



Farming pigs and future proofing for a crate-free era

The global business case for loose sows for indoor farrowing and lactation

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Executive summary

Planning a crate-free future – good for business, good for pigs

Powerful calls for change from millions of consumers and the public have led to fewer of the world's sows being confined to crates throughout their 115-day pregnancies. And now attention is shifting to their caging during farrowing and lactation. This practice still confines millions of sows to a space not much larger than their bodies for around a quarter of their lives to deliver and suckle their piglets.

The welfare implications around such confinement for these highly social animals are well documented. Their natural behaviours – nest building to give birth to their young, foraging, rooting, and forming mother-piglet bonds – are denied; attempts to turn around are thwarted. Such restriction severely affects their physical and mental states and clearly contravenes the central pillars of food business animal welfare policy (1).

Switching supermarkets – avoiding confinement

Public concern for crated sow suffering is highlighted by a 2017 World Animal Protection worldwide poll. Almost 70% of shoppers in Australia, Brazil and Thailand would consider switching to supermarkets that did not sell pork products from sows confined to crates.

We also asked consumers in Canada, Chile, Denmark, New Zealand, Sweden and the UK about confinement systems for farrowing and lactation. Between 45% and 65% said they would probably not, or definitely not, buy pork from supermarkets supplying pork from systems confining sows during this stage.

Future proofing – developing production systems that work

Some countries have established or are reviewing legislation to prohibit the use of crates for farrowing (New Zealand, Norway, Sweden, Switzerland,) and lactation (Austria, Germany, New Zealand, Norway, Sweden, Switzerland). In other locations, initiatives have been driven by producers, consumer choice (through labelling), and food companies (Corporate Social Responsibility) (3).

This pressure on the pork supply chain to produce confinement-free meat has led to different approaches to changing production systems worldwide. Producers in Asia-Pacific, Europe, Latin America and North America are investing in crate-free alternatives for farrowing and lactation.

These higher welfare systems are moving forward in allowing greater freedom of movement for sows, including nest-building. They aim for sustainability – meeting or exceeding the production and economic performance of conventional farrowing crates across the value chain. They focus on optimising the welfare of the litter, and profitability for the farmer while enabling careful husbandry and management in an indoor environment.

Sharing experience – benefitting farms and pigs

Sustainable development and improving animal welfare are compatible (1); higher welfare systems increase the economic value of animals from market premiums and improved quality. Farms report more pleasant working conditions and attract committed stock people. These systems also reduce stress on the animals and improve their immunity – including resistance to zoonotic and production diseases – and decrease antibiotic use. This in turn contributes to a reduction in antimicrobial resistance – creating healthier animals, people and ultimately, protects our planet.

In this report, producers share their experiences with indoor crate-free farrowing and lactation pens. They reveal what they have learned, the drivers for the investment, the challenges, successes and unexpected benefits of the system adopted. Where possible, they have generously provided their production figures.

We encourage pig producers to work with us to adopt crate-free farrowing and lactation systems and build a crate-free future. Collaboration across the supply chain, enables the success of crate-free alternatives and facilitates a transparent and comprehensive approach addressing all aspects of pig welfare.

Together, we can give the world's 80 million sows better lives, and farms a sustainable future...





Photo: Steel cages (farrowing crates) have restricted the movement of sows since the 1960s.

Making pigs' lives better – why crate-free farrowing and lactation?

There are several systems used to house breeding pigs (sows) for farrowing and lactation (when they give birth and feed their young) (2). These include:

- outdoor systems for free-range and organic pigs where sows and piglets are kept on pastures with individual huts for sow nesting and farrowing
- systems combining indoor and outdoor accommodation where sows and piglets can go indoors for shelter and choose to stay outside.

However, most of the world's 80 million sows spend their whole lives indoors within crated systems for farrowing and lactation.

Understanding the crate's widespread use, purpose and history is important when considering alternatives. Farrowing crates were

introduced in the 1960s. They are designed to restrict sow movement from around five days before farrowing, when sows enter the system, to weaning, three to five weeks afterwards. Their main purpose is to reduce piglet mortality by lowering the risk of piglets being crushed by their mothers, especially when the sows lie down.

Farrowing crates are also considered efficient – the types of flooring and sow movement restriction make them easier to clean and manage. And they are considered safer for stock people, especially when handling piglets. The restriction stops sows following their natural instincts to build a nest and care for their young.

Recognising pig behaviour

Pigs are active animals that, given the right environment and left to their own devices, choose to root, forage and, in the case of sows, build nests to give birth in. Most crate systems prevent these natural behaviours. Their structures, with full or partially slatted floors, don't accommodate nest building materials, or other devices that give sows comfort and relieve boredom.

Nest building is natural to all expectant sows; domestication or genetic selection has not diminished this instinct. Nest building is so important that, no matter what environment they live in, sows will try to do it.

Because farrowing crates stop nesting behaviour, they cause sows great stress which then negatively affects their maternal hormones and maternal behaviour. Conversely, satisfying a sow's need to nest results in calmer and more relaxed births. (see Science spotlight 1 - Nest-building behaviour and nesting materials).

Crate confinement also makes it hard for sows to shift positions to make themselves comfortable and to regulate their body's temperature. And this confinement, when combined with partly or fully slatted floors with no substrates like straw, creates an environment in which the piglets and their mothers cannot interact normally with each other.

Overall, crating limits normal piglet-sow social interaction, and the piglets' ability to learn from their mothers. These negative early life experiences affect the young animals' brain development and influences their behaviour later in life (3). Conversely, social and environmental stimulation in a piglet's early life and positive interactions with people promote positive behaviour and reduce confinement issues such as tail biting and aggression.

Photo: A sow collecting nest materials in a PigSAFE pen. Photo by M.Farish/SRUC.



Science spotlight 1

Dr Sarah H Ison and Dr Jen-Yun Chou

Nest-building behaviour and nesting materials

Despite thousands of years of domestication, modern sows perform elaborate nest-building behaviour 1–2 days before farrowing (4,5). Nest building is an important maternal behaviour, innately regulated by the sow's hormonal system. It stimulates oxytocin release – an important prelude to farrowing.

Oxytocin triggers farrowing contractions. It reduces the duration of farrowing and promotes colostrum production and good maternal behaviours. Oxytocin release also facilitates uterine involution, when the uterus contracts to return to its pre-pregnancy shape and size. This is important in reducing risk of metritis (uterine infection) and promoting faster recovery of the uterus immediately after farrowing.

Even when housed in restricted farrowing crates, sows are still motivated to perform nest-building behaviour, however, crating inhibits it. Crating increases sow restlessness, stress and abnormal behaviour (eg bar biting, floor nosing and pawing).

Whereas free/loose (pen) farrowing systems that include nesting material enable a balance of sow/piglet needs and welfare, plus workers' safety (6,7). Nest building in crates is not satisfactory, due to restricted space with limited access to nest-building substrates, and can be associated with longer farrowing and more stillbirths (8,9). Sudden crate confinement affects nest building and may have associated impacts (10).

The important activities constituting nest-building behaviour are circling, rooting, arranging the materials and lying comfortably. Therefore, sufficient space is an important element, while substrates available are similarly important. Branches and long straw bedding are identified to be the best materials for sows (5,11). Indestructible material such as chains or rubber items sometimes provided to crated or loose sows cannot satisfy the behavioural needs and may frustrate nest building.

Suitable materials can satisfy sows' nest-building behaviour more quickly and reduce restlessness before farrowing. They can also facilitate the farrowing process by shortening the farrowing duration, reducing stillbirths and stimulating positive nursing behaviours. Improved maternal behaviour and milk production can reduce the need for teeth reduction on piglets (12). Studies show that fulfilling nest building can reduce piglet crushing (13).

Besides long straw bedding, other types of materials have been researched where the manure removal system hampers the use of straw. A combination of sawdust, shredded newspaper, chopped straw, branches and sisal ropes have been found effective in satisfying nesting behaviour and promoting its benefits. These benefits include higher oxytocin level in sows, increased colostrum intake from piglets, and more careful behaviour from sows when lying down (14–16). Although chopped straw and peat provided alone does not perform as well as long straw, most studies found some benefits were retained. On fully-slatted systems, jute sacks were preferred over straw balls and ropes. They produced some limited benefits on sow's peripartum activity level as opposed to no nesting material (17).

Providing sufficient quantities of substrates is also crucial. Free access to nesting materials is recommended at least 2–3 days before farrowing, with a minimum of long straw provision at 2kg per day (18). For suboptimal materials such as peat and chopped straw, the quantity needs to be increased to at least 4kg per day (19–22).

Crate confinement combined with large litters from hyper-prolific sow lines (those bred for ever-increasing litter sizes) negatively affect piglet welfare and their ability to survive and thrive. And the inability of crated sows to fulfil their natural nest-building behaviour is linked to an increased risk of piglets being born dead. Sows in crates can also demonstrate greater abnormal aggression towards piglets and cause their injury or death (23). Due to increasing litter sizes, farrowing takes 3–5 times longer than 30 years ago; this makes the sows more susceptible to post-farrowing illness that can affect their milk production (24).

Piglets born in large litters are usually born lighter than those in smaller litters. Also, large litters mean some piglets are born heavier than others which in turn affects the growth and development of the whole litter. More piglets and longer farrowing means less colostrum consumption per piglet, particularly for smaller and weaker individuals. Colostrum is vital in piglets to gain immunity. Piglets from large litters and sows with lowered milk production increase the need for painful piglet teeth reduction (25). Teeth reduction is carried out to reduce bite injuries to littermates and the sow's udder during the competition for access to milk (26).

Looking at solutions – the crate-free alternatives

FARMS

The Farm Animal Responsible Minimum Standards (FARMS) for pigs (28) provide evidence-based guidelines on the minimum standards for the production of higher welfare pigs globally. FARMS uses a welfare risk and mitigation approach.

Under the FARMS' 'limitations on space' welfare risk, farrowing crates must not be used. The sow may only be confined for a maximum of three days after farrowing to reduce the risk of piglet crushing. She is given freedom of movement for the nest-building phase and any sows showing risky behaviour can be confined for the critical period to reduce piglet mortality.

World Animal Protection

World Animal Protection advocates for the adoption of FARMS as a minimum welfare standard while encouraging the application of zero confinement of sows wherever possible. Farrowing and lactation systems, giving sows complete freedom of movement, with design features to maximise piglet survival and allow nest building, offer a good level of welfare.

World Animal Protection is pressing the pork supply chain, and working with them, to publicly commit to systems allowing pigs better welfare. And giving sows freedom of movement for nest-building, farrowing and lactation is central to our call.

Considering crate-free – the users and their needs

The key direct users of the system are sows, the piglets and stock people, who all have individual needs. Some of these needs conflict, meaning compromise is often necessary. Ultimately, however, the animals use the farrowing system all or most of the time and stock people have more limited interactions.

Figure 1 illustrates how care is provided by the sow to the piglets and by the stockpersons to the sow and her piglets.

The sow's main role is caring for her piglets; however, sometimes 'mis-mothering' happens. Consequently, all farrowing system designs must meet the sows' needs as primary caregivers and also mitigate any impacts of mis-mothering. And the stockperson should focus their main caregiving effort on the sow, enabling her to focus on the piglets.

Successful farrowing environments meet the needs of all three users.

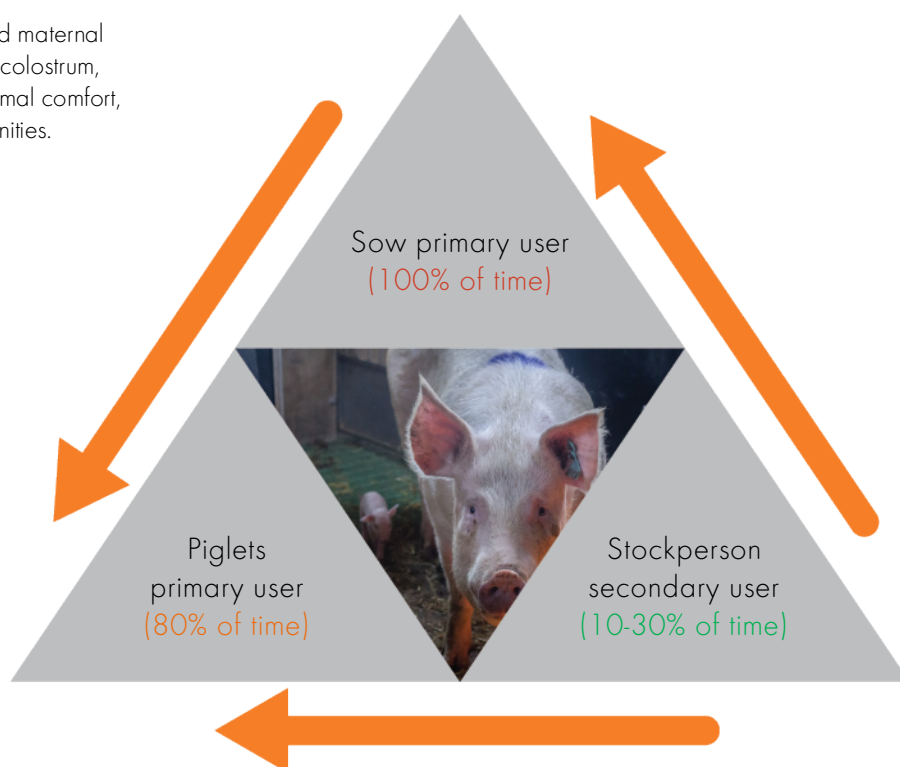
- **A sow** needs space and substrate such as straw to behave normally. Being able to build her nest is vital. She also needs to be able to isolate herself from other sows, move and lie so that her udder is comfortable, regulate her own temperature and be treated well by people. Meeting a sow's needs results in easier farrowing, good maternal behaviour, high quality colostrum and an adequate milk supply for her growing litter of piglets.
- **The piglets** need to be kept at a comfortable temperature and get high-quality colostrum and regular milk from their mother. They should be prepared for farm life by being protected by their mother and stock people. They also need to be given opportunities to socialise normally with other pigs and be given environmental enrichment such as straw. These factors facilitate piglet survival, growth rate, litter uniformity at weaning and good behaviour throughout life on the farm.
- **The stockperson** or farmer needs the system to perform well regarding key performance indicators (eg piglet performance, sow fitness and re-breeding). They also need an efficient, cost effective, safe working system and environment to perform their husbandry tasks quickly and easily. Meeting these needs will create job satisfaction and a sustainable income.

Points of conflict between system users include:

- i) mis-mothering by sows which can negatively affect piglet welfare, performance and system profitability
- ii) greater financial investment and higher running costs may be involved in providing space and opportunity for normal sow behaviour
- iii) risks to stock people from protective maternal behaviour; they are more vulnerable when sows are loose
- iv) greater input and skill from stock people is needed regarding medical or farrowing intervention, cleaning and piglet management in a larger, more complex system.

Sow provides the piglets

Ease of farrowing, good maternal behaviour, high quality colostrum, easy milk let-down, thermal comfort, social learning opportunities.



Stockperson provides

- 1) The sow.** Nutrition, nest-building materials, medical care, pen hygiene, enrichment.
- 2) The piglets** Enrichment, nutrition, pen hygiene, medical care.

Figure 1: The 'triangle of needs' showing farrowing system users and how sow and piglet care is provided. Illustration adapted from: www.freefarrowing.org.

Farrowing crates are currently more economical than indoor crate-free systems. This is due to their greater availability through widespread adoption and smaller use of space (29). Installation and running costs of crate-free alternatives are also greater. This makes the cost of production 1.6–3.5% higher, depending on the system and assuming similar production figures to farrowing crates (30,31).

This means producers would need to receive a premium price for pork produced in crate-free systems or achieve better performance including greater weaning weights and higher re-breeding success. The economics could also be more favourable if construction costs were reduced. This is possible if crate-free systems are more widely adopted on large-scale farms.

Farrowing crates prioritise stockperson and farmer needs. They do not meet the physical and behavioural needs of the sows and piglets they confine – with one exception... Preventing the risk of piglets being crushed.

However, unlike crates, well-designed pens give sows freedom of movement and have features promoting piglet survival and ease of management. Consequently, pens offer the best compromise in meeting the biological needs of sows and piglets within indoor systems, and in providing economic sustainability (32). Several systems that meet all these needs are presented in this report.

Leading crate-free producers – what’s happening and where?

Driving change – the factors

A mixture of factors are leading producers to choose loose farrowing and lactation. Norway, Sweden and Switzerland have banned crate confinement altogether, including for farrowing and lactation.

Changes in the law are key drivers. From 2033 Austrian producers must give sows freedom to turn around three days after farrowing, and from 2035, German producers can only use a crate for five days after farrowing.

Austria

Restriction on farrowing crate use in Austria stemmed from a debate regarding the legality of the system according to the country’s Federal Animal Welfare Act, 2005.

The Act states that: ‘space and freedom of movement have to be adequate to the animals’ physiological and ethological needs....the animals’ somatic functions and behaviour must not be disturbed and their ability to adapt must not be overstrained...freedom of movement must not be constrained in a way which inflicts pain, suffering or harm on the animal’ (translated by Baumgartner, 2011, in (18)).

Scientific evidence on biological needs of sows and the impacts of confinement, led to the conclusion that farrowing crates contravened Austria’s Animal Welfare Act.

New Zealand

A similar approach was used in New Zealand, where the NGO SAFE campaigned for an end to farrowing crates. They commissioned a comprehensive report of the evidence scrutinising the confinement system (33) and gained 122,844 signatures in support of a ban (34).

In 2019, SAFE and the New Zealand Animal Law Association filed legal proceedings against the government for violating New Zealand’s Animal Welfare Act 1999 through farrowing crate use. They won the case in November 2020. A month later, the

Associate Minister of Agriculture, Meka Whaitiri, announced a five-year timeframe to phase out farrowing crates and breeding stalls by 2025. The National Animal Welfare Advisory Committee is currently reviewing the science, global best practice and regulation of farrowing crates. This will be used to advise the Minister responsible for animal welfare on the changes needed to protect sow and piglet welfare by May 2021.

Such success questioning the legality of the farrowing crate, means this approach could be replicated in other countries.

Denmark and Finland

In 2014, the Danish pig industry made a Declaration of Intent at the Animal Welfare Summit, setting a target of 10% of sows in loose lactation by 2020/2021. As a result, the Danish research organisation SEGES conducted a test of 10 different farrowing pens for loose-housed sows under identical conditions in a commercial herd (35).

Finland also opted for an industry-led approach rather than a ban on confinement for the farrowing and lactation phase. Farmers receive government subsidies to install crate-free farrowing and lactation systems. They also receive a per sow payment to assist with running costs.

In other locations, consumer preference for higher welfare products has led to the creation of labelling schemes or marketing products not linked with crate confinement. Some producers are already responding to predicted changes in consumer demand and others believe the benefits of crate-free systems outweigh the costs.

Global snapshot

There are a variety of alternative systems used worldwide. We include case studies of farms visited to create this report and other examples from direct communication, reports or industry publications (Figure 2). The decision making processes around specific systems and going crate free are highlighted. Examples use production data and staff perspectives to show how the systems are managed. Positive outcomes and the challenges involved in loose systems are discussed.

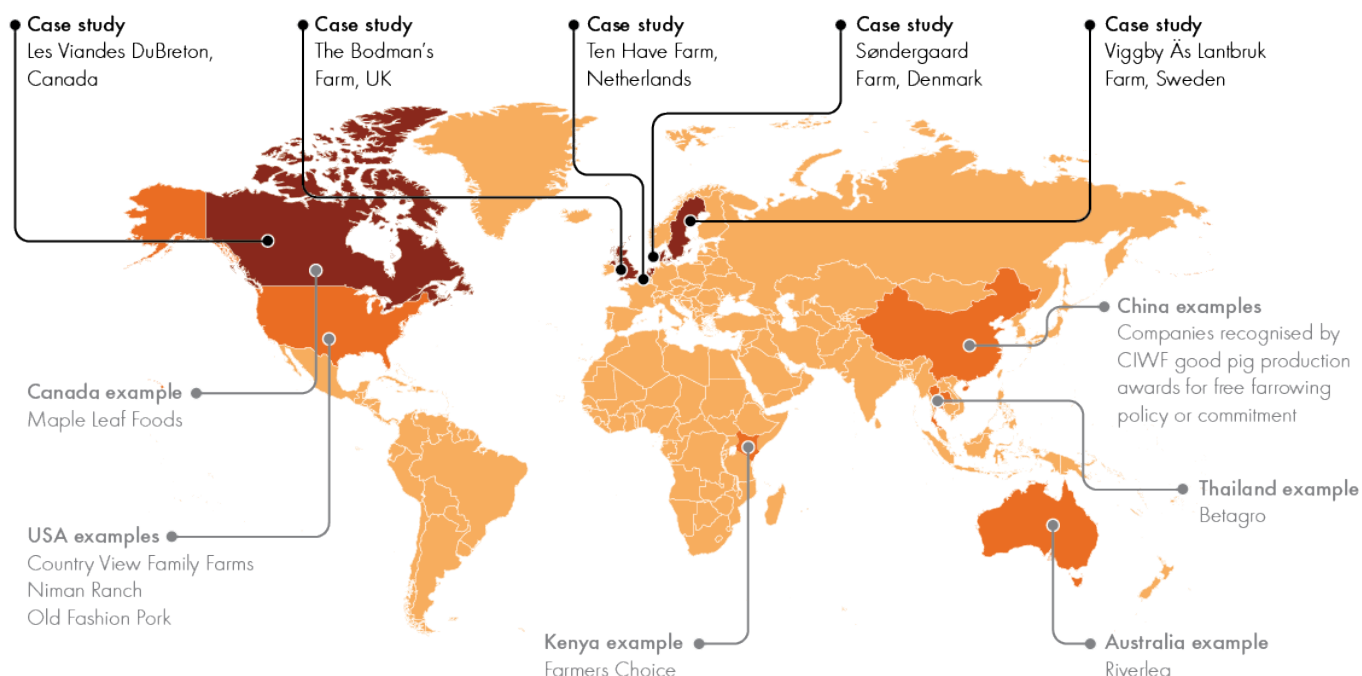


Figure 2: Map showing case study and other examples of crate-free systems for farrowing and lactation across the globe.

1. Choosing the right system

Case study – the Bodman’s Farm, UK

James Bodman began pig farming, with 25 sows around 30 years ago and produced pork with no growth promotors or in-feed antibiotics for the Real Meat Company. His remit was higher welfare from the beginning and involved a straw-based system. However, he still used farrowing crates – normal for indoor farming in the UK at that time.

In 2008, the UK government’s Department of Food, Farming and Rural Affairs (DEFRA) funded a research project to develop an alternative pig farrowing and lactation environment. The project was undertaken by Scotland’s Rural College (SRUC) and Newcastle University. It involved a critical review of the biological needs of sows and piglets (6,32), development and testing of a prototype pen (23,36–38), and economic analysis of free farrowing systems (29,30). The result was the PigSAFE (Piglet and Sow Alternative Farrowing Environment) pen (39).

In 2010, the Bodmans obtained a new site and moved weaners to it from their other farm. On this farm, they decided to install the PigSAFE system as a higher welfare alternative. They based this decision on the research at SRUC and Newcastle University and partly due to what was then perceived as ‘saturation’ in the UK outdoor herd. The PigSAFE system was installed and the first 20-place shed opened in 2013. The Bodmans initially obtained a £10,000 research grant from M&S to help build the first system and then in 2015 received a 12% Rural Development Grant for another 40 places. This site produces RSPCA Assured pigs and supplies supermarkets and processors under the RSPCA Assured label.



Figure 3: The Bodman's Farm PigSAFE design; 1) a single pen with pen features and measurements; 2) two neighbouring pens mirror images of each other and an image of the pen from the angle shown.

Adapting PigSAFE

Because the Bodman's Farm provides pigs with wet-feed, they changed the original PigSAFE design (39) to accommodate this feeding method. They removed the feeding stall and added a moveable door to enclose the sow in the dunging area; this is to keep staff safe when giving medication (see Figure 3). When altering the original pen design, they paid close attention to the design features required to address the needs of sows, piglets and stock people.

One day after farrowing, the low barrier (Figure 3) is removed that keeps the piglets in the nest area. This barrier is kept in place for the first 24 hours to prevent piglets going into the slatted dunging area and getting stuck and cold. By this time, piglets are using the heated creep, the sows get more freedom of movement – which they prefer – and piglets are prevented from getting crushed against the barrier.

After all sows have farrowed, the temperature is reduced using the ventilation system and opening windows as required to drop the temperature from around 20°C to 14°C. This is more comfortable for sow lactation and encourages the piglets to use the heated creep area for warmth.

'Pop-holes', which allow the piglets to move from the nest to the dunging area through the static wall, are opened around day 5 (Figure 3). This improves overall hygiene because it helps prevent the piglets dunging in the nest area.

Case study – Ten Have Farm, the Netherlands

Ten Have Farm is a 600-sow farrow to finish operation. It has around 1,500 gilts and 4,900 growing pigs and produces 'Hamletz' branded pork.

Ten Have Farm's owner, Annechien Ten Have-Mellema, is a 2014 Nuffield Scholar who investigated the added value of higher welfare pig systems to the food production chain (40). Her vision is to produce pigs under the 2** Beter Leven assurance scheme (from the Dutch Animal Protection Society). This includes sows kept in straw-based group gestation housing and piglets born in free farrowing. Growing pigs are given double the legal minimum space requirement, straw bedding and outdoor access.

So far, the farm has completed grower-finisher buildings to conform to the Beter Leven scheme and they are constructing a nursery facility. Following this, they will build the remaining free-farrowing pens (as they currently have both crates and loose pens) to complete the transition to meet the 2** standard.

The farm currently has 80 Pro Dromi II farrowing pens, which was based on a concept conceived through working with 13 other farmers (41). This Pro Dromi system was then developed collaboratively with researchers at Wageningen University Research, and the Pig Innovation Centre Sterksel and is manufactured by Vereijken.

Ten Have Farm uses the Pro Dromi II pen. This pen was designed with a temporary crating option, but the farm allows the sows to be loose at all times. The Pro Dromi II measures 2.2m × 3.25m (7.15m²); has a ¾ solid floor and ¼ metal slats.

Ten Have stresses the importance of good flooring (and flooring layout) in a free farrowing pen. They also advocate the benefits of the Pro Dromi nanny (a large creep area), as piglets use this area, on average, within 15 hours of farrowing. Ten Have reports they are happy with the 'good-looking' piglets they wean which have an average weaning weight of 8.12 kg (aged 28 days).

The farm's experience has resulted in some slight adjustments to the initial design. Initially, the ventilation was not working correctly with their liquid feeding system and piglets were getting cold from a draught coming up beneath the sow feeder. So, they created some plates to block the holes which stopped the draught.

They also added a vertical bar in front of the piglet creep area entrance and a curved bar on the pen side for additional piglet protection.

Case study – Søndergaard Farm, Denmark

Søndergaard Farm is operated by a husband and wife team and three other full-time employees. They farm 237ha of land on the Island of Bornholm, of which they own around 130. They have around 600 sows on site and keep piglets up to 30kg; these then get sold to four other farms which raise them to slaughter weight.

Søndergaard produces pigs for the [BORNHOLMERGRISEN® label](#), which is sold in the supermarket Coop. The farm was purchased in 1997. By 2000, it had been refurbished for UK

production (ie meeting UK welfare requirements for crate-free gestation). However, this ended when Bornholm was designated too far from the UK to produce for it. They then switched to conventional production, before re-building the farm for BORNHOLMERGRISEN® in 2007.

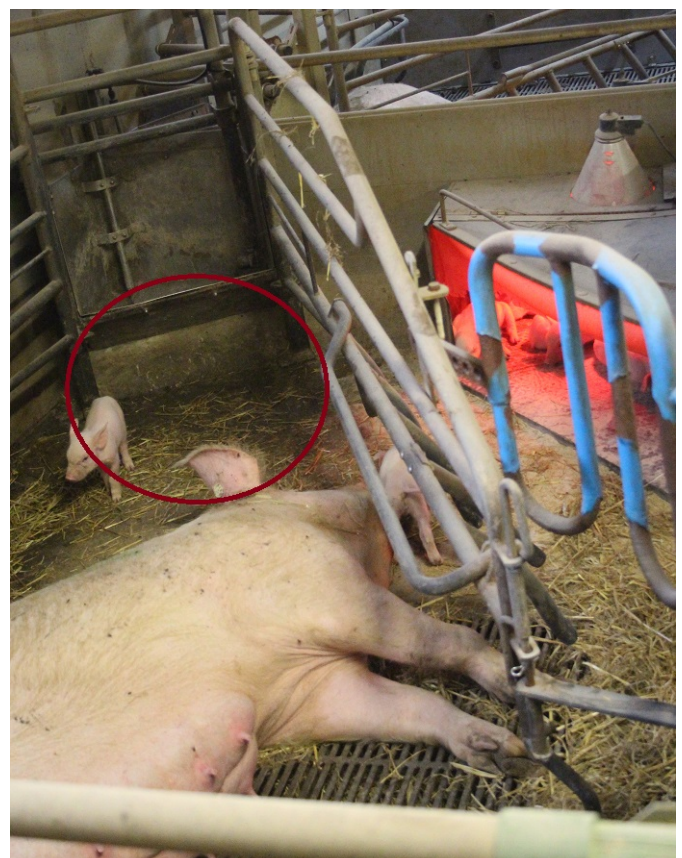
In May 2018, the BORNHOLMERGRISEN® label required increased pig welfare. This included zero sow confinement, more space and no tail docking, so the farm adapted accordingly.

The system is their own design – see the image below – which they used because there were few alternative systems to choose from when they started in 2007. The system was originally designed to crate sows for the first seven days, but now crating is only permitted to administer medication or to perform piglet procedures.

Because the system was designed for temporary crating, it is not the best design for free-farrowing. If a sow farrows with her back end facing the feeding trough (which would not be possible if the sow was fixed for farrowing), piglets can get stuck in the fluid. The solid floor in that location then creates a slippery surface and puts the piglets at risk of crushing (risky location circled on the image).

The system cannot be adapted, so the farm is making it work as best they can until it needs replacing. They would like to adapt the system to have a piglet creep feeder next to the sow feed trough. This would encourage piglets to learn to feed with their mother.

Photo: A sow with her litter of piglets on Søndergaard Farm, Denmark. The red circle shows the location where piglets may be at risk of crushing.



Case study – Viggby Äs Lantbruk, Sweden

This farm was one of 300 originally donated in the 17th century to Uppsala University by the then King of Sweden, Gustav II Adolf (1611 – 1632). He wanted university studies to be available to more people and the leases from the farms paid for the university's costs well into the 19th century. The Elander family has leased the site for more than 13 generations.

Today, Jeanette Elander farms with her husband on the 371ha of land. They have two farm sites to house pigs and the remaining land is used to grow feed. They produce around 8,000 pigs a year – just above average for Swedish farms. They have three employees – one Swedish agricultural graduate who takes care of the sows – and two other staff members.

When Jeanette and her husband started in 1992, the quickest way to begin pig farming was to rent pregnant sows, which they did from a local farm. This worked well, and saved building extensive gestation facilities, so they have rented sows ever since.

They began with 40 farrowing places and pens to grow piglets to sell at 30kg. Then in 1996, they expanded to grow pigs to slaughter

weight. They expanded further in 2001, 2007, and 2012, and then continued to expand the farm every five years or so.

Crate confinement is banned in Sweden, so all farms are experienced in loose farrowing and lactation. The Elanders have a pen of their own design measuring 7m². This is a generous space but means the open space in the centre is a danger area for crushing. To reduce the risk, they place a temporary bar across the pen (image) to support the sow as she changes position. This bar is removed when the sow has finished farrowing.

Each pen has permanent bars along the pen sides to support the sow as she lies down. This allows her piglets room to move away when in the lying zone. All pens have long troughs allowing the sows to feed with the piglets. This enables the piglets to drink their mothers' milk, learn to how eat solid food and adapt to consuming vegetable protein. The piglets also have access to a heated creep area.



Photo: A sow with her litter of piglets on Viggby Äs Lantbruk, Sweden. The metal bar helps protect the new born piglets when the sow changes position and is removed after farrowing.

Case study – Les Viandes du Breton, Canada

Les Viandes [DuBreton](#) is a third-generation family farming business. This Canadian company consists of a network of 300 family farms in Ontario and Quebec. In 2000, the company started a new strategy to include rustic and organic livestock programmes. This made them the first organic pork producer in North America.

By 2003, DuBreton had earned their Certified Humane Raised and Handled® (Certified Humane®) certification. The company has since gained organic labels, and a GAP certification. In 2015, they committed to raising 300,000 pigs to a high standard of welfare by 2018 and exceeded this target by 40,000.

DuBreton's welfare standards include no crates or physical alterations like tail docking and teeth reduction, and all pigs have access to an enriched straw-based environment. Their philosophy: 'Allow pigs to be pigs'.

DuBreton chose to adopt a higher welfare remit to access the market premiums and the more stable income higher welfare products attract. They could also see a trend towards higher welfare production, had a strong interest in these systems and wanted to be a market leader in this area.

Across the family farms, different systems are used to house farrowing and lactating sows. The systems chosen depend on each farm's preference; all are crate-free and include either group housing for sows and piglets or designed pens.

One farm has a modified pen design. It measures a generous 1.83m × 4.88m (8.93m²). The design includes a heated creep area for the piglets, and bars attached to the walls to provide support for sows as they lie down to avoid crushing piglets.

The farm manager reports: "Because piglet crushing is very critical, the climate control in the farrowing section is very important. If it's too cold the piglets will sleep close to the sows and they will be crushed. We have to teach the piglets where is the safe place to sleep".

Examples elsewhere in the world – large and small

There are many examples of companies with indoor loose farrowing and lactation, and others opting to trial and adopt new indoor systems.

Africa

Farmers Choice is the leading pig producer in Kenya, producing 25–30% of the country's pigs; it owns around 1,300 sows (Kenya's total sow herd is around 7,000). The company's key aim is to get top quality, healthy pigs to slaughter. Efforts towards achieving this, led Farmer's Choice to establish a pig procurement department that oversees all operations bringing in pigs for slaughter. This team of technical field staff is led by a veterinarian and provides free extension and advisory services.

The company also provides free transportation of pigs to the slaughterhouse, and offers farms the latest genetics from the company's nucleus herd. They offer quality nutrition to the pigs and train farms on the latest technology.

A farm within the Rosemark Division of Farmers Choice operates a free farrowing system (image), under the management of Graeme Waudby. The pen is a simple concrete design, with a sloping floor for drainage, straw bedding and a heated creep area accessible only to the piglets.



Photo: A sow with her litter of piglets on a farm within the Rosemark Division of Farmers Choice, Kenya.

North America

Crate confinement remains a top welfare issue in the region; there are several commitments to ending gestation crates in progress (42). Some big players in North America are anticipating further changes in consumer preference and are future proofing their businesses by trialling loose housing alternatives for farrowing and lactation.

Maple Leaf Foods was the first major company in Canada to commit to converting sows from gestation crates to an open housing system. By the end of 2019, they had moved approximately 50,000 sows (77%) to their Advanced Open Sow Housing system.

In 2019, Maple Leaf Foods began a trial of two different designs for loose lactation. The pilot has been successful in allowing increased freedom of movement for lactation and not compromising piglet safety during farrowing and the post-farrowing critical period. They are continuing the trial to gather more data and increase their understanding of sow and piglet behaviour in these advanced welfare maternity pens (43).

In the USA, Country View Family Farms (part of Clemens Food Group), are testing modern, swing-gate farrowing pens on 40% of their farms. These allow sows to interact with their piglets without confinement when the crates open one week after birth (44).

Old Fashion Pork (part of New Fashion Pork) is a 1,400-sow operation that meets the Global Animal Partnership Step 1. This means no crates, no cages, no crowding. As such, they have a farrowing pen system that gives the sow substantially more room. It allows 360° turning and the ability to lie fully recumbent.

Niman Ranch is a branded network of around 650 small, independent family farmers in the USA. It is committed to raising livestock humanely and sustainably while producing high quality products for a diverse market. Larger retail partners of the company include Whole Foods Market, Harris Teeter, Sprouts and Natural Grocers. The brand also sells to thousands of restaurants across the country, including high-end restaurants and quality-driven fast casual chains including Chipotle, Pret A Manger and Shake Shack.

The Niman Ranch pork protocols (45) include providing sows the opportunity to care for, interact with, and nurture their young. They also ensure sows can build nests, turn around and move about easily and freely at all times. For indoor farrowing pens, sows and litters must have at least 6m² – 33% larger than GAP's Step 1 standards – or 4.5m² with access to a larger common area twice a day.

Photo: A sow with her litter of piglets on an independent family farm of Niman Ranch, USA



Thailand

Betagro group is a large food producing corporation; it produces around 2.4 million pigs for consumption annually, and is in the top 20 pig producers globally (46). In 2017, Betagro committed to have all company sows in loose farrowing pens by 2027.

To replace farrowing crates, Betagro worked within the same pen area to design a system where sows can turn around and interact fully with their piglets. The initial design had a temporary gate restricting sow movement for the critical period, when piglets were at risk of being crushed, and to enable confinement for veterinary treatments.

However, as both the sows and stock people became familiar with the system, they could keep the pen open all the time and so the company has opted for an open design. The pen has a warm creep area for piglets, anti-crush bars on the walls to support the sow as she lies down, plus chewable mats for nesting behaviour.

China

China is home to around 40 million sows – half the world's sow population. Within the country there is some interest in loose farrowing and lactation. Recent research from China has been promising. It shows reduced farrowing duration and stillbirth rates and comparable piglet performance results in loose pens compared with conventional crates (47). Loose systems combined with enrichment promote positive maternal behaviour, improving sow welfare and performance (48–51).

Several Chinese companies have been recognised by the [Compassion in World Farming \(CIWF\) good pig production awards](#) for their pig welfare policy. These include those with a free farrowing policy or have committed to using free-farrowing systems in the future.

Australia

Legislative restrictions on sow stalls during gestation has stimulated interest in reducing confinement during the farrowing and lactation period. Loose systems are now commercially available (52). Rivalea, one of the largest pig producers in Australia (around 18% of the total pork volume), has explored alternatives. The company tested the PigSAFE system, developed in the UK, for its commercial viability in Australia (53).

The performance of PigSAFE was comparable to the farrowing crate system. Piglet survival was similar with slightly higher piglet growth rates and sow feed intake during lactation in the PigSAFE system. However, PigSAFE was harder to manage in the Australian summer. Sows and piglets spent more time in the dunging area to keep cool, and in this area, piglets are at greater risk of crushing.

Although PigSAFE performed as well as crates, the company decided, given the construction costs, that the performance would need to improve further for them to proceed.

In a second stage of the project, a two-phase system was tested. Sows were individually housed in crates or PigSAFE for farrowing and lactation, or individually housed in either system for 14 days. They were then group housed until weaning. This reduced the number of individual pen spaces needed and the associated construction costs. The 'two-stage' system was promising. Many of the performance parameters were similar to the farrowing crate and PigSAFE systems under Australian conditions (54).

Rivalea is still seeking a commercially-viable loose farrowing system. They continue to investigate systems including PigSAFE and SWAP (Sow Welfare and Piglet Protection pen) and have recently constructed 100 additional loose farrowing pens for commercial evaluation. SWAP also means 'Starts With A Pen', recognising the importance of nest building for sows, and ensuring freedom of movement for this phase.

The SWAP pen then allows temporary crating as an option when sows are showing risky behaviour that could lead to piglet mortality (55). Rivalea's 'Guiding principles for animal welfare' document outlines their pig welfare programme (56).

2. Managing the system

Design features and management

Some procedures must be managed differently in loose systems and may require adaptation. For example, greater care is needed around cross-fostering, as sows can interact more easily with piglets.

The Bodman's Farm evens up the litters to 13–14 even-sized piglets on days two and seven by using cross-fostering. On occasion (one in around 200), a sow may reject foster piglets, if she recognises them as not her own. The staff manage this process by staying in the barn for around 40 minutes to keep an eye on the piglets when fostering.

When sows are in crates, the dunging location is fixed. However, dunging can happen anywhere in loose pens and so pen design, management and hygiene measures need to consider this. Designed pens usually encourage sows and piglets to use specific areas for dunging. For example, the Pro Dromi II is designed to easily maintain hygiene and reduce the spread of infection, and PigSAFE is designed to encourage dunging in designated areas. However, piglets and sows are individuals and despite best design efforts for hygiene, they may still dung in the wrong place.

Ten Have Farm has occasional issues with pen cleanliness. Some sows use the dunging area, others make a mess of the solid floor and some piglets end up dunging in the heated creep area. They anticipate this improving when all the sows adapt to going through the same system, rather than between conventional crates and the loose pens.

Because sows can move about more easily, loose pens can leave piglets at greater risk of crushing. Most pens have design features, including sloped walls, anti-crush bars and other features – like the metal bar placed in the Viggby Äs Lantbruk pen for farrowing – to reduce this risk. Another management option is to increase supervision for the critical periods when piglets face most crushing risk.

To minimise piglet mortality during farrowing, Ten Have Farm has a dedicated person checking the sows for eight hours during the working day. At farrowing time, staff at Søndergaard's Farm spend longer in the barn at feeding times. They make sure all sows lie down safely after feeding to save as many piglets as possible.

One DuBreton farm highlighted design features that helped them reduce piglet mortality caused by crushing. This included an anti-crush bar installed at the back of the pen, and a cover under the heat lamp to better define this area, encouraging the piglets to lie away from the sow. The manager said: "We also had to educate our farm workers and farmers how to raise piglets with less crushing. We have an agronomist and veterinarian working to educate them."

Loose pens need to consider stockperson safety. Some designs, like PigSAFE have an optional feeding stall. This allows the sow to be shut in her feeder for short periods (for pen cleaning, sow and

piglet treatments or management procedures). In the design without the feeding stall (as at the Bodman's Farm) a gate confines the sow to the dunging passage while a stockperson attends to the piglets' safely.

Søndergaard Farm has the option to confine sows for short periods. They only do this when needed, and mainly for maternal sows who may pose a risk to workers. They find around 10% per batch are particularly protective, but these sows are often good mothers. Ten Have Farm's Pro Dromi nanny, which is a large creep space, allows staff fast and easy access to inspect and treat the piglets.

All systems use materials and freedom of movement, to enable sows to exhibit nest-building behaviour. These materials also act as enrichment for both sows and piglets during lactation.

To function as a straw-based system, the Bodmans collaborate with their grain-growing neighbours. They do a straight swap with muck (their neighbours use this as fertiliser) for straw. And, as part of the deal, they deliver the muck and bale the straw. They use barley straw in the farrowing system as it is softer and more comfortable for new born piglets.

In the days before farrowing, Ten Have Farm provides its sows with hessian sacks attached to their pens for nesting behaviour. Sows and piglets are also given a handful of chopped straw every day for nesting and enrichment. After farrowing, the hessian sack is moved into the Pro Dromi nanny. This encourages the piglets to move to the nanny as soon as possible after birth for warmth and safety.

Jeanette Elander, of Viggby Äs Lantbruk insists: "Our job is to look after the sow, the sow's job is to take care of her piglets". As such, they have used the 'strategisk halmning' (or strategic straw use) technique since 2013. This technique was developed during a PhD project (57). This involves giving a large volume of straw to sows from around four days before they are expected to farrow. They are given a fresh layer on top each day. All the straw is removed around three to four days after farrowing, replaced with wood shavings to soak up any remaining moisture, then smaller volumes of straw are added until weaning.

Examining piglet performance

Some farms are achieving excellent performance with loose systems and others are gaining experience with the system and working towards improving performance.

The PigSAFE system is a useful example that has been tested in commercial research facilities in two locations in the UK over one year. The system has also been tested in commercial systems in the UK over several years (the Bodman's Farm) and as a trial system in Australia (Rivalea).

The performance of PigSAFE was evaluated using 140 sows in PigSAFE and 164 sows in contemporary crates at two different research farms. These are: Site A (minimal straw, liquid manure handling) and Site B (straw-based, solid manure handling) (38).

The mortality of liveborn piglets until weaning was similar in crates (C) and PigSAFE (PS) at both sites A (PS = 6.6%, C = 7.4%) and B (PS = 12.7%, C = 10.6%). At Site B, PigSAFE performance was initially poorer, but improved over time to match that in crates. At site A, performance was consistently good. Staff at Site A had previous experience with crate-free farrowing systems whereas Site B only had farrowing crate experience. This indicates staff training and experience are important in successfully implementing crate-free systems.

DuBreton also stressed the importance of good staff: "Some workers didn't want to change and quit, but the majority see a better way of raising pigs as a very good improvement for their job..... Our people are using more time to observe the animal behaviour to prevent problems."

Under commercial conditions in Australia, liveborn mortality (PS = 14.9%, C = 13.5%) and the number of piglets weaned (PS = 9.1, C = 9.2) was similar between conventional crates and PigSAFE (53). This was based on 143 sows in crates and 145 in PigSAFE.

At the Bodman's Farm in the UK, sows initially performed similarly to the commercial research farm at Site B, with 12.4% liveborn

mortality (Table 1, 2015). One year later, liveborn mortality increased to 15.5% and remained higher over subsequent years (Table 1). This coincided with more liveborn piglets per litter from 11.5 in 2015, to 12.5 in 2016, then 13.3 in 2017, 13.9 in 2018, 14.4 in 2019 to 15.0 in 2020.

Compared with crated systems, the Bodman's Farm and its PigSAFE system has more incidences of crushing in the first few days after farrowing and around cross-fostering. Additionally, in 2018, the farm tackled post-partum sow illness and reduced milk production, this increased the liveborn mortality for that year. This issue was most likely related to sow feed composition, which they have worked to improve. The consequences of this problem were easier to detect, but more difficult to manage in a loose system.

In the early days, the Bodmans used the the PigSAFE system on one farm and a crated system on the other, with sows going between the two systems. They noted that sows experiencing crates for their first litter were easy to move into the PigSAFE system. However, those experiencing PigSAFE first and then crates were much harder to move as they were not used to entering a confined space. They also noticed that the same sows displayed more maternal instincts and mothering behaviours in the PigSAFE system than they did in the crates.

"the majority see a better way of raising pigs as a very good improvement for their job..... Our people are using more time to observe the animal behaviour to prevent problems."



Photo: A sow with her litter of piglets on a DuBreton Farm. Photo by N.DeVries / World Animal Protection

The mixture of conventional crates and loose pens could be affecting performance at Ten Have Farm. In 2017, liveborn mortality was 16.5% in the Pro Dromi pens, compared with 10.9% in their conventional crates. They also noted that sometimes, when sows experienced Pro Dromi for the first litter, they refused to enter a crate for their next. Consequently, they had to be moved or they stopped eating. It's hard to properly determine the impact of going between two different systems as the farm has not formerly studied it, but it is likely to affect performance.

Problems with moving sows between different farrowing systems is indicated in a scientific study. The data was collected by Newcastle University researchers on commercial pig breeding unit in the North East of England. Three different farrowing systems

were used within the same farm: conventional crates, a temporary crate system (the 360° farrower) and a kennel and run straw-based pen system. Performance records of 753 sows giving birth to their first and second litters showed that returning sows to the same farrowing system appears to reduce piglet mortality (58).

Viggby Äs Lantbruk Farm also has the challenge of large litter sizes. Their Topigs Norsvin sows average 15.1 piglets per litter with 17.7% liveborn mortality (Table 1). Since they rent sows from another farm to produce piglets, they pay to keep one to three sows per batch (of 40) to act as nurse sows for surplus piglets. Their current goal is 15% liveborn mortality, which they think they can achieve with greater experience of using nurse sows.

Table 1: Key performance indicators by year for the Bodman’s Farm in the UK (PigSAFE system) and Viggby Äs Lantbruk in Sweden (own-designed pen)

Key performance indicator (KPIs)	The Bodman’s Farm (2015-2020)						Viggby (2016-2018)		
	2015	2016	2017	2018	2019	2020	2016	2017	2018
Born alive per sow	11.5	12.5	13.3	13.9	14.4	15.0	14.0	15.0	15.1
Born dead per sow	0.6	0.7	0.8	1.3	1.0	1.1	1.0	0.9	1.0
Total weaned per sow	10.1	10.6	11.2	11.2	12.1	12.6	11.8	12.0	12.3
Liveborn mortality, %	12.4	15.5	15.7	19.6	16.0	17.0	17.6	20.4	17.7

Denmark has the largest litter sizes worldwide. On Søndergaard Farm, the average liveborn litter size is 17–18 piglets and they wean around 35 piglets per sow per year. Piglets per sow per year dropped to 31 when they first started with the loose system for farrowing as well as lactation. Problems with adapting to the new system and extreme summer heat led to greater piglet mortality.

Before having loose sows, they achieved 12% piglet mortality using temporary crating until the piglets were seven days old. This liveborn mortality increased to 26% at the worst point in the summer and is now between 16–18%.

Søndergaard Farm thinks this performance is the best they will get in this system, which is designed for temporary crating rather than free farrowing. They manage the large litters using split suckling to ensure all piglets get colostrum, then use a two-step nurse sow system.

Each farrowing room holds 60 sows, so they have 52–53 sows farrowing per batch, with the remaining 7–8 places filled with nurse sows to take the excess piglets. They would prefer a litter size of 16, as sows usually have 14–16 teats, meaning this number would be easier to manage (see Science Spotlight Box 2 – Hyper-prolific sow: production gain or loss?).

Science spotlight 2

Dr Jen-Yun Chou

Hyper-prolific sow: production gain or loss?

Development in genetic selection, breeding, nutrition and management has enabled increased production performance in growing pigs and also breeding sows. One of the reproductive traits genetic selection focusses on is litter size. This usually manifests in the number of piglets born alive, viable (alive for certain duration), or total born (excluding mummified) (59). In the past 30 years, litter sizes in some genetic lines have almost doubled from around 10 piglets in 1990 to almost 20 piglets in 2019 (24).

Large litter size has detrimental effects on piglet health. During foetal development, within the limited uterine space, increased number of fetuses need to compete for space and nutrients; leading to overcrowding in the intrauterine area. This is the main reason for piglets born with reduced weight and incomplete development (eg Intra-uterine Growth Retardation, (IUGR)), and a high within-litter weight variation. The nonuniformity of litter weight then results in increased competition for udder access. It is also linked with a growing risk of crushing by sows due to the longer time spent at the udder from insufficient milk intake, and therefore a higher pre-weaning mortality. Reduced birth weight and higher variation of birth weight within a litter is also associated with lower weight at weaning and growth at the later stage of finishing production (60–63).

Sow health and welfare is impaired by large litter size as well. Large litter size is associated with longer farrowing which can lead to exhaustion. As litter sizes have almost doubled, farrowing duration has simultaneously increased from 1.5–2 hours 30 years ago to 7–8 hours now (24). This is also a factor for increased stillbirths (18). Delivering large litters also creates more challenges for sows in maintaining energy balance during lactation and recovering their body condition post-weaning. The high energy demand during lactation can create 'thin sow syndrome', where sows fail to recover and be ready for rebreeding.

In addition, large litter size negatively affects sows' mothering ability which also affects piglet survival (64). Maternal investment in caring decreases with litter size and the effect becomes more apparent in later parities which has long-term consequences (18,65). Although sow milk yield may increase with litter size, their colostrum yield and suckling frequency does not (66).

With increasing competition for colostrum and milk at the udder, large litter size becomes a major risk factor for piglet facial and sow teat lesions. Therefore, teeth reduction is commonly practised to reduce these lesions. However, even when piglets' teeth are resected, the risk of teat lesions is still higher when competition is fierce. This can compromise sow health as lesions act as a route of infection (67).

To keep excessive piglets alive in large litters, some management procedures are conventionally used. These may include prolonged crating of sows, cross-fostering or split-suckling piglets, using nurse sows, and teeth reduction. These procedures have negative welfare consequences for pigs and require intensive labour in the farrowing house.

Excessive cross-fostering can cause higher incidences of teat fights, disrupt sow nursing and even sow aggression towards piglets; these can all impair piglet growth (68). Some case studies showed constant piglet movement between litters is associated with an increased risk of disease outbreak (68). In conventional farrowing crates, intervention may be more easily carried out, but it may be more challenging in free farrowing systems. Conversely, well-designed free farrowing systems should minimise the need for human intervention during farrowing and save labour input. This is provided sows are rearing an optimal-sized litter and given adequate space, nutrition, and nesting materials.

World Animal Protection recommends that litter size should not exceed the number of functional teats of the sow. Based on the average functional teats recorded in western commercial breeds of sows, research suggests a normal litter size should be between 7–13 piglets (69). The European Food Safety Authority (EFSA) recommends the optimal born alive litter size should be 11–12 piglets (70). Today's hyper-prolific sows can have litter sizes stretching to 18–20 piglets. This type of selection is solely based on excessive prolificacy of a single litter rather than sows' lifetime performance and mothering ability. It brings long-term liability to maternal, offspring and herd health, generating production loss rather than gain.

Swiss experience – with large data sets of the country's sow herd – provides a good example of performance in crate-free farrowing and lactation systems. From 1997, new buildings had to involve free farrowing; crate systems had to be completely phased out by 2007. In 2002–2003, during the transition period, piglet mortality was similar between free farrowing and crate systems. There were 1.42 and 1.40 piglet losses per litter (approx. 12%) on farms with and without crates. A total of 482 farms with crates and 173 farms without crates were researched (71).

Between 2008 to 2017, the number of liveborn piglets per litter in Switzerland increased from 11.9 to 12.9 and weaned piglets from 10.3 to 11.3. (72). More detailed examination of litter size revealed that beyond 15 piglets, the number of weaned piglets did not increase

with litter size. This was due to a greater number of low-birth weight piglets that have a considerably lower chance of survival than normal-weight piglets. The Swiss researchers concluded that increasing litter size further is not recommended as the additional piglets are unlikely to survive (see Science Spotlight Box 2).

One feature of free farrowing systems seen in Switzerland, during the transition and other studies comparing the performance to conventional crates, is the difference in cause of piglet mortality. While deaths due to crushing by the sow can be higher in loose systems, other causes of death are often lower leading to comparable results overall (71,72). In general, conventional crates have greater stillbirth and starvation-related deaths, whereas in systems where the sow is loose, crushing is a more common cause of death.

DuBreton reports a similar trend, with piglet crushing their main concern regarding system performance, but the company highlights that sows and piglets are generally healthier in loose systems. They are continuously working on the genetic line and pen designs to improve results and feel that it will improve with time and experience.

The Bornholmer Grisen concept used by Søndergaard Farm requires a specific cross-breed of Landrace × Yorkshire dams with Duroc sires. This gives a finished pig with the right amount of intramuscular fat for this premium product. This sow breed has good mothering ability regarding ease of farrowing and milking, but not good maternal behaviour in loose systems. Poor maternal behaviour can lead to piglet mortality.

The first three days after farrowing are most critical as piglets remain close to the udder to establish a stable teat order. They select and suckle the same teat until they are weaned (73). After the critical period when piglets are at most risk, sows in loose systems are more comfortable, self-sufficient and, so, can have improved milk

production. This can be reflected in increased growth rates and higher weaning weights in loose systems compared with crates.

The Bodman's Farm finds sows are more comfortable and eat more in PigSAFE. This means the feed cost is higher, but with a greater piglet weaning weight, it is worth it. It is also worthwhile as sows have better body condition at weaning, improved fertility and a higher re-breeding success rate.

In summary, since crushing by the sow is the biggest cause of piglet mortality in zero-confinement farrowing systems, reducing this risk remains the goal for many farms operating loose systems. Most are optimistic of improvement with experience, better training and selecting the right sow for the system (see Science spotlight 3 – Selecting the right sow).

Other causes of mortality and piglet performance indicators, like growth rate and weaning weight, are also improved and producers have noticed additional benefits of free farrowing and lactation systems. These are documented in the following section.

Science spotlight 3

Dr Emma Baxter and Prof Sandra Edwards

Selecting the right sow

Studies of the genetics of piglet survival often show that, in both systems with farrowing crates and with free farrowing indoors or outdoors, the influence of traits associated with the mother is just as important as those of the newborn piglet itself (74–76). These maternal influences include aspects of the uterine environment which determine piglet vitality at birth, aspects of the supply of colostrum and milk, and appropriate behaviour of the sow during and after the farrowing period. The biggest factor affecting piglet vitality at birth, and their subsequent successful suckling, is the size of the litter.

The choice of very prolific sow lines will increase piglet mortality, especially in free farrowing systems where interventions to aid survival of newborn piglets, such as targeted supplementary heating and human assistance to obtain adequate nutrition, are more difficult. The use of breeds delivering fewer but more robust piglets is a sensible strategy in these circumstances (77). Selecting sows which have a high number of functional teats and good udder conformation, where the teat rows are close to the midline and teats are small and well-spaced, will improve the early suckling possibilities for their piglets (78). These udder conformation traits should be checked at the time of gilt selection, but like colostrum quality, they also have a genetic component which can be considered in breeding programmes (79). Another important physical characteristic which should be checked at gilt selection, but which is also amenable to genetic selection, is leg conformation (80). Sows who are lame or have weak legs have less control over their lying behaviour and are consequently predisposed to crush piglets, especially in free farrowing systems where unsupported lying is more likely to occur.

In addition to the physical traits of sows, their behavioural traits are also of great importance, particularly in free farrowing circumstances where reliance on maternal capability is greater than in the more controlled conditions of a crate system.

Important behavioural characteristics influencing piglet survival have been identified as greater expression of nest building prior to farrowing, good communication with piglets prior to lying, care when lying and a rapid but controlled response to piglet distress calls (81,82). A number of desirable behavioural traits have now been shown to have a genetic component, although often with relatively low heritability, including lack of aggression towards piglets (savaging), calmness or lack of fearfulness, carefulness around piglets, responsiveness to piglet distress and good nursing behaviour (83–87). Another desirable trait in free farrowing sows is lack of aggression towards people, since stockperson safety is an important consideration. This trait also has a genetic basis (83,84,88), but its selection must be considered with care since some studies suggest maternal defensiveness may be linked to other traits of a good mother (86). Finally, it should be emphasised that it is not only genetic traits which are of importance in achieving desirable maternal outcomes, since these will interact with the current environmental conditions and previous experience of the sow. Prior experience of a free farrowing system seems important in the development of maternal behaviour which is appropriate for that environment (89), while experience of positive interactions with stock people can reduce fearfulness and increase piglet survival (90). Correct design details of the farrowing environment and access to suitable nest-building substrate in sufficient quantities allow maternal behaviour to be appropriately expressed to benefit offspring survival and growth (91).

Exploring wider benefits of the crate-free systems

Many producers notice other benefits to sows and piglets in the crate-free system and beyond (at other stages of production), and to general system management.

The Bodman's Farm reports less aggression when the sows are mixed into group housing following weaning. They attribute this to sows being able to contact each other through the 'chat windows' between neighbouring pens (Figure 3).

During their PigSAFE trial, Rivalea reported that sows in pens were easier to move out of the system at weaning compared to the sows from farrowing crates. Sows moved from the PigSAFE to group lactation on day 14 had fewer fresh injuries, lower salivary cortisol (indicating stress) and suckled their litter faster than sows introduced from crates (54).

The Bodman's Farm reported finding it easier to detect lameness. This is because the sows can move around the pen; they also get fewer sores from rubbing on metal crate bars and have better body condition to protect them. Helen Bodman says: "It's easier to get the sows up to check they are OK, which makes it easier to spot and treat any illness."

DuBreton also noticed a difference in their sows' leg health compared with conventional systems. As sows are always standing in one spot in crates, they can't move around much and tend to have more foot problems due to lack of exercise. DuBreton also noticed that sows in loose systems are better mothers, they are more maternal and protective as they can fully interact with their piglets.

Søndergaard Farm employees said that the sows have improved milk production when loose, they eat more, have better body condition and are fitter. This is important when weaning later since piglets grow

very fast in the last week and sows need to maintain body condition for successful re-breeding.

Since changing from seven days crated to 100% loose, Søndergaard Farm has around one third fewer sows needing farrowing assistance. This also means fewer sows need to be treated for farrowing problems (eg with antibiotics and anti-inflammatories).

Jeanette Elander from Viggby Äs Lantbruk mentioned that lots of straw means good nest building. This in turn encourages the right balance of hormones for a smooth fast farrowing and a positive start to milk production. An additional benefit to the volume of straw was a reduction of piglet leg problems from 15% to 5% and, as a result, a decrease in the volume of antibiotic treatments. Piglets were damaging their skins on the rough floor when establishing the teat order, and straw helps to protect them. Lots of straw has so many benefits, it creates additional work regarding dealing with the volume of straw, but is worth it for the results.

Several farms mentioned that loose sows react better to human approach, as they can orientate themselves towards the human handler. Improved sow-human interaction makes it easier to move the sows in and out of the individual pens. Annechien Ten Have-Mellema said: "Loose sows are quiet, calm, they look better, there's no question about that."

Søndergaard Farm also mentioned better human-sow interaction in loose pens. When they approach the pens from the front, and the sows approach them, they give them a scratch. Sows' can express their individual personalities, some like to approach and like a scratch, others are less keen!

Both Søndergaard and DuBreton report that, like group housing systems for pregnant sows, loose farrowing and lactation systems are a nicer place for staff to work than conventional systems.



Photo: A sow with her litter of piglets on Ten Have Farm, the Netherlands. Annechien Ten Have-Mellema said: "Loose sows are quiet, calm, they look better, there's no question about that."

3. Looking at barriers and solutions to the uptake of crate-free alternatives

Before the 2016 free farrowing workshop (2–3 September, Belfast, Northern Ireland), the organisers conducted an informal survey for workshop participants to collect some information about barriers to uptake from their home countries. They were asked to score their level of agreement (from 1 completely disagree to 7 completely agree) with the following statements.

1. The capital cost of a free farrowing system compared to crates prevents uptake.
2. The lack of differentiated market opportunities for pigs produced in free-farrowing systems prevents uptake.
3. Having to convert existing buildings for free farrowing systems prevents uptake.
4. Concerns about higher piglet mortality in free farrowing systems prevent uptake.
5. Concerns about worker safety and aggressive sows in free farrowing systems prevent uptake.
6. Concerns about maintaining pen hygiene in free farrowing systems prevent uptake.
7. Concerns about increasing amounts of time spent on animal husbandry tasks prevent uptake.
8. Concerns about additional cleaning prevent uptake.

The top three barriers, with an average (median) score of 6 were statements 1. Capital cost, 2. Lack of market opportunity, and 4. Piglet mortality (92). The next highest score, with an average of 5 was statement 3. Need to convert buildings. The remaining statements were similar with an average score of 4, including: 5. Worker safety, 6. Pen hygiene, 7. Time for husbandry tasks, and 8. Additional cleaning.

Three Chinese producers operating conventional crate systems were also asked about the challenges they face in considering converting to free farrowing and lactation systems. One producer mentioned that they are already struggling with piglet mortality including crushing, so this is their biggest concern.

Another is concerned about getting good stock people to manage the system as they require different skills and converting existing buildings, specifically the need to reinforce the floors. The main obstacle for a third Chinese producer is investment, since free farrowing pens require greater floor space and, secondly, the ease of management aspects including administering vaccinations.

Farms participating in the current report were also asked to respond to the statements above outlining concerns regarding

uptake before they considered converting to loose farrowing and lactation.

For early adopters, like the Bodman's Farm, the installation cost was a big consideration due to the financial risk and uncertainty. They would like to install more pens to replace crates but need time to be able to reinvest.

Pigs born from PigSAFE are marketed on the RSPCA Assured Scheme, for which there is a premium price. This price premium is worthwhile when the pig price is good, or there is a significant difference from the conventional price. But variation in pig price leads to uncertainty and financial risk, and they can incur significant losses when the pig price is low due to the higher cost of production.

For Ten Have Farm, the crate-free system costs more, which is predominantly due to the additional space, as the pen footprint is larger compared than conventional crates. There is less metalwork, which costs less, but the creep costs more. Otherwise not much else is different, and ultimately, it's down to space.

DuBreton also recognises the cost implications of the increased space: "[It] costs about 30–50% more to produce using farrowing pens, because we need 2.5–3 times more space per sow." They consider the capital cost to be the biggest barrier, along with concerns about converting existing buildings. Ease of management aspects including pen hygiene, increased management and cleaning times were also considerations.

Piglet mortality was an important concern and an aspect they continuously work to improve. Concerns for worker safety and lack of market opportunity were not a concern for them.

For Søndergaard Farm, piglet mortality was (and still is) a concern, followed by worker safety due to protective sows. They were less concerned about costs. This is because they received a government grant to build the system and have opportunities for market differentiation with a price premium to cover additional running costs. Regarding labour time for husbandry and cleaning, the owners acknowledged this is less important since the environment is a nicer place to work in compared with conventional systems.

Conclusion

Public concern regarding confining sows during pregnancy is extending to how they are kept during farrowing and lactation. And so, more and more companies are interested in future proofing and investigating crate-free indoor pen systems.

Current commercial uptake of crate-free farrowing and lactation systems is at an early stage. These systems have been adopted by progressive producers, those accessing premium markets and by larger companies taking the lead on pig welfare and staying ahead of inevitable change.

As early adopters gain experience and share this with others, system design, management and performance improve, which increases commercial viability for mainstream production.

A non-negotiable for crate-free systems is freedom of movement for the nest-building phase. Such freedom clearly improves ease of farrowing and has many other associated benefits for sows and

piglets. Design and management practices to reduce the risk of piglet mortality via crushing by the sow remain a priority for researchers and early adopters alike.

Many are confident this will improve with experience; advances in system designs; selecting the right sow, including maternal traits; selecting robust, viable piglets and, importantly, avoiding hyper-prolific genetic lines. Training dedicated stock people is also crucial for success in crate-free systems.

World Animal Protection encourages pig producers to work with us to adopt crate-free farrowing and lactation systems for a crate-free future. Collaboration across the supply chain enables the success of crate-free alternatives and encourages a transparent and comprehensive approach addressing all aspects of pig welfare.

Together, we can give the world's 80 million sows better lives, and farms a sustainable future...

Table 2: Key features and recommendations for crate-free farrowing and lactation (18)

Key features	More detail	Animal welfare benefits	Stockperson / production benefits
Pen dimensions and floor space	Minimum total floor space for the sow: 5m² (excluding piglet creep area). Nest space to enable turning and posture changes: minimum 2.44m² Lateral lying space for farrowing and nursing: 2.79m². Creep area: 0.7 – 1 m².	Ease of movement and comfort. Allows sows to perform highly motivated nest-building behaviour. Space for full sow-piglet interaction (including grouping of piglets). Space for piglet safety. Space for piglet play.	Sow physical and thermal comfort leads to improved milk production and piglet performance. Space for fulfilling nest building can lead to faster farrowing, fewer stillborn piglets, lower farrowing problems needing fewer antibiotic and anti-inflammatory treatments. Greater sow movement can increase a stockperson's ability to fully inspect sow mobility and health.

Key features	More detail	Animal welfare benefits	Stockperson / production benefits
Pen design	Dunging space: separate from nest and feeding spaces. Feeding and foraging: separate from dunging and nest site. Creep area: for all piglets. Partition or dividing walls or bars, eg between nest and dunging area to define these spaces. Barred 'windows' outside of the nest area.	Provides separate areas for feeding, resting, dunging and activity. Partition walls allow the sow to avoid piglets and provide a distinct safe, darker space for the nest. Windows provide cross-litter social contact. Creep area allows all piglets to have a safe space away from the sow.	A well-designed pen can reduce labour time, particularly after the farrowing phase. Inter-litter socialisation can improve outcomes when sows and piglets are re-grouped at weaning. Attractive safe spaces for piglets can reduce mortality.
Flooring	Solid flooring in nest space to allow for substrate use. Slatted flooring in the dunging area for drainage and hygiene.	Solid flooring with substrates provides physical and thermal comfort for sows and piglets. Substrates allow for highly motivated nest-building behaviour. Slatted flooring for hygiene and health.	Improved health reduces the need for sow and piglet treatments. Good hygiene can reduce labour time for day-to-day cleaning.
Temporary crating options	Options to restrict sow movement can be for very short periods (1 – 2 hours or less) for husbandry procedures or a few days during the critical post-farrowing period when piglets are at greater risk of crushing.	Temporary confinement must allow for sow nest building behaviour. Piglet welfare can be improved when sows show risky behaviour. The pen should be designed around the needs of loose sows, rather than a crate that can be opened.	Stockperson safety from sows showing risky or aggressive behaviour. Ease of management for health and hygiene. Reduced time to perform husbandry procedures.
Piglet 'creep' options	A defined area for piglets to rest and sleep, with a heat source using heat lamps, mats or under-floor heating. Substrate on the floor or rubber matting for lying comfort. Piglets can be encouraged to locate the creep space using heat, lighting or sow scent.	Piglets are kept safe when the sow changes posture and provided with thermal and physical comfort with additional heat, substrate or rubber matting. The rest of the pen can be kept cooler for greater sow comfort, with cooling options for hotter climates (eg cooling mats or fans).	Providing optimal temperatures for both sows and piglets improves survival by avoiding hypothermia and starvation (due to low or reduced milk production) and improves growth rates. Enabling sow thermal comfort improves milk production, health, feed intake which promotes re-breeding success. Stock people can easily locate piglets to monitor health and welfare and perform husbandry procedures. Piglets can be introduced to solid feed at an early age, which cannot be accessed by the sow.

Key features	More detail	Animal welfare benefits	Stockperson / production benefits
Piglet protection features	Sloped walls or bars on the walls and sides of the creep.	Sloped wall and bars provide support for sow lying behaviour to help protect piglets from crushing.	Reduced piglet mortality for improved performance.
Nest-building materials, bedding and enrichment	Materials should be safe, chewable, destructible and ideally edible. Ideal nest-building substrate is at least 2kg of long-stemmed straw or 10-12cm of deep bedding replenished daily in days leading up to farrowing. Substrates can be provided on the floor, in racks or both locations.	Nest building is a highly motivated behaviour that improves ease of farrowing, maternal behaviour and piglet suckling success. Enrichment throughout lactation satisfies sow and piglet exploration and prevents boredom. Sows and piglets can root and forage together and piglets can learn to consume solid feed from their mothers.	Ease of farrowing can reduce the incidence of stillbirths, improve milk production and reduce the need for farrowing intervention and subsequent treatments. Straw bedding provides protection to reduce rubbing on rough floors, reducing infection and subsequent treatments. Early life experience with enrichment can reduce the incidence of unwanted abnormal behaviour later in life (eg tail biting).

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Key resources

The following website, maintained by Dr Emma Baxter and Professor Sandra Edwards is a comprehensive resource for pig farmers, veterinarians and others who want to know more about any aspect of alternative farrowing and lactation systems:

<https://www.freefarrowing.org/>

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