenum. Bile salts are the active portion of bile and aid the digestion and absorption of fats and the absorption of fat-soluble vitamins.
    - Jejunum- (middle section of the small intestine), links the duodenum to the ileum. This portion allows for the further breakdown of nutrients as well as starting nutrient absorption.
    - Ileum- (final section of the small intestine), continues nutrient absorption. The jejunum and ileum contain intestinal mucosa which are made up of finger like projections called villi. Villi have an increased surface area which contain masses of blood vessels which absorb nutrients, allowing the movement of nutrients around all cells in the body via the circulatory system.

      All amino acids (proteins), simple sugars (carbohydrates), dietary fats and vitamins are absorbed by the intestinal mucosa.
- Large Intestine- the large intestine or hindgut encompasses the caecum, the rectum and anus. The main function of the large intestine is the absorption of water. The food that passes through the small intestine and into the large intestine initially is very fluid. The large intestinal cells (epithelium) absorb water from the food. Limited chemical digestion occurs in the large intestine.
    - Caecum- The caecum has two sections, first a section that has a blind end, where material cannot pass though. The caecum's second portion connects to the colon passing waste to the rectum and colon for excretion. The caecum in pigs has little function.
- Rectum/anus- the majority of water has been removed, the food is condensed into a semi-solid material and passed out of the rectum and anus.

31. Complete the table to summarise information about the pig's digestive tract. The first example has been given.

Organ		Function	Identify the digestion type where applicable (physical, chemical or both)
Mouth		• Mouth consumes and physically breakdowns food through the grinding action of teeth. • Chemical – saliva contains enzyme amylase begins breaking down carbohydrates (starch) into maltose.	Both
Oesophagus			
Stomach			
Small intestine	Duodenum		
	Jejunum		
	Ileum		
Large intestine			
Caecum			
Rectum/Anus			

Swine nutrition

Feeding pigs requires more thought than just selecting feed ingredients. A pig's nutritional needs change over time as it grows, matures, breeds and lactates. There are also seasonal and environmental conditions that affect the feed use efficiency of the pig. Properly fed pigs have better health, welfare, reproductive performance and profitability. Pigs have high and specific nutritional requirements to meet their rapid growth and production stages. If any nutrient requirement is not met, the pig will not carry out correct bodily function, growth and development.

The six nutrient categories are:

- Water: is an essential nutrient needed for all chemical processes in the body. Fresh, clean water must always be available. Lactating sows have a higher water requirement due to the high water content of milk. Restricting water leads to problems in all body parts and functions. It also reduces feed intake, which slows growth.
- Carbohydrates: contain high amounts of energy. Energy is needed for normal body maintenance and activity. Foods high in carbohydrates are cereals such as wheat, barley, maize, oats and sorghum. Energy requirements are expressed as kilocalories (kcal) of digestible energy (DE), metabolizable energy (ME), or net energy (NE).
- Proteins: needed for growth, maintenance, foetal development, and milk production in lactating sows. High protein feed sources include fish meal, oilseeds (such as soybean meal and cotton seed meal) and milk proteins.
  Protein supplies essential amino acids required by the pig for healthy body function and growth. Of the 22 amino acids, 12 are synthesized by the animal; and the other 10 must be provided in the diet for normal growth (essential amino acids). Pigs have high protein and amino acid needs due to their rapid growth. Not meeting these requirements can cause irreversible growth and development issues.
  The most important amino acids in diet formulation (i.e., those most likely to be deficient) are lysine, tryptophan, threonine, and methionine. Maize, the basic grain in most swine diets, is markedly deficient in lysine and tryptophan. Other main grains for pigs (grain sorghum, barley, and wheat) are low in lysine and threonine.
  Lysine is the first limiting amino acid and must be managed in pig rations. Lysine deficiency leads to animals being more susceptible to infectious disease and poor muscle development.
- Fats: are an important energy source. They improve food palatability, are higher in energy than carbohydrates and contain fat soluble vitamins. Fats are needed for body maintenance as they are the basic unit of many hormones. Essential fatty acids are not produced by the pig and can only be obtained from dietary fat. As fats are very high in energy, added fats must be managed at different production stages. For example, so that market pigs meet market specifications for lean muscle: fat ratios. Feed sources high in fats include oils such as canola oil, linseed oil, sunflower oil as well or grains such as maize, sunflower, linseed and soybean.
- Vitamins: are only needed in very small (trace) amounts but are essential to chemical processes taking place in the body. Some are naturally produced in the pigs body, some are in common feeds and some must be supplemented. Vitamins are either fat soluble or water soluble. Examples are vitamin A (required for normal growth); vitamin D (needed to prevent rickets) and vitamin E. Vitamin E deficiencies result in muscle wasting and poor co-ordination. Vitamin A is found as carotene in green plants. Vitamin D is provided by sunlight and from plant material which has dried in the sun. Vitamin E is found in green plants and grain.
  Other essential vitamins include: vitamin K, Riboflavin, Niacin. Vitamin B_{12}, Thiamine, vitamin B_6, vitamin C, Biotin and Folacin. All play important roles in normal health, metabolic function, growth and development.

- Minerals: are only needed in small amounts for a wide range of body functions, growth and development. Examples are Calcium and Phosphorus, which are needed for correct skeletal growth and structure. Copper and Selenium are essential for metabolism and can maximise feed conversion ratio of growing pigs. Calcium can be provided as ground limestone (calcium carbonate). Phosphorus is present in grains such as maize, barley and soybean. Selenium can be provided through Selenite and Copper through copper chloride.
  Other essential minerals include: Sodium and Chloride, Potassium, Magnesium, Sulphur, Iron, Iodine, Manganese, Zinc, Chromium, Cobalt. Minerals should be managed carefully as an excess can be toxic.
  Read more at: 'Nutritional requirements of pigs', Veterinary manual, University of Kentucky.

32. List the 6 nutrients essential for swine.

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33. What it the importance of essential amino acids and essential vitamins and minerals to a pig's diet?

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34. A batch of piglets in a commercial piggery all present symptoms over a 3-week period after changing ration. They are all increasingly getting sick and are wastey with poor muscle development and growth for age. All animals are on the same ration. What could be the possible problem/deficiency?

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_____

Rations for different growth and production stages (matching feed to need)

The aim of any nutrition program is to meet the pig's nutritional needs, which change over time as the young pig matures or the sow progresses from gestation to lactation.

When lactating animals' nutritional needs are not met, sows access the components for the milk production from their own body tissue. As a result, the sows lose weight. Weight loss is not restricted to their fat reserves; it can include muscle tissue and bone minerals. Poor sow diets can result in low piglet weights at weaning, sows not returning to service at weaning, poor litter size for subsequent litters and early culling of sows for health or breeding issues. Lactating sows should also be fed as much as they want, especially if they have large litters – ten or more suckling piglets.

Weaner pigs are in a high growth phase and need high quality rations to add muscle and bone as they grow. Depending on their age at weaning they are also changing from milk to solid feeds. Offering a 'creep' feed, while they are still suckling, helps them adjust to solid feed. The feed needs to be easy to digest, easy to access and palatable.

As the pigs grow the diet will change, and nutritional needs reduce. Rations must be altered so that grower or adult pigs only get what they need and don't get too fat.

See table 9 for energy and Lysine requirements for pigs at different production stages.

Table 9: Guidelines for energy and Lysine requirements for pigs at different production stages. *Source: Pig nutrition, get the basics right, NSW DPI*

Group	Age range (weeks)	Energy MJ DE/kg	Lysine grams: MJ	Daily feed intake (kg)
Weaner	4-10	14.5-15.0	0.80	0.3-1.5
Grower	10-17	14.0	0.67	1.7-1.8
Finisher	17-24	13.2	0.50	2.4
Dry sow or boar	(adult)	13.0	0.40	2.5-3.0
Lactating sow	(adult)	14.0	0.55	6.0+
Lactating gilt	1st litter	14.2	0.72	6.0+

Other points to consider when feeding pigs:

- Pigs outdoors will need up to 15% more feed allowance due to exercise and variable temperatures
- Housing and season can affect the amount of feed needed by pigs – pigs eat more when cold. Hot weather can reduce feed intake – lactating sows can be most affected so consider changing the feeding time or increase feed quality.
- Pigs are monogastric omnivores and can eat a wide range of feedstuffs. However, feed that is high in fibre or moisture content will not be suitable for young growing pigs due to their small gut capacity. Adult pigs can manage higher fibre diets but it takes time for them to adjust to these diets.
- ***It is illegal to feed swill to any pig in Australia*** (including pet to commercial pigs). There are strict Swill feeding regulations in Australia. By-product feeds from the human feed supply chain can be attractive on a price basis but not all products are within regulations. Products containing meat or have been in contact with meat are illegal. Examples include restaurant waste, household waste, and bakery waste that contains meat such as pies and pizzas. For more information read the Swill Feeding Primefact. If in doubt ask at your Local Land Services office.

Click on the images to find out more!

Further reading at:

- 'A diet fit for a pig: seven basic rules', NSW DPI Primefact
- 'Pig nutrition: get the basics right' NSW DPI Primefact

35. Define swill feeding and give examples of prohibited matter.

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36. Why is swill feeding illegal in Australia?

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37. Identify and list 6 different production/growth stages of pigs

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Group activity- Selecting rations

(Adapted from University of California, 2014, 'Pig Nutrition: what you need to know', Agriculture and Natural Resources, University of California)

Students work in groups of five to complete the activities to match a ration to different pig production and growth stages.

Teacher guide:

- Divide students into groups of five.
  - Each member of the group is assigned a pig growth and production stage:
  - Weaner pig
  - Grower pig
  - Finisher pigs
  - Late gestation sow
  - Lactating sow
- Each student has a copy of Table 10, Pig Rations and a copy of the Selecting rations- worksheet.
- Part 1-Students work individually to complete a single investigation
- Part 2- Students share their individual work with group members to complete group investigation
- Part 3- Student's collaboratively work in their groups to complete the graphing activity- (e.g. using google sheets or similar collaborative digital software).

Selecting rations- worksheet

Feeding pigs requires more thought than just selecting feed ingredients. A pig's nutritional needs change over time as it grows, matures, breeds and lactates. Complete the following activities to select and match rations that meet a range of pig nutritional requirements at different growth and production stages.

Growth/production stage	Daily feed intake (kg)	Energy MJ/DE/kg	Nutrients			
			Crude protein	Lysine	Calcium	Phosphorus
Weaner	0.3-1.5	14.5-15.0	24.5%	1.43%	0.85%	0.68%
Grower	1.7-1.8	14.0	19.5%	1.05%	0.65%	0.55%
Finisher	2.4	13.2	14.5%	0.68%	0.48%	0.42%
Late gestation sow	5.0+	14.0	12.5%	0.55%	0.75%	0.65%
Lactating sow	6.0+	13.0	17%	0.95%	0.75%	0.65%

Table 10 Approximate daily pig nutrient requirements

Table 10 provides the approximate daily pig nutrient requirements for five production and growth stages. Use this information to complete your individual work Part 1-3 below.

Part 1

A. List your pig production stage:

_____

B. Use Table 10 to list pig nutrition requirements and complete the table

Growth and production stage:	
Crude protein:	
Lysine:	
Calcium (Ca):	
Phosphorus (P):	
Energy MJ/DE/kg:	

C. Select a suitable ration from the 'Pig rations' list that will suit the pig nutritional requirements for your growth and production stage. Complete the table below regarding the ration you have chosen.

Ration name:	
Crude protein:	
Lysine:	
Calcium (Ca):	
Phosphorus (P):	
Energy MJ/DE/kg:	

Justify your choice of ration by answering the following:

D. Explain how this ration meets your pig's production stage dietary requirements

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_____

_____

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_____

_____

E. List the potential befits of the ration your chose:

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_____

F. List the potential drawbacks of the ration you chose:

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G. Explain what you might be able to modify to improve your pig's feed:

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Pig rations

Ration 1
Crude Protein- Min 19.93%
Lysine- Min 1.18%
Crude Fat- Min 5.75%
Crude Fibre- Min 2.39%
Calcium (Ca)- 0.85-1.15%
Phosphorous (P)- Min 0.65%
Energy- 13.2 (MJ ME/kg)

Ration 2
Crude Protein- Min 20.41%
Lysine- Min 1.18%
Crude Fat- Min 6.53%
Crude Fibre- Max 2.68%
Calcium (Ca)- 1.2-1.60%
Phosphorous (P)- Min 0.70%
Energy- 10.1 (MJ ME/kg)

Ration 3
Crude Protein- Min13.5%
Lysine- Min 0.6%
Crude Fat- Min 3.2%
Crude Fibre- Max 2.2%
Calcium (Ca)- 1.2-1.5%
Phosphorous (P)- Min 0.83%
Energy-14.2 (MJ ME/kg)

Ration 4
Crude Protein- Min 16.1%
Lysine- Min 0.8%
Crude Fat- Min 8.3%
Crude Fibre- Max 2.3%
Calcium (Ca)- 1.05-1.35%
Phosphorous (P)- Min 0.69%
Energy-13.2 (MJ ME/kg)

Ration 5-
Crude Protein- Min 20.06%
Lysine- Min 1.2%
Crude Fat- Min 5.41%
Crude Fibre- Max 2.33%
Calcium (Ca)- 0.78-1.08%
Phosphorous (P)- Min 0.73%
Energy- 14.1 (MJ ME/kg)

Ration 6
Crude Protein- Min 14.0%
Lysine- Min 0.6%
Crude Fat- Min 3.0%
Crude Fibre- Max 5.5%
Calcium (Ca)- 0.6-1.1%
Phosphorous (P)- Min 0.5%
Energy- 5.2 (MJ ME/kg)

Ration 7 (Cracked maize)
Crude Protein- Min 10.0%
Lysine- Min 1.45%
Crude Fat- Min 4.1%
Crude Fibre- Max 11.0%
Calcium (Ca)- 0.03%
Phosphorous (P)- Min 0.32%
Energy- 13.2 (MJ ME/kg)

Ration 8 (steamed maize)
Crude Protein- Min 9.0%
Lysine- Min 1.5%
Crude Fat- Min 4.1%
Crude Fibre- Max 9.0%
Calcium (Ca)- 0.02%
Phosphorous (P)- Min 0.29%
Energy- 10.8 (MJ ME/kg)

Ration 9 (Lucerne hay)
Crude Protein- Min 17.0%
Lysine- Min 1.37%
Crude Fat- Min 2.3%
Crude Fibre- Max 30.0%
Calcium (Ca)- 1.4%
Phosphorous (P)- Min 0.24%
Energy- 8.5 (MJ ME/kg)

Ration 10 (Soybean meal)
Crude Protein- Min 50.0%
Lysine- Min 0.97%
Crude Fat- Min 1.8%
Crude Fibre- Max 0.6%
Calcium (Ca)- 0.39%
Phosphorous (P)- Min 0.71%
Energy- 11 (MJ ME/kg)

Ration 11 (Cottonseed meal) weaner
Crude Protein- Min 47.0%
Lysine- Min 0.72%
Crude Fat- Min1.3%
Crude Fibre- Max 15.0%
Calcium (Ca)- 0.22%
Phosphorous (P)- Min 1.3%
Energy- 13.1 (MJ ME/kg)

Ration 12 (Oats) weaner
Crude Protein- Min 47%
Lysine- Min 0.55%
Crude Fat- Min 4.9%
Crude Fibre- Max 11.0%
Calcium (Ca)- 0.05%
Phosphorous (P)- Min 0.4%
Energy- 9.1 (MJ ME/kg)

Part 2 **Share results within your groups to complete the following table.**

Pig growth and production stage:	Ration:	Why did you choose this ration?
Weaner:		
Grower:		
Finisher:		
Late gestation sow:		
Lactating sow:		

Part 3 **Collaboratively work with your group to create four separate bar graphs illustrating Approximate daily pig nutrient requirements (%) (Table 10) for the 5 pig and growth production stages.**

Complete a separate graph for:

- **Crude protein requirements**
- **Energy requirements**
- **Calcium requirements**
- **Lysine requirements**
- **Phosphorous requirements**

Swine reproduction and reproductive technologies

Swine terminology

Use the NSW DPI 'Pork Production' poster and the internet to answer the following questions.

38. **What is a sow?**

_____

39. **What is a gilt?**

_____

40. **What is a boar?**

_____

41. **What is a barrow?**

_____

42. **What is a piglet?**

_____

43. **What is a sucker pig?**

_____

44. **What is a weaner?**

_____

45. **What is a grower pig?**

_____

46. **What is a finisher pig?**

_____

47. **Sows and gilts are nonseasonal and Polyestrous animals. What do the two terms mean?**

_____

_____

_____

_____

48. **What does gestation period mean and what is the gestation length for pigs?**

_____

_____

_____

_____

49. **What does oestrous mean and what is the oestrous length for pigs?**

_____

_____

_____

_____

50. **What is standing heat and how long does it occur in gilts and sows?**

_____

_____

_____

_____

Reproductive anatomy in females

Female reproductive parts overview:

- The female reproductive parts (major structures) include ovaries, oviducts, uterine horns, uterus, cervix, and vagina.
- Ova (female sex cells) are produced in the ovaries. Ovaries are shed every 21 days as a part of the oestrous cycle. Pigs can shed up to 15 ova every cycle. Multiple ova are released from both ovaries at the same time. If ova are fertilised the oestrous cycle which is controlled by hormones ceases. Fertilisation occurs in the uterine horn. Fertilisation is the process whereby a females' ova is fertilised by the male sex cell spermatozoa. When ova are fertilised, they attach at points called caruncles throughout the uterine horns and body the uterus. Here the fertilised ova will undergo cell division, to become a foetus. If fertilisation does not occur the ova pass through the reproductive tract (oviduct, fallopian tube, body of uterus, cervix, vagina) and will be expelled from the body via the vulva.
- Sows release multiple ova from both ovaries every oestrous. Highly fertile sows can release around 20 ova every oestrous.
- The body of the uterus and uterine horns are the locations where the multiple piglet foetuses develop.
- Sows and gilts have a unique cervical shape, with interlocking cervical rings that match the boars corkscrew shaped penis.

For greater detail on female mammalian livestock reproductive anatomy, physiology and lactation go to the NSW DPI Schools- Dairy Production series)

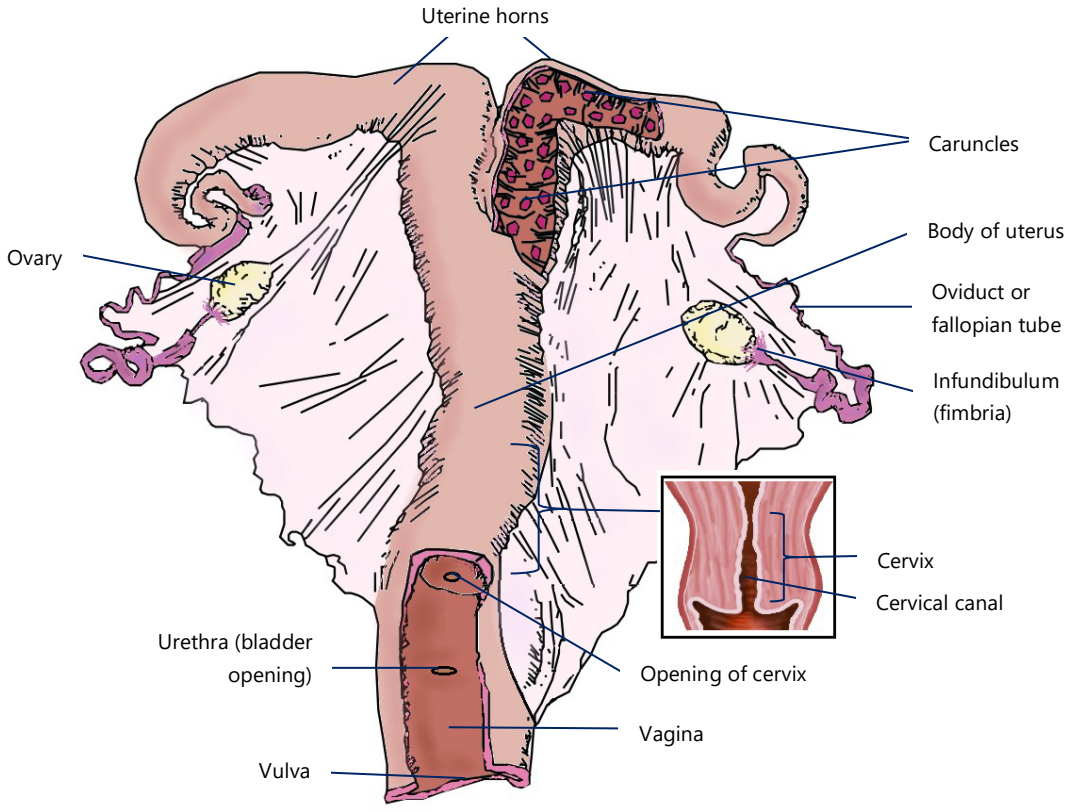


Figure 4 Anterior view of sow's reproductive tract

51. List the major structures of the female reproductive tract:

_____

_____

52. What is fertilisation?

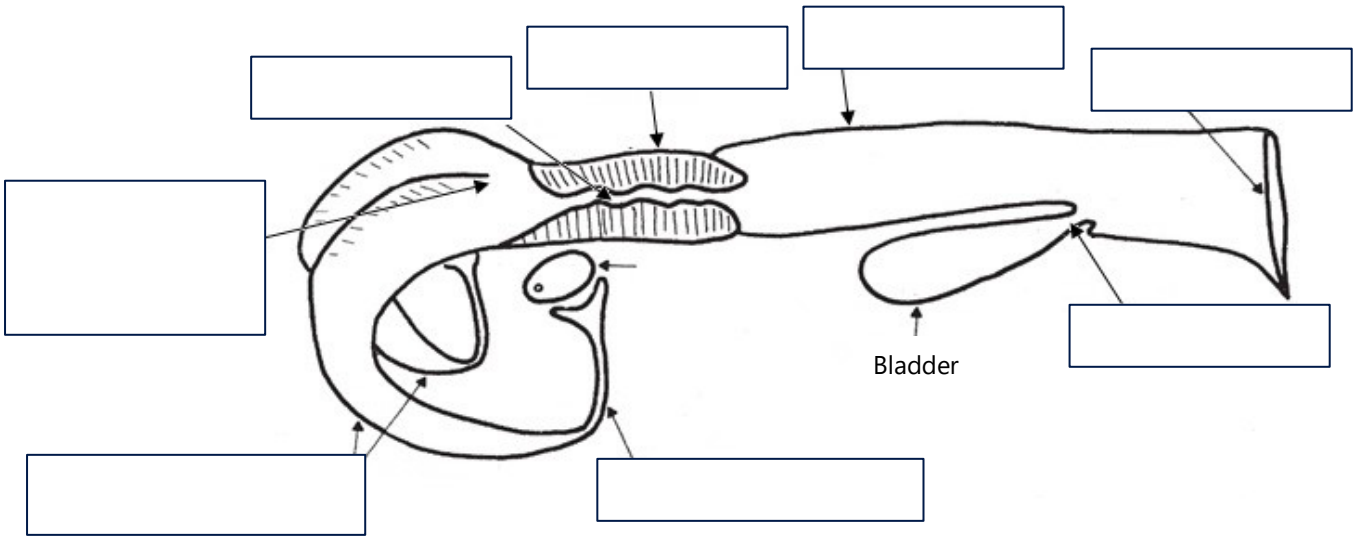
_____

_____

_____

_____

53. Use Figure 4 to label the following lateral view of the female pig's reproductive tract.



Reproductive anatomy in boars

Male reproductive parts overview:

- The male reproductive parts (major structures) include spermatic cord, testes, epididymis, accessory sex glands (bulbo urethral gland and prostrate), and the penis.
- The spermatic cord plays a role in temperature regulation (temperature sensitive muscles surrounding the spermatic cord lower the scrotum when temperatures are high and retract, raising the scrotum when temperatures are low to maintain a temperature close to the boar's core body temperature of 38.5-39°C. Cold or hot temperatures damage sperm production and reduce boar fertility. Heat stress is the most damaging to sperm production.
- Pigs have a unique 'corkscrew' shaped penis to interlock with the female's cervix.

(*For greater detail on male mammalian livestock anatomy and physiology go to the NSW DPI Schools- Dairy Production series*)

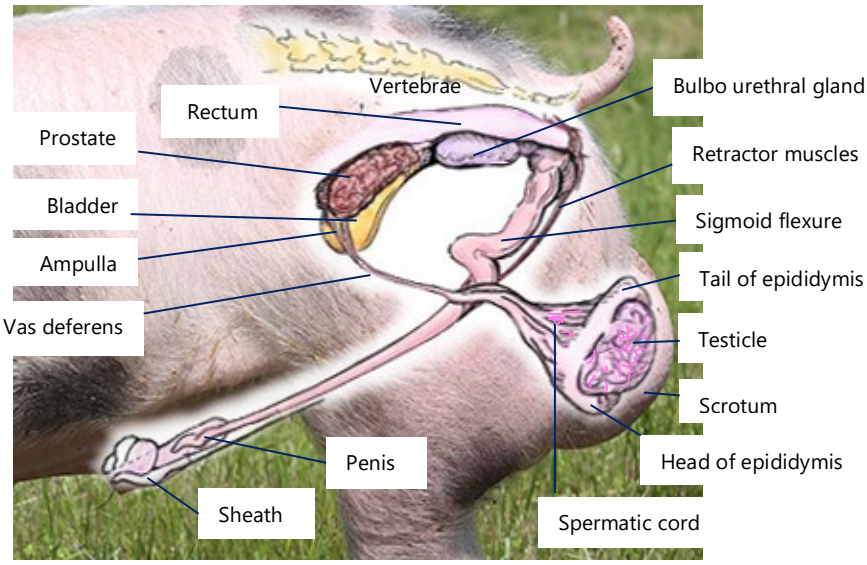


Figure 5 Lateral view of a boar's reproductive tract

54. List the major structures of the male reproductive tract:

_____

_____

55. Why is temperature regulation important for males?

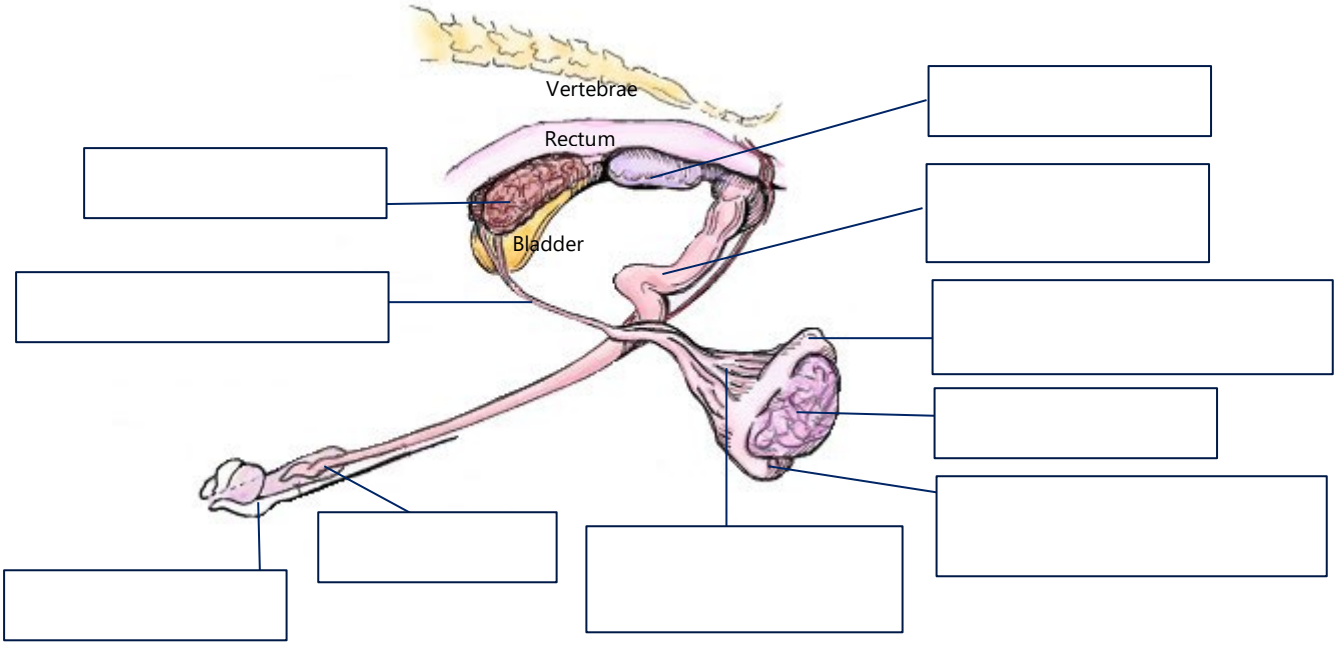
_____

_____

_____

_____

56. Use Figure 5 to label the boar's reproductive tract.



Reproductive technologies in swine

Artificial Insemination

Artificial Insemination (AI) is a technique used in agriculture to artificially breed female livestock. In pigs, it involves placing semen directly into the body of the uterus, via the cervix.

AI of pigs has been used in Australia since the early 1970s but only became popular after 1981 when boars and frozen semen were imported. The genetic influence of imported boars with higher estimated breeding values, has been more widely spread by the use of AI.

Currently, all semen in Australia is produced from Australian stock. It is illegal to import any genetics (semen, embryos or ova) or live pigs into Australia. These strict Biosecurity measures protect Australia's pork industry from many exotic diseases, such as African Swine Flu, and Foot and Mouth Disease to name a few, which could destroy our pork industry.

AI in the Australian pork industry mainly uses fresh or chilled semen. Cryopreserved frozen semen is rarely used. This is because boar semen is difficult to freeze and thaw.

Advantages of AI	Disadvantages of AI
• Semen from a range of top-performing tested boars of several breeds is available from AI centres. • The genetic influence of genetically superior boars can be widely accessed. • AI is a safe, cheap method of introducing new genes into pig herds, especially from those herds classified as specific pathogen-free, minimal disease or high health status, compared with bringing in live pigs. • AI overcomes size differences between boars and sows, thus improving animal welfare. • AI may be used during temporary shortages of boars from death, lameness or failure to work.	• Reduced farrowing rate (50%) with frozen semen. • Lower than average results with chilled semen stored longer than 72 hours. • Disappointing results where AI is poorly timed or done incorrectly.

Succeeding with AI

Whether using semen collected on-farm or buying it from an AI centre, successful insemination relies on:

- Detecting oestrus in the sow- see 'Practical activity: detecting oestrous in sows' below
- Correctly timing the insemination
- Correct AI technique see Inseminating Sows, Department of Agriculture and Fisheries, Queensland Government
- Correct semen handling and storage

AI timing

Multiple ova (eggs) are shed from both ovaries approximately 40 hours (range 36 to 50 hours) after the onset of oestrus. Spermatozoa in freshly collected or chilled semen, must mature for 2 to 3 hours in the female's oviduct before being capable of fertilisation, but frozen semen requires no time for maturation.

Spermatozoa can survive in the oviducts of naturally mated sows for 24 hours or more after copulation. Frozen and then thawed spermatozoa can survive between 8 to 10 hours in the oviducts. Ova have a much shorter life, being viable for less than 6 hours in the oviduct. Ideally, the eggs should be fertilised within hours of being shed; embryos from aged eggs tend to die more readily.

The achieve high conception rates, the optimal time for insemination using fresh or chilled semen, is 12 hours before ovulation. Since ovulation occurs after the female is on heat, the best insemination time for insemination is 28 hours (about a day) after onset of oestrous. As the exact time of oestrus onset is difficult to pinpoint, on-farm, inexperienced handlers should perform at least two inseminations 12 to 16 hours apart after heat to achieve best results.

Insemination should be carried out:

- One insemination only: 24-32 hours after the sow stands to the Back Pressure Test
- Two inseminations: 8-12 hours after the handler first identifies the 'standing' reaction and again 8 to 16 hours later (See Figure 6).

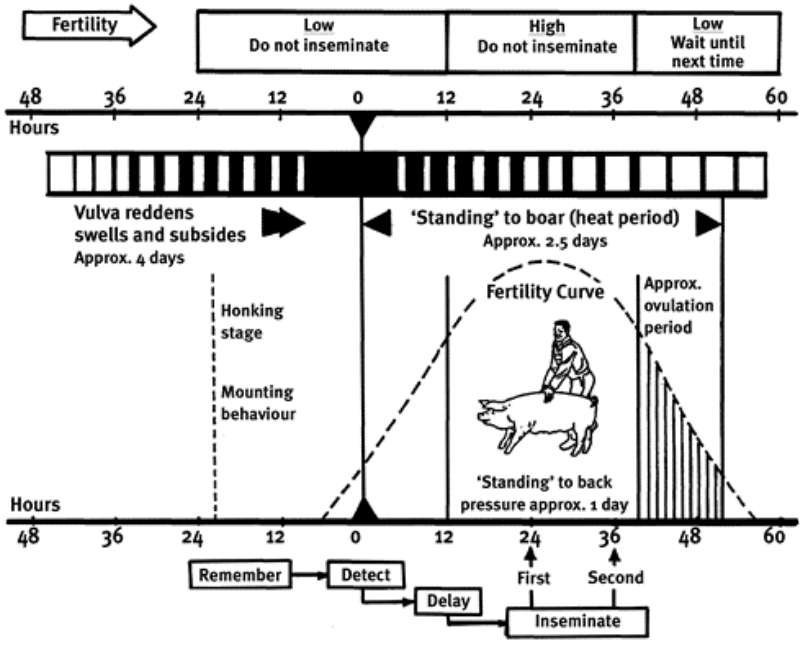


Figure 6 Inseminating sows, Source: Department of Agriculture and Fisheries, Queensland Government

AI technique in sows and gilts

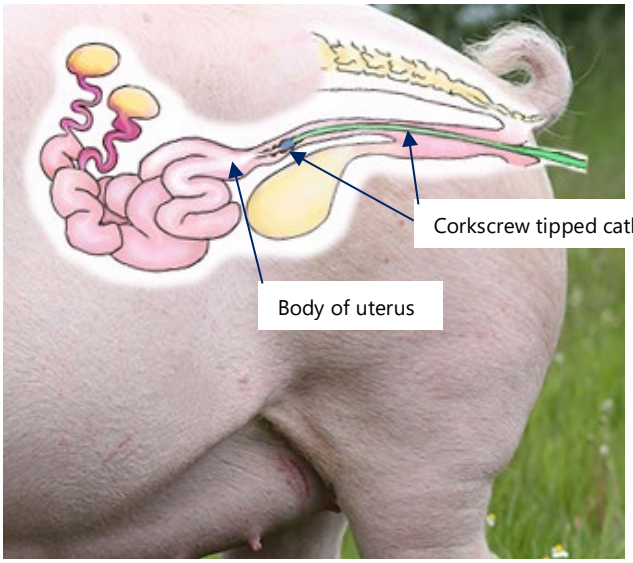
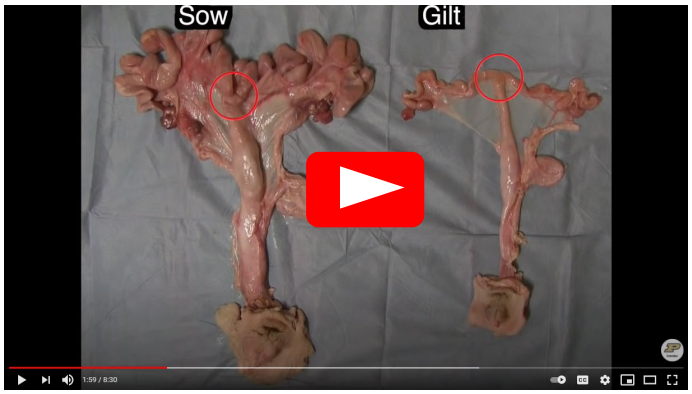


Figure 7 Lateral view of sow's reproductive tract and AI

- The catheter is gently inserted via the vulva, into the vagina in an upward direction to avoid contact with the bladder. It is then gently pushed through the vagina until it reaches the opening of the cervix. The sows cervix is corkscrew-funnel shaped, so sow and gilt AI catheters are spiral tipped.
- The spiral tipped catheter is rotated anti-clockwise through the cervix. The catheter is inserted as far as it will go and locks into place. Placement of the catheter tip will be in either in the cervix (traditional AI) or body of the uterus (Post cervical AI), dependant on the AI technique being used.
- Semen bottle or tube containing fresh, or chilled semen is connected to the catheter and gravity fed into the body of the uterus. This allows sperm to travel up both fallopian tubes and uterine horns to reach the released ova.
- AI in pigs should take 5-10 minutes.
- A new catheter should be used for each insemination to eliminate the possibility of transmitting disease or infection between females.



Watch Post-Cervical Artificial Insemination in Sows AS-623-WV

57. What is Artificial Insemination?

_____

_____

58. Complete the table to contrast advantages and disadvantages of AI in pigs

Advantages of AI	Disadvantages of AI

59. List the fours factors essential to successful Artificial Insemination results:

- _____
- _____
- _____
- _____

60. When should AI be carried out after oestrous onset if:

- **Inseminating once**

  _____

  _____

- **Inseminating twice**

  _____

  _____

61. Is the majority of boar semen in Australia fresh-chilled or frozen? And which has greater breeding success rates?

_____

_____

_____

_____

62. Can semen be imported into Australia and why/why not?

_____

_____

_____

_____

63. Apply your understanding of sow's reproductive tract anatomy to label the missing parts of the sow's reproductive tract.

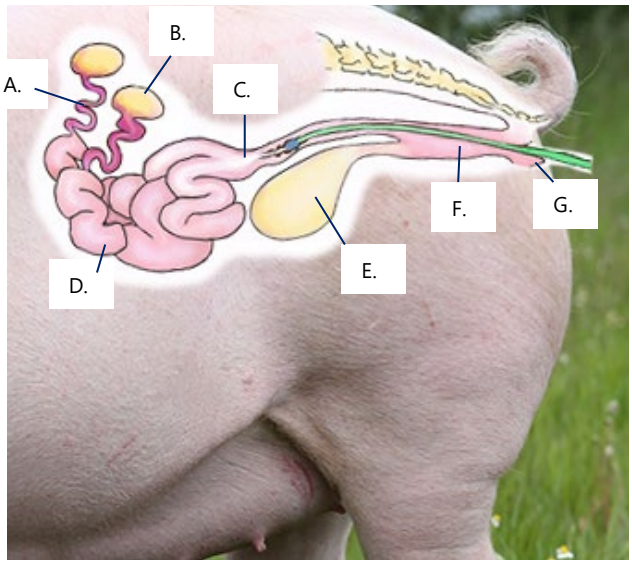
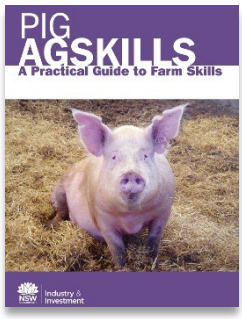


Figure 8 Lateral view of sow's reproductive tract and AI

	Part		Part
A.		E.	
B.		F.	
C.		G.	
D.			



Practical activity- detecting oestrus in sows

Adapted from Pig Agskills available in hardcopy or as an eBook. Find this activity and more at the Tocal online bookshop.

Aim: To determine if a sow or gilt is in oestrus.

Background: Oestrus (standing heat) is defined as a period of sexual receptivity and ovulation during which the female will accept the male and is capable of conceiving. The pubertal or first oestrus usually occurs at about 170 to 210 days of age in gilts. In mature sows, oestrus normally begins within three to 10 days postweaning.

Oestrus generally lasts 40 hours in gilts and 55 hours in sows, but variation among individuals occurs (range 12 to 84 hours). Ovulation typically occurs at about two-thirds into an individual gilt or sow's oestrus (usually 30 to 40 hours after onset of oestrus). The oestrous cycle, or interval from oestrus-to-oestrus, typically averages 21 days and can vary between 17 to 24 days.

Oestrus is more easily observed in sows than gilts. Sows usually come into oestrus three to ten days after their litter has been weaned. Sows that return to oestrus within three to five days display oestrus for a longer period than sows returning greater than five days after weaning.

Signs of oestrus in sows and gilts become more apparent in the presence of a boar. Without a boar, females can have silent heats which potentially reduces productivity. It is good practice in commercial operations to have a boar present for oestrous detection, even if females are artificially bred. Boar behaviours to females in oestrus includes interest in females and chomping motions and frothing of the mouth (which releases hormones (pheromones) that stimulate the sow/gilt to display oestrus.

A sow or gilt in oestrus will exhibit a range of the following physical and behavioural characteristics:

- Standing reflex- Some females in oestrus will exhibit the 'standing reflex' without any direct physical stimulation. It occurs when they see a boar walk by them, or when pressure is applied to their back. The ears may spring into an erect position in some breeds and females often arch their back slightly and brace their legs through isometric muscle contractions, as if standing to be mounted. They will remain in this position for 10-15 minutes.
- Standing to be ridden and riding- Gilts and sows coming into or going out of oestrus often mount and ride pen mates when group housed. Most females will not tolerate being mounted and will vocalize loudly and make moves to escape if they are not on heat. Females that stand immobilised when ridden are in oestrus and may develop rough hair and rub marks on their back from being repeatedly ridden.
- Reddening and swelling of the vulva and clitoris- This is caused by increased blood flow and fluid retention in the reproductive tract. This is stimulated by estrogen released by the developing ovarian follicles.
- Mucous discharge- Clear sticky mucus may drip and hang from the vulva in response to the increasing levels of oestrogen. The mucus becomes increasingly sticky as the sow approaches oestrus.
- Boar seeking-When exposed to a boar, sows and gilts will begin to seek out a boar throughout proestrus (the first part of oestrous). The 'boar seeking' behaviour intensifies when they are fully in oestrus.
- Vocalisations may change to a 'honking' sound, activity may increase, and feed intake may decrease as females approach oestrus.

What you need:

- Pig yards/pens
- Sows or gilts to observe
- Boar (if available)
- Note pad to record observations

What to do:

- Observe the gilts and sows in their pens for a range of oestrus signs: increased activity, attempting to mount, standing to be ridden, mucous discharge, reddening and swelling of the vulva.
- If a boar is available, move sows or gilts to a mating area where there is an interested boar on the other side of the fence, with head-to- head contact.
- Apply pressure using your hands, to the females backs (called the Back Pressure Test). Gilts and sows not in oestrous will squeal and move away. Sows and gilts in oestrus will lock into the standing position when back pressure is applied.
- Some gilts will only stand for a boar, so a boar may need to be introduced into the pen. If the gilt is not in oestrus, when the boar attempts to mount her, she will squeal and move away.
- Peak fertility (for AI and natural mating) is in the middle 24 hours when both boar and inseminator can get a strong 'standing' reaction (starts about 12 hours after onset of oestrus). The swollen red vulva has noticeably subsided by this. Mucous is plentiful and has better lubricating qualities than that seen at the beginning of oestrus. The colour of the mucous changes from clear to greyish coloured at this stage.
- Record your observations.

If oestrus has been detected.

Gilts:

- Gilts should not be joined on their first heat after reaching puberty. Check records to determine if it is the gilts' first oestrus. If it is the gilts' first oestrus return her to her management group and check her for oestrus in 17 days onward.
- If it is the second oestrous, proceed with natural mating at standing heat or AI 24-28 hours after standing heat. Repeat AI 12-16 hours later if the gilt is still exhibiting oestrus. Check her in 17 days to see if she returns to oestrus.

Sows:

- Sows should return to oestrus 3-10 days after weaning.
- Test the sow for 'standing' reaction twice daily (she 'stands' more readily to back pressure when she can see, hear and smell a mature boar and is face to face with him).
- Inseminate twice, 8-12 hours after the handler first identifies the 'standing' reaction and again 8 to 16 hours later.
- If only inseminating once, it should be done 24 to 32 hours after the onset of 'standing' heat. In practice, where checking for 'standing' heat twice daily, inseminate about 24 hours after the sow 'stands' to back pressure.
- Check sow in 17 days to see if she returns to oestrus.
- Most sows display oestrus for approximately 2 days.
- If sows or gilts do not stand well, do not mate or inseminate them, as this increases risks of uterine infections.

Boar management

- Boars must be regularly mated to maintain their interest, or they can become lethargic and may be temporarily infertile.
- Boars need to be frothing and chomping at the mouth to provide sufficient stimulus for sows and gilts to display oestrus. The froth contains pheromones which stimulate oestrous behaviours and onset.
- Boar contact through a fence (head to head with females) is usually sufficient to detect sow oestrus, along with a Back Pressure Test.
- Boars should not be continually penned amongst sows, as this can reduce the intensity of the oestrus response, making oestrus detection difficult.

Animal welfare

For details on handling, approved activities and Animal Welfare for pigs in schools go to the NSW Animal in Schools -Pig page.

Activity: Complete the table to list physical and behavioural signs of oestrous in sows and gilts.

Physical	Behavioural

Current and emerging technologies in the pork industry

Dramatic improvements have been achieved by new technology in the Australian pork industry, in terms of farm production, market growth, animal welfare, food safety, sustainability and environmental impact. With global food demands expected to increase by 100% in 2050, technology must advance in commercial swine production. To achieve this the swine industry must continue to rapidly adopt and embrace new technology that increases production of safe, wholesome and nutritious pork, while at the same time using fewer resources and reducing its impact on the environment.

Technological improvements in the pork industry fall into the following broad categories:

- Record systems
- Genetics
- Reproduction
- Health and welfare
- Nutrition
- Meat production and processing
- Production and management systems
- Education systems
- Sustainability and environment management
- Marketing

64. List the technology categories used in the pork industry.

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

Some examples:

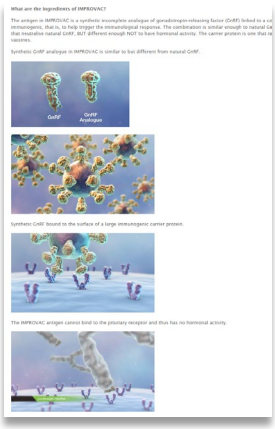
Immunological castration (immunocastration)

Pork production around the world traditionally saw boars routinely surgically castrated before reaching puberty to reduce aggressions and remove boar taint in pork. Boar taint is caused by the hormones skatole and andotestosterone which accumulates in the animal's fat after puberty.

Immunological castration (immunocastration) is a technique used extensively in Australia and New Zealand which replaces surgical castration of piglets. It consists of two consecutive vaccinations which induce antibodies which temporarily suppress testicular function, hormone production and minimise boar taint. The method ensures both a high-quality product, high levels of animal welfare and meets domestic and export market requirements. The vaccine used is Improvac®, an Australian invention.

Immunocastration advantages:

- Labour saving compared to surgical castration
- Greater animal welfare outcomes due to non-invasive/non-surgical castration. Injection is quick and relatively pain free.
- Entire boars are higher yielding with a leaner carcass (anabolic advantage) than females and barrows. Immunocastration allows the anabolic advantage of high yield carcass, lean carcass and optimal feed conversion ratios and efficacy as entire boars, but also removes boar taint.
- Increase feed conversion ratios that reduce the environmental impact by using fewer resources to produce each kilogram of meat.



Read: Improvac

Sustainability of Pork Production with Immunocastration in Europe

Read: Sustainability or Pork Production with Immunocastration in Europe

Watch: Improvac Mode of Action

65. Evaluate immunocastration in the pork industry in terms of:

For assistance to create an evaluation, use the scaffold on page 35!

- **Animal welfare**

_____

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- **Sustainability**

- **Productivity**

Precision Livestock Farming (PLF) technologies in Australian pork production

Precision Livestock Farming (PLF) is already widely used in commercial Australian pork production.

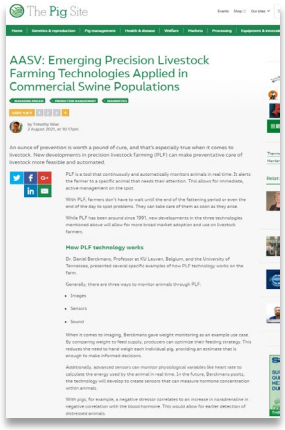
Applications for PLF include climate control sensors and equipment; automated feeding systems; computer models and decision support software; individual animal health and welfare monitoring and surveillance equipment with real time data.

Advantages:

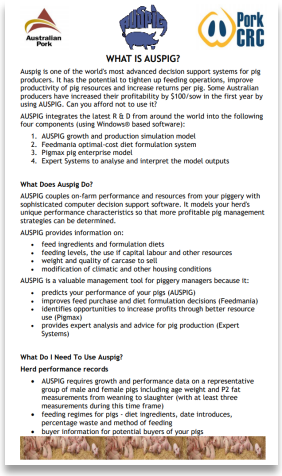
- Better on-farm efficiency through increased animal productivity, improved animal welfare and health.
- Reduced environmental impact through best use of resources.
- Direct performance monitoring.
- Increased product consistency and the potential for real time supply chain management throughout the industry.

- Improved scientific understanding of nutritional, health and environmental effects on the animals as almost major parameters will be monitored.
- Production-related information generated from PLF systems can improve farm management but cannot replace entirely the farmers own knowledge and experience.
- Efficient use of time and labour.

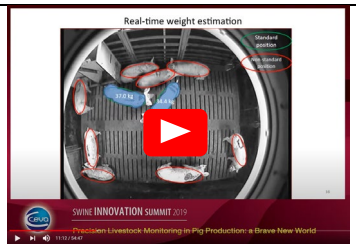
Check out the following to find out more:



Read: Emerging Precision Livestock Farming Technologies Applied in Commercial Swine Populations



Read: What is AUSPIG



Watch: Precision Livestock Monitoring for swine - Swine Innovation Summit 2019

Watch: SwineTech "The Fitbit for Pigs"

66. Select a Precision Livestock technology in the pork industry to further investigate. Use the internet to compile a 1- 2 page report on your selected technology.
Your report should include:

- **Name of the technology**
- **Images of the technology**
- **Thorough description of how the technology works**
- **Description of how the technology is used to improve production efficiency**
- **A table contrasting the advantages and disadvantages associated with using the technology**

The Australian Pork Industry and the environment

Over the past four decades, major changes have occurred in Australia's pork industry, affecting productivity and the environmental impacts from production.

Australian pork producers and the Australian pork industry have a massive focus on reducing its environmental impact through sustainable production. The Australian pork industry has identified the main environmental priorities as:

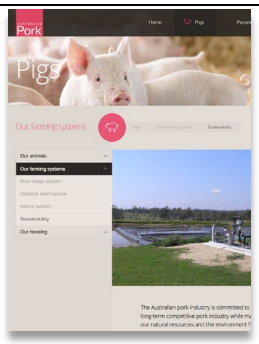
- Resources and services including:
  - Water usage
  - Energy usage
  - Transport
  - Feed grain supply
- Soil and catchment health. This includes:
  - Best use of by-product nutrients
  - Developing healthy soils
  - Improving catchment health
- Climate change—effectively managing and using:
  - Gaseous emissions
  - Renewable energy
  - Climate variability and drought

- Community interactions including:
    - Amenity impacts
    - Community perception of industry
    - Regulatory environment

Initiatives Australian Pork producers are adopting include:

- Waste Management (PigBal)
- Water Use
- Greenhouse Gases
- Renewable Energy (Biogas)
- Environmental Sustainability
- Environmental Guidelines
- Planning and Development
- Outdoor Production

Check out the following to find out more:

		
Read: Pigs- Our Farming Systems	Read: Environmental sustainability	Watch: Integrity Ag and Environment- Trends in environmental impacts from the pork industry

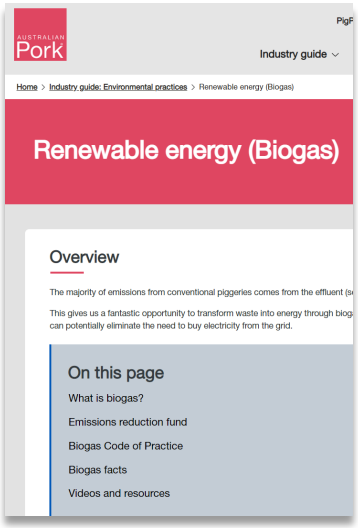
Industry case study: The Australian Pork Industry and Biogas

It is becoming common for commercial Australian pig farms to produce their own biogas, a renewable energy and by-product of production. There are about 20 commercial piggeries in Australia currently capturing and using biogas, representing 14% of total Australian pork production.

Biogas is a fuel mixture of mostly methane and carbon dioxide that is produced naturally when organic matter (e.g. pig manure) decomposes biologically in the absence of oxygen (anaerobically), such as in effluent ponds. Biogas can be captured and used on-farm as an energy source to heat, cool or generate electricity, or can be purified into compressed/liquified methane for higher-end use.

Farmers collect and treat effluent (manure and waste feed), from pig sheds and housing areas, which is flushed into anaerobic ponds. Methane gas (CH4) is captured from the ponds and used to create enough electricity to power the farm, with surplus going into the grid. This has significantly reduced the. Australian pork industry's Green House Gas (GHG) emissions and put the industry in a position to have the lowest global warming potential for pork production worldwide (Pork Australia, 2019).

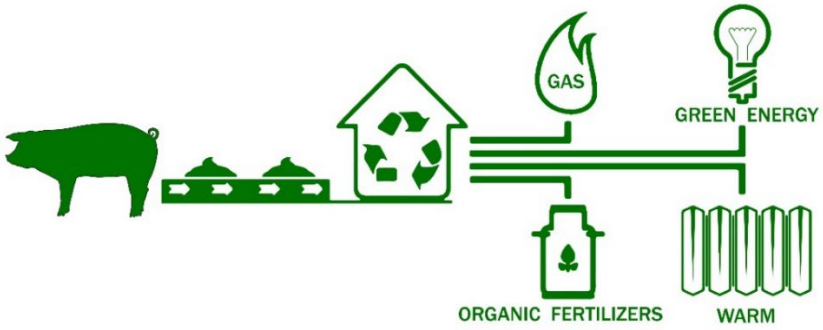
Check out the following to find out more:



Read: [Renewable energy (Biogas)]

Watch: [Renewable energies- Emission reduction and biogas] '[Pig poo']' Landline

Watch: [Australian Biogas Benefits – Pork CRC]



For assistance to create an evaluation, use the scaffold on page 35!

67. Evaluate biogas production in the pork industry in terms of:

- **Sustainability**

- **Productivity**

Pork careers

When you think about careers in Agriculture – the first job you probably think of is a farmer, right? Think again.

There are hundreds of jobs within the sector which – quite literally – are changing the world.

From scientific breakthroughs to designing autonomous robots, campaigning for changes in legislation, to environmental engineering, careers in agriculture are at the forefront of innovation. Technical developments are enabling the sector to lead the way in tackling many global challenges – such as feeding a growing world population, battling climate change and protecting the environment.

Of course, farming remains at the heart of the industry, but the job of a farmer is very different today from the image of an old man wearing overalls, chewing straw. Agriculture is in a time of exciting change. It is now one of the most fast-paced and dynamic industries to work in, giving young people plenty of job options to choose from. A career in agriculture offers great quality of life, the chance to help others, make a difference, and it can pay generously.

There really is more to agriculture than you think.

Think careers? Think agriculture.

Source: This is agriculture

Follow this link to find out more about careers in agriculture at "This is agriculture – How agriculture is changing the world"

The Australian pork industry has changed a lot from the pastoral days of old. It is a highly efficient industry, full of advanced technologies and innovation, which produces high quality products while practising high pig welfare standards, environmental stewardship and education of staff entering the industry to maximise production and animal welfare.

The Australian pork industry is the only Australian food industry operating in a global market in the true sense. The industry competes in the export arena, with markets in Asia, and products are imported into Australia from North America and Europe.

There is huge potential to exploit growing demand for pig meat. The pig sector in Australia embraces and uses new technologies and modern management practices for efficiency of production and sustainability. This has improved pig production and the sector is experiencing firm growth in export demand for pork products, particularly to South-East Asia.

Pig production is specialised. Different markets require exact carcass specifications. Production is increasingly concentrated in the hands of specialist, large-scale producers capable of controlling genetics and feed to produce carcasses that the markets demand.

Most Australia's pigs are housed indoors, creating a comfortable and efficient environment for the animals and the workforce.

The industry requires competent and skilled operators on the farm all the way to qualified and skilled professionals to develop and engineer new technologies; conduct research; work with markets and agribusiness—all the way to pig nutritionists and geneticists off-farm to continuing growing the great industry. (Rural skills Australia, 2019).

The following is a list of NSW Department of Primary Industries roles associated with the pork industry to get you thinking.

- Development officer-Pigs
- Intensive livestock industries manager
- Research scientists
- Research officer
- Pasture production specialists
- Irrigation specialist
- Nutrition research officer
- Monogastric efficiency research officer
- Geneticist
- Contracts manager
- Legal officer
- Biometrician
- Mechanical/trade engineer
- Biosecurity officer
- Piggery manager
- Piggery assistant
- International engagement officer
- Communications officer
- Stakeholder engagement
- IT technician
- System developer
- Economist
- Business analyst
- Administration support officer

68. **Use the internet and other sources to investigate a pork industry-related career of your choosing. For this career find out the following:**
    - **Title of the career/job**
    - **Role description**
    - **Personal qualities**
    - **Skills required (if formal courses or education is required, find out where you could train and the timeframe to complete the course)**
    - **Salary or wage range**
    - **Identify opportunities for job progression in the role**
    - **Useful sites to help you with your research include:**
    - **Building your career in dairy, Dairy Australia**

Useful sites to help you with your research include:

- **People- Australian Pork**
- **Careers- Australian Pork**
- **Pig farming – Rural careers Australia**
- **Riverlea Australia- Careers**
- **A career in pork – EatPork.org**

Watch 'Our stories: Aeger Kingma', Australian Pork Limited

Outcomes	Content
AG5-1 explains why identified plant species and animal breeds have been used in agricultural enterprises and developed for the Australian environment and/or markets AG5-2 explains the interactions within and between agricultural enterprises and systems AG5-3 explains the interactions within and between the agricultural sector and Australia's economy, culture and society AG5-4 investigates and implements responsible production systems for plant and animal enterprises AG5-5 investigates and applies responsible marketing principles and processes AG5-7 explains and evaluates the impact of management decisions on animal production enterprises AG5-8 evaluates the impact of past and current agricultural practices on agricultural sustainability AG5-9 evaluates management practices in terms of profitability, technology, sustainability, social issues and ethics	Core A: Introduction to Agriculture • identify the characteristics of animal breeds and plant types specific to chosen enterprises, for example: – identify pasture types – associate plant growth patterns with local climate patterns • explain the significance of agricultural industries and products, and their intended markets, for example: (ACTDEK044) – create a market chain for a range of agricultural products – use the Australian Bureau of Statistics website to find data about agricultural industries • research a range of current and future employment opportunities in agriculture, for example: – agricultural practices employing Aboriginal knowledge – development of automation, e.g. irrigation, milking – operating unmanned aerial vehicles (UAV) – precision farming and Global Positioning Syst • research an agricultural problem and develop possible solutions, for example: (ACTDEP048) – the Murray–Darling Basin – dryland and irrigation salinity – proximity to markets – mulesing of merino lambs – the live export trade • identify and apply ethical and WHS practices, for example: (ACTDEP050) – demonstrate correct methods of operating and maintaining agricultural tools, equipment and machinery – demonstrate safe and ethical handling of animals Core A: Animal Production 1 • describe an animal enterprise, for example: – fresh cow's milk for the domestic market – fine wool from Merino sheep – bulls for the beef seedstock market • investigate a range of important animal management skills, for example: – monitoring and recording production data, eg growth rates, – drenching, drafting, mustering, yarding, catching and restraining • investigate and implement a range of animal husbandry operations, following animal welfare guidelines, including Animals in Schools (ACTDEK044) • investigate technologies that assist in record-keeping and monitoring an animal enterprise and its performance (ACTDEK047) • collect accurate evidence and record relevant data relating to the animal enterprise, for example: – weight gains – health treatments – feeding rations • research the markets available for chosen animal agricultural products, for example: – chilled export lamb market,– domestic fresh milk market, – free-range egg market • assess the market specifications required to market chosen animal agricultural products, for example: – quality and quantity criteria for beef, lamb, milk • evaluate current sustainable and unsustainable agricultural animal management practices, for example: (ACTDEK044) – overstocking livestock, – animal effluent management, – integrated pest management, – biosecurity • investigate the social and ethical issues that affect the chosen animal enterprises, for example: (ACTDEK040) - animal stocking rates, – use of

hormonal growth promotants (HGPs), – mulesing, – the use of battery cages in egg production

- research an agricultural issue relevant to the animal enterprise and propose possible solutions, for example: (ACTDEK044) – stock theft – shearer shortage – live exports – rising cost of feed

Core B: Agricultural systems and management

- identify animal breeds and plant types specifically developed for a particular climate or market, for example: (ACTDEK044) – selection of pasture for the cold temperatures of winter, eg grazing oats – Bos indicus cattle for tropical regions – fine wool Merinos for hot and dry regions
- investigate the effect of beneficial and harmful microorganisms and invertebrates on plant and/or animal production
- investigate the influences of Australia's developing multicultural society on an increasing variety of agricultural products, for example: (ACTDEK040) – halal and kosher products – Asian-style products, eg bok choy, coriander – increase in goat consumption
- identify opportunities provided by the agricultural sector, both as an employer and as a user of products
- investigate information from secondary sources on agricultural production and Australian export trends in agricultural products, for example: – Australian Bureau of Statistics data regarding lamb and beef production and exports
- evaluate different production techniques for a chosen agricultural system or enterprise, for example: – rangeland beef production versus feedlot production – caged layers versus free-range layers – tramline farming
- investigate the role of value-adding in marketing agricultural products, for example: – potatoes, eg chips, potato bake, potato flour – milk products, eg cheese, butter, ice cream – bouquets of cut flowers for special occasions, eg Mother's Day

Core B: Animal Production 2

- identify some of the programs, techniques and tools used in animal breeding and analyse their impact on production, for example: (ACTDEK046) – crossbreeding, inbreeding, outbreeding, linebreeding – artificial insemination – embryo transfer – the use of estimated breed values for a particular enterprise
- analyse nutritional requirements for the production cycle of an animal, for example: – nutrition for growing animals – nutrition for pregnant animals
- investigate timing and impact of relevant operations in an animal production cycle, for example: – shearing – breeding – drenching – culling
- identify emerging technologies that affect sustainability, for example: (ACTDEK041) – genetic engineering, eg sex selection of embryos – electronic pasture meters – electronic monitoring of sheep
- investigate Australian animal welfare codes and their effect on the management of intensive and extensive systems, for example: (ACTDEK044) – egg production systems, eg caged, free-range – feedlot beef cattle – ages for the carrying out of particular husbandry practices
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- Van Barneveld, R, Mullan, B, Slade, J, 2107, "Producers' guide to pig production and nutrition" Australian Pork Limited, http://australianpork.com.au/wp-content/uploads/2019/11/WEAN-to-Sale_Final-low-res.pdf (viewed 23/03/2021)
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