Evidence report: Comparing the potential implications of widespread use of different farrowing systems in the British pig sector

August 2020

Contents

Definitions

For the purposes of this report, definitions of some of the terms used are summarised below:

Conventional farrowing crate- where sows are confined throughout farrowing and lactation.

Free farrowing systems - where sows are non-confined during farrowing and lactation.

Temporary crating – systems where the sow is generally first confined for farrowing and the following few days, but is later unrestrained for most of lactation. One slightly different system allows the sow to be unrestrained first during farrowing, but can be crated later after farrowing if necessary.

Alternative farrowing systems – where farrowing takes place in any pen or crate that is not of a conventional farrowing crate design or size. This encompasses both free farrowing and temporary crating systems.

Summary

During the final week of pregnancy and throughout lactation, the majority of sows used for commercial pig production around the world are closely confined in a farrowing crate. While this system was originally designed to reduce the risk of piglets being crushed, and facilitate management activities, there has been increasing concern about the effect confinement has on the sow. This has led to **increasing interest in alternative farrowing systems, where sow confinement is restricted or absent entirely.**

In the UK, about 40% of sows are kept outdoors and will not be confined during farrowing. The remaining 60% are kept indoors and the vast majority will farrow in crates. **Margins for the indoor pig sector are low, averaging just 1p/kg on a deadweight basis over the past decade.** Any change in production system that increases costs will challenge the economic viability of indoor pig production in Britain.

The UK already imports about 60% of its pig meat consumption from the EU. If British pig meat loses competitiveness, and the industry declines, import requirements would be expected to rise further. Imported pig meat may not be produced to the same standards required of UK producers; most European countries are not currently planning to phase out farrowing crates.

There have been a number of studies looking at alternative indoor farrowing systems, with mixed results. **Some studies have been able to achieve pre-weaning mortality levels comparable with conventional farrowing crates, whereas others have seen higher levels**. However, even if comparable mortality levels are achieved, other factors could still push up production costs.

Although it is not yet clear exactly what pen design would be optimal, most **designs require additional floor space** and this increases building costs. Based on the current evidence available, we also expect some other changes that would increase production costs, such as **increased use of straw/bedding and increased feed consumption.** From an industry-wide perspective, **these costs are not likely to be sustainable**, due to low average margins.

There seems to **be limited awareness and concern regarding farrowing crates amongst the British public**. Consumers are more concerned about animals having access to the outdoors. This suggests it might be difficult to achieve higher prices for “alternative farrowing” indoor pork and consumers may not perceive “temporary crating” as an improvement. It would be useful to establish public perception of any new system proposed if mandatory changes were to be made.

Some evidence is available that suggests **production benefits**, such as a lower rearing mortality and/or an extra piglet born alive per litter, **might be achievable in well-managed alternative indoor farrowing systems**. Training of stockpersons and sows and consistent use of chosen farrowing system will be necessary to optimise productivity. This could help offset additional costs associated with the larger floor space. More work is needed to refine pen designs and stockperson protocols to establish whether these benefits can be achieved more widely.

Environmental impacts of different indoor farrowing systems have also not been established yet. Some research is underway with results expected in early 2021.

Deciding which farrowing system is most appropriate for Britain going forward will require balancing the welfare of piglets, sows and stockpeople, as well as the realities of consumer demand requirements and practicalities in the supply chain. Further refinement of alternative indoor farrowing options and more work surrounding consumer perceptions may ultimately be beneficial in decision-making.

Part I: Introduction

What are farrowing crates and why are we using them?

During the final week of pregnancy and throughout lactation, the majority of sows used for commercial pig production around the world are closely confined in a farrowing crate. While this is by far the dominant system internationally, usage is lower in Britain as a significant portion of the breeding herd is kept outdoors. Based on figures from the Defra 2009 Farm Practices survey, we estimate about 60% of the UK breeding herd is kept indoors and the vast majority of these will farrow in crates. This represents approximately 245,000 sows in 2019.

The farrowing crate system was originally developed to reduce piglet mortality by restricting sow movement; the sow is significantly larger than her offspring (about 150 times the size) and crushing can occur. The system also helps stockpeople, making it safer to carry out management activities with sows and piglets and easier to clean. It became increasingly popular in Britain from the 1960s when there was a drive to increase productivity. Originally, sows were typically only confined during farrowing and the succeeding few days (approximately 3-5 days) (FAWC, 2015). However, standard practice is now to confine sows for the full duration of lactation. This means the sow will be in the crate for around 4 weeks and this can extend for up to 9 weeks if the pig acts as a foster sow for a second litter.

Piglet mortality and stockperson safety can be a challenge for alternative farrowing systems. However, the restriction on sow movement and ability to express natural behaviour while in the crate has attracted increasing concern in recent years. There is a range of evidence suggesting the environment creates stress for the sow, such as elevated cortisol levels and increased incidence of abnormal behavioural stereotypies. Research has shown that the sow has a strong drive to exhibit nesting behaviours in the days leading up to birth and this complex behaviour is significantly impeded if kept in a farrowing crate. Detailed reviews of the implications of this can be found in the literature.

There is increasing pressure to stop using farrowing crates from NGOs and some vocal consumers, as well as an interest in legislating for these changes from governments. So far, only a few small pig producing nations (Switzerland, Sweden and Norway) have banned the use of farrowing crates; although the ability to restrain the sow is permitted in exceptional circumstances (e.g. if the sow shows aggression towards her piglets). However, Germany, the largest EU pig slaughterer, announced in early July 2020 that farrowing crates will be phased out over a 15-year period. In Germany, “temporary crating”, where it is possible to confine the sow (if necessary) for a few days post-farrowing, will still be allowed. Here in Britain, the latest Pig Welfare codes also express the aim for farrowing crates to no longer be necessary.

In light of the growing interest in alternative farrowing systems, this report aims to highlight what the consequences might be if British pig producers were required to move away from the use of farrowing crates. Using the available evidence, we will highlight the possible welfare outcomes, environmental impacts and implications for the financial sustainability of the industry. We will also highlight areas where evidence is limited or contradictory.

Ultimately identifying the most appropriate way forward will require weighing up the relative importance of different factors; including sow, piglet and stockperson welfare; food security and affordability for consumers. AHDB is an evidence-based organisation, and so it is not the intention of this report to comment on the ethical dimension of this practice. Here, we aim to provide information so that readers are able to make their own informed judgement.

Outline of different farrowing systems

Some of the key features of different farrowing systems are highlighted below. Where possible, metrics relating to sow, piglet and stockperson/farmer needs are included, as well as perceptions of wider society. Information on these aspects is not well established for all systems, particularly for alternative indoor farrowing systems that have not been widely used commercially.

Environmental aspects are also an important consideration, but differences between different systems have not yet been widely researched.

Detailed information regarding features of alternative farrowing systems can be found on SRUC and Newcastle University's free farrowing website.

Aside from this outline, we will not review further the relative welfare outcomes in the different systems. Other literature is available detailing these aspects (see reference list). When considering the different systems, the needs of the sow, piglets and stockperson can conflict, meaning it is challenging to determine which system is "best". How to weight these different aspects also needs to be considered, but, as this is a subjective ethical debate, it is not discussed in this report.

Conventional farrowing crates:

Currently the most popular system globally.

- Design:
  - Overall pen area consists of a crate where the sow is confined for farrowing and lactation with adjacent area for piglets that the sow cannot access. Bars enable piglets to access sow teats
  - Typical floor footprint 4.3m^2
  - Generally built on fully or partially slatted floors
- Sow behaviours:
  - Movement restricted to standing up and lying down
  - Limited ability for enrichment/nesting materials due to slatted flooring and movement restriction, though some producers do provide this
- Piglet safety:
  - Average pre-weaning mortality in GB indoor systems is approximately 12% (with average 13.8 pigs born alive per litter). Comparisons with alternative indoor systems in academic research and commercial trials have been mixed.
  - Slatted flooring and limited space restricts ability to provide enrichment materials
- Management:
  - Relatively easy to maintain hygiene levels due to slatted flooring
  - Easy to observe and access piglets for management tasks
- Consumer perception:
  - 56% of British consumers surveyed were not aware of farrowing crate use; 25% were aware and concerned; 18% were aware and not concerned (AHDB/ Blue Marble Trust Research June/July 2019)
  - Most consumers are either not aware of the potential issues surrounding farrowing crate use or are not concerned about the practice. However, a quarter do have concerns and this includes those pushing for change.

Alternative indoor farrowing systems:

Individual designed free farrowing pen

PigSAFE pen

360 farrower - a “temporary crating” system

These systems are not widely used commercially at present, except in the few countries where farrowing crates have been prohibited. In this report, we use the term “alternative farrowing” to refer to a range of alternative indoor farrowing systems, some of which include the ability to temporarily confine the sow during and/or immediately after actual farrowing.

- Design:
    - Wide range of designs exist - key differential from the conventional crate is that the sow is not continually confined while in the pen
    - Some systems retain the ability to confine the sow when necessary
    - Confinement would typically be during the first few days after farrowing, which is the highest risk period for piglet mortality. Confinement could be allowed routinely or only allowed for sows that display poor mothering ability. These features are known as “temporary crating”
    - Some systems do not confine the sow at all during farrowing or lactation and are known as “free farrowing”, although some “free farrowing” pen designs do have the ability to restrain the sow if necessary (e.g. danger to piglets or stockperson)
    - Pen designs may incorporate a range of features to promote good mothering ability e.g. sloped walls to reduce risk of crushing
    - Some designs incorporate a creep area for piglets that is inaccessible by the sow
    - Pen size is highly variable ($4.8m^2 – 7.2m^2$), a few can be built on the same footprint as the conventional farrowing crate, others are considerably larger
    - May use slatted, part-slatted or solid flooring
- Sow behaviours:
    - Has a greater capacity of movement, such as turning around, at least for most of the lactation period.
    - May or may not be confined for nest-building and farrowing
    - Ability to provide enrichment and nest-building material depends on pen design
    - More behaviours can be expressed when crating is not used. Larger pens also facilitate introduction of more enrichment material
- Piglet safety:
    - Limited comprehensive studies on piglet mortality levels, compounded by difficulties interpreting results broadly due to wide range of designs available

    - Litter size also influences piglet mortality (more pigs born alive per litter, on average the higher pre-weaning mortality) and can confound the interpretation of trial results
    - Some GB on-farm trails find levels are higher up to over 20% mortality, though other academic studies have achieved results similar to conventional crates
    - Size and design of pen also influence piglet mortality; significantly larger pens may mean piglets are more likely to stray away from the nest or creep area
    - Provision of creep that is inaccessible to sow and other design features may also reduce risk of crushing
    - Piglet mortality is also dependent on sow mothering ability
    - Ability to provide enrichment materials depends on size and design of the pen
- Management:
    - Systems that enable sow restraint or confinement and/or have separate creep areas for piglets facilitate management activities and stockperson safety
    - Maintaining hygiene generally easier with slatted flooring and if less nesting/enrichment material is required
    - The more the system differs from conventional crates, the greater the change in stockperson mind-set and training required
- Consumer perception:
    - We are not aware of any surveys testing consumer perceptions of alternative indoor farrowing systems
    - Considering the low level of understanding of general farrowing crates, it is likely only a very small minority of consumers will be aware of these alternative indoor farrowing systems
    - 73% of British consumers surveyed agree that “all farm animals should have access to the outdoors”. Combined with the low level of understanding around farrowing crates, it is uncertain the extent to which consumers will perceive alternative indoor farrowing systems as an improvement in animal welfare (AHDB/ Blue Marble Trust Research June/July 2019)
    - Though consumer perception has not been tested, “temporary crating” systems in particular may not be viewed favourably

- *Group systems:*

Group multi-suckling pen in Sweden (2017)

  - Some producers in countries practicing alternative indoor farrowing systems keep sows and piglets in large group pens for most of the lactation period
  - Sow and piglets may start in an individual pen and are later moved into a group enclosure
  - Alternatively sows may be in a group throughout, with free access to more private areas off a central area to use for farrowing
  - Crating may or may not be used and design features/provision of enrichment vary
  - Mixing of sows and piglets before weaning can reduce post-weaning aggression for sows and weaning stress for piglets
  - Limited data available, but studies generally indicate group systems show the most inconsistent results and highest piglet mortality

Outdoor:


Approximately 40% of British sows are kept outdoors, though this system is not widely used in the world, partly due to environmental constraints (such as soil type, rainfall and temperature range).

- Design:
  - Usually use individual huts/arks placed within individual farrowing paddocks
  - Straw bedding will be provided
- Sow behaviours:
  - Able to move freely throughout nest-building, farrowing and lactation
  - Bedding material provided to enable nest-building to take place
  - Maintains contact with other sows - reduced aggression as opposed to mixing post-weaning
  - Exposure to a range of weather conditions increases risk of heat or cold stress
  - Different sow genetics are used in outdoor production. Sows need to be more docile, with better mothering abilities, and be physically hardy to deal with climatic conditions. They must still produce animals with carcass qualities comparable to indoor production
  - Sows may be nose-ringed to prevent damage to the land, which restricts natural behaviours and is a painful procedure. However, this does bring environmental benefits for the land
- Piglet safety:
  - Average pre-weaning mortality in GB outdoor systems is comparable to indoor at approximately 12%. Note that outdoor sows have smaller litters, which is also associated with lower pre-weaning mortality. It is also more difficult to record early mortalities in an outdoor system as early accessing piglets is generally more difficult, so mortality may be under-recorded
  - Piglet safety more dependent on appropriate maternal behaviour from the sows
  - Environmental enrichment present
  - Exposure to a range of weather conditions increases risk of heat or cold stress
  - Mixing with other piglets prior to weaning may reduce weaning stress
- Management:
  - Operation is significantly different to a conventional crate and a different mind-set is required. If changing to this system, more training will be required

    - More difficult to separate sows and piglets to access animals for management activities. Management protocols may need to change (e.g. vaccinate only at weaning)
- Consumer perception:
    - 73% of British consumers surveyed believe “all farm animals should have access to the outdoors” (AHDB/ Blue Marble Trust Research June/July 2019)
    - 43% of consumers have heard about “outdoor access” and are concerned about it as a welfare issue; 31% haven’t heard about it; 26% have heard about it but aren’t concerned. Although the survey does not specifically ask if “lack of” outdoor access is the concern, combined with the strong positive response in favour of farm animals having access to the outdoors, and the prevalence of indoor pig production, we expect concerns are primarily regarding a lack of outdoor access.
    - Access to the outdoors represents a greater concern for consumers regarding pig welfare at the moment - indicating this is probably a more important driver for purchasing premium-welfare pork than the farrowing conditions specifically.

This report primarily focuses on the potential consequences of transitioning to the alternative indoor farrowing systems likely to be preferred by current British indoor producers as replacements to the farrowing crate.

Group systems are significantly different to current indoor designs and the limited physical performance data available suggests that piglet mortality is higher and more inconsistent than in other systems. We expect concerns about piglet mortality and the more significant training and adjustment to management protocols required for group systems to result in low interest in developing this further. For this reason, group systems are not considered further in this report.

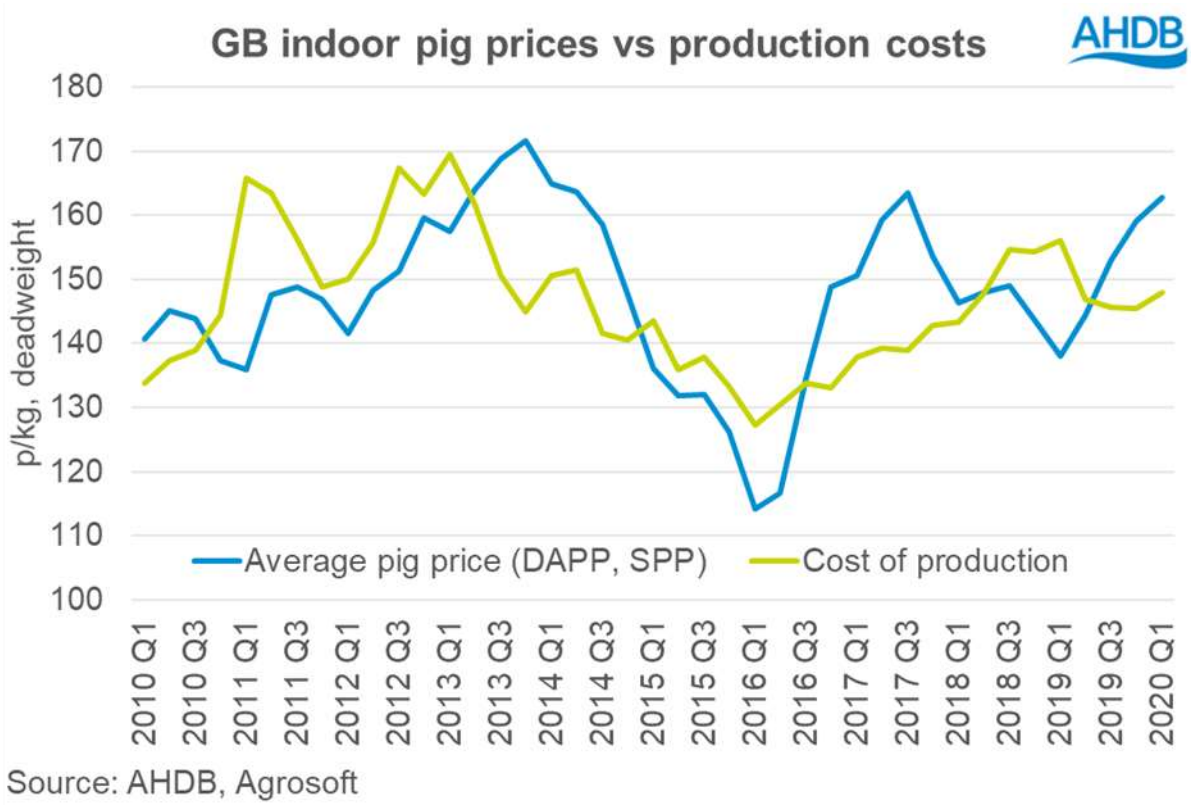
Outdoor production requires considerably more land, and this land must be of a suitable type for keeping pigs outdoors. We will also consider what the implications may be for the outdoor sector if farrowing crates were no longer permitted in Britain. However, it is unlikely that the majority of indoor producers could feasibly convert to this production type, even if there was a desire to do so.

Pig industry economics- why the cost implications matter

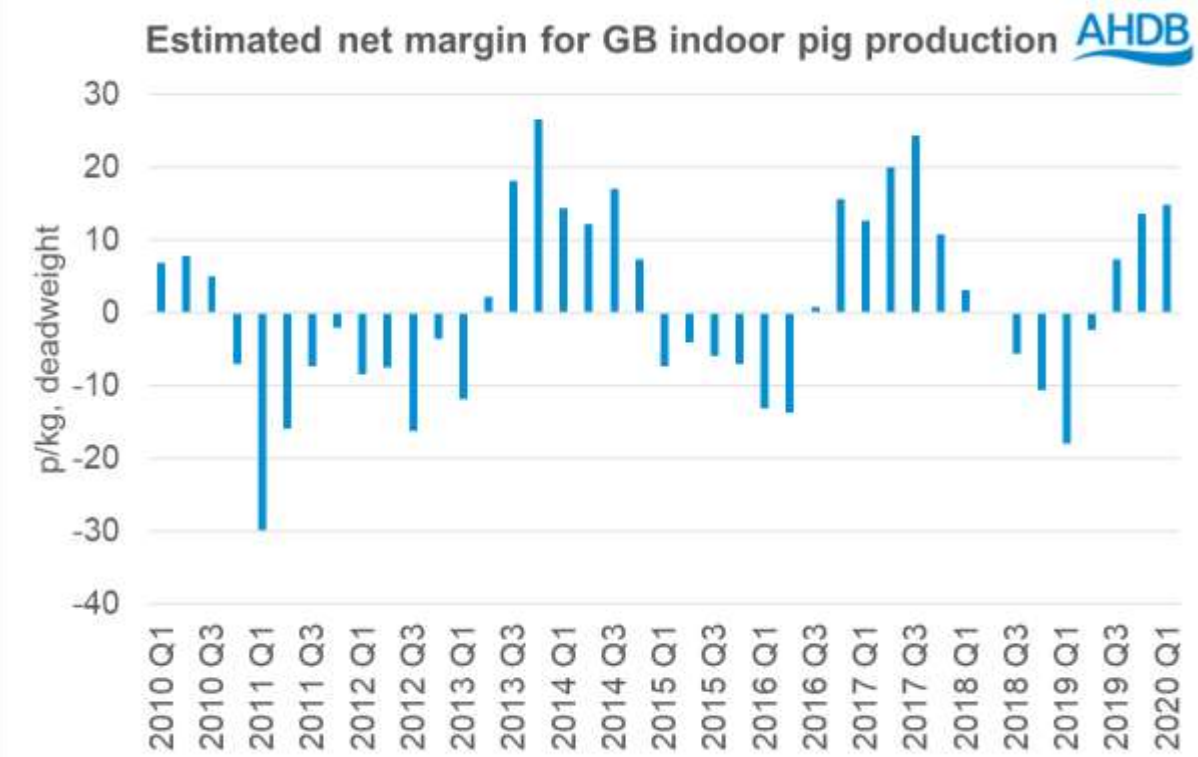
If pork production is to continue in Britain, it must be economically viable. To be sustainable, pig producers must be able to achieve a pig price greater than the cost of production. Profits also need to be available to processors and retailers further along the supply chain.

Profitability in pig production is extremely volatile. The farmer is exposed to changes in feed prices, which reflect the supply and demand balance in cereals and oilseeds markets, as well as changes to pig prices. Pig prices go through a cycle of peaks and troughs characteristic of agricultural commodity markets, with supply unable to respond quickly to changes in demand, while production may be affected by uncontrollable external events such as disease or weather.

Below you can see the estimated cost of production for GB indoor pig herds compared with average pig prices over the past ten years. Note that although we are currently in a period of good profitability, **margins are low across this period overall, averaging 1p/kg deadweight.**



Source: AHDB, Agrosoft



Source: AHDB, Agrosoft

This means even a relatively small increase in production costs threatens the sustainability of the sector, unless an increase in pig prices is also achieved. Even if production practices were required to change in the UK, the option to import pork produced to different standards with lower production costs would remain. It is already the case that 60% of British pork consumption is imported from the EU, particularly Denmark, Germany, the Netherlands and Ireland. Except for Germany, these countries only have a very small percentage of farms using alternative farrowing systems and do not currently have plans to make them compulsory. In 2014, Denmark voluntarily pledged to have 10% of the national herd free farrowing by 2021, but are reportedly only at 3-4%. In 2018, their tests on 10 different designs concluded that further pen development was needed to find a satisfactory solution.

It is also important to note that Germany are able to import weaner pigs born in other countries, where there are not currently plans to change to alternative farrowing systems. About 14 million pigs are imported into Germany each year, 11 million as weaners for finishing and 3 million as finished pigs for slaughter. Germany slaughter about 57 million pigs each year in total, so currently almost 25% of slaughter is imported. If the German sector faces increasing costs associated with breeding pigs, we may see an increase in weaner imports from neighbouring Denmark and the Netherlands, or other countries that are currently smaller suppliers. This option is less accessible for Britain, with trade flows not already established. Live animal trade over long distances, and across the channel, would also be more difficult practically and from an animal welfare perspective, as well as contentious with animal welfare NGOs and the public.

So, it is important to establish whether a change in farrowing practices is likely to increase production costs, and if so, how this could be paid for. The rest of this report models how pig production costs might change in Britain if alternative farrowing systems were required, what the consequences of this could be for the industry, supply chain and consumer.

Part II: Scenario modelling

Our estimates of the cost of pig production (COP) are based on a methodology agreed by InterPIG, a group of economists from major pig producing countries across the world. The calculations provide an estimate of the cost of producing a kilogram of pig meat. This means that as well as being influenced by the price of inputs, they are also affected by how efficiently the inputs are used and how productive the industry is.

We already publish quarterly COP estimates, designed to provide an indicative average cost of pig production in Britain. These figures reflect the whole industry using a ratio of indoor sow and outdoor sow commercial breeding systems (60% indoor, 40% outdoor) with piglets finished in slatted pens and straw barns.

As this report considers the impact of indoor production moving to alternative indoor farrowing systems, the COP calculations in this report are based on indoor production with the finishing of indoor-bred piglets on slats and will exclude outdoor kept sows and the finishing of their progeny.

An overview of the assumptions made in each scenario modelled is provided below, along with the outcomes. More detailed information regarding the modelling work and the assumptions behind it can be found in the Appendix.

Base scenario - estimated COP in 2019:

We have used GB physical performance data provided by Agrosoft, alongside estimated input costs, to calculate the cost of production for indoor pig herds in 2019:

Key costs & physical performance metrics	
	2019 Actual
Pre-weaning mortality	**12.34%**
Transfer weight from breeding to rearing unit	7.3kg
Sow feed/sow/year	1370kg
Gilt/sow average purchase price	£220
Building cost/sow (inc. farrowing, lactation & dry)	£2100
Straw & bedding/sow	£31.85
Disposal of dead animal costs/sow	£12.89

Cost of production, p/kg deadweight	
	2019 Actual
Feed	89.76
Other variable costs	11.39
Labour	12.47
Building, finance & misc.	34.92
Total costs	**148.54**
Increase from base	**-**

Stage 1: Pre-weaning mortality

The evidence available indicates a wide variation of the impact on pre-weaning mortality in alternative farrowing systems compared to current farrowing crates. In some research and commercial trials, no difference in pre-weaning mortality has been observed. In other trials and commercial environments, pre-weaning mortality up to 22.5% has been experienced.

Each percentage point increase in pre-weaning mortality increases the cost of production by about 0.5p/kg deadweight, where sow-dependent costs such as the building and sow feed remain the same. The cost of any increase in mortality has to be recouped from the sale of fewer finished pigs.

Taking into account various sources of information, we have modelled the impact of different mortality rates:

1. at 12.34%, which is the current GB Indoor average
2. 14% (S1)
3. 18% (S2)

This is intended to illustrate a range of pre-weaning mortality rates that could be found on farms with farrowing crates and alternative farrowing systems and could represent the range across British producers if a national switchover to alternative farrowing was required; some may achieve figures lower than this, whereas others might see higher.

Considering that the long-term average margin for indoor pig production is only about 1p/kg deadweight**, pre-weaning mortality levels above 14%, irrespective of system, challenge the long-term economic viability of indoor pig production in Britain**.

Key costs & physical performance metrics			
	2019 Actual	S1	S2
Pre-weaning mortality	**12.34%**	**14.00%**	**18.00%**
Transfer weight from breeding to rearing unit	7.3kg	7.3kg	7.3kg
Sow feed/sow/year	1370kg	1370kg	1370kg
Gilt/sow average purchase price	£220	£220	£220
Building cost/sow (inc. farrowing, lactation & dry)	£2100	£2100	£2100
Straw & bedding/sow	£31.85	£31.85	£31.85
Disposal of dead animal costs/sow	£12.89	£12.89	£12.89

Cost of production, p/kg deadweight			
	2019 Actual	S1	S2
Feed	89.76	90.04	90.75
Other variable costs	11.39	11.55	11.94
Labour	12.47	12.62	12.99
Building, finance & misc.	34.92	35.17	35.84
Total costs	**148.54**	**149.37**	**151.51**
Increase from base	**-**	**0.83**	**2.97**

Stage 2: Other variable costs

There is evidence to suggest that, as well as pre-weaning mortality, some other physical performance metrics are likely to be affected by alternative farrowing systems. This comes from observations in British trials as well as data from Sweden, where free farrowing is required. We have made the following assumptions in the model:

- Higher transfer weights from the breeding to the rearing unit, with piglets consuming more creep feed
- Sows consuming more feed
- Additional straw/bedding usage - we have assumed this will also be a requirement if legislative changes were made
- Increased disposal costs when piglet mortality is higher

Key costs & physical performance metrics				
	2019 Actual	Constant mortality	S1	S2
Pre-weaning mortality	**12.34%**	**12.34%**	**14.00%**	**18.00%**
Transfer weight from breeding to rearing unit	**7.3kg**	**7.6kg**	**7.6kg**	**7.6kg**
Sow feed/sow/year	**1370kg**	**1470kg**	**1470kg**	**1470kg**
Gilt/sow average purchase price	£220	£220	£220	£220
Building cost/sow (inc. farrowing, lactation & dry)	£2100	£2100	£2100	£2100
Straw & bedding/sow	**£31.85**	**£32.34**	**£32.34**	**£32.34**
Disposal of dead animal costs/sow	**£12.89**	**£12.89**	**£13.33**	**£14.41**
Extra piglet creep feed/sow	**-**	**£1.37**	**£1.35**	**£1.28**

These changes add about another penny onto production costs, on top of any increase due to higher pre-weaning mortality levels. So, when these expected costs are also taken into account, **any increase in pre-weaning mortality is enough to challenge the economic viability of the industry**, considering the long-term margin is only 1p/kg deadweight.

Cost of production, p/kg deadweight				
	2019 Actual	Constant mortality	S1	S2
Feed	89.76	90.64	90.94	91.70
Other variable costs	11.39	11.39	11.55	11.94
Labour	12.47	12.47	12.62	12.99
Building, finance & misc.	34.92	34.98	35.26	35.98
Total costs	**148.54**	**149.48**	**150.36**	**152.61**
Increase from base	**-**	**0.94**	**1.81**	**4.06**

We have not seen sufficient evidence to change other performance metrics, including litters per sow per year, sow mortality or replacement rate, age at weaning, daily rearing and finishing weight gains or feed conversion ratios. Water, energy, labour usage per sow and manure disposal costs are also assumed to remain the same on average.

There is some evidence to suggest that pigs born alive per litter may increase in certain circumstances and this is modelled later in the report.

There is also some evidence to suggest that where pre-weaning mortality is higher, subsequent rearing mortality is lower. An analysis of international indoor data shows that the average for countries with pre-weaning mortality of 14.5% or above is 15.3% and their average rearing mortality is 2.9%. GB rearing mortality averages 3.9% in 2019.

However, we do not feel there is enough evidence at present to suggest confidently that GB rearing mortality could be lower in piglets from alternative farrowing systems. The majority of evidence comparing farrowing crates and alternative farrowing systems finished the comparisons when piglets were weaned. One GB producer that did provide a comparison found no difference in rearing mortality between alternative farrowing and farrowing in crates; although, their rearing mortality at 2% was already low compared with the GB average.

More research is needed to determine whether this could offset some of the additional costs of alternative farrowing. Similarly, piglets with a heavier weaning weight may have improved growth at later stages in the production, but this has not been extensively investigated.

Stage 3: Building costs

Alternative indoor farrowing systems are more expensive than conventional farrowing crates, driven by the requirement for more floor space. Our estimates based on industry sources suggest that

(including buildings) farrowing crates at 4m^{2}cost about £3000-£3500 per place. Alternative farrowing systems requiring 6m^2 are about £2000 over the base cost while those requiring 8m^2 are about £4000 over the base cost.

While some alternative farrowing systems do fit in the same floor space as the conventional crate, many systems do require additional space and other countries who have adopted or are considering adopting alternative farrowing pens have a minimum overall pen requirement of 6m^2. Although it is not yet clear exactly which indoor alternative farrowing system would be favoured, or what stipulations might be made in any changes in legal requirements, it seems likely increased floor space will be needed.

The **additional building costs significantly increase the cost of pig production**. A **6m^2 pen adds about 2p/kg deadweight** onto the base cost, while an **8m^2 pen adds about 4p/kg deadweight**. With margins only averaging 1p/kg deadweight over the past decade, this is a significant challenge to economic viability, especially when combined with higher pre-weaning mortality levels and other additional costs.

Key costs & physical performance metrics							
	2019 Actual	Constant mortality		S1		S2	
		6m2	8m2	6m2	8m2	6m2	8m2
Pre-weaning mortality	12.34%	12.34%	12.34%	14.00%	14.00%	18.00%	18.00%
Transfer weight from breeding to rearing unit	7.3kg	7.6kg	7.6kg	7.6kg	7.6kg	7.6kg	7.6kg
Sow feed/sow/year	1370kg	1470kg	1470kg	1470kg	1470kg	1470kg	1470kg
Gilt/sow average purchase price	£220	£220	£220	£220	£220	£220	£220
Building cost/sow (inc. farrowing, lactation & dry)	**£2100**	**£2570**	**£3040**	**£2570**	**£3040**	**£2570**	**£3040**
Straw & bedding/sow	£31.85	£32.34	£32.34	£32.34	£32.34	£32.34	£32.34
Disposal of dead animal costs/sow	£12.89	£12.89	£12.89	£13.33	£13.33	£14.41	£14.41
Extra piglet creep feed/sow	-	£1.37	£1.37	£1.35	£1.35	£1.28	£1.28

Cost of production, p/kg deadweight							
	2019 Actual	Constant mortality		S1		S2	
		6m2	8m2	6m2	8m2	6m2	8m2
Feed	89.76	90.64	90.64	90.94	90.94	91.70	91.70
Other variable costs	11.39	11.39	11.39	11.55	11.55	11.94	11.94
Labour	12.47	12.47	12.47	12.62	12.62	12.99	12.99
Building, finance & misc.	34.92	36.80	38.63	37.12	38.98	37.93	39.88
Total costs	**148.54**	**151.31**	**153.13**	**152.22**	**154.08**	**154.56**	**156.51**
Increase from base	**-**	**2.77**	**4.59**	**3.67**	**5.53**	**6.01**	**7.96**

Stage 5: Gilt prices

As the increase in pen size in particular will also impact the production of replacement gilts (home-bred or purchased from breeding companies), we have also modelled the effect of an increased gilt purchase price to reflect this. It has been suggested that the breeding companies might be able to absorb this additional cost in their margins, but we cannot be certain they would be willing or able to do this and those breeding their own replacements would incur the additional cost

Key costs & physical performance metrics							
	2019 Actual	Constant mortality		S1		S2	
		6m2	8m2	6m2	8m2	6m2	8m2
Pre-weaning mortality	12.34%	12.34%	12.34%	14.00%	14.00%	18.00%	18.00%
Transfer weight from breeding to rearing unit	7.3kg	7.6kg	7.6kg	7.6kg	7.6kg	7.6kg	7.6kg
Sow feed/sow/year	1370kg	1470kg	1470kg	1470kg	1470kg	1470kg	1470kg
Gilt/sow average purchase price	**£220**	**£223**	**£225.50**	**£223**	**£225.50**	**£223**	**£225.50**
Building cost/sow (inc. farrowing, lactation & dry)	£2100	£2570	£3040	£2570	£3040	£2570	£3040
Straw & bedding/sow	£31.85	£32.34	£32.34	£32.34	£32.34	£32.34	£32.34
Disposal of dead animal costs/sow	£12.89	£12.89	£12.89	£13.33	£13.33	£14.41	£14.41
Extra piglet creep feed/sow	-	£1.37	£1.37	£1.35	£1.35	£1.28	£1.28

Cost of production, p/kg deadweight							
	2019 Actual	Constant mortality		S1		S2	
		6m2	8m2	6m2	8m2	6m2	8m2
Feed	89.76	90.64	90.64	90.94	90.94	91.70	91.70
Other variable costs	11.39	11.47	11.53	11.62	11.69	12.02	12.09
Labour	12.47	12.47	12.47	12.62	12.62	12.99	12.99
Building, finance & misc.	34.92	36.80	38.63	37.12	38.98	37.93	39.88
Total costs	**148.54**	**151.39**	**153.27**	**152.30**	**154.22**	**154.64**	**156.66**
Increase from base	**-**	**2.84**	**4.73**	**3.75**	**5.68**	**6.10**	**8.12**

Summary

Based on the evidence currently available, when taking account of likely changes to physical performance and costings, we expect the cost of production for GB indoor herds installing alternative farrowing systems to increase by 3-8p/kg deadweight depending on the chosen pen design's footprint and the mortality achieved. Even for those producers who might achieve comparable pre-weaning mortality levels, costs are likely to rise by 3-5p/kg deadweight. From an industry-wide perspective, this is not likely to be sustainable without a rise in pig prices, as long-term margins for indoor pig producers only averaged 1p/kg deadweight over the previous decade.

Additional upfront costs

This modelling looks at the economic sustainability of the GB indoor pig sector if a transition away from traditional farrowing crates was required. However, upfront costs for new buildings and equipment may be problematic, particularly depending on the transition time granted to change systems.

For the modelling, we have assumed that producers fully finance new buildings, including principal and interest payments. Using international conventions, buildings are depreciated over 20 years and equipment over 10 years. Overall building and equipment costs are estimated as 62% building and 38% equipment.

A transition time less than 10 years means a portion of the industry that has recently invested will need to scrap equipment before it is fully monetised. Similarly, a period less than 20 years may mean some producers need to have buildings demolished and rebuilt before they have been fully remunerated; although on some units, retrofitting (installing new equipment in current buildings) may be possible.

We can express this financial hit as temporary additional building costs in the cost of production.

5-year transition:

Here, at a national level, 50% of previous equipment costs are still being paid for at the time of transition, and 75% of previous building costs. This is equivalent to adding a further 2p/kg deadweight

to production costs for the first five years, dropping back to an extra 1-1.5p/kg deadweight for the following decade.

10-year transition:

Within this timeframe, we would expect all older equipment to be fully monetised. However, half of buildings would still need to be replaced before their time (assuming retrofitting is not possible), effectively adding 1p/kg deadweight to production costs over the following decade.

15-year transition:

Over a transition of this length, only 25% of older buildings would not be ready for replacement before the changeover. Expressed on a p/kg deadweight basis, this equates to an additional 0.5p/kg on the cost of production in the following five years.

So, there are additional cost implications if businesses have to scrap equipment and buildings before the end of their useful life, on top of the ongoing running costs previously discussed. The shorter the transition time, the greater the economic challenge this presents to the industry.

It should be noted that any increase in pen size for the new systems installed has an increased requirement for building floor space to keep the same number of sows. Land availability and any potential planning permission issues have not been evaluated, but may also pose significant difficulties. These include the need to purchase additional land, loss of income from current land use, timescales to obtain planning permission or obtain or convert land, cost of planning application and the likelihood of planning application success.

Part III: What would happen if we lost the indoor pig sector?

The modelling highlights how a mandatory transition away from farrowing crates towards alternative indoor systems is likely to challenge the economic viability of indoor pig production in Britain.

The figures used for the modelling above are averages and variable performance and cost structures between farms mean some businesses may well be able to face additional production costs and remain profitable.

Nonetheless, without higher pig prices and/or government support, we would expect unprofitable enterprises, which would be in the majority, to leave pig production. This would likely lead to a contraction in the sector unless there is expansion from the remaining businesses (either indoor or outdoor), though the feasibility of either of these is uncertain.

In 2019, assuming indoor accounts for 60% of the UK pig meat production, trade and consumption of UK meat, the indoor pork sector performed as follows:

- Slaughter: 6.5 million clean pigs and 150,000 sows and boars, worth in the region of £890 million.
- Pig meat production: 575,000 tonnes
- Exports: 175,000 tonnes carcase weight equivalent, worth £1.5 billion. Offal exports totalled 10,000 tonnes and were worth a further £11 million.
- Domestic consumption: 400,000 tonnes (carcase weight equivalent) of UK indoor pig meat was available for consumption in the UK last year, about **25% of total supplies available for consumption**

Note that outdoor pork receives a premium, so will account for slightly more of the slaughter pig market by value than volume in reality. We have also assumed here that indoor and outdoor product

are consistently represented on the export and domestic market - it is not possible to use exact figures as this information is not recorded.

For illustrative purposes we will consider what the consequences might be, if production from the indoor sector ceased entirely and British pork production fell by 60%:

Farm closures:

There were 800 farms with over 100 breeding sows in 2018, averaging about 500 sows per farm (farms with small numbers of sows are less likely to be commercial units operating with farrowing crates). This means an estimated **500 breeding farms would be affected by a change in farrowing legislation and may find their profitability at risk.**

Each sow represents about 13.2 hours in labour a year, including the labour for rearing her piglets. A loss of 245,000 sows (60% of the UK total) represents a loss of about **1,600 full time equivalents** (based on 40 hours a week).

It is more difficult to estimate the number of finishing units that might be affected as farms may finish a mix of indoor and outdoor bred piglets and may buy piglets at either 7kg or 30kg, meaning the time spent on the farm is variable. However, there **were 1,300 units with over 1,000 fattening pigs on 1 June 2018**, and it is likely most of these will be involved in finishing indoor bred piglets to some extent. Note that some of these farms will also have breeding pigs, and so be included in the estimated 500 breeding farms affected.

We can estimate that 0.35 hours of labour is required to take each pig from rearing to finishing. If about 6.5 million indoor-bred clean pigs were slaughtered in the UK last year, the loss of these pigs would represent a decline of about **a further 1,100 full time equivalents** (based on 40 hours a week).

Abattoir closures:

Details about pig abattoir throughput is available at England level only. Abattoirs in England killed an estimated 5.3 million indoor-bred pigs last year.

99% of pigs in England are killed in 9 specialist pig abattoirs with an average annual throughput of 730,000 head. Abattoirs must run at their operating capacity in order to be profitable, so if the industry contracts individual abattoirs are more likely to close than scale back their operation at individual sites. Losing production from the indoor sector would likely make operations **unviable at 5 of these abattoirs**.

Closure of abattoirs would probably have implications for transportation times to slaughter for the remaining pig industry. Slaughtering animals as close as possible to the place of production is already acknowledged by the government as better for animal welfare. Local slaughter facilities are required in order to achieve this, so as many facilities as possible need to be maintained. Minimising the distance animals travel for slaughter also reduces the risk of spreading disease, and less faecal contamination reduces the health risk to consumers and abattoir staff.

Wider **consequences in allied industries would also be expected**, such as loss of jobs for specialist pig vets and a decline in industries supplying the industry with feed, equipment, genetics etc.

Increased import requirement:

The UK is currently just under 60% self-sufficient in pig meat production. However, 30% of production is exported, so the **UK share of the domestic market is only 40%.**

Even if we stopped exporting pork, if pig meat production dropped by 60% we would be less than 25% self-sufficient in pork production, meaning at least 1.3 million tonnes of pig meat (carcase weight equivalent) would need to be imported to maintain 2019 consumption levels. This is a 29% increase (+290,000 tonnes) in imports.

However, it is unlikely exports would drop to zero. Exports are used to achieve best value from the carcase, with some parts of the pig being more valuable abroad and having little demand on the British market. If 30% of the remaining production continued to be exported, we would need to import 1.5 million tonnes (carcase weight equivalent), a 56% increase (+550,000 tonnes) from 2019 levels.

Where this would come from depends on how our trading relationship with the EU and rest of the world develops. Virtually all imports currently come from the EU (especially Denmark, Germany, the Netherlands and Ireland). There is the possibility the US may be granted more favourable market access in the future.

EU pork is generally cheaper than British product, so this would not present an economic problem for retailers/foodservice outlets. Over the past 5 years, EU pig prices averaged 16p/kg lower than the GB SPP (the average price for standard British pigs, which excludes outdoor reared production) at farmgate level. Different deductions and bonuses are applied to pig prices in different countries and it is likely that the difference between the GB and EU prices is a few pence less than this in reality, but the principle remains the same. US pigs are typically about 40p/kg cheaper at farmgate level.

The EU exports over 3 million tonnes of pig meat each year, the extra pig meat that would be required by the UK represents about 10-15% of current EU export levels. It is realistic to assume volumes of this magnitude could be shipped to the UK if the demand existed. Demand in the EU is stagnant at best, and import demand from China is expected to peak, so we can reasonably expect sufficient product to be available. The UK is also a relatively high value export market for the EU, with export prices averaging £2.80/kg in 2019, higher than the overall average of £2.56/kg. The US similarly exports over 2 million tonnes annually, though there is no significant established trade flow to the UK at present.

Of the large global pig meat exporters, only Germany has announced a plan to move towards alternative indoor farrowing systems. It is unrealistic to assume the majority of the imports would be produced to the standards that would be required in the UK if we changed to mandatory alternative farrowing systems. There are already differences in production practices between the UK and the meat we import, e.g. castration is widespread in European production. Some retailers may set requirements that match those in the UK, but this would not be the case for all outlets.

In 1999, the UK banned gestation stalls (a small pen that restricts movement in a similar manner to the farrowing crate, but is used to house the sow for the 16.5 weeks of pregnancy) before the EU-wide ban came into force in 2013, placing the UK at a competitive disadvantage. UK production fell sharply in the decade following the ban, with annual clean pig slaughter falling from nearly 16 million head in 1998 to a low of 8.9 million head in 2006. Over the same period, import market share rose from 40% to over 60%. If farrowing crates were banned in a manner that significantly reduced the economic viability of indoor pig production in Britain, the industry could similarly shrink further.

If Britain decides to ban farrowing crates from an ethical perspective but consequentially imports pork produced using crates, arguably, this is not a morally superior position.

Part IV: How could alternative indoor farrowing systems be sustainable in Britain?

We have illustrated that, based on the evidence currently available, it is likely the average producer will experience a rise in production costs upon switching to alternative indoor farrowing systems and will not have sufficient margins to absorb this cost themselves. This may cause UK production to shrink, increasing our import requirement. However, there may be factors that could mitigate the potential for eroded margins and these are explored below:

Could consumers, or another part of the supply chain, pay more for pork produced without farrowing crates?

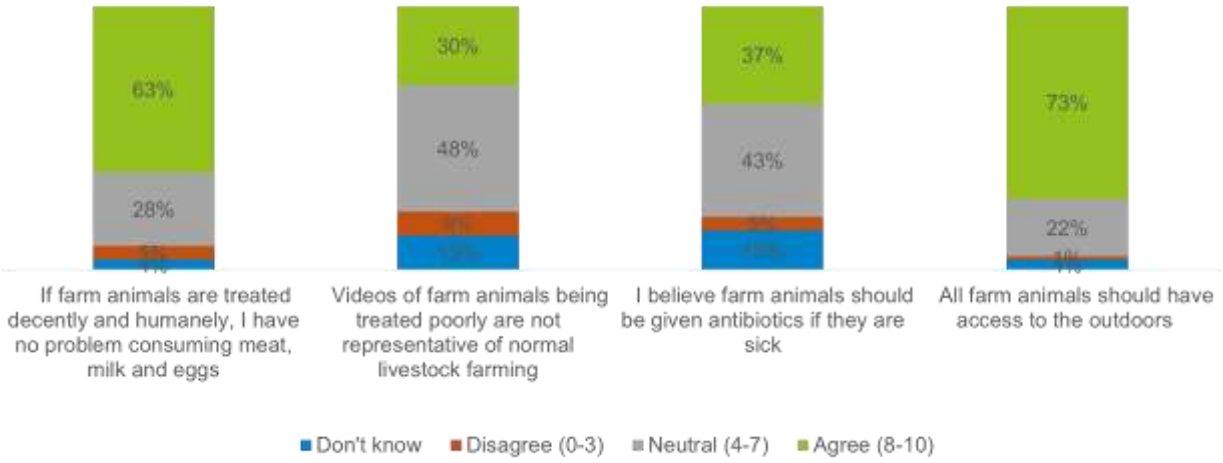
56% of UK adults are not aware of farrowing crates, according to AHDB/Blue Marble Trust Research conducted in June/July 2019:

Q28: Looking at these specific concepts, terms and practices related to farming please state your position on each of these topics - I heard about it before today and I am personally concerned about it. Base all respondents (1500)

Of the remaining 44% that are aware, just over half are concerned about the practice (25% of the total). Lack of both consumer awareness and concern for the use of farrowing crates suggests the portion of the market willing to pay extra for products produced without using this system is currently limited.

A secondary potential difficulty with obtaining a retail premium for alternative indoor farrowing systems is that the pigs in these systems are still kept without outdoor access. A greater portion of consumers, 43%, are aware and concerned about outdoor access as a welfare issue within the pig industry. Combined with the fact 73% of respondents in the same survey agreed with the statement “all farm animals should have access to the outdoors”, it may be difficult for the market to perceive what is still an indoor-only system as promoting higher pig welfare.

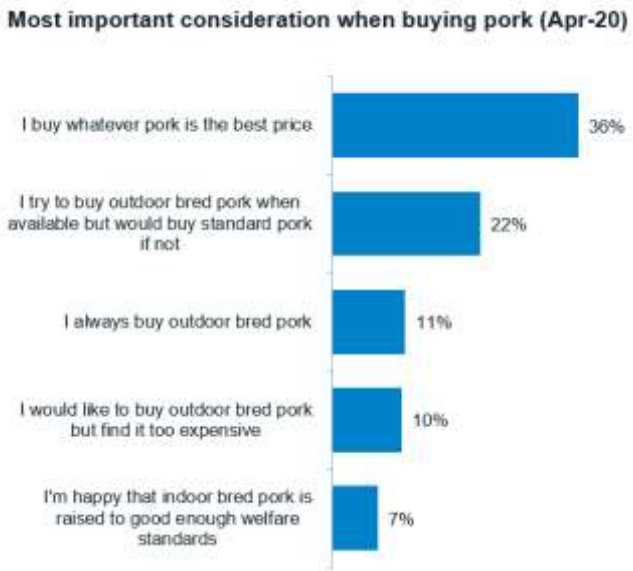
Q17 How much do you agree or disagree, where 0 means 'strongly disagree' and 10 means 'strongly agree'. Base all respondents (1500)



Outdoor-bred pork already accounts for 40% of UK pig meat production and is sold at a premium at retail level. According to Kantar, in the 52 weeks to 16 June 2019, 12% of total pig meat volumes sold carried an outdoor claim. However, this is a lower percentage than would be expected considering that 40% of pork sold in the UK is British and we would expect 40% of this to be outdoor (16% overall). Anecdotal reports from those in the supply chain suggest that it is not possible to sell all the outdoor pork as a premium product, as the market is oversupplied.

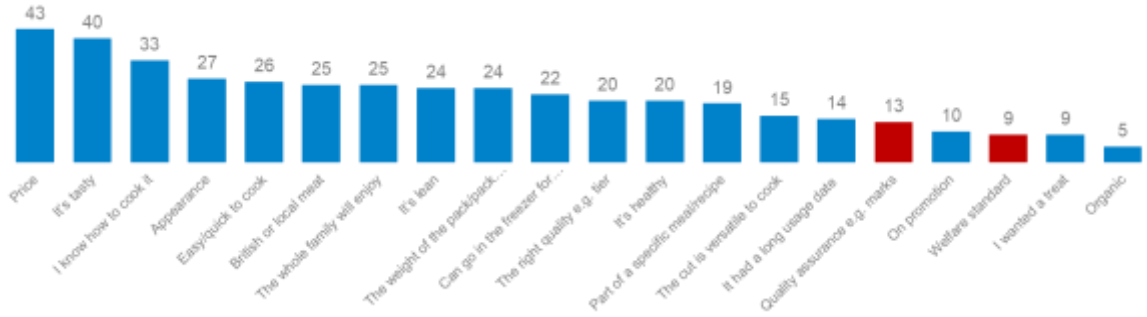
Carcase balance is likely to be a difficulty; the majority of the volume sold with an outdoor claim is processed product (79%) – such as sausages, ham and bacon – with only 11% of the volume coming from primary pork cuts (Kantar, 52 w/e 16 June 2019). This again suggests there may be a difficulty in asking consumers to pay more for a different "premium pork welfare" product, especially one that does not tap into the common belief that farm animals should be able to access the outdoors.

Ultimately, price is the most important consideration for consumers when buying pork, according to a recent AHDB/YouGov survey (April 2020):



In 2018, welfare was not a top driver of meat purchase (AHDB/Future Thinking Decision Tree Research 2018)

Which of these played a part in your decision to buy ... on this occasion? Base: all respondents n=751



This might suggest most consumers are likely to choose cheaper imported pork over more expensive pork produced using "alternative farrowing systems" in Britain, if those are the only options available.

The number of consumers claiming to have eaten less red meat was 27% in February 2020, up from 21% in February 2019, and animal welfare was one of the main four drivers, after health and environment (AHDB/YouGov February 2019 vs February 2020).

It is also important to note that buying British/local meat is relatively important to consumers.

If alternative farrowing systems were compulsory in Britain, then consumers would have no option but to purchase this pork if they still wanted to buy British. British pig meat already generally attracts a premium over European pork, at least at farmgate level, though reports indicate this is also generally the case on UK wholesale markets. This indicates there is a market for product labelled as British, and indeed a number of supermarkets carry claims to only sell British fresh meat.

Perhaps it is possible some retail outlets would be willing to absorb any additional cost in order to continue with this supply and promote a favourable image to consumers. Nonetheless, this is unlikely to be a priority for all outlets.

While the current evidence suggests there is limited market demand for alternative farrowing pork, with time it might be possible to increase consumer awareness and demand for this product. More research would be needed to determine whether consumer willingness to pay would increase with further education.

We did see increasing public interest in free-range eggs leading up to the ban on barren battery cages in 2012. Demand is also still growing by 3-4% each year, according to the British Free Range Egg Producers Association and free range eggs account for around half of British production.

It is not clear though whether there would be a similar increase in interest in alternative farrowing systems with increasing consumer awareness. The ethical arguments surrounding farrowing crates are arguably more complex, with judgements to be made about the balance between sow, piglet and stockperson welfare. There is also the possibility consumers will not view the alternative indoor systems favourably, perhaps a particular risk with systems that still temporarily confine the sow in a "temporary crate" resulting in increased awareness shifting demand further into outdoor pork or out of pork entirely.

Clearly at this stage it is speculative to consider how consumers might react when the precise details of what the final system may look like is yet to be decided. However, if farrowing crates are to be

prohibited, it would be imporant to conduct research into how any replacement system will be received by the public if we are to avoid farmers investing in a system that might have a limited market or is rejected by the consumer.

Could performance from indoor farrowing systems improve if the system is optimised?

Academic research and on-farm trials have so far experienced a range of physical performance outcomes. Although higher pre-weaning mortalities have been experienced, some trials have been able to achieve comparable levels in both farrowing crates and alternative farrowing systems.

Some trials have also suggested some potential performance benefits from alternative systems.

- **Pigs born alive per litter**
    - If alternative farrowing sows are in better condition at weaning, as a result of improved lactation feed intake which is often reported, subsequent conception rate and numbers born may be improved
    - There is no conclusive evidence of this and it would need further investigation in large scale comparative studies
- **Rearing mortality**
    - There is some suggestion that where pre-weaning mortality is high, subsequent rearing mortality may be lower than where pre-weaning mortality is low
    - The majority of evidence comparing farrowing crates and alternative farrowing systems finished the comparisons when piglets were weaned. Trials following pigs all the way through are needed to determine the extent of any benefit
- **Finishing mortality**
    - As for rearing mortality, there have been limited trials following pigs through to this stage of production. Further investigation is needed
- **Daily liveweight gain (DLWG)**
    - There is some suggestion that DLWG from weaning to finish was greater for piglets from alternative farrowing systems than farrowing crates
    - Heavier weaned piglets transferred from alternative farrowing systems will also benefit the rearing and finishing period
    - Both of these would result in achieving the same carcase weight within fewer days or achieving a higher carcase weight in the same days
    - Without comprehensive evidence for both DLWG and associated feed conversion ratio (FCR) it is not possible to confirm that piglets from alternative farrowing systems will perform differently to current GB performance.

More large-scale research in commercial-type environments may help identify how some farms are able to achieve better performance than others. Learnings from this could be used to educate the wider industry in how to achieve the best performance in alternative farrowing systems, mitigating the impact of increased pen size and reducing the risk of negative performance impacts.

How some of these potential improvements in performance might offset some of the increases in production costs modelled previously are highlighted below. DLWG and FCR have not been changed in these scenerios:

Cost of production, p/kg deadweight							
	2019 Actual	12% pre-weaning mortality, 6m2 pen			14% pre-weaning mortality, 6m2 pen		
	3.9% rearing mortality, 3.2% finishing mortality	3.9% rearing mortality, 3.2% finishing mortality	2% rearing mortality and 3.2% finishing mortality	2% rearing and finishing mortality	3.9% rearing mortality, 3.2% finishing mortality	2% rearing mortality and 3.2% finishing mortality	2% rearing and finishing mortality
Feed	89.76	90.64	90.22	89.60	90.94	90.51	89.89
Other variable costs	11.39	11.47	11.31	11.22	11.62	11.46	11.37
Labour	12.47	12.47	12.33	12.24	12.62	12.47	12.38
Building, finance & misc.	34.92	36.80	36.50	36.28	37.12	36.81	36.58
Total costs	**148.54**	**151.39**	**150.36**	**149.34**	**152.30**	**151.25**	**150.22**
Increase from base	**-**	**2.84**	**1.81**	**0.79**	**3.75**	**2.71**	**1.68**

Cost of production, p/kg deadweight							
	2019 Actual	12% pre-weaning mortality, 6m2 pen			14% pre-weaning mortality, 6m2 pen		
	13.8 piglets born alive/litter, 3.9% rearing mortality	13.8 piglets born alive/litter, 3.9% rearing mortality	14.8 piglets born alive/litter, 3.9% rearing mortality	14.8 piglets born alive/litter, 2% rearing mortality	13.8 piglets born alive/litter, 3.9% rearing mortality	14.8 piglets born alive/litter, 3.9% rearing mortality	14.8 piglets born alive/litter, 2% rearing mortality
Feed	89.76	90.64	89.60	89.20	90.94	89.88	89.47
Other variable costs	11.39	11.47	10.93	10.78	11.62	11.07	10.92
Labour	12.47	12.47	11.97	11.83	12.62	12.11	11.97
Building, finance & misc.	34.92	36.80	35.77	35.49	37.12	36.06	35.78
Total costs	**148.54**	**151.39**	**148.27**	**147.30**	**152.30**	**149.12**	**148.14**
Increase from base	**-**	**2.84**	**-0.27**	**-1.24**	**3.75**	**0.58**	**-0.41**

Decreasing rearing mortality to 2% takes about 1p/kg deadweight off production costs. Decreasing finishing mortality to 2% also reduces production costs by this amount.

An extra piglet born alive per litter particularly decreases production costs, by about 3p/kg deadweight.

Some of our competitors (Denmark, Finland, Germany, Netherlands, Sweden, Czech Rep and top third producers in France) produce, on average, over 14.8 pigs born alive per litter. Agrosoft top third GB Indoor sows produce, on average, 14.9 pigs born alive per litter with corresponding pre-weaning mortality averaging 12.6%. It is not clear at present if all our pig producers can achieve these sort of production gains, but if they could the potential is there to offset most or all other increases associated with the alternative farrowing systems.

Taking into account evidence from various sources, it seems that a key aspect to making any type of alternative farrowing system work is training of both stockpersons and sows and consistent application. Having a **consistent system type** and not having to chop and change (e.g. when running different farrowing systems concurrently) should lead to maximum efficiency and lowest possible mortality rates for the system adopted.

Attention to detail will be key to improving overall productivity and optimising the lowest cost of production for the system adopted.

Sows need to be trained from gilts and experience the same farrowing environment at each subsequent farrowing to optimise their ongoing performance. Older sows introduced to a new farrowing environment may need help to adjust and to lessen any negative impact such as on piglet mortality.

For consistent performance **sows will also likely need to be bred to best suit new farrowing environments** and this will influence pig breeding.

Pen design has to be practical for everyday use by sows, piglets and stockpersons, and suitable for stockpersons to handle sows safely. The current range of models and makes available have not been adequately assessed for commercial suitability.

Evidence would suggest that being able to confine an individual sow **if necessary** at farrowing for a short period of time could lead to lower mortality rates compared to not being able to confine a sow at all.

Farmers and staff need to understand what is best for their farm situation and learn best by seeing and doing before having to implement a significant change.

Taking these comments together, a transition time that enables further research to take place into optimising pen design, sow genetics and handling, and stockperson training, will likely support achieving the best possible performance from alternative farrowing systems.

Is financial support from the government appropriate?

Another option to increase the economic viability of alternative indoor pork production systems could be for the government to provide financial support.

We previously highlighted how short transition times, particularly those less than 10 years, incur additional costs due to premature scrappage of equipment and buildings. Grants to cover the upfront cost of paying for the new building or to offset the loss of the previous building could help overcome this initial barrier.

Short-term grants alone do not help with the ongoing difficulty of running a pig farm that is not profitable due to ongoing higher costs when compared to competitors. Sweden provided an initial subsidy to enable farmers to change to free farrowing and, due to the continued higher costs of production, Sweden continues to provide a subsidy for pig production.

Whether it is in the public interest to subsidise production in this manner is a matter for debate. More research into public opinion of alternative farrowing systems, and wider education on this matter, may be appropriate.

Part V: How might outdoor pork production be affected?

A switch to alternative indoor farrowing systems would also have implications for outdoor-bred pork production.

Broadly speaking, pork is currently either sold as standard “commodity” product from indoor pigs, or “premium” outdoor product from outdoor-bred pigs. A change to alternative indoor farrowing systems in the UK would disrupt this relationship, though the consequences are not clear at the moment as we don’t know what consumers think of indoor systems without crates.

Alternative indoor farrowing systems might be seen as a mid-tier option, eroding the premium achieved by outdoor if some consumers find the indoor product acceptable. Depending on the extent of this, outdoor profitability might be compromised.

On the other hand, consumers may find alternative indoor farrowing systems unacceptable, with increased awareness of indoor production in general driving increased demand for outdoor bred pork, or reducing overall demand for pork.

The above options assume consumer awareness of crate usage increases and there is engagement with the issue. This may not be the case, with demand for outdoor remaining similar, but demand for indoor British pork, if requiring a higher price point, struggling.

As well as the consumer perception of the two systems, the relative production cost of each product is also important. In 2019, the cost of outdoor pork production in Britain was 151p/kg deadweight. This is lower than the alternative farrowing production costs modelled previously, before any potential mitigating factors are taken into account.

Considering the importance consumers place on outdoor access for livestock, it seems unlikely that indoor alternative farrowing would be regarded as premium over outdoor product. The likelihood of being able to charge even higher prices for pork is also questionable. This creates a difficulty regarding how to market the products.

Would we see a drive to increase outdoor pig production instead of investing in improving alternative indoor farrowing systems?

It is not clear how much more suitable land is available for outdoor pig production. The best sites for outdoor pig units are level, free-draining soils such as chalk and sand due to their porous nature. Exposed and steeply sloping sites or those with heavy land (e.g. clay) or high rainfall can aggravate soil erosion challenges.

Although outdoor pigs can be beneficial for clearing vegetation and producing manure to naturally fertilise the land, difficulties can also arise due to run-off contaminating nearby water sources. Poaching of the land can also occur and nearby residents may object to the odour and degraded appearance of the fields. Nose-ringing is used in some circumstances to help maintain grass cover, however this has welfare consequences as it is a painful procedure and interferes with the pig's natural rooting behaviour. Increased outdoor pig production on less than optimal land may result in increased nose-ringing.

Further practical difficulties arise from the fact current indoor producers may not have sufficient or suitable land to transition into outdoor production, meaning any expansion in this sector may need to come from new entrants.

Finally, we have already highlighted that the production of outdoor-bred pig meat probably already surpasses current demand, especially for some cuts. Increasing expansion would lead to oversupply and would be expected to erode the premium this product can receive and reduce profitability.

Part VI: Conclusions

Deciding which farrowing system is most appropriate for Britain going forward will require balancing the welfare of piglets, sows and stockpeople, as well as the realities of consumer demand requirements and practicalities in the supply chain.

A comparison of differences in enrivonmental impacts between farrowing crates and alternative indoor farrowing systems has not been possible at this time, though research is ongoing and some results should be available next year. Animal welfare and environmental benefits can be conflicting so, again, finding a balance will be needed going forward.

The evidence available currently suggests indoor alternative farrowing systems are likely to challenge the economic viability of indoor pig production in Britain. However, there is the potential for these effects to be mitigated if performance in the system can be optimised.

Further research should help establish what best practice looks like for these systems and the most appropriate pen designs. Low consumer awareness of the farrowing crate debate also presents a difficulty for demand for alternative indoor farrowing systems and it is unclear exactly how and if this may change going forward.

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Appendix

Cost of pig production in alternative farrowing systems – model assumptions

AHDB's estimates of the cost of pig production (COP) are based on a methodology agreed by InterPIG, a group of economists from major pig producing countries across the world. The calculations provide an estimate of the cost of producing a kilogramme of pig meat. This means that as well as being influenced by the price of inputs, they are also affected by how efficiently the inputs are used and how productive the industry is.

AHDB already publish quarterly COP estimates designed to provide an indicative average cost of pig production in Britain. These figures reflect the whole industry using a ratio of indoor sow and outdoor sow commercial breeding systems (60% indoor, 40% outdoor) with piglets finished in slatted pens and straw barns.

As this report considers the impact of keeping indoor sows in alternative indoor farrowing systems, the COP calculations in this report are based on indoor production with the finishing of indoor-bred piglets and will exclude outdoor kept sows and the finishing of their progeny.

A range of physical performance data are used within the COP calculations. Data for GB are provided to AHDB by Agrosoft and, for 2019, include records from multiple indoor breeding, rearing and finishing units representing approximately 79,000 indoor sows and 250,000 piglets.

There are two key factors that influence the overall COP: the amount of pig meat produced per sow per year and the efficiency with which feed is used.

Producing more pig meat per sow means that overhead costs are divided by a larger quantity, thereby reducing the average cost of production. Key factors influencing the amount of pig meat produced per sow per year include:

- The number of litters produced in the year
- The number of piglets born alive in each litter
- The mortality rate, both before and after weaning
- The weight of the pigs when they are sent to slaughter

Feed efficiency is influenced by a number of factors including the quantity of feed consumed by each sow, how well feed is converted by pigs between weaning and finishing (Feed Conversion Ratio) and how quickly these pigs put on weight (Daily Liveweight Gain).

Base Data and Assumptions

As mentioned above, AHDB has access to GB performance data and, as a member of the international InterPIG group, data from 17 countries. The group includes Sweden who have forbidden the routine confining of sows during lactation, service and pregnancy since 1993.

The COP base data used in this report is for the 12 month period ending 31 December 2019.

Physical Performance

Data points included in the calculation of COP are:

Litters per sow per year – there is no current evidence to suggest this would be different for alternative farrowing systems and the GB Indoor sow average is currently 2.27.

Pigs born alive per litter – the GB Indoor sow average is 13.8.

If alternative farrowing sows are in better condition at weaning, as a result of improved lactation feed intake which is often reported, subsequent conception rate and numbers born may be improved. However, there is no conclusive evidence of this and it would need further investigation in large-scale comparative studies.

Sweden has an average of 14.8 pigs born alive which is an average increase of three pigs over the last 17 years, the same average increase as GB Indoor over the same time period. Their higher starting point in 2003 may be due to a combination of: changes in genetics; drop in pig farms after 1993 including a higher proportion of less productive farms; higher weaning age and long-term free farrowing.

An analysis of 10 InterPIG EU countries (Belgium, Denmark, Finland, France, Germany, GB Indoor, Ireland, Netherlands, Spain, Sweden) who perform as well or better than GB Indoor for pigs born alive per litter shows an overall average of 14.8 pigs born alive per litter with a pre-weaning mortality of 13.8%. Evidence indicates that, on average, pre-weaning mortality is expected to increase as litter size increases.

An analysis of the Agrosoft data for 149 GB Indoor sow herds (79,000 sows) indicates that the top 50 herds (30,500 sows) are currently averaging 14.9 pigs born alive per litter with a corresponding pre-weaning mortality average of 12.6%

A meta-analysis of free farrowing research that was a combination of results from different trials in different countries working with different breeds with piglets born alive per litter varying between 8.4 and 17.1 provides no evidence that the pigs born alive per litter would change just due to a change in farrowing environment. It reported that 50% of the articles indicated a decrease in piglets born alive in farrowing pens, 32% saw an increase in born alive and the rest saw no change. However, UK experts have challenged the authors and believe the paper is flawed due to relevant papers not being included and inaccurate extraction of data.

Evidence from a couple of studies (Cain, 2013 and Hales, 2014) looking at various aspects (economics, mortality) of alternative farrowing systems also reported finding no significant interactions between housing and litter size.

Evidence from farmers running alternative farrowing systems side by side report no observed difference in pigs born alive per litter from alternative farrowing systems compared with farrowing crates but in some cases the sows have not experienced consistent alternative farrowing and results are not conclusive.

There is evidence that first parity sows that free farrow have significantly higher litters in their second parity without increasing piglet mortality.

Due to inconclusive evidence (possibly due to sows not experiencing consistent use of farrowing system over time), it is assumed pigs born alive per litter is 13.8. However, given the higher pigs born alive in Sweden and UK evidence indicating sows continually experiencing free farrowing have higher

pigs born alive per litter, additional analysis will calculate the impact of increasing pigs born alive per litter from 13.8 to 14.8.

Sow mortality (%) currently averages 7.6% for GB Indoor sows and is comparable to the Swedish sow mortality of 7.5%. There is no evidence to assume that this would change for farrowing system.

Pre weaning mortality (%) in GB Indoor sows is currently an average of 12.34%.

The evidence available indicates a wide variation of the impact on pre-weaning mortality in alternative farrowing systems compared to current farrowing crates.

Evidence indicates that as pigs born alive per litter increases so does pre-weaning mortality, irrespective of system.

In some research and commercial trials, no difference in pre-weaning mortality in free farrowing systems and farrowing crates has been observed. In other trials and commercial environments, pre-weaning mortality of up to 22.5% has been experienced. GB farm based comparisons run over more than one year and documenting sows who were temporarily confined for up to 3 to 4 days after farrowing and sows who were not confined at all, found pre-weaning mortality in sows confined for a short period averaged 14% and those not confined at all averaged 18%. Results are likely to be greatly influenced by the actual alternative farrowing system adopted, consistency of use by individual sows and by the suitability of sow genetics and staff skills.

In Sweden, pre-weaning mortality over the last ten years (2009 to 2019) saw a variation between 16.9% and 18.3%, with an overall average of 17.6%. This is based on a litter size that was, on average, one piglet alive per litter higher than in UK indoor herds.

In Denmark, a trial of 10 different alternative farrowing systems (9 temporary crating options and 1 zero-confinement option) did not allow for clarification of piglet mortality for each design. Correspondence with the InterPIG member in Denmark indicated that free farrowing systems without any sow confinement was expected to increase pre-weaning mortality by 4 to 5 percentage points and alternative farrowing systems with the ability to confine for 4 days after farrowing was expected to increase pre-weaning mortality by 1 to 2 percentage points. Denmark currently have an average number of piglets born alive of 17.5 per litter with an average pre-weaning mortality of 14.8%.

There is evidence in various literature that higher litter sizes are associated with higher mortality rates. An analysis of 10 InterPIG EU countries (Belgium, Denmark, Finland, France, Germany, GB Indoor, Ireland, Netherlands, Spain, Sweden) who perform as well or better than GB Indoor for pigs born alive per litter shows an overall average of 14.8 pigs born alive per litter with a pre-weaning mortality of 13.8%. This supports the observation that, on average, higher litter sizes are associated with higher mortality.

This may be true on average, but the top third Danish producers currently achieve 18.1 piglets born alive per litter with a pre-weaning mortality of 12.9% and top third GB currently average 14.9 pigs born alive per litter with a pre-weaning mortality of 12.6%. This probably indicates how important stockpersonship and attention to detail are to outcomes.

An Austrian trial compared temporary confinement with no confinement. It showed that the most benefit for limiting any negative impact on pre-weaning mortality was obtained when the sow was confined for 3 days after birth (until the fourth day of life) and there was no advantage in further confinement. When sows were temporarily confined, pre-weaning mortality on the research and practical farms was 12.4-12.6% with an average of 11.4 piglets weaned per litter (13 pigs born alive per litter). When sows were not confined at all, the pre-weaning mortality averaged 17.5%.

The results concluded that the temporary confinement was comparable to current Austrian production in farrowing crates but no sows in farrowing crates seem to have been included in the trial and the only comparison stated was with the top 25% production at 11.9% piglet mortality and 11.5 weaned piglets per litter (13.1 pigs born alive per litter). From the international InterPIG data for Austria, the national average for 689 farms is 13.8% pre-weaning mortality and 11.03 weaned pigs per litter (12.8 pigs born alive per litter).

Taking into account various sources of information, we will model the impact of different mortality rates:

- Mortality rate of 12.34%, which is the current GB Indoor average
- Mortality rate of 14%
- Mortality rate of 18%

The above rates illustrate a range of pre-weaning mortality rates that could be found on farms with farrowing crates or alternative farrowing systems. It is important to note that whenever a change of system is adopted on a farm both stockpersons and sows need to be trained and have time to adapt and experience continuous use of the same system for a number of farrowings to achieve best performance.

It is likely that in the early stages of adoption and training of both stockpersons and sows, and particularly if there is a mixture of traditional and alternative farrowing systems in place which neither use on a repeated basis, the actual mortality rates may be higher than normal on any farm.

Rearing mortality (%) in GB is 3.9% for 2019. The majority of evidence comparing farrowing crates and alternative farrowing pens finished the comparisons when piglets were weaned. Information provided of a GB comparison that continued collecting data through rearing and finishing, found no difference in rearing mortality. However, their experience of only 2% rearing mortality was nearly half the GB average.

There is some suggestion that where pre-weaning mortality is high, subsequent rearing mortality may be lower than where pre-weaning mortality is low. An analysis of international indoor data shows that the average for countries with pre-weaning mortality of 14.5% or above is 15.3% and their average rearing mortality is 2.9%. For countries with pre-weaning mortality under 14.5%, the average rearing mortality is 3.3%.

In Sweden, pre-weaning mortality from 2009-2019 averages 17.6% with rearing mortality over the same period averaging 2.1%. In the most recent year, 2019, Sweden's pre-weaning mortality was 17.7% with rearing mortality at 2%. It should be noted that Sweden has a high health status in its national herd and is free of PEDv Type I and PRRS. With significantly higher weaning age (32.5 days) and higher weaning weights (9.5 kgs), this results in more robust piglets entering the rearing stage.

Mortality will be affected by production systems; whether piglets are moved onto different farms when weaned; disease challenge, type, prevention and control; effective stockpersonship, attention to detail and access to skilled labour.

As PEDv Type 1 (which affects growing pigs as a low-level endemic disease in the UK), PCV2, EP and PRRS are present in the UK, for this COP it is assumed that rearing mortality does not change.

An analysis of data for 235,000 rearers from 88 farms indicated that 26% achieved a rearing mortality of 2% or less (average 1.4%), whilst 74% had a rearing mortality of more than 2% (up to 11%; average 4.5%).

Additional calculations will look at the impact of rearing mortality reducing to 2%.

Finishing mortality (%) in GB is 3.2% for 2019. There is no evidence to suggest that finishing mortality will be affected by farrowing system.

In Sweden, finishing mortality is below 2% at 1.8%. The same lack of disease challenge applies as mentioned under rearing mortality as well as the impact of higher piglet weaning weights.

Due to PEDv Type I, PCV2, EP and PRRS being present in the UK, for this COP it is assumed that finishing mortality does not change.

An analysis of data for 297,000 finishers from 144 farms indicated that 23% achieved a finishing mortality of 2% or less (average 1.5%), whilst 77% had a finishing mortality of more than 2% (up to 10%, average 3.7%)

Additional calculations will look at the impact of finishing mortality reducing to 2%.

Sow replacement rate (%) is usually a result of overall pig management and herd policy regarding genetic turnover or motivation to improve the genetics of the herd. Current GB Indoor replacement rate is 55% and there is no evidence to suggest that the replacement policy would change on an on-going basis due to any change in farrowing system. The replacement rate in Sweden is 54%.

It should be noted that it is likely that the genetics of the sow will change if there is large-scale adoption of alternative farrowing systems, so that the relationship between the sow and her environment are optimised to benefit both the sow and the overall productivity of the herd.

Weaning weight per piglet (kg) is the average weight of each piglet rather than the weight of the litter as a whole. Although it is expected that in any litter there will be a variation of individual piglet weights, the GB Indoor average is 7.3kg per piglet weaned.

Many farms take whole litter weights rather than individual weights, so it is unsurprising that litter weight data from farms that are experiencing higher mortality in alternative farrowing systems shows that total litter weight from alternative farrowing pens is lower compared to conventional farrowing crates, whereas individual piglet weight may be higher. From the data available from one farm for the period 2015-2019 inclusive, when the average weight per piglet is calculated the piglets from the alternative farrowing pens are, on average, 0.3kg heavier than those from farrowing crates.

It has further been suggested that average piglet weights from alternative farrowing pens and conventional farrowing crates on slats are heavier than those in both farrowing crates and alternative farrowing on solid floors but further research is needed to provide conclusive evidence.

Additional information has confirmed that piglets from alternative farrowing systems are often heavier than piglets weaned from farrowing crates, although this has been achieved with the sow consuming more sow feed (additional 100kg per year) and the piglets consuming more creep feed (additional 30kg per 200 piglets). This was partly offset by the alternative farrowing piglets not requiring any additional milk replacer compared to the milk replacer used in the farrowing crates. It also led to the sow being in better body condition at the end of lactation.

In Sweden, piglets cannot be weaned before 4 weeks of age and the average weaning age is 32.6 days with the average piglet weight 9.5kg. When adjusted to the GB Indoor weaning age, this would also indicate a heavier piglet weight at weaning.

The assumption used is that weaning weight of piglets from alternative farrowing systems are 0.3kg heavier than piglets from conventional farrowing crates but that this is achieved at an additional net cost of 5p per piglet (at current feed prices). This does not include extra sow feed, which is discussed later.

Age at weaning (days) for GB Indoor is an average of 26.5days. There is no evidence to suggest that this would change due to any change in farrowing system.

Transfer weight from rearing to finishing stage (kg) in GB was an average of 36.5kgs in 2019. This is higher than many other countries because GB systems result in a relatively small number of '30kg weaners' being sold at that stage. Other EU countries, such as Denmark and Netherlands, sell a significant proportion of '30kg weaners' to other countries such as Germany.

There is nothing to suggest the current transfer weight from rearing to finishing stage would change in GB Indoor systems but if the weaned piglet weight coming in is higher this will result in less feed being consumed and less days to achieve the transfer weight for the same DLWG and FCR. The COP model automatically calculates the consequences of different transfer weights.

Rearing Daily Liveweight Gain (DLWG) (g/day) There is no comprehensive evidence to suggest how current DLWG will be affected by alternative farrowing systems. The 2019 GB average is 484g per day.

Rearing Feed Conversion Ratio (FCR) There is no comprehensive evidence to suggest that FCR is affected by farrowing system. The 2019 GB average is 1.83.

Finishing Daily Liveweight Gain (DLWG) (g/day) There is no comprehensive evidence to suggest how current DLWG will be affected by alternative farrowing systems. The 2019 GB average is 860g per day.

Finishing Feed Conversion Ratio (FCR) There is no comprehensive evidence to suggest that FCR is affected by farrowing system. The 2019 GB average is 2.68.

From information provided, there is some suggestion that DLWG from weaning to finish was greater for piglets from alternative farrowing systems than farrowing crates. This would result in achieving the same carcase weight within less days or achieving a higher carcase weight in the same days.

There is evidence that higher weaning weights lead to better DLWG in the rearing and finishing stages than lower weaning weights. Without comprehensive evidence for both DLWG and associated FCR, it is not possible to assess how piglets from alternative farrowing systems will perform compared to current GB performance.

Sow feed per sow per year (kg) for GB Indoor is an average of 1370kgs. Experience of those using alternative farrowing systems indicates that for an increase in weaned piglet weight, the sow ate about an additional 100kg of feed in a year.

In Sweden, the average sow feed per sow per year is 1481kgs, which would equate to the observations in GB.

It is assumed in the COP estimations that sow feed for alternative farrowing systems is increased by 100kg per sow per year.

Piglet rearing and finishing feed consumption (kg) is calculated within the model from performance figures for weaning, rearing transfer and slaughter weights; FCR and DLWG.

Pigs weaned per litter, Pigs weaned per sow per year and Pigs sold per sow per year are not inputted specifically as they are calculated using the data points for litters per sow per year, piglets born alive per litter and the mortality rates at the different stages of production.

Mortality feed costs

The COP model takes account of the cost of rearing pigs which are lost during the pre-weaning, rearing and finishing production stages. The model assumes that rearing and finishing mortality occurs half-way through each production stage but, as lighter pigs have better Feed Conversion Ratio, the model assumes one third of the feed cost has been incurred by the pig at the half-way stage in each cycle.

Inputs

Various costs are included in the COP estimations including veterinary and medicine costs; fallen stock disposal; manure disposal; transport; levy; abattoir deductions; overheads including insurance, professional fees, administration and office expenses.

The majority of these are not assumed to change for any difference in farrowing system except fallen stock disposal to take account of different mortality rates. There is also some suggestion that higher antibiotic use may be associated with dirty pens used in several solid floor alternative farrowing systems but for these COP calculations it is not assumed any change in veterinary and medicine costs as they are not based on any particular pen or flooring type.

Building and equipment costs assume new buildings and equipment fully financed including principal and interest payments. For sows, the total costs include farrowing and dry sow accommodation. Buildings are depreciated over 20 years and equipment over 10 years. Long-term interest rates included in the COP model for 2019 are obtained from the Bank of England website.

In Denmark, SEGES tested 10 different alternative farrowing pen designs (nine temporary crating options and one zero confinement option) and found there was a big difference between makes and models. Their conclusion was that none of the manufacturers achieved the rating ‘good’ or ‘very good’ on all parameters for function and production. They concluded there was still a need for further development and testing as the challenge was to meet the requirements of sow, piglets and stockpersons all at once.

The different alternative farrowing pens available vary significantly in design. Some allow the sow to be confined, if necessary, for 3-4 days after farrowing. Others provide no ability to confine the sow whilst allowing the piglets to suckle, but may provide the ability to hold the sow separately (such as in a separate feed area) whilst stockpersons need to handle piglets. Some have separate sow feed areas and whilst most provide separate piglet creep areas they can vary in size and design. Some pens have solid floors, some slats and some a mixture of materials with and without heating or cooling options and with and without the need for bedding material.

There are a number of different alternative farrowing pen designs and, from the research, it appears that design detail is key to performance optimisation.

Examples include: overall alternative farrowing pen size is often indicated as being required to be larger than current pen sizes but there is mention that the nest area shape and size within the overall pen may be of importance for piglet survival. Another detail may be the position of the creep area and even the lighting colour within that area.

Whilst there are variations on pen designs and design detail, the main impact on cost between alternative farrowing systems is pen size. A conventional farrowing crate would equate to 4m^2; Switzerland requires a minimum of 5.5m^2; Sweden, Norway and potentially Germany, require a minimum of 6m^2 for farrowing pens; by 2033 Austria require that temporary crating will be the standard with 5.5m^2 as the minimum pen size and the biggest current alternative farrowing pen is over 8m^2.

Information from various sources would indicate that to provide a conventional farrowing crate system (including building) would be £3000-£3500 per place; for alternative farrowing systems of 6m^2 £5000-£5500 per place; and for alternative farrowing systems of 8m^2 around £7,000 per place.

Obviously, sows do not spend all their time in a farrowing place and although they have more than one litter a year, more than one sow would use each place.

It is assumed that the additional cost over the cost of providing current farrowing crates is £2000 per place for alternative farrowing pens of 6m^2 and £4000 per place for the alternative farrowing pens of 8m^2. It is also assumed that 4.25 sows will use each place in a year for all their litters per year.

It should be noted that the COP model includes the cost of all sow accommodation including those when not lactating and the overall cost is currently estimated at £2,100 per sow. Therefore, the different alternative farrowing options above will be applied as additional cost to the current base.

Any increase in pen size has an increased requirement for building floor space to keep the same number of sows. Land availability and any potential planning permission issues have not been evaluated (purchase of additional land, loss of income from current land use, timescales to obtain planning permission or source and convert land, cost of planning application, and likelihood of application success).

For the COP modelling we will assume fully financed new build, although some producers may consider retrofitting (installing new equipment in current buildings). Retrofitting will be farm-specific depending on the adaptions required. Adaptions can include different manure handling, the need to re-position ventilation, lighting, water, and energy systems as well as adapting or designing around existing doors and passageways. For many, it might actually be cheaper and result in better performance if replacements were built on a new or levelled site rather than trying to adapt existing structures.

Feed prices are spot prices for purchased compound feed for indoor sow feed (dry and lactating), indoor rearer feed, and finishing feeds for grower and finishing periods.

Breeding costs include commercial artificial insemination costs, purchased replacement gilt prices and cull sow weights and prices.

For alternative farrowing systems, it will be assumed that whether a farm produces its own replacement gilts or whether they are purchased from GB based breeding companies, either will need to implement alternative farrowing systems and therefore have the increased costs of implementing alternative farrowing pen sizes. Only the cost of implementing increased pen size has been included and no account taken for any impact if there is a change in mortality.

Although it would take time for breeding companies to genetically select and breed for any changes to traits found necessary to optimise alternative farrowing systems, it is assumed that there are no other on-going increased costs as genetic selection is what breeding companies are continually doing.

Water (drinking and washings), energy and labour usage are taken from various AHDB surveys, costed at current prices. Prices are from national statistics and local water authority with labour costs including Employers National Insurance, Pension Contributions, Employer Liability Insurance and Insurance tax.

Labour costs assume all time working with the pigs is paid for and therefore includes the value of any pig-related family labour. It does not include any additional allowance for partners or directors drawings.

Labour time per sow is taken from a BPEX survey and is not assumed to increase, particularly as it is already higher than the labour hours per sow reported by Sweden. However, it should be noted that in the short-term a change to alternative farrowing systems is likely to increase labour time due to training and needing to adapt to new systems and ways of working.

Energy use was also taken from a BPEX survey, which reported a wide range of energy consumption, even between different housing with the same farrowing systems on the same farm. There are a range of options and will depend on housing management and the adoption of new technology. It is assumed that, on average, overall energy use does not change.

Straw usage is based on 650kg per indoor sow, mainly used in dry sow accommodation and current enrichment. It is assumed that any alternative farrowing system would increase the amount of bedding and/or enrichment provided and although it is acknowledged that the bedding or enrichment may take a number of different forms, for this analysis it is assumed straw use will increase by 10kg per sow per year. Straw costs are based on autumn wheat straw prices.

Manure disposal costs – Any change to farrowing accommodation and the impact on manure management will depend on an individual farm's current situation. Adapting current buildings may have a number of different cost implications compared to building new on a greenfield site.

It is difficult to assess the impact on the cost of manure management when there is a wide range of experience in the pig industry. Some will relate to current and future environment policy, some to access to suitable land, and some to the access to and uptake of technological innovation relating to the handling of manure. Some farms experience little net cost, some experience a positive net margin and this can be by the same farms in different years; others experience significant cost.

Environmental impact due to manure and disposal has not been assessed due to lack of evidence. An AHDB ammonia emissions project comparing farrowing crates and alternative farrowing systems is not due to be finalised until the end of 2020. Both policy and environmental impact will have impact costs but it has not been possible to assess what that may be.

For this report's COP estimations, it is assumed that the current overall cost impact will not change.

Carcase weights and prices

The Levy Board (now AHDB) has collected carcase weights and prices for many years. In 2014, in response to changing industry needs for pig price reporting, GB SPP (Standard Pig Price) and the GB APP (All Pig Price) replaced the original GB DAPP (Deadweight Average Pig Price).

The GB Standard Pig Price (SPP) is a voluntary survey of pig abattoirs who provide their weekly kill data including weight, probe, sex and price. Data providers are audited for quality assurance purposes. Only

'standard pigs' are included in the GB SPP; these are pigs on which no explicit premium is paid for a specific attribute other than weight and grade. Further details are available on the AHDB website.

The price collected each week is the gross price paid to producers and reported for UK and EU specifications in pence per kg deadweight. For COP estimations, the price and weight used relate to EU specification.

Whilst there is some seasonal variation in carcase weights, the general annual trend over recent years has been towards higher carcase weights. The average carcase weight used in this report for COP estimations is 84.5kg deadweight (EU specification).

Swedish experience

Sweden is a member of the international InterPIG group and has provided commercial data since 2003. Data during the period 2009-2019 are from an average of 147 farms with a farm average of 320 sows.

In Sweden, it has not been allowed to routinely confine sows during lactation, pregnancy or service since 1993. A more recent exception, after trial work, is to now allow the sow to be confined for a few days after farrowing if needed. It is an offence if farrowing sows are confined as a routine. Fully slatted floors are prohibited (two thirds of floor must be concrete) and bedding and enrichment materials must be provided. Houses for pigs must have windows and daylight provided. The minimum pen space for sows with piglets is $6m^2$.

Pigs cannot be weaned before 4 weeks of age and the average weaning age is 32.6 days with a piglet weaning weight averaging 9.5kg. Since January 2016, male piglets can be castrated with anaesthesia and analgesia. Weaned pigs are mainly kept in part-slatted pens where a moderate amount of straw must be used as bedding material. Tail docking is not allowed.

The use of growth promoters was banned in 1986 and antibiotics may only be used for therapeutic purposes and only bought on veterinary prescription.

In Sweden, batch 'all-in, all-out' is the main production system to allow for the cleaning of pig pens and houses between each batch and limit the spread of infection from older to younger animals.

Sweden provided an initial subsidy to enable farmers to change to free farrowing. Due to the continued higher costs of production, Sweden continues to provide a subsidy for pig production.

Since 1993, the number of pig farms has fallen from around 13,000 in 1993 to around 1,000 by 2017. Production has fallen from around 310 thousand tonnes carcase weight in 1993 to 240 thousand tonnes in 2015.

Since 1993, as home production decreased imports increased reaching around 40% by 2013. More recently, there has been an increasing demand for Swedish produced pig meat and imports were around 30% by 2016.

Average pork consumption per capita in Sweden is around 24kg of pork per year.

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