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AUSTRALIAN Pork®

Alternative farrowing systems- A holistic review focussing on piglets, pigs and people.

Final Report
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1. Background to Research

The purpose of this report is to gather and present relevant information for Australian pig producers who are considering the implementation of a loose lactation system, with a specific focus on the practical management aspects of production. This report is designed to be relevant for farmers and as such is comprised of a literature review and five case studies of farms that have converted to loose lactation production, focusing on other farmer experiences.

The information presented in this report is intended to focus on the management practicalities that should be considered when implementing loose lactation production systems, rather than assessing the welfare states of animals or advising farmers if they should make the transition themselves. The literature review is therefore not conducted as a comprehensive overview of all subjects in relation to loose lactation studies, though five relevant and comprehensive recent reviews are provided as support material to this report.

Several companies provide modern loose lactation pig production pens which have been implemented in commercial production throughout the world. This review does not seek to compare the designs but rather highlight general key features which might be relevant for Australian pig producers.

2. Objectives of the Research Project

This project sets out to undertake a literature review to source and compile relevant information associated with alternative farrowing systems and undertake European farm visits to interview relevant farm personnel to achieve the objectives and outputs detailed below.

Objective: The objective of the review is to provide industry with the latest global information available on alternative farrowing systems, such as those that are described as being confinement free systems or systems that allow for reduced time in confinement.

Outputs: A comprehensive literature review and four case studies addressing (but not limited to) the following in regard to alternative farrowing systems.

- Description of alternative systems commercially available, including adaptations to existing farrowing systems
- Types of alternative systems currently in use in commercial production (case studies)
- Stock people considerations, including skill base and safety
- Impacts on hygiene, husbandry management, animal welfare and productivity
- Use and management of enrichment materials in alternative systems.

The review should highlight any considerations of described systems should they be adopted commercially under Australian conditions.

3. Literature Review

1.1 Introduction and background to the report

The production of animals, and their welfare, is under constant scrutiny by members of the public, regardless of if they are consumers or not, with their perceptions having a significant influence on future animal farming systems. The animal welfare agenda of animal activists means that the conditions in which animals are produced will be challenged, especially with regards to the production of animals in confinement at any stage of the cycle. The 2014 voluntary ban of sow stalls in gestation by the Australian pig industry is an example of the proactivity of the industry to maximise the welfare standards of animals. More recently however, the use of farrowing crates (also known as piglet protection pens) are being challenged in modern pig production. The uptake of conversion to production with loose housed lactating sows is limited, mainly due to the concern of an increase in piglet mortality, in addition to the higher space requirements per pen. If loose housed lactation systems are to be considered an alternative to production using traditional farrowing crates, it is important that they can deliver the same production results under commercial conditions, whilst maintaining a higher welfare state for both the sow and her piglets.

Farrowing crates are widely used in pork production throughout the world for the protection of piglets from crushing injuries and mortality caused by the sow. Additionally, farrowing crates enable the quick, safe and easy checking of animals by the stockperson (L. Boyle et al., 2022; Moustsen et al., 2023). Pork production with sows housed in loose lactation systems (including temporary confinement) has been developing for some years in animal welfare research. It has recently been accelerated in Europe due to the European Citizen's Initiative 'End the cage age', whereby close to 1.4 million European signatures were submitted from EU member states to parliament (European Commission, 2021a), resulting in a public hearing in 2021 and an outcome statement from the European Commission that by the end of 2023, a legislative proposal to phase out and finally prohibit all cage systems would be in place (European Commission, 2021b). The outcome of the recent European Citizen's Initiative to "End the Cage Age" and the EU's Farm to Fork Strategy will both see the enactment of additional pig welfare legislation in the coming decade (L. A. Boyle et al., 2022). At the time of publishing this report, no further details on the specific legislation proposals are available.

Within Europe, farrowing crates are currently banned in Sweden (since 1987), Switzerland (since 1997) and Norway (since 2000), with legislative plans enacted by Germany (from 2036) and Austria (from 2033) (Baxter et al., 2022). Much scientific and commercial research has been conducted to develop the specific features and design of the loose lactation pens required to optimise performance and meet biological needs (Baxter et al., 2011) however, there is a significant knowledge gap in identifying practical management strategies and training of stock people responsible for pig rearing in how to use this new production system.

Investment in the infrastructure alone required to implement these systems is significant and added to this is the potential increased mortality of piglets via crushing if the system is not managed correctly. The greatest risk for piglet death is in the first four days of life (Marchant et al., 2000), a crucial factor for the management of piglets in loose lactation production, where it can be much higher due to the free movement of the sow. Additionally, other considerations such as environmental impacts should be considered- and whilst it is well documented that increased space allowance and systems with a

solid floor can increase sow welfare, this also comes at a risk of higher pre-wean mortality, and therefore reduced piglet welfare (Moustsen et al., 2023).

A well designed and managed system without permanent crating can achieve the same performance as conventional farrowing crates (Weber et al., 2007; Weber et al., 2009; Kinane et al., 2021; Andersen & Ocepek, 2022; Baxter et al., 2022). However, from anecdotal experiences of commercial pig producers that have already installed these systems in Denmark, it has taken up to two years post installation for the production figures of these farms to return to an acceptable level. The underlying reasons for this time lag have occurred as while the stockpeople on these farms were experienced in traditional pig production, they were totally unprepared and untrained in the use of these new lactation systems, with no training tools or specific management recommendations currently available. Given that in Denmark an estimated 4 % of sows are housed in either a temporary or zero confinement system (Goumon et al., 2022), there is significant support needed in terms of vocational training materials for this transition for pig producers and their staff, to meet a higher animal welfare production system and maintain workplace safety. To put the enormity of this into perspective, the total sow population in the European Union in 2022 was estimated to be 9.8 million, with the Danish sow herd estimated at 1.2 million (Mateos et al., 2024) and Denmark being one of the 'early adopters' to this housing system.

Further to the transition from production using farrowing crates to loose lactation, the pig and wider agricultural industry in Denmark and beyond has seen a gradual but sustained decline in the number of people and organisations that offer knowledge transfer and support (Labarthe & Laurent, 2013). Whilst the numbers of international staff working on the farms is increasing, access to education and training programs for these farm staff is extremely limited, and this training responsibility has been shifted to the owner/ manager (Knuth & Knierim, 2013; Knierim et al., 2017), creating additional industry knowledge gaps. There are a growing number of experienced stock people who are working with non-confined sows during lactation (Baxter et al., 2022) and learning from those experienced in day-to-day management of these system is seen as an important factor in encouraging the successful adoption of alternatives (Sutherland & Marchand, 2021). There is also evidence about the motivation of farmers to make changes in production that will enhance animal welfare (Anneberg & Sørensen, 2020), highlighting the importance of consulting stock people to share their experiences, which positively influenced their connection and engagement with the transition. Typically, the training of new stockpeople (from outside of Denmark) is provided by managers or peers on individual Danish farms, with this training approach being informal, anecdotal, and not studied, despite the signifiant effect of the stockperson that is attributed with higher performing herds.

1.2 Temporary confinement vs. free farrow production systems

For the purpose of this report, free farrow is defined as a production system where the sows are kept completely unrestricted for the entire time in which they are in the farrowing unit. i.e. sows farrow with zero confinement and continue to raise their piglets unconfined until the point of weaning where the sows are moved to the service unit. In free farrow production, there are limited interventions that can be made by the stockperson to reduce piglet mortality and therefore generally relies on the pen design to attract piglets away from the sow to the safety of the piglet creep area. Temporary confinement on the other hand utilises (typically) a farrowing crate which is then opened three to seven days after farrowing- this allows for the protection of early neonate piglets by restricting the sows' movement during their most vulnerable stage of life whilst still later providing a freedom of

movement for the sow. The use of temporary confinement, however, restricts the sows' ability to perform natural behaviours around farrowing- specifically nest building (depending on when she is confined), even though it may reduce piglet mortality and create a safer working environment for stockpeople.

There is conflicting evidence in research with regards to the piglet preweaning mortality and the relation to lactation housing- with reported piglet mortality rates in general of loose lactation production systems highly variable. In more recent research, it is generally reported that loose lactation systems which incorporate temporary confinement of the sow, can achieve similar production results as crated production, with free farrow systems generally reporting higher pre-wean piglet mortality. The European Food Safety Authority (EFSA) released a scientific opinion on the welfare of pigs on farm in 2022, with the following recommendations to be the basis for future lactation housing within European pig production, based on the estimated piglet mortality rates: A situation where the sow is never crated in a pen designed for temporary crating will increase piglet mortality relative to permanent crating by 24% (with 90% certainty range from 3% to 59%). A temporary crating system with an average space for the sow of 4.3–6.3 m^2 can achieve the same piglet survival as a permanent crating system. The minimum confinement time of a sow in a temporary crating system to achieve this is 7 days after farrowing (90% certainty range between 3.4 and 16 days). The estimated mortality in a permanent crating system or a temporary crating system with a minimum of 7 days of confinement is 14% (with 90% certainty range from 12% to 17%) and a temporary crating system where the crate is never closed is 18% (with 90% certainty range from 14% to 24%) (S. S. Nielsen et al., 2022).

A meta-analysis conducted in 2019 showed that there is a 14% increase in relative risk of piglet mortality in farrowing pens when compared with farrowing crates (Glencorse et al., 2019). Hales et al., (2014) documented a higher preweaning mortality in loose lactation pens without temporary confinement and Moustsen et. al., (2013) observed a lower piglet mortality when sows were confined in a crate within a pen for four days after farrowing, relative to when sows were free to move unrestricted within a pen for the entire parturition and lactation period. Hales et al., (2015) showed that crating during farrowing did not have a negative impact on the farrowing duration or the number of still born piglets. Although there is a highly varied reported mortality rate of piglets in temporary confinement production systems, there is equally as high variation in the designs of pens used in the studies as well as the management decisions implemented, making it impossible to make an accurate comparison. To keep to the primary purpose of this report, only the timing of the confinement of the sow is discussed - both before and after farrowing.

The recommendations for the time at which a sow should be confined around farrowing ranges greatly, with timing reported as sows confined from entry to the pen, confinement the day/s prior to expected farrowing date, as well as farrowing loose but then confined at the conclusion of farrowing. The choice of when to confine the sow involves several considerations- since the stress that the confinement may cause to the sow could have a negative impact on the farrowing process and restrict the sow's ability to perform natural behaviours, though the impact of this on the farrowing process and subsequent piglet mortality is unclear. A recent review into the temporary confinement of farrowing and lactating sows by Goumon et al. (2022) provides a comprehensive scientific evaluation of the research to date, with the authors conclusion that confining the sow briefly after farrowing may be the best compromise, allowing the sow to perform motivated nest building behaviour, though noting that the risks of crushing during the unconfined farrowing period may increase.

The age (and therefore vitality) of the piglets should be considered as a key factor as to when to open the temporary confinement, to be sure that the piglets are aware enough of their surroundings and able to escape accidental layovers by the sow. King et al., (2019) studied the age as seven days, whereas other studies such as Kinane et al., (2021) piglets were as young as three days, with crates opened on day four post farrowing. An accurate comparison between studies is not possible, due to the confounding effects of differing pen layouts and management strategies, but anecdotal evidence indicates that piglets should be a minimum of three days old as an individual litter, since this also corresponds to the highest risk period of piglet mortality as demonstrated by Marchant et al., (2000). It has been reported that more piglets are crushed when temporary confinement is opened earlier than three days (Lohmeier et al., 2019; Ceballos et al., 2021; Kinane et al., 2021) suggesting that subsequent crate reopening seems to increase piglet mortality, but only if done earlier that three to five days after farrowing (Goumon et al., 2022).

There is even less literature available as to how the temporary confinement should be opened, with King et al., (2019) demonstrating that opening the crate in the evening at individual pens when the piglets reached seven days significantly reduced the piglet mortality as compared to opening the crates in the morning or as a batch/ room at the same time rather than individual litter age. It could be assumed that opening the crates in the evening just prior to stockpeople leaving the farm would mean that mortality risk is lower due to a lower sow/ piglet disturbance, in addition to a higher chance the sow and piglets would be resting during the evening.

Although there is not available literature on the subject, it seems a logical conclusion that the safety of stockpeople could be increased when temporary confinement is used - farrowing assistance and medications can be provided to the sow in a much more controlled manner, and the piglets can be accessed and moved where necessary without the risk of attack by the sow. The lack of evidence for stock person safety is simply due to a lack of research and acknowledgement in this area.

Takeaway message: The temporary confinement of the sow is designed to minimise early injuries to piglets from to crushing and overlays, by allowing the piglets to gain strength and learn how to use the pen for their own safety prior to the sow being completely free to move around. Whilst this does restrict the sows' natural behaviour, it could be a good compromise for the safety and welfare of all animals involved in the system, although management routines need to be considered as to when to open the crates. To combine the benefit of temporary confinement without significantly compromising piglet mortality, confining the sow at the completion of farrowing and releasing her (at the minimum) three days later, may be the best compromise to reduce the piglet mortality whilst still allowing the sow to perform natural best building behaviours.

1.3 Key considerations for pen design

In the development of loose lactation housing systems, significant focus is placed on the improvement of the sows and piglets within the system, and as such there are many design features that have been evaluated in available literature, with likely significantly more evaluated in commercial production. Aside from sow and piglet welfare, there are other aspects to consider in the pen design, predominantly the environmental effect and economics of the implementation of the system, in order to consider all three pillars of sustainability. A recent review paper by Moustsen et al., (2023) evaluated the need to consider emissions, economics and pig welfare in the transition from farrowing crates to pens with loose lactating sows, indicating that there are ways to house lactating sows loose indoors

with increased opportunity to perform highly motivated species-specific behaviours compared to conventional crated production with continuous confinement. Nevertheless, a trade-off for continual freedom of sow movement may be required as zero-confinement increases the risk of piglet mortality and increased emissions. This paper is included in the supplementary material to this report, and it highly recommended to read in entirety, since it contains a lot of details about the trade-offs of pen design, environmental impact and the effect on animal welfare. Similarly included, is a roadmap for pig producers to navigate key decisions when transitioning from crates to free farrowing written by Baxter et al., (2022), providing very practical insights and subsequent impacts on not only the pig producer, but also stockpeople and animals. The key highlights of both these papers are presented in this literature review, though only as key takeaways.

Sows and piglets have differing thermal temperature requirements and using this is the basis for most loose lactation pen designs. The sow resting area is significantly cooler than the piglet resting area (creep), and as such various heating and ventilation strategies are applied to encourage sows and piglets to make use of the space designed for them. It is important to note that most of these systems are designed for use in Europe, particularly in countries which are typically colder, where the buildings are designed to keep heat in, rather than out, which is generally the opposite approach in Australian conditions. Nevertheless, the principles remain the same- to use temperature to make the sow area uncomfortable for piglets to lay on, so that they use the creep area for their own safety.

Moderately high ambient temperatures in lactation can cause heat stress to the sow, resulting in a reduced feed intake and subsequent decreased milk yield (Kirkden et al., 2013). The Danish recommendations for ambient room temperature for the sow throughout the lactation period is 18 – 20 ℃ pre farrowing, 20- 22 ℃ from farrowing to day four, which is then reduced to 18 – 20 ℃ at the point of weaning, noting that this for sectioned rooms, partially slatted flooring and heat provision to piglets in the creep. The recommendations for the temperature inside of the creep for piglets is 34 – 36 ℃ for the first four days, reduced to 32 – 34 ℃ days until two weeks, and then 30 ℃ until weaning (Landbrug og Fødevarer, 2024). In most commercial loose lactation pen designs, the creep area is placed close to the sows' head, although Madeira Pacheco et al., (2024) was able to demonstrate that modifying this layout, with sows placed further away from the heating source, can reduce the percent of overlays in sows with high mortality by up to two piglets. Being able to control the temperature to meet the needs of both the sow and piglets is crucial to making the loose lactation system perform successfully, regardless of pen design. This is something to be considered when deciding on conversion or building a new site- if the existing ventilation/ temperature control systems are adequate to accommodate this key design element.

European legislation states that there should be farrowing rails or similar to protect piglets in loose lactation production systems, to prevent the accidental injury or layover by the sow. Often this is incorporated in the pen design as a rail or sloping wall to support the sow whilst laying down or even having areas around the edge of the pen that the sow cannot reach. Considerations need to be made for piglet size, and should therefore be wide enough to fit the shoulder width of a three to four week old piglet, and account for the height of at least a seven day old piglet, if not a weaner (Baxter et al., 2022).

The minimum space that the loose lactation pen should be is greatly contested, with the pen design needing to accommodate the length, width and height of the sow, as well as allowing for the movement of the sow and her piglets (assuming their size as at weaning). Covering the technical arguments of the

calculation of each is detailed and complex, though this specific information can be found in Goumon et al., (2022) and the EFSA report of S. S. Nielsen et al., (2022) accompanying this report. Although it is assumed to be substantiated by scientific backing, the implementation of legislation around minimum space requirements is in the end a national decision. At the time of writing this report, there has been no update to the general EU legislation with regards to this matter, though it is likely to follow the precedent set by Germany, that is, a minimum space of 6.5m^2 per pen. Despite this, it should be noted that Plush et al., (2024) were able to successfully demonstrate that sows housed in the Maternity Ring, a free farrow pen design of 4.23m^2, experienced a higher welfare standard than sows housed farrowing crates, with these sows being considered as in a positive affective state as according to the five domains assessment of sow welfare.

Takeaway message: Although significant research has been conducted into loose lactation pen design, there is no specific design that is proven to be the best. As a minimum, design considerations should include protective features for piglets at all edges of the pen, in addition to a dedicated space for piglets to rest without risk of layover by the sow. The design and functionality of the pen should consider safety features not only for the piglets, but also for the stockpeople and their safety working within them. Since the infrastructure investment is over such a long term, the projected production targets should be considered, to meet production needs of the future. It is highly recommended to read the papers by Baxter et al., (2022) and Moustsen et al., (2023) since both contain highly detailed information on the decision pathways that are relevant for Australian pig producers to take into account when considering loose lactation pen design and implementation.

1.4 Genetics and parity

There is a large variation in the genetic lines used in loose lactation production studies, and this can influence the management procedures that need to be implemented relevant to each genotype. In European pig production (where most available literature is written from) commercial pig production tends to favour highly prolific genotypes that produce a higher litter size, likely due to the higher cost of production pressures and available genetics. This in turn has a flow on effect on the piglet management procedures that the stockperson must implement, such as the use of nurse sows. This practice is widely used in herds with hyperprolific sows as the number of live born piglets often exceeds the number of functional teats of the sow and is therefore performed to enhance the survival and growth of piglets during the nursing period and to decrease piglet variation between litters (Baxter et al., 2013; Rutherford et al., 2013). The management of such large litters is important for Australian pig producers to be aware of, since it has a large influence on both the pen design and the stockpersons daily tasks, as can be seen throughout the case studies in this report.

The genetic influence on an animals' behaviour is difficult to measure, since environment and handling also has a significant effect on the traits displayed by an individual animal. In crated systems, the genetic selection for favourable maternal behaviours have been successful in improving piglet survival (Knol et al., 2022). Although commercial breeding companies do not currently measure the performance of breeding stock in loose lactation housing (to identify genetic lines potentially more suited to such a production system), Lipori et al., (2025) recently demonstrated that the predictive value of the estimated breeding value for mothering ability was retained by sows in free farrow systems, additionally suggesting a stronger association with piglet survival in this environment. Selecting sows

with a higher genetic merit for mothering ability could therefore help to reduce piglet mortality in loose lactation production systems from a genetic perspective.

Responsiveness to piglets is an important maternal trait, especially in farrowing pens where a lack of response to piglet vocalisations by the sow can be detrimental to piglet survival when a piglet makes a distress call (Lay et al., 2002, Chidgey et al., 2016). Mothering ability can also be interpreted in a sow as aggression towards stockpeople, with certain breeds associated as having an aggressive tendency, though again, this is also highly influenced by environmental conditions and management. Limited studies exist to reliably demonstrate a specific breed effect- rather, this is generally discussed within industry and hence should be considered not reliable, though an understanding of when a sow might act aggressively is of value when considering training needs of stockpeople working within loose lactation systems. Kecman et al., (2022) examined the genetic aspects for the behaviour of lactating sows towards humans, with the study aiming to develop tests that would assess the behaviour of lactating sows kept in temporary confinement farrowing systems towards stockpersons during routine management procedures. Although the genetic selection aspect of a commercial breeding program is outside of a farmer's influence, the authors attention to stockperson safety and measurement of individual sow aggression during certain routines are relevant to this review. Their results suggest that the probability of a human injury during the handling of piglets is considerably higher than during trough cleaning or other similar procedures that do not involve contact with the piglets. They also identified that a piglet's distress call engaged the sow to react more actively to protect her piglets. Consequently, the authors recommend that the sows are temporarily confined for the first days after farrowing, for the stockperson's safety. Similarly, (Chidgey et al., 2016) observed in their behaviour study that piglet vocalisation towards littermates tended to decrease over the first three days of life. Whilst these studies did not examine the effectiveness of pig husbandry procedures, it does provide valuable information with regards to the sows' natural behaviour and reactionsand identifies subsequent risk periods to stockpeople that should be considered in the management of loose lactation production systems.

Previous housing experiences in prior parities can influence sow behaviour during early lactation, and it has generally been reported that older sows that have transitioned from a farrowing crate environment perform worse than younger sows. Piglet mortality (including still born) has been shown to increase with sow age in commercial pig production, with a negative relationship demonstrated between increased parity and preweaning survival (Weber et al., 2009; Klimas et al., 2020; Madeira Pacheco et al., 2024). This effect may be further exacerbated when sows are housed in minimal confinement systems in later parities, since previous housing experience can influence sow behaviour during early lactation (Weng et al., 2009; Cronin et al., 2000; Hales et al., 2014; King et al., 2018). This is also logical, since a younger sow is more agile, and can move herself around the pen more easily than an older sow, who has perhaps also learned to lean on the crate to support herself to lay down- giving reason as to why higher parity sows have a higher number of layovers, particularly those who are used to being confined to a crate throughout lactation. Taking these factors into consideration, the culling strategy for age related performance needs to be clear in loose lactation production systems, since these effects may be amplified when compared to conventional crated production.

Takeaway message: Younger sows, and sows with previous experience in loose lactation systems have been observed to perform better in terms of a lower piglet mortality, which is likely due not only to their physiology, but their experience learning how to use the loose lactation system for their first farrowing. A good culling strategy for aged sows is more important to implement in loose lactation

production systems, due to the sow's physiology and higher chance of layovers with age. Whilst genotypes and breeds used in commercial production vary throughout the world (as represented by multiple breeds and genotypes of pigs discussed in papers presented throughout this report), European pig production tends to favour hyperprolific genotypes, requiring a higher level of management due to the higher number of piglets born alive. Regardless of genotype, the behaviour and reaction of the sow is important information for the stockperson to be aware of, since a routine task asked of them is to help the sow throughout farrowing and early piglet care, where the temperament of the sow is something to consider, since in this period she is likely at a higher stress level.

1.5 Stockpeople and management interventions to reduce piglet mortality

Stockmanship is an occupation that requires expertise, endurance, and empathy. Stockpeople have a direct impact on agricultural animal welfare and productivity, yet they are often undervalued and their role overlooked in the production system (Daigle & Ridge, 2018). Skilled staff, motivated to deliver a high level of technical performance, are essential in pig production (L. A. Boyle et al., 2022). They play a critical role in the success or failure of the implementation of a production system such as loose lactation housing, which relies on the stockperson being able to provide animal husbandry interventions to the pigs to maximise piglet survival without compromising sow welfare. When sows are loose housed at farrowing and in the following lactation period, it puts higher demand on management input from the farmer to keep piglet mortality low (Rosvold et al., 2017) which is not only in the interest of piglet welfare, but also in the economic output of the production system (Andersen et al., 2007). A review into the influence of farrowing and lactation housing and positive human contact on sow and piglet welfare by (Hemsworth et al., 2023) concluded that together with housing, the behaviour of the stockperson is a key determinant of animal welfare. A recent publication by Staveley et al., (2025) explored the attitudes of stockpeople employed on farms with experience working in both free farrow and crated systems, to better understand the contributing factors that shape these attitudes via an anonymous survey. The authors found that the main driver of negative attitudes towards the free farrow system appeared to be a lack of understanding of sow behaviour and concluded that the development of ways to modify stockperson behaviour to improve sow and piglet welfare outcomes, will result in having a better chance of introducing alternative farrowing systems.

In general, the effect of the application of pig husbandry routines are rarely systematically researched (including conventional pig production) with peer reviewed literature scarce on this subject, despite several authors citing the importance of the role of the stockperson looking after the animals. Pig husbandry routines and management procedures that are recommended as best practice tend to be delineated from research trials which show an effect of treatment, rather than observing the implementation of such treatment in commercial practice by stockpersons responsible for animal husbandry. The effect of the stockperson in loose housing systems could therefore even be considered of greater significance, given the sows are unrestrained, requiring more trust and competency of the stockpersons both to maintain their own safety and provide adequate assistance to the sow and her piglets. The natural maternal instincts of sows to protect their piglets, especially in these housing systems, can represent a serious risk for stockpersons during common management procedures such as trough and pen cleaning, piglet handling and disease treatment (Kecman et al., 2022).

To the authors knowledge, there are only two peer reviewed papers that examine the effect of the stockperson and subsequently the implementation of pig husbandry practices on the performance of

loose lactation production systems, with both being conducted in Norway, where farrowing crates are banned. Both studies of Andersen et al., (2007) and Rosvold et al., (2017) were conducted as a field survey of the management practices that producers implement in loose lactation production, with the general recommendations being that stockpeople are more present during farrowings, have systematic and frequent contact with the sows, dry newborn piglets, assist piglets to obtain colostrum, use nurse sows for cross fostering and conduct split suckling in large litters. The efficacy of each of these pig husbandry practices was unable to be determined since they were not studied individually, nor were they validated as being consistently implemented by stockpeople on farm. However, they do provide an indication of the practices that Norwegian farmers consider as important to implement in loose lactation production- which are seemingly consistent with practices which are recommended for implementation in conventional crated production in Denmark (Landbrug og Fødevarer, 2024), although an accurate understanding of which practices are implemented commercially is not currently understood. A review of piglet mortality and management solutions conducted in pig production by Kirkden et al., (2013) concluded that although the literature does not allow a single, optimal management protocol to be identified, the authors proposed a basic set of routines that their experience and research determined to be of key importance. These recommendations included that stockpeople should be present at farrowing to assist sows, encourage sows to eat and drink after farrowing, identify sows that are hypogalactic, intervene to prevent piglets from being crushed or savaged to death, take action to prevent piglets from becoming hypothermic, and rescue piglets that may have their feet stuck in the floor. Additionally, fostering of surplus piglets should be done in 24 hours, with the largest piglets that have received colostrum moved first.

At the time of feed delivery in the farrowing unit, sows usually stand very quickly to eat and lay down again shortly after the meal. During this period, piglets tend to stay close to the sow and are therefore at high risk of injury or death while the sow is focused on eating her ration. Loose-housed sows may be more active or have another pattern of activity than crated sows; therefore, more piglets are at risk of layovers in this system (Lambertz et al., 2015; Chidgey et al., 2017; Bolhuis et al., 2018). To teach the piglets to use the creep whilst the sow is eating as a safety zone, it is a common practice in Denmark to confine piglets in the creep are for the duration of the sows feeding time in the first days of life. This practice is implemented commonly in Danish conventional crated production, though may have an even more significant effect in loose lactation systems where the piglets need to learn to use the creep for their own safety.

Takeaway message: The performance of loose lactation systems, in particular the pre-wean mortality of piglets, is highly variable- indicating that management, and stockpeople implementing this, influences individual farm performance. Pig husbandry practices that should be implemented may be the same as in conventional crated production, though evidence from commercial farms working with loose sows would be beneficial to understand this relationship and enable stockpeople to do their job efficiently and safely.

1.6 Use and management of enrichment materials by the sow

Enrichment materials provided to sows throughout the farrowing and lactation period generally have a higher focus in loose lactation systems than crated production, since the enabling of sows to exhibit natural nest building behaviour is a key improved welfare aspect in loose lactation production that also leads to the improvement of piglet survival. In crated production systems, this behaviour is restricted both due to often lack of sufficient materials and due to the physical confinement of the sow by the

crate. Allowing the sow to perform some aspects of nesting will enhance welfare, as well as piglet survival through improved farrowing ease, reduced risky posture changes and increased maternal bonding and colostrum/ milk access (Plush & Nowland, 2022). Pre farrowing, the enrichment is designed to allow the sow to carry out highly motivated nest building behaviour, whereas post farrowing, the environmental enrichment is provided to reduce boredom and frustration of sows and piglets, motivating them to investigate their environment.

In most commercial pig production, the enrichment provided to the sow is straw, likely due to the convenience/ availability to pig producers (as a byproduct of grain production) and the cost (relatively cheaper than other materials which could be used as animal feed). Limited studies exist to evaluate both the optimal amount of straw to provide to sows, as well as alternative substrates to straw even though commercial pig production is often concerned by the management of this material by the effluent systems. In some parts of Europe where African Swine Fever is present in the wild boar population, the use of straw is strictly advised against due to the biosecurity risk- perhaps providing another motivation for the investigation of alternatives.

In experimental studies a variety of alternative substrates were offered to sows and gilts in the farrowing unit, including lucerne hay, peat, wood shavings, sawdust, shredded newspaper, ropes and branches, though none of these have been evaluated under commercial conditions to the authors knowledge. Of the limited alternative substrates studied, the use of a hessian (also referred to as burlap) has been evaluated as an enrichment for sows by (Bolhuis et al., 2018; Fynn et al., 2021; Plush et al., 2021), with all authors reporting use of the hessian by sows for nest building behaviour, and could be considered as an alternative possibility, though likely a higher cost substrate it could be advantageous from a biosecurity perspective.

Takeaway message: Environmental enrichment, specifically allowing the sow to exhibit natural nest building behaviour, underpins the higher welfare ideals of loose lactation systems. There are practical aspects of the management of these materials by the farmer, though the amount and type of enrichment material should be considered to meet the demands of existing slurry systems. Whilst straw is traditionally used, alternative sources of fibre such as hay or silage could also be considered, which is more likely to be consumed by the sow and not be forced down the slats, or hessian which can remain in the pen.

1.7 Feeding strategy of sows in loose lactation

In loose lactation housing systems, it is often assumed that sows will have other energy and nutrient requirements than crated sows. This assumption is due to that fact that in loose lactation housing, piglets have more access to the udder due to the absence of a crate (Pedersen et al., 2011) and may have a higher milk production than crated sows because of a more undisturbed slow of nutrients to the mammary glands (Krogh, 2017). Sows are also more active when housed in loose lactation systems compared to farrowing crates and will remain more active around farrowing and lactation than what the farrowing crate allows them to do (Kinane et al., 2022). Very limited research has been conducted to identify if there is a need for a differentiated feeding strategy for loose lactation production, or if the feeding strategy applied to conventional crated production is adequate. Different housing conditions and a longer lactation period, combined with large litters, high milk production and leaner animals might affect the sows' feeding capacity and body composition (Thingnes et al., 2012). In Denmark, the industry recommendation is to feed the lactating sow a minimum of three to four times

per day (Landbrug og Fødevarer, 2021), since from a practical perspective, she cannot consume her daily ration in two larger portions. It is the most common practice in Denmark that sows in lactation are allocated to a step-up feeding program, rather than *ad libitum*, which gives the producer more control over the sow feed intake, and allows the increase of the ration to be in a controlled manner. Thingnes et al. (2012) compared *ad libitum* and step-up feeding strategies in late lactation in loose housed sows, and found no difference in parameters of litter gain, weight loss, backfat loss or total feed consumption, although the authors did find a different in the number of feeds refusals and individual variations in the *ad libitum* strategy as compared to the step- up strategy. A high feed intake during lactation, in particular late lactation, is necessary to minimise the weight loss of sows, maintain high milk production and subsequently increase the litter gain- paying attention to individual sows' appetite and refusals is crucial to manage this, and thus the step-up feeding strategy during lactation, rather than *ad libitum* enables easier management of this, in addition to the easier identification of sows which may be struggling.

In a recent study by S. E. Nielsen et al. (2025), the authors aimed to examine how an increased number of daily feedings and different dosing speeds affected piglet growth and survival, sow body weight and backfat thickness and milk production of loose housed lactating sows. Although no difference between dosing speeds was observed, compared to Danish studies of crated sows of the same genetic origin, there was a greater loss of backfat thickness, but with similar changes in body weight despite a higher average daily feed intake, which is assumed to be attributed to the higher energy requirement since the sows had a higher activity level in loose housing. It was expected that a higher feed intake would be seen in the group fed six times per day as compared to being fed three times per day, but it was observed that the feed intake was higher in the three times per day group. In their conclusion, offering more daily meals did not increase the feed intake of the sows, though they were able to demonstrate that it is possible to maintain piglet mortality comparable to that of crated sows in loose housed lactating sows, accomplished by good management of the piglets and temporarily crating (six days) of the sows around farrowing. More knowledge is needed on milk production and energy requirements for the activity of loose housed lactating sows, with future research needing to identify the optimal feeding strategy considering the interaction between feeding speed, number of daily meals and nutrient and energy concentration to fulfill the requirements for milk production and minimise body mobilisation (S. E. Nielsen et al., 2025).

Further to nutrient requirements during lactation, in an observational study of management practices of herds in Norway using loose lactation housing, Andersen et al. (2007) found that herds practicing moderate roughage feeding during pregnancy tended to have a lower piglet mortality, with farmers recorded as giving between 500g to 1.5kg per day to each sow in the gestation period. This observation does indicate some potential positive digestive effects of the roughage; however, this should be interpreted with some caution since this was not conducted as a controlled experiment which directly observed this effect.

Takeaway message: Loose lactation housing has the benefit of a potentially higher milk production by the sows, though further research is needed in this area to determine the energy and nutrient requirements of the sows during their lactation period. As more commercial pig production moves towards loose lactation housing, it is likely that this area of research will develop.

1.8 Additional factors to consider when making the transition

There is limited information on how to transition animals which have previously farrowed in crated production to loose lactation housing systems. As discussed earlier in 'genetics and parity', previous farrowing experience in crated production has an influence on the behaviour of the sows in subsequent farrowings in loose lactation systems. When making the strategy to transition, there are two main options for the sow herd- transfer them to the new system or depopulate and repopulate with gilts. Whilst the depopulation/ repopulation option may also be attractive for other reasons, such as health and biosecurity concerns, it can also bring challenges with having an all-gilt production for some time- meaning that lower productivity is to be expected until the sow herd has a more established parity profile. Whilst older sows are less mobile and are at a greater risk of layovers of piglets, they also bring an experience to the herd and a stability in productivity- which can also be an advantage.

Regardless of transition strategy, handling gilts well prior to their entry to the farrowing unit will have a positive effect on their experience and make the job of the stockperson looking after them easier, since loose lactation systems require a higher level of human and animal contact than crated production. Maintenance of animal welfare happens at the ground level beginning with the interaction between the animal and the stockperson, where curating a positive human- animal relationship is essential for the stockperson in order to ensure they are properly caring for the animals on a daily basis, since the productivity and health of food animals have been directly connected to the attitudes and actions of the stockperson (Daigle & Ridge, 2018).

It is not only people that are learning to use the system, but the animals too. It is to be expected that as stockpeople become more familiar with the management of loose lactation production, the sows and their piglets do also. This effect was able to be demonstrated by (Chidgey et al., 2016), who identified that piglets born to gilts that were born and raised in a farrowing pen (not crate) spent more time active in the creep area compared to those raised in crates, demonstrating that the expression of some piglet related directed behaviour was influenced by the system in which a gilt was born and reared. This is an important factor to consider when a farm is transitioning to a loose lactation housing system- since it is not only the stockpeople that are learning to use the system, but also the animals, and improvements will also occur between generations. This evidence suggests that animal adaptation and performance will continue to get better over time as the animals acclimatise to the new system.

Takeaway message: It is an individual farms choice as to how to make the transition from crated to loose lactation production, with the main area focused on in this paper being the management of animals for the transition. The socialisation of gilts with positive human contact can help prepare them for the farrowing and lactation period, where an association with positive contact by humans may help stockpersons provide assistance to them and their litters when needed. Previous farrowing experience has an influence on a sows' adjustment to farrowing in a minimal confinement system and should be considered if transferring the sow herd to the new site is the strategy. Alternatively, gilts may be used in a total startup of the herd in the new environment, which may also be a benefit depending on disease status and goals of the transition.

1.9 Conclusion

Although a lot of information loose lactation production systems is presented within this review, significantly more has been eliminated due to the primary purpose of the project- the practical aspects of the management of sows and piglets housed loose throughout lactation. Despite significant research being conducted on this topic, there are still no clear guidelines on what pig husbandry routines should

be implemented, nor is there census on design features of the pen. Most evidence on the subjects presented is conflicted with other similar research, which makes comparisons between studies impossible to do with accuracy.

A significant portion of the work done in loose lactation housing and management research is now somewhat 'outdated'. In more recent studies, the performance of these systems is improving, particularly in regard to the pre-wean mortality of piglets in the lactation period. Although a positive development, it also makes research outcomes difficult to compare, since rapid advances have been made in the knowledge of how to manage these systems over the last ten, but especially five years, with this timeline correlated to the public perception pressure applied on the industry in Europe to change.

The improvement in understanding is perhaps due to a better understanding and management of the systems based on experience, driven by a slowly increasing number of commercial pig production transitioning to loose lactation production, shifting the mindset from a more ideological research perspective to acceptance that this is the way pig production in Europe at least is headed. Finding ways to manage these systems therefore comes from necessity, and a collaborative approach between research and industry should lead to the generation and sharing of knowledge for the improvement of animal welfare and stockperson safety.

4. Case Studies

The information in the case studies presented in this report is designed to demonstrate how individual farms have adapted to loose lactation production, with a primary focus on the animal management and how the stockpeople have learned to work in a new system. Between the four case studies from Denmark, there is a variation in time since transition, pen design, genetics, confinement time and size of the sow herd- with the sites being chosen as a representative sample of commercial pig production in Denmark that house sows loose throughout their lactation period. Additionally, SunPork farms have been included as a case study for an Australian perspective.

Data for the Danish case studies was obtained by applying Participatory Action Research (PAR) principles, which involves collaborative research, education and action oriented towards social change (Kindon et al., 2007) by involving researchers and participants (both farmers and stockpeople in this case) working together to examine a problematic situation or action to change it for the better (Wadsworth, 1998). This mixed methods approach was taken to both identify and validate if a pig husbandry practice is actually implemented on farms and can be considered more accurate than solely relying on information given in a survey or interview. The methodological approach of the four phases to identify and validate the pig husbandry procedures and implementation can be summarised as being:

1. A semi structured interview
2. Observation of working routines and pig husbandry procedures by stockpeople in the stables
3. Vision mapping exercise
4. Cross checking with herd performance data.

Each case study presents the average key production figures of the last year, taken directly from the herd recording software. To put these figures into context, the following production data is taken from the reported industry average in from the last year in Denmark (Hyttel, 2025), noting that this is taken only from herds using DanBred genetics and conventional crated production.

Born alive per litter (gilts and sows)- 18.8
Pre wean mortality- 14 %
Total piglet mortality (including still born piglets)- 21.4 %
Weaned piglets per sow per year- 36.3
Average weaning weight- 6.1 kg
Average lactation period (including nurse sows)- 31 days

5. Tvilumgaard

Tvilumgaard, owned by Susanne Holm Kuhr and her husband Thomas Kuhr, is a 580 sow loose lactation production system that recently transitioned from crated production. In October 2024, animals were moved into the new site that features 190 farrowing places with temporary confinement for sows around farrowing. The old farrowing site will soon undergo a renovation to convert to additional housing for gestation, mating and gilts, with the goal to increase capacity to 750 sows per year in production.

Previously, half of the piglets produced were sold at 30 kg, with the remaining finished themselves and sold for slaughter in Denmark. However, a new finisher unit was completed in February, enabling the grow out space for 23 000 slaughter pigs to be produced annually for the UK production concept for Danish Crown. This expansion has made Tvilumgaard a completely farrow to finish production, in addition to 400 acres of arable land for crop production.

The pen is Thomas's own design, which he developed and tested in production in the old site before deciding to have it commercially constructed and installed for all farrowing places. At this time of this visit, Tvilumgaard was approximately seven months into the transition to loose lactation production. Susanne and Thomas operate as a team- it is Susanne who takes care of the management of animals and oversees all aspects of the pig production, and Thomas is involved in the construction, conversion and installation of infrastructure in all units.

1.10 Key Production Figures

Born alive per litter (gilts and sows)- 19.9
Pre-wean mortality- 7 %
Weaned piglets per sow per year- 41
Average weaning weight- 6.5 kg
Average weaning age- 25 days

1.11 Pen Design

The pens used at Tvilumgaard are 3.3m x 2m (total area of 6.6m^2), were designed by Thomas Kuhr and constructed and implemented by Vissing Agro. The starting point of the design was to include a crate for temporary confinement of the sow around farrowing, with the creep then placed away from the sows' head (when she is confined) to be closer to the aisleway- this is usually the opposite creep location in most commercial pen designs. The design was tested in the old farrowing unit, where they also installed video surveillance to note how the sow was using the pen. They observed that when the sow was loose, she generally lays with her head next to the creep- they also observed only two dead piglets from layovers in the seven sows that went through the test pens, and it was on this basis that they decided then to approach a commercial company with their design to implement it in their new building.

Overview of pen features

Only the piglet creep and a small area next to it is solid flooring, the rest of the pen is fully slatted- enabling good hygiene, with traditional slurry management channels beneath the pens. The flooring is Schonlau FERROCAST®, a German manufactured specialist cast iron slatted system that includes round edges on the bars (for animal comfort and thermoregulation/ ventilation) that are also sandblasted and coated for animal comfort and longevity.

Sow confined to the crate prior to farrowing

When the sow is loose in the pen, one side of the crate remains fixed, while the other separates into two wings that form the edge of the sows' access area. Safe spaces for piglets are enabled around the entire edge of the pen, with sufficient space to allow piglet access to the udder regardless of the way the sow lays down.

Straw is always available to the sow via a basket, and only one sow feeder is incorporated into the design (on the wall, furthest aspect from the aisleway). Milk cups were installed, though not in use- instead these are used as a second point of water provision for piglets.

1.12 Sow and piglet management

Sows are moved into the farrowing pens the week prior to their due date and usually have between four and seven days to acclimatise to their surroundings. Two days prior to their expected farrowing, they are confined to the crate, though at the time of the visit they were trialling allowing gilts to farrow loose in pen if they were observed to be too stressed by the confinement. Crates are opened on an individual basis- generally this is in the morning on the second day after farrowing. For some litters (where the piglets are smaller or weaker) it could be up to day four- this is dependent on the managers decision of the strength of the piglets in the litter. Admittedly this is a process that they are still learning themselves as to what works best for their system.

Split suckling is not carried out unless there is a sow that has a long duration between first and last piglets born, or there is a large variation in piglets born. In general, they do not experience many still

born piglets- though this is likely due to the dedicated farrowing attendants that result in the constant monitoring of farrowing status, rather than intervening with piglets- the focus is on assisting the sow.

At the point of farrowing, the room temperature is 23 ℃, which is slowly reduced to 20 ℃ by the point of weaning. Heat is provided to piglets via the floor and a lamp- which is on an automated curve to lower the temperature as the piglets get older. If they need to retain heat for smaller or sick litters, a plastic cover is applied to the front of the creep. Sawdust is placed in the creep area once before birth, with more added as necessary to keep the area dry. Straw is only provided to sows via baskets, and pens are generally not scraped- usually this is not needed since most of the flooring of the pen is slatted.

Plastic cover applied to the creep for heat retention

Nurse sows are used to manage the high number of piglets born alive- noting that they are using a one-step nurse sow system (i.e. a sow's piglets are weaned early, and she is then given day old piglets, rather than using another sow in between). Each week usually three to five nurse sows out of 20 farrowings are used (20 %), which is lower than what the industry generally would use (30 % would be considered normal in Danish pig production). The working routine is clear- to keep as many piglets with the sow as possible, and to support the sow to have a high milk production, so that she can take care of as many of her own piglets. When selecting piglets to move to a nurse sow, the largest are selected as priority. Most of the sows have 16 functional teats, so they can raise at least that on their own.

Piglet processing is conducted on day one and currently includes tail docking- though they are considering beginning production with intact tails. All male piglets are immunocastrated.

Piglets comfortably using the safety of the creep

Susanne highlights that water supply is critical and is often an overlooked aspect of pig production. For this reason, there are two sources of water for the piglets to teach them to drink as much and as early as possible, with water dripping all the time to encourage piglets to engage with it. Although there is a milk cup system installed, it is only used for water distribution and is turned on from day one.

Based on their experience thus far, Susanne thinks that that the sows eat a little bit more in the loose lactation pens compared to when they were in crates, though observes that they are making more milk. She credits this to the fact that they can use their body more freely, stretch out and therefore have more blood circulation. Sows are fed four times per day throughout their lactation period and are encouraged to eat as much feed as possible to get them to 10 Danish feed units per day when they are the top of the curve in peak lactation.

Weaning is carried out each Friday- with the process being to close as many piglets as possible in the creep and then let the sows out of the pens. The piglets are moved to the weaner section later the same day. Prior to the transition, the average weaning weight of piglets in crated production was approximately 5.3kg. In the initial months after starting in the new stables with loose lactation, Susanne and her staff observed that they were up to 7kg but have stabilised now to average around 6.5kg.

Tvilumgaard has demonstrated a very low piglet mortality in the farrowing unit, especially when considering that they have only very recently transitioned from crated production. Susanne credits this to the fact that they are not surgically castrating anymore (reducing a possible route of infection), and that the sows being loose is better for her body and subsequent higher milk production. ´Being loose is good for the sow, I think her whole body is working better with the walking, with the blood pumping around. And when she's doing that, she's giving more milk, and when there's more milk, you get stronger pigs when you have stronger pigs, you have less mortality, and this has lifted us to a better level. Our goal is to have piglet mortality under 7% in the farrowing unit, and we are currently below that´. Additionally, the flooring in the pens also helps to keep the area dry and clean without creating wounds on the piglets. There has also been an improvement in the performance of the sows and

piglets that can be seen since the implementation of the piglet survival, piglet and sow robustness and litter weight gain (milking capacity) breeding traits by DanBred.

Overview of pen layout without confinement- noting the wings of the pen opened out to form the barrier for the sow

Tvilumgaard uses DanBred genetics for both their maternal and sire lines. They make their own gilts via zig zag production (also known as criss cross breeding) and have done since 2013. This breeding strategy for self-replacement gilts is where males of two breeds are used to cross with F1 females in an alternating pattern- in this case, the breeds being the DanBred Landrace and DanBred Yorkshire. By implementing this breeding system, the resulting offspring maintain a relatively consistent proportion of genetics from both breeds. There are no rules about maximum parity- though they start to begin culling sows for age related performance after parity six.

All sows were transferred from the old into the new site at start up- i.e. they did not depopulate and repopulate the herd and therefore had a mix of parities learning to use the pens at the same time. Tvilumgaard are also building up the number of replacement gilts (to increase production), and with the transition between old and new buildings there was not spare space to produce extra gilts. They did not observe a difference between gilt and sow use of the loose lactation pen, even sows that have had several parities in crates.

Gilts are not specifically prepared for loose lactation production, however they are well socialised and used to the staff since they are raised in the stables where they will later farrow. They have been there all their life, so they are by default also socialised with human contact regularly, since they are not

moved offsite for grow out, or brought in from a multiplier and spending time in a quarantine unit where replacement gilts often housed with limited human contact.

1.13 Learning to work in the system

In the sow site, there are three full time staff (including the manager). All are Romanian, as is the manager (who herself has 19 years of experience) and have been working together as a team in the old production site for at least five years- meaning that they are very experienced in pig production and working together as a team prior to the transition. The stockpeople have found that that medicating sows and catching piglets are a more difficult task to carry out in this system, but acknowledge it just takes some more time and care on an individual basis when compared to carrying out the same tasks in crated production. They have not seen any injuries since the transition to either people or piglets, though it is acknowledged that the stockpeople are more cautious of the sows being loose. Although they are not afraid of them, more attention needs to be paid to each individual sow, especially when piglets are also calling to her- they need to have a higher interaction with the sow and be able to read her signals. Susanne observes that 'I think it is natural, they are just taking care of their piglets, and that is actually the sows just doing their job.'

Susanne felt that the staff have adapted smoothly to learn how to work in the new system, but notes that every week they are still learning small details. Considering that Tvilumgaard is only seven months into the conversion, this is to be expected- and their production results are exceptional. At the implementation of the new system, piglet mortality in the farrowing unit was around 10 %, though now it is stabilised to 6 – 7 % in recent months. It is also important to acknowledge that Tvilumgaard is really still in the process of learning the new system themselves, whereas the other case studies presented in this report are some years down the track. Susanne believes that the bigger issues have now addressed in the first six months, and now they are closing the corner on the finer details to fine tune the system and management of animals. Farrowing unit staff themselves felt that they became comfortable with loose sows quite quickly, and that it was more of a challenge learning to work with new infrastructure i.e. ventilation and feeding systems etc. In this way, it was an advantage that the team already works well with each other.

Although at the time of the visit all of the sow production was operational, there were parts of the building still being finished (staff kitchen and meeting area for example). Susanne can envisage that they would like to have training videos and staff learning sessions in the kitchen of the stables, where all staff can come and learn about what is going on inside and out of the farm (even if they are not working in the farrowing unit). When she thinks about how she learns, it is visually and intends to start incorporating this approach into their training and communications. Whilst it is only the three staff in the sow farm (as discussed here), there are additional stockpeople on other sites (grow out, field work) as well as two craftsmen employed full time for building development and maintenance.

1.14 Advice for farmers considering making the transition

The biggest challenges experienced in the transition process thus far have mostly been around learning to work with new infrastructure and systems, rather than the challenge of learning to work with sows in loose production. Susanne and her team felt ready and prepared for the change, and perhaps this is a key for success in the mindset of achieving the results that they have, whilst also limiting the dip in

productivity that is often seen when farms make the transition to loose lactation production. Her advice is to go for it, that they have never seen such great production results as they have in this system. Some things they have found out by coincidence, and they are still learning to adjust their working patterns and management to optimise the system.

Currently there are 580 sows in production, however the goal is to increase to 750 sows when the whole system is finished, though Susanne notes that they can already see this might cause some issues in the available space for weaned piglets. ´When we were drawing the new stable, we had anticipated on having 35 weaned pigs per sow per year. Over the last two months, we have now stabilised to more than 40 piglets per sow per year, so this is going to limit capacity for a while simply as we do not have the additional space to house them for time being. In the old farrowing unit, the infrastructure was 25 years old and only 138 cm wide, it was simply physically impossible to keep that many piglets in a small area. So the sow didn't mean to lay on her pigs and kill them, but often she actually could not avoid it in the crates since there was not enough pen space for the piglets to be around her. In that way, the old production inventory was the limiting factor for us.' Based on this experience, her advice is that it is really important for farmers to consider the needs of the future production, and be sure that what is implemented is not only meeting the production capacity currently, but what is possible into the future.

Although not part of a professional learning group, the farm is well supported by industry professionals such as vets, advisors and nutritionists, whom Susanne utilises as an opportunity for advice when it is needed- a lot of people are curious about the new pen design and implementation, though mostly the team are focused on helping themselves solve challenges as they arise.

6. Nørregaard

Nørregaard, owned by Ole and Sanne Mathiasen, is a 750 sow free farrowing system built in 2014. Each year 21 500 30kg pigs are sold to two buyers, with the remaining 4 000 pigs raised by for slaughter themselves. Nørregaard operates on a two-week batch farrowing system, with a total of 408 farrowing pens, where piglets remain in the farrowing pens until they are 30kg. There are six sections of 68 pens, with three of the sections occupied by sows and piglets and three occupied by weaners, where they stay until they are 30kg. Nørregaard supplies to the Antonius brand of Danish Crown, which among other conditions, requires that the piglets are kept with the sows for an average of 30 days (minimum 28 days for individual litters), are produced with long tails and that sows are always loose throughout their farrowing and lactation period. Nørregaard is managed by Frederik Holm Vistedsen, with six full time employees in the stable, one of which is a trainee.

1.15 Key production figures

Born alive per litter (gilts and sows)- 18.4
Pre-wean Mortality (of liveborn)- 19.64 %
Weaned piglets per sow per year- 31.17
Average weaning weight- 8.5 kg
Average weaning age- 33 days

1.16 Pen design

The pens used at Nørregaard are 2.3m x 3m (total area of 6.9m$^{2)}$ and were built by Jyden (since overtaken by Skiold), with no confinement of sows throughout the farrowing or lactation period. There is a designated creep area for piglets with floor and lamp heating, and all internal pen walls have a protection mechanism for the piglets from the sow to support her when she lays down, either from the sloped wall or bars. Social contact between sows is enabled via nose-to-nose contact at one side of wall the slatted end of the pen (opposite to the feeder location, to discourage feeding aggression).

Internal aspects of pen (noting bars for piglet protection and sow support)

The flooring is a mix of approximately one third cast iron slats and two thirds solid concrete. Sprinklers are installed above the slatted floor to not only to keep the area clean but also to encourage the correct use of the pen for sow and piglet dunging behaviour. These are not operated during farrowing- when the last litter born in the room is two days old then the sprinklers are activated to come on again. The timing is set for 30 seconds every 30 minutes, but this can be increased in the summer when necessary.

The farm was built with full line winch slurry scrapers under the flooring, with slurry scraped every day, everywhere- not that it is necessary from volume, but it is good for the system to be moving, and the ammonia won't get stuck. Slurry cooling has also been installed in the barn facility, with the slurry layer to be cooled at a maximum of 10cm thick, which makes the cooling more efficient. Heat from the slurry cooling is used everywhere in the farm, including the showers for employees.

Overall, they are satisfied with the pen design and features, with only minor changes made after the original build including the installation of a milk cup system (which is no longer used), an extra 'finger' put on the piglet entrance to the creep (to provide more separation to the sow feeder) and new flooring. After about seven years, the old flooring was worn out and giving the piglets bruising on the knees and extra infection points, so a new coating was added. Initially this was epoxy, but it was found to be too slippery for the animals, so it was removed, and a high-powered concrete was added which improved the system, though made it a bit harder to wash. A possible addition would be to try to incorporate a different feeder that can also be suited for the weaner pigs, as currently it is only a sow feeder.

Overview of pen at Nørregaard

Piglets can nurse at all aspects of the pen

1.17 Sow and piglet management

Nørregaard is in the process of converting their female line to Topigs Norsvin (TN), from Danish Genetics, with the oldest TN animals at the time of the farm visit in their third parity. DanBred Top Duroc is used as the sire line.

Sows are moved into the farrowing pens on Thursday the week prior to their due date, allowing them usually just over a week to get used to the pen prior to giving birth. It is observed that TN gilts can be a little more nervous or stressed the first time they are using the farrowing pen, Frederik emphasises that it is important to load gilts and sows in at their own pace- do not rush, stress or push them, and allow them time to wander down the aisle on their own. Normally, it takes two to load them in- one receiving them and another following the tail end of the group.

Straw is provided once per day- though this is stopped when the sow is farrowing. To maintain pen hygiene, a drying powder is used instead on the solid flooring, and distribution of straw resumed after the completion of farrowing- delivered to all animals once per day. They observe that the straw is used/ consumed by the sow/ piglets, and don't experience a problem with the slurry system, since limited straw makes it down the slats, and it is provided chopped up (made via a special baler) less than 5cm in length.

There are assigned farrowing attendants who take care of the young piglets and sows for the first two weeks, after which point another stockperson is taking over until the pigs are sold at 30kg (when they leave the farrowing section of the farm).

Farrowing usually begins on Friday/ Saturday, at which point all the lamps are turned on in the creep- so that the light and heat (also in the floor) is ready to attract newborn piglets. Usually, the lamps are left on for four to six days, but this is dependent on the piglets. Stockpeople observe the piglets to note if they are huddling together (too cold) or lying outside of the creep area (too warm). This piglet behaviour identifies how hot the creep is, and the lamp is adjusted accordingly on their terms. Initially a 100-watt light bulb was used in the creep, but this was soon changed to 175-watt (with two heat levels) which is better suited to the large creep area. The room temperature is 22 - 23℃ at farrowing and reduced gradually to 19℃ just prior to weaning.

Piglet behaviour is observed by stockpeople to ensure correct thermal temperature

Painkillers are administered as routine to sows prior to farrowing via a powder that is added to their feed. In their experience, sows that get farrowing fever tend to throw themselves down, resulting in more piglet overlays. Providing painkillers to the sow in the farrowing week began five years ago, and resulted in a reduction of 4 % of their pre-wean mortality, with staff observing that the sows were calmer when they laid down to give birth. Ole notices that in summer they see a little higher pre-wean mortality, and attributes this to the fact that the sows are having a hard time being hot and they just lay down. In that way, it is the same as if you have a sick sow that just flops down due to lack of energy, whereas if she is a healthy sow and she feels good, then she can lay down correctly (with more body control). They can also see some more shoulder wounds in the summer since they are sleeping more and therefore more inactive.

Staff take the temperature of every sow to monitor for early signs of sickness- both on the day of and the day after farrowing. If the temperature is increasing from the first to second time, then a third temperature will be taken. Antibiotics are administered (dependant on symptoms) if the temperature is above 39.5℃, in addition to painkillers to make the sow as comfortable as possible. Ole notes that it is not enough for staff to observe if the sow stands to eat, as she can eat whilst also developing a fever, and they prioritise catching sickness in early stages to promote faster recovery.

Manual examinations are most often carried out on older sows, with stockpeople not concerned about completing this task while the sow is loose. Sometimes this can be a challenge if she is lying in a difficult position in the pen, but then the sow will be made to stand in order to provide the assistance. There is no maximum parity for sows, but most exit the system after six or seven litters.

Litter equalisation is carried out so that piglets are equal in size in the same litter, as is fostering of excess piglets. Split suckling is not routinely carried out, with the exception being if the sow has more than 20 liveborn piglets. In order to determine the number of piglets that the gilt or sow will nurse, staff count the number of functional teats and assign the same number of piglets (no additional). Smaller piglets are given to second or third parity sows, whereas gilts are always given larger piglets (for udder stimulation and development) as are older sows (for their milking capacity and teat size). TN gilts are given one less piglet per functional teat, and are flex weaned so that they do not lose too much condition from milk production. i.e. a week before weaning, if a TN gilt has 18 piglets, then the three largest piglets are taken off. During either process of litter equalisation or fostering, piglets are always moved to a sow, rather than the sow moved to them. This is done to help the sow with the acceptance of the new piglets, since she is already comfortable in her own environment. Before being moved, piglet naval cords must be dry (as a determinant of time after birth).

Piglets are processed on day two, as the first task in the morning. During processing, an injection for coccidiosis prevention and iron treatment is administered, naval cords cut (if necessary) and sprayed with iodine. Currently, piglets are surgically castrated on day three however there is an intention to soon to change and use immunocastration instead. Teeth are also ground down but note that they are starting to phase this out.

During the lactation period, sows are fed three times per day, with piglets locked away for the first four feedings. i.e. If a sow has farrowed overnight, then the piglets are locked in the creep during sow feeding time for all three feedings the first day, and the morning feeding of the next day. Two feed mixes are currently used in the farrowing unit- one prior to farrowing and another when the sows have farrowed (noting that the two mixes are slowly mixed/ adjusted to each other, so it is not an abrupt change). At the highest point of lactation, the maximum feed allowance is 10.5 (Danish) feeding units for sows. Frederik thinks that the sows eat a little bit more in this system than what you would see in crated production, but that it is also combined with the piglets helping, in addition to a higher number of days that the sow and piglets are in the farrowing unit together. It is ok that the piglets also nibble at the sow feed, since it is the feeder that they will be eating from after weaning- in this way they are learning from her.

Creep feed is given to piglets from one week of age. In the beginning, each pen is given a handful twice a day, building up to 1kg two times per day. The first creep mix is a specialist mix for young piglets, which is slowly transitioned to weaner feed one week prior to the sows' removal from the pen.

Prior to weaning, sows are classified into a small, medium or large stable gestation group based on their body size, with each group a maximum of 23 sows. The weaning process begins on Sunday, when as many piglets as possible are locked in the creep and then the gate opened for the sow to leave the pen (in gestation group order). According to Frederik, it takes only a minute for the older/ experienced sows to leave the pen, but the gilts can need some more encouragement- with stockpeople using a board and rattle where necessary. The day after sow removal, the weaners are adjusted for uniformity as necessary, filling each pen with 16 and keeping litter mates together where possible. In Ole's opinion, keeping weaned pigs until 30kg in the farrowing pens is an advantage of their system, since a lot of traditional stress at weaning is removed from the piglets- they stay in the same pen, with the same feeders, water source and feed system, it is just the sow that has been removed.

Weaned piglets are fed three times per day, which is increased to four times per day in the last ten days before sale. On average, it takes four weeks to reach the 30kg sale weight, though the smallest can be held back an additional two weeks if needed. One week after weaning, the floor heat is turned off, at which point the room temperature stabilises to 17℃. If any tail biting is observed, ropes are placed in the pens, and more straw is given. The pigs that are sold are moved from the farm on Thursday and Friday.

50 gilts are bought every eight weeks, in a variation of size and age, and housed in a separate quarantine unit until they are moved prior to insemination, where they join the smallest sized sow group. Altrenogest (synthetic progestin) is administered for 18 days to synchronise heat prior to moving them, which finishes about five days prior to arriving at the mating unit. Ole has observed that if the TN gilts are moved prior to this point, then it affects them getting into heat (the movement disrupts their cycle). Gilts are not socialised specifically for free farrowing, though Ole believes that it's a good idea to mix them together with the small sows in gestation because they're already used to the system- this way the gilts get to socialise and learn from the older sows without the pressure of size dominance.

Regardless of task, staff always work from the youngest to oldest rooms and then clean their shoes before going back to younger age animals, both in the sow/ piglets and weaner sections to stop the potential spread of pathogens to more vulnerable animals. Pens are scraped every morning to maintain pen hygiene, and the creep has drying powder put in two to three times a day, to maintain the piglet lying area to be clean and dry. Usually this is only needed for the first two weeks of age. Ole notes that in this sense, these tasks result in the need for an extra 0.5 FTE compared to crated production, since it takes more time to move between the pens as it is on the animals' terms, which is important to him to maintain positive human animal contact.

1.18 Learning to work in the system

When teaching staff to work with free farrowing sows, the first thing that Frederik and Ole focus on is getting that person comfortable in the farrowing pens, being with the sow when she is loose and learning to read what sort of mood she is in. 'It takes time to learn, it takes time to listen to the sow and see what mood she is in, and it is a priority for us that people should feel safe when they are working'. When entering a pen, the first thing you must do is establish contact with the sow so that it is not a surprise for her that you are coming into her space. For stockpeople, checking sows in the farrowing section is one of the most important tasks that they need to learn, and by establishing contact with the sow when entering the pen, they are also keeping themselves safe- since if they are

scared or startled, then they are more likely to react in fear and bite. In this way, it is important that stockpeople are aware of their own actions and what reaction they can create from the sow.

When first entering the pen, contact with the sow must be established

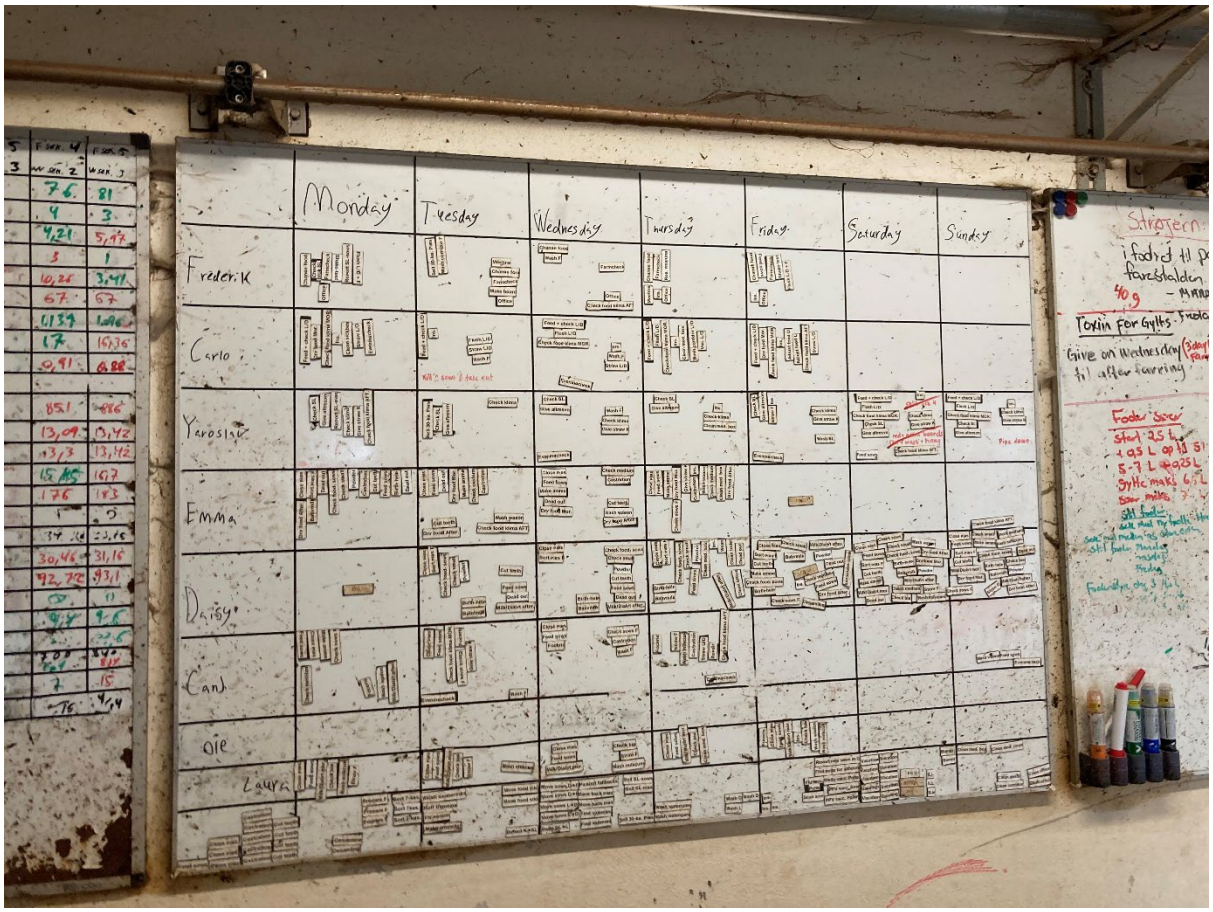
The most challenging tasks for staff are medicating sows and catching piglets (especially when they are vocal and can attract the sow's protection). Not all staff have been able to adjust to working in the system, and Ole notes that it is important to have people where they are comfortable- not only for their safety, but also to ensure that the work is being carried out effectively. Previously, they have moved staff to other sections of the farm as they were too scared to go in with the sows, and the production results were consequently slipping. Moving staff around to suit their capabilities is a focus for Frederik- if staff are scared, then it is not good for them or the sows. Tasks are therefore adjusted to reflect this- e.g. one stockperson responsible for sow medication who is not afraid to carry out the task.

In the main farrowing week, one stockperson is with the farrowing sows and early piglets almost all of the time, in order to keep an eye on how the sows are progressing and provide help when needed. This person is also not involved in the castration, since they prefer to be able to continue walking around the stables monitoring the farrowing process, as that is when there is the most noise from piglets and therefore the sows can become most agitated.

Despite this, they have not seen more injuries to staff as a result of sows being loose. They do note that it is possible that they see more injuries on the piglets- not from savaging or attacking, but it is more likely that they will be stepped on, also as an injury to their tail. The biggest risk for piglets to

be stepped on by the sow is at feeding (hence the piglets are taught to use the creep) or if a sow gets a fright and jumps up quickly.

Ole reflects that different people also see different things when they are checking on the animals, and that depends on their interest and experience- which Nørregaard try to capitalise on to optimise their workforce. It is important to keep staff in their area of speciality for consistency, as for example it is harder for someone to go to the gestation stable and work when they are used to the tasks in the farrowing unit- this is a risk for things to be missed as they do not know how things are supposed to look. In a free farrowing system, this aspect of staff management becomes even more important to the success of the farm and also applies to the weekend roster where each area needs an experienced stockperson. As is the case for most Danish pig production, all tasks are assigned and presented visually for all staff members, encouraging job responsibility and transparency.



Visualisation of weekly tasks for each staff member

1.19 Advice to farmers considering transitioning

If someone calls and asks for Ole's opinion about building a stable, the main thing that he advises is to consider allocating more square metres than what the legislation calls for, simply to be able to use the pen infrastructure for a longer period of time. He acknowledges that although it will cost a bit extra, but it could save the farm if new rules come into play that could otherwise mean you need to rebuild again- so better to be safe for the future.

He notes that if he had the option (if the Antonius brand would allow it), he would prefer to have two or three days confinement of the sows around farrowing, as he has observed many companies that make the inventory to fixate sows temporarily and believes that would help with reducing the pre-wean mortality. He would also like to use wet food for the weaned piglets, since a lot of the time in the current system (mixing his own feed) the feed can get stuck in the feeder which costs in labour.

When Ole thinks back to how things were ten years ago when they started farming with free farrowing sows, everything was new- housing, feeding and management challenges, with no one to ask which was especially hard for him and the staff. He has had to work a lot of things out for himself and admits that he has used a lot of hours on this, but now that the system is working well, it is effective, and he enjoys it. His advice is clear though, that to make the transition successfully to free farrowing production, you need to have the interest in doing it. 'If you're just looking for, I don't know if it sounds silly, but if you're just working for profit then this is not the system- I try to inspire other farmers to do it, because if you like working with animals, this will be the right system.' Frederik agrees with this and enjoys working with the sows being loose 'When you switch the lights on in the morning, the sows all get up and come and say hi, and I find that really nice to work with'. In that way, it is also important to optimise the workforce, for staff to be working where their strengths are. This can of course be a challenge with sourcing labour, but it is a key to success in their opinion.

7. Frenderupgaard

Frenderupgaard is a 1 400 sow loose lactation production owned by Niels Aagaard Jørgensen and his wife Mia, producing 52 000 30kg pigs for sale each year under UK production for Danish Crown. The farm has 348 farrowing places with temporary confinement for sows around farrowing. They also have 225 ha of arable land and produce all their own food themselves, except for soy and minerals which are purchased.

The initial conversion to loose lactation production was made five years ago, though it has been a dream of Niels to implement this system for many years. Three pen designs have been installed, with 60 farrowing crates still used in production. It is intended to transition these remaining crates to loose lactation pens in 2026. The process of transition has been a gradual one and has also been used an opportunity to test three different pens- with the preferred pen type (as presented in this case study) to be the replacement of the remaining crates.

1.20 Key production figures

Born alive per litter (gilts and sows)-
Pre-wean mortality- 11.8 %
Weaned piglets per sow per year-
Average weaning weight-
Average weaning age- 26 days (30 taking into account nursing sows)

1.21 Pen design

The preferred pen that has been installed at Frenderupgaard is 3m x 1.8m (total area of 5.4m^2) and was built by Jyden (since overtaken by Skiold), though Niels also had some of his own ideas incorporated. He notes that if she should make any changes to the pen design, it would be to increase the 1.8m side to 2m, to make it easier for the older/ larger sows to turn when they are less flexible.
There is a designated creep area for piglets with floor and lamp heating, with this placed at the opposite end of the pen to the aisleway, allowing easier viewing of piglets by stockpeople, which is also why this is the preferred pen design. Temporary confinement is to the sow is enabled via a crate, whose wings fold back to create a protection mechanism for the piglets in the pen (restricting the sows access to all areas).

Overview of pen with sow in temporary confinement

The flooring is a mixture of approximately one third solid concrete and two thirds cast iron slats. Ventilation and temperature control is a key factor in making the pen design work, since a draft is provided at the front of each pen for the sows, designed to keep her cool and to encourage the piglets to stay in their creep as the slats are too cold to be comfortable for them.

Ventilation is provided above each sow

Niels feels that the secret to success in reducing the piglet pre wean mortality in a loose lactation system is to make the creep as comfortable as possible, and the outside as uncomfortable as possible, as he thinks the piglets are also drawn to the dark protective nature of the creep with a roof over their head to rest safely, with the lower light also attracting them to this.

1.22 Sow and piglet management

Frenderupgaard is a full line DanBred genetic system (including Top Duroc semen), with weekly farrowings of 63 sows. When sows are moved to the farrowing unit, they are initially loose so that they have a chance to get used to the pen, usually for three to four days. The day prior to their expected farrowing date, they are confined in the crate (confined for 24 hours before they are due to give birth). Temporary confinement is opened on an individual pen basis four days after birth, with no specific time of day that this occurs.

During farrowing, straw is placed behind the sow so that the piglets are able to get dry as fast as possible. Niels notes that in the summer it is not so bad, but since the sows are giving birth onto the slatted floor it is important that they have something to help the piglets and prevent temperature shock as it can get cold in that location even if the temperature of the room is 25℃. Boards are used behind the sow to direct the piglets to the creep via a v shape towards the creep, rather than having piglets wandering around the slatted flooring getting too cold and easting energy. These boards are

removed when the sow is finished farrowing. Additional straw for enrichment is given every day in via a metal straw holder, for the sow to pull out as she likes.

On a weekly basis, stockpeople are assisting an estimated 10-15 sows with a manual examination during farrowing (approximately 20 %). The sows are in temporary confinement for this process however, so it is the same procedure as it would be in crated production.

The large numbers of born alive piglets are managed using nurse sows and providing milk to piglets via milk cups. Milk cups are cleaned once per day and started for piglet use when they are one day old. Nurse sows are made in the first 24 hours after birth, with larger and stronger piglets chosen for movement a nurse sow. If there are any extra small piglets, second or third parity sows are used in preference as a nurse sow since they are softer on them. It is estimated that up to 30 % of the farrowing places are used by nurse sows, which is the same typical ratio seen in crated production.

When making a nurse sow, stockpeople count the number of functional teats of every sow, with the goal being for the first three litters, the sows are given two more piglets than the number of functional teats. In gilts this is done to stimulate their udder development, and later for older sows as they have the milking capacity for it. Since most of the sows have 14 functional teats, the first three litters are therefore typically given 16 piglets (i.e. two more than they have functional teats). For parity fours and five, stockpeople look at how she has performed, and is usually given 14 or 15, depending on the number of functional teats, acknowledging that often after four or five lactations, there may be a teat that does not work. It is for this reason that it is important that stockpeople count functional teats even in the older sows to identify accurately what she can raise herself.

Stalosan is used in the creep area once before birth, with more added as necessary to keep the creep dry. Pens are not scraped every day but done on an as needed basis if the pen hygiene needs improvement. Litter processing is carried out in the first two days and includes tail docking and iron injections. Piglets are not castrated, neither surgically nor immunocastrated (though they are all sold as 30kg pigs).

Initially sows are fed three times a day in lactation, and once all sows in a section have farrowed, this is increased to four times per day. Sows are made to stand at every feeding for stockpeople to carry out individual welfare checks. Piglets are locked in the creep for the first 24 hours each time the sow is fed, this helps teach them to use the creep for safety whilst also keeping them out of the sows' way so she can stand and eat without the risk of stepping on a piglet.

When the sows are loaded into the pens the room temperature is 18.5℃, which is raised to 21 ℃ at farrowing. Once farrowing is finished, the room temperature is reduced gradually to 19℃ at weaning. Heating fins are used in the winter to give extra warmth, and to help with the drying of the rooms after washing and disinfection between batches. Heating is delivered in the pen from both floor and lamp heat. The floor heat is reduced via an automated curve, and the creep lamp is turned down as according to the piglet behaviour (with stockpeople observing if they are laying comfortably in their creep area).

Correct thermal temperature for sows and piglets

Niels thinks that they can observe a seasonal effect on productivity- if there is a hot period then it can be an issue with piglet overlays if they are choosing to be in the sows' area to be cooler. In addition to the summer, he also notes that if there is an Autumn which is very wet, cloudy, cold outside and the weather is changing a lot, then this can be a bad period for production since it is often when diarrhoea in the farrowing unit is a challenge due to optimal conditions for bacterial growth.

Sows are never culled for aggression- simply as they don't see truly aggressive sows, and they never experience an aggressive sow in the gestation unit. If they experience a sow showing aggression in the farrowing unit, it is just nature- she is protecting her piglets. They handle it by making sure that all staff know that she is protective (via signage at her pen) and is treated with caution- though it usually passes as the piglets get older. They don't observe that gilts are more stressed or nervous than sows when entering the farrowing pen for the first time, they find the gilts calm and not reactive. 'It is seldom where we have a sow that will bite a piglet, it is not very often at all and that goes for people too'.

When they made the transition to loose lactation, Niels believes that he saw an increase of approximately half a kilogram per weaned pig improvement in weaning weight. He does not think that the sows are eating more during lactation, but observes that they are more active, and turn around a

lot more in the pens than when they are crated. Weaning occurs on Friday, with sows moved out of the pens first, followed by piglets moving to the weaner section on the same day.

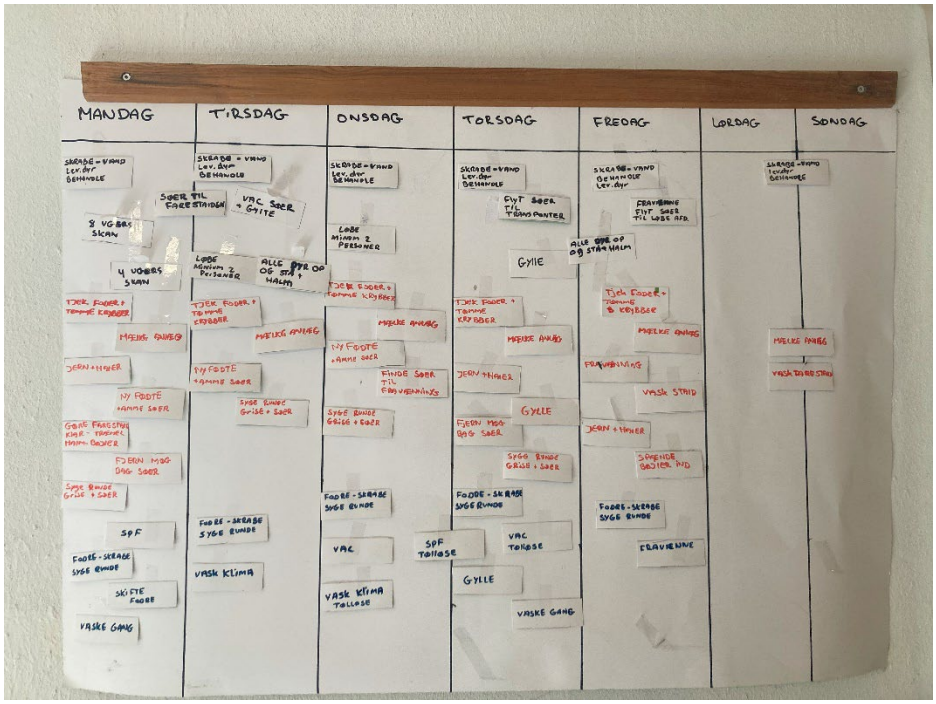
Previously Frenderupgaard have made their own replacement gilts, but as of last year they began buying them in due to a lack of space. Altrenogest (synthetic progestin) is administered to the gilts for 18 days for heat synchronisation. Electronic feeding systems are used in the gestation unit, and training gilts to use this system is when gilts are predominantly socialised. When gilts are approximately five months old, they are brought to the training area from the quarantine unit, with this period chosen since it is better for them to lose a little bit of weight in this compared to later. Gilts spend four to five weeks in this training pen. Backfat scanning is not carried out on every gilt, but a sample size is taken every month to ensure they are in the right target range (13-15 mm by first mating).

In gestation, sows are kept in stable groups to a maximum of 70 animals. Gilts are mixed in these groups, although they move to the gestation pen the day before the rest of the sow population, which reduces fighting and aggression at pen entry/ mixing. Of the 63 farrowings each week, 15 of these should be gilts. Although there is no maximum parity for sows, usually at parity eight or nine they need to be culled for size regardless of performance.

1.23 Learning to work in the system

Frenderupgaard employs eight staff full time on the farm (including an agriculture college student), plus Niels (considered as an extra labour source when needed). Staff are a mix of Danish and foreign persons who are from three different countries- Ukraine, Vietnam and Uganda. Language can be a challenge, as is culture- in respect to making sure that people truly understand the task and what is expected of them to complete it. He notes that it is one thing to have a plan and schedule, but it is another to follow up on the tasks with the staff- which is the key to performance.

All tasks are included on the working roster board for everyone to see. Each Friday morning this is reviewed for the week ahead between Niels and his manager, to be sure that all staff know what they are responsible for each day in the coming week, and that all sows and piglets are taken care of. Niels is in the farm almost every day to see how things are running and help if needed. Each evening, he is checking the farrowing unit, though is particularly careful on Sunday, Monday and Tuesday nights since these are the main farrowing days.



Overview of the weekly tasks

Each Wednesday morning an all staff breakfast is held by Frenderupgaard where everyone in the farm is expected to meet, and any changes or issues are discussed as a group. At that meeting, if there is to be a change to be implemented then everyone is informed at the same time- regardless of where in the farm that change may be. 'Everybody knows the same and everybody gets the same information'. This is important even for people to know what is happening that are not working in that section (i.e. gestation and farrowing unit).

The sow farm at Frenderupgaard is divided into three working units- the gestation and the service unit, the farrowing unit and the weaner unit. There are three persons that are specialised in working on a daily basis in both the gestation and farrowing unit, and two in the weaning unit. Three persons work every weekend, and each area must have a specialist working within it that would normally be working there during the week- even though the staff are helping each other, it is important that everyone is familiar with the tasks that need to be carried out.

Staff are taught to look when they are walking through the aisles to observe the piglets first- don't just walk straight through to where you are going, pay attention to the pens and what is happening in them to identify if there is something that is not right. This approach is really emphasised to everyone working at Frenderupgaard, and it is aimed that this will pick up things quicker that are wrong. If staff see a problem, then they need to either act on it right away or at least make a note so that the person responsible for the section can take care of the issue.

Cloudfarms is the herd recording software program used at Frenderupgaard, and it is also the tool that is used to record individual animal status- used as communication between stockpeople to identify animals that need to be followed up on. For example, the farrowing sow status is recorded, so that all staff members can see what stage of farrowing she is at and when she was last checked. All staff have a phone with them, and there is Wi-Fi signal in all the stables. This way, people can stay connected, and everyone can see the performance/ results in real time so everyone is clear on what is happening

in the herd. If a specific sow or piglet needs more attention then all staff members can be aware of this, with the tool helping to ensure that all animals are managed in a timely manner.

There aren't really any tasks that staff reportedly don't like doing, except for perhaps managing the odd sow who is protective of her piglets. Aside from that, they find that it is not so different to work with than in crated production (i.e. the tasks are the same that need to be carried out). When transitioning, he didn't think that it took a long time for his existing staff to learn to work with the sows being loose, but then he also acknowledges that they were people interested in working there that wanted to work with loose production, and that's the best part for them. He also doesn't think that there was a particularly big lag in production figures and believes that they got into doing what they wanted to do quite fast. He attributes this to being prepared, talking to other farmers who had made such a set up and learning from their experience- not much has changed from what they originally implemented in terms of the management of the sows.

Niels cannot recall an injury from the sows to people since making the transition. He highlighted that the key importance is to establish contact with the sow prior to entering the pen, and if they are displaying an aggressive behaviour, or protecting their piglets, then don't immediately walk in with them unless necessary. It is stockmanship- 'you can feel it by the sow, if you can just reach a hand to the sows- if she is aggressive, she will go for it, and if she's not, and you can get your hand on the sow then that's it, you can walk in'.

When new people start to work with loose lactation production, it takes at least a month in Niel's opinion to start to be comfortable working in the system- with the full capacity after two or three months. In the first month, it is mostly following an experienced person around to observe and learn with them before they can work competently on their own- though this is of course dependant on their prior experience with pig production. This applies not only to foreign staff that they might need to teach, but to the students that are hosted from agriculture college, who can also require a lot of following up to determine if they are competent at a task.

1.24 Advice to farmers considering transitioning

In general, Niels feels that he was ready to make the transition, and once the decision was made, then the mentality became about finding solutions to challenges. 'Well, there wasn't a lot that was surprising me. I have always been interested in the system with loose housing and when we did the loose housing in the gestation many years ago, there was lots of farmers who said that 'oh, we couldn't do that we couldn't do that'. But I still did it because I had our work with some of the first herds where we have loose housing for in the gestation and I think that was a good experience, so I'm not afraid to do the next step.'

He notes that the worst part was the expense of the pens, and since there are more square metres involved in loose lactation production, then this always worries farmers since it is an additional expense with no additional return for the business- but it helped that they could speak to other farmers about their experience that they had in a similar position.

'The mortality of the piglets has been up and down, but is now stabilised around 11-12 %, which of course we could wish that was better, and we are working on a daily basis to improve, but for loose

housing I think that is ok.' (This is also better than conventional production using DanBred genetics in Denmark, with the average 14 % in 2024).

Niels uses his network well- both he and his staff participate in professional learning groups for farmers, where they sought a lot of information prior to making the transition, so everyone could be as prepared as possible for the change. He also looks to SEGES Innovation for their professional knowledge and help, though acknowledges that having the science is one thing, but putting it into practice must also be possible for people working into the system, since it is also a business at the end of the day. He considered what was important for the sows and for the staff, and how to run the farm. He also hosts other farmers that are considering transitioning to loose lactation production and is regularly part of school visits/ open days for public to come and see how pig production is in Denmark.

8. Krannestrup

Krannestrup, owned by Niels Aage Arve and his son Kristian Arve, is a 1 350 sow loose lactation system that has been in the family since the 1890s. In addition to pig production, 470 hectares of crops are grown each year, including wheat, rye and barley (mostly for pig feed) and canola and grass seeds as cash crops. The manager of the pig production is Rene Dejgaard Thomsen, who together with about ten employees operates a weekly farrowing system with a total of 348 farrowing places with temporary confinement for sows. Approximately 46 000 pigs are produced each year, where 25 000 are sold at 30kg and the rest are finished to slaughter, suppling the UK and California production concept of Danish Crown.

The site in which sows are housed today at Krannestrup was built in 2012. The decision to build a new site with loose production was driven by the fact that the old 800 sow site still used gestation stalls, and to keep operating after 2013 (to comply with incoming Danish legislation on gestation housing) they needed to change the inventory, so decided to increase the herd and incorporate loose production in both gestation and lactation periods.

1.25 Key Production Figures

Born alive per litter (gilts and sows)- 19.2
Pre- wean mortality (of liveborn piglets)- 16 %
Weaned piglets per sow per year- 37.3
Average weaning weight- 5.9 kg
Average weaning age- 29 days

1.26 Pen Design

The pens used at Krannestrup are 2.1m x 3m (total area of 6.3m^2) and were built by Jyden (since overtaken by Skiold) with a total of 348 farrowing places. Originally, half of these places were free farrow and half temporary confinement, as Krannestrup was used as a commercial trial of pen design. At the conclusion of the trial, temporary confinement was added to all pens since a lower piglet mortality was clearly demonstrated by an additional piglet weaned per sow using temporary confinement.

Overview of pen design, sow in temporary confinement

There is a designated creep area for piglets with floor and lamp heating, with this placed at the aisleway (staff can lift the lid to observe piglets). The temporary confinement of sows is enabled by a crate, whose wings fold back to be secured against the pen wall and piglet creep. Social contact between sows is enabled via nose-to-nose contact at one side of the wall at the slatted end of the pen (opposite to the feeder). There are two troughs in the pen- one for when the sow is temporarily confined (where she is hand fed) and another trough connected to the main feed line that is used when she is out of confinement. Heat fins around the edge of the rooms are used for drying between batches after washing and disinfection, and scrapers are used to manage the slurry system.

The flooring is a mix of approximately one third cast iron slats and two thirds solid concrete. There have been many minor modifications to the pens over the years since installation. Rene thinks that the most successful modification was the movement of the side wall to the middle of the pen, so that the sow can remain confined but in a different position. In this way, there is better access to the udder from both sides, so it does not matter which way the sow lays down. This modification meant that the confinement of the sow remained, but it moved her a bit more out from the wall, enabling not only better udder access but also creating more room for the staff to work.

Overview of pen design as seen from rear of the pen. The additional bar can be observed that moved the sow away from the wall

As according to Rene, the biggest challenge that they see with the pen design is that there is too much solid concrete flooring, as it causes issues with hygiene conditions for the sow and piglets. It could be changed since there is enough air space underneath the flooring, but it would be a major operation that is not realistic commercially viable to implement. Rene also feels that the solid flooring is too nice for the piglets to lay out by the sow, and therefore it is not only a hygiene challenge, but also contributes to the crushing of piglets.

Farrowing pen overview with crate folded back, as seen from aisleway

1.27 Sow and piglet management

Krannestrup is in the process of transitioning their female line from Danish Genetics to DanBred and use DanBred Top Duroc semen. The oldest DanBred animals were at their second parity at the time of this visit, and therefore much of the sow herd (60 %) is still Danish Genetics.

Sows are moved into the farrowing pens on Wednesday, where they remain loose until two days prior to their due date to get used to their surroundings. It is most often Fridays that the sows are confined to the crate where they remain until the Monday after they have farrowed. Gilts are the exception to this rule- their confinement is opened earlier on the Friday, even if that means that they only have three to four days in confinement. Gilts are more agile in their body and can easily handle being loose earlier- this not only saves labour (from handfeeding) but also allows the gilts to relax. For the sows, the confinement is opened at the second feeding on Mondays- the entire room at the same time. The only exception to this a sow which has been identified for use as a foster sow, since it is more stressful to have to re-confine her later.

When sows are first entering the pens, the room temperature is 19 ℃ which is then raised to 20.5 ℃ for the week that the sows are farrowing and reduced to 19 ℃ again once the farrowing is completed. Straw is provided each day to the farrowing sows on the floor when they are in confinement, and via a basket when they are loose.

The biggest farrowing days are Monday, Tuesday and Wednesday, with all sows receiving a non-steroidal anti-inflammatory pain relief after farrowing- this is also given to foster sows when they have received new piglets. It is estimated that approximately 10 – 15% of the sows are given a manual examination during farrowing each week, but since they are already confined this is the same procedure as in crated production. After farrowing, the temperature of every sow is taken to monitor early signs of sickness.

To prepare for newborn piglets, sawdust is put in the creep prior to farrowing, with heating provided via the floor and lamp. Usually, the lamp is turned off after three to four days, but this is depending on the piglets. In their experience, it is better to shut it off too early than too late so that the piglets are not learning to sleep outside.

Sawdust is placed in the creep prior to farrowing, piglets are seen here at a comfortable temperature

Previously Krannestrup have performed litter equalisation and split suckling, but not anymore since it created a lot of extra work for no real benefits- instead they focus on keeping as many piglets with their mother as possible. To get the sows and piglets off to a good start, a specialist stockperson is responsible for the farrowing week, who spends all their working hours taking care of the farrowing sows and newborn piglets and can monitor piglet nursing and milking of the sows.

Additional piglets are managed via nurse sows, with the largest piglets prioritised for selection for movement, though if there are enough small piglets born then they will select a sow that can take care

of them specifically. Each week up to 30 % of the farrowing pens are used for nurse sows, and this procedure is carried out within 24 hours after birth. All gilts are given an additional two piglets per functional teat to raise, with sows usually given the same (provided they could raise them in the previous parity). Litters are processed on the second day, with iron injection and tail docking, and all males are left entire.

When the sows enter the farrowing unit and in the farrowing week, they are fed twice per day. The week after farrowing this is increased to three times per day, and then one week later again on Fridays they are increased to four times per day feeding. Sows are made to stand every feeding to check their condition, and piglets are locked in the creep for the first three sow feeding times.

Milk cups are not used, though a specialised yogurt (mixed from a powder) is given as an extra boost for the smallest and foster sow piglets from day one. Creep feed for piglets is initiated in the first week and is provided in the creep four times per day.

Piglet creep feed, each week is an increase in scoop size

Piglets are usually weaned from the sows at least at 27 days, and the sows are moved out of the pens on Sunday and the piglets moved out on the Monday. When the sows are moved out, the piglets are distracted by feed in the creep.

If they experience a hot period in the summer, the piglet mortality can be higher since they are laying outside of the creep more, so they are more at risk of being crushed by the sow during a posture

change. However, Rene also notes that in general the pens are often cleaner in the summer than in the winter since there is more air being drawn through the stables, so it evens out.

Gilts are bought in from a multiplier in batches of 15 – 22 weeks of age and spend seven weeks in quarantine at a separate location prior to being moved to the main sow herd. They are then housed in the pens right by the entrance to the farm and are subsequently socialised since staff are always walking past them and able to make positive contact. A synthetic altrenogist is used for 18 days for gilt synchronisation, and to train them to take this, they are first given apple juice as a sham (teaching them to come to the stockperson for a treat).

1.28 Learning to work in the system

Krannestrup has six full time staff working with pig production, with three and a half of those dedicated to tasks in the farrowing unit. On Mondays, an all of staff meeting is held to review the productivity figures and discuss the upcoming week to ensure that everyone is informed at the same time. The standard working time for stockpeople is 7am to 3.30pm, with evening checks conducted on Sunday, Monday, Tuesday and Wednesday. This is carried out anywhere between 7 – 10pm, and is only focused on the farrowing section, usually taking less than an hour. Staff work one in every three weekends, with two people able to cover the workload- there almost never farrowings which helps reduce the amount of labour needed.

Most of the staff at Krannestrup have been working there for a considerable time (including Rene himself for 18 years) and are therefore quite experienced in pig production and working together as a team. Approximately half of the workforce are Danish and half foreign, though all of them have a permanent right to work in Denmark. When a new stockperson is started, they first need to follow an experienced stockperson, learning by watching and doing a task with supervision. Since the sows are confined during the period of the highest risk of aggression, Rene notes that it is usually not so bad for people learning to work in the system, though if they are scared entering the pens, then they tend to have more challenges since the sows are reacting to their presence and energy.

The farrowing manager works exclusively with the farrowing sows and newborn piglets during the first week, after which point the management of the animals is moved to other stockpeople working in the farrowing unit. As is it the first few days of life which is the most crucial for getting piglets off to a good start, Krannestrup prioritises having a specialist that only works with these tasks every week. This also helps a lot also with the time management, as it older litters do not need as much time spent on them once they are started correctly.

When Krannestrup first made the transition, it was not only the management of the sows and piglets in loose lactation production that had to be learnt, but also how the pen functions and what features should be added or taken away. Many trials have been run at Krannestrup to try and figure out what works best for their system. Initially, staff were afraid of the change, since they were worried about the confrontation of the sows, though Rene has observed that this has lessened since the sows were confined for the farrowing duration. He can only recall one injury since the transition- a sow biting him on the leg, but admits it was his mistake since he stepped in front of her when she was eating.

Some tasks can take longer to complete when compared to crated production- this is usually since there is more inventory in the box to navigate, and this can especially have an effect when stockpeople

need to catch piglets as they have more area also to run around. However, moving sows and piglets in and out of the pens is easier in loose lactation production, with Rene responsible for this task, where on average it takes him 45 minutes to move 58 sows out of the pens at weaning.

There have been many ups and downs in productivity since the transition, with genetics, health, and management having an influence. Gilts were used to start up production at the new site in 2012, and in the beginning, this contributed positively to production results. However, as the sow herd gained age, they experienced that this challenged the results due to higher layovers of piglets. Therefore, three years ago they began working on their culling and replacement strategy and have seen the benefits. The current strategy is that most will exit the herd after parity six, and unless they are exceptional performers then they don't go further than that. Rene reflected that they had a lot of years where they were steadily around 20 % pre wean mortality, but in the last two years this has been reduced to average around 15 %. This is partly attributed also to the change in genetics, from Danish Genetics to DanBred (the oldest DanBred sows are now at their second farrowing), and partly also attributed to disease impact- with circovirus (PCV3) developing in the herd that caused the sows to farrowing two to three days too early and weak piglets being born (piglet mortality was up to 30 %). Rene is in professional farming learning groups, and has regular advice from vets, advisors, researchers etc visiting the farm- so there is a strong network to consult for help to solve challenges as they arise.

1.29 Advice to farmers considering making the transition

Renes advice with regards to pen design for farmers considering transitioning is clear- have a fully slatted floor, and the pen should be 2.4m x 2.4m (square design). That is what he sees working successfully in newer installations of the SWAP pen, where in the newer design of the pen, they do not need to feed by hand when the sow is confined temporarily. The fully slatted floor improves the hygiene of the pen and therefore the performance of the system, although despite this challenge at Krannestrup, they are not scraping pens regularly.

When learning to work in the system, Rene highlights that it is important to have respect for the sows- make yourself known that you are coming into their space. Don't be banging or make loud noises- if you stay calm and relaxed, then she will stay calm and relaxed. That is what he teaches the most to people that come to see how the system is working. 'Let her know that you're coming. Because that's the biggest problem is that she's often sleeping, and then you're standing there and looking at her, which can frighten or anger her. So let her know that you're coming. Touch her a little bit if she's laying away from you so she knows you're coming. So that's the key.'

In general, he reflects that at the basis of it, most tasks are the same as that of crated production- at the end of the day it is still pig production. Some things of course take longer to complete and there is a higher level of management and stockmanship required, but most of the challenges can be compared to crated sow production in terms of disease, reproduction, nutrition etc. What is different however, is that mortality of the piglets goes up much faster when there is a problem in loose lactation production, so you need to be more on top of everything- a higher level of management and observation of the animals is required, in this sense you need to work with pens individually. Rene prefers working with sows that are housed loose in their lactation period 'It's the way that's better for the sows, there's no doubt about it, she has more freedom.'

9. SunPork- the Maternity Ring

The SunPork group the largest pig farming integrator in Australia, consisting of 53 000 sows and producing 1.25 million pigs farrow to finish each year. In October 2024, the announcement was made within SunPork group that all farrowing crates would be converted to the Maternity Ring, a free farrowing pen that their research and innovation team has been developing over the last ten years. 1 000 Maternity Ring pens are already installed in five sites across Australia, with the group committed to converting the rest of the farrowing places in the coming years.

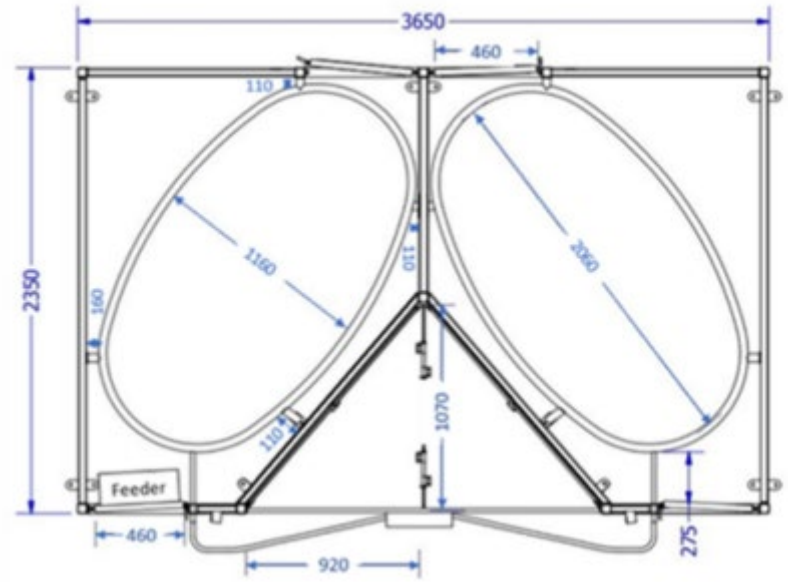
Dr Darryl D'Souza, Executive General Manager - Technical Services, and Dr Kate Plush, Science, Technology and Adoption Manager, shared their experiences in developing and implementing the Maternity Ring in SunPork farms.

1.30 Key production figures

Born alive per litter (sows and gilts) - 15.8 pigs (average parity 3.4)
Pre-wean mortality (%) - 15.4%
Average weaning weight (kg) - 6.9 kg
Average weaning age (days) - 20.8 days

1.31 Pen design

The Maternity Ring provides 4.32m^2 of available space for the sow and her piglets, enabling this design to be retrofitted into an existing farrowing crate footprint. As seen in figure 1, the Maternity Ring pen is 1.8m in width and 2.35m in length, with a triangular creep area measuring 1.07m x 0.92m. The ring itself has internal dimensions of 1.16m x 2.06m and is placed diagonally within the pen at a height of 25cm from the floor. Two gates provide two entry points to the front and back of the pen, allowing stockpeople access easily to all areas of the pen. The creep is fitted with a hinged lid, with heating provided via heat mat and an LED light to attract piglets.



Dimensions of key design features of the Maternity Ring. (K. Plush et al., 2024)

The key design feature of this pen is the ring, which provides the sow somewhere to lie against whilst reducing piglet overlay, acting in the same way that a sloped wall does in other free farrowing pen

designs. The sow is not restricted in her movement in the pen and is able to freely turn around throughout the entire lactation period.

The entire floor is slatted to allow for good pen hygiene. Initially, the ring was installed on plastic slatted flooring, though this is now changed to Tri-Bar slatted flooring, a flat-topped steel flooring. This change was made to encourage piglets to make use of the creep, since it is not as comfortable temperature for them to stay lay outside their creep area as the Tri-Bar floor temperature is much cooler, which also helps keep the sows at their optimal thermal temperature. The goal of the pen is to keep the sow area below 20℃ and the piglets' area in the creep above 30℃ (as newborns). The current version of the Maternity Ring is version ten- with the group now happy with the current features and functionality. Additional minor changes include the installation of a quieter chain for locking the creep, that doesn't startle the piglets.

1.32 Sow and piglet management

Across all SunPork farms, specific stockpeople are trained to provide assistance to sows and piglets on day one. This involves monitoring birth intervals, assisting sows, drying piglets at birth using drying powder, tying up umbilical cords, warming cold piglets and moving them to the creep area. Split suckling is performed on all sites to ensure adequate colostrum intake, with piglets also placed on the udder of the sow. On smaller farms this occurs as soon as litters are born, though on the larger farms this is done twice a day- first thing in the morning for any sow that has farrowed overnight, and last thing in the afternoon for any sow that has farrowed during the day. Kate prefers that sows are milked for colostrum which can then be administered to piglets that need it, though also notes that Piggy Boost (an energy drench) is used when the staff either don't have time for milking or the colostrum availability is limited.

In their experience, fewer sows require manual assistance during farrowing in the Maternity Rings compared to farrowing crates, with the height of the ring allowing for staff to place their arm over the bar to assist the sow- if the sows are in a position that is difficult to access, then they are stood up for the examination.

Nurse sows are used throughout the sites, making up approximately 15 % of the farrowing rooms. Increasing the number of functional teats has been a focus in the selection of the replacement gilts, and although they see the positive results of this, the number of piglets born alive still outweighs the number of functional teats. As a rule, sows are assigned the same number of piglets to raise as functional teats, with gilts and well performing parity one sows being assigned an extra piglet.

Piglet use of the creep is crucial to the success of the Maternity Ring, as it is for all other free farrowing pen designs. The light and heat in the creep attracts and retains piglets, and they are taught to use the creep area as a safe space. Piglets are locked in the creep for the first three days whilst the sow is feeding, to ensure that they are protected while the sow is given time to eat without disturbance. Fostering is carried out during the afternoon feed time, which is not only a practical strategy for the stockpeople since the piglets are already confined while the sow is eating (preventing double handling of the litter) but also allows the litter to co mingle with their litter mates for an hour before they are let out after the sow has finished eating and is laying down.

Less udder damage has been observed on sows in the Maternity Ring, as are less piglets dropped back due to ill thrift. Although it is not experienced that the sows are eating more throughout the lactation

period in the Maternity Ring, it is observed that they are milking better than sows in crates. Kate attributes this to the likelihood that they can stretch out more during milk let down than sows in crates- allowing a better access to the udder and subsequent stimulation from the piglets.

Feedback given from managers is that the weaning weight is higher in the Maternity Ring than in crates. Although this hasn't been able to be able to be demonstrated in their research, Kate notes that this is likely due to the fact that piglets are weighed out of trials at 21 days, although the actual weaning process occurs after this point, accounting for the higher weight gain. The higher weaning weight is thought to also be attributed to a reduction in the prevalence of scours, and less ill thrift or runt piglets being removed, resulting in less of a tail end in piglet quality that is usually seen in crates.

It is not only the weight of the piglet that should be considered, but also the health that contributes to the quality and robustness of the piglets being produced in the Maternity Ring pens. In the New Zealand herd that is transitioning, medication usage has been reduced from 62 % to under 50 % of the litters, primarily due to a reduction in the prevalence of scours. This is attributed not only to the better pen hygiene in the Maternity Ring, but also to increased colostrum intake in free farrowing (as demonstrated by (Nowland et al., 2019). Additionally, from a more practical perspective, the design of the Maternity Ring means that it is more difficult for stockpeople to walk between pens when medication is administered. This task is usually done whilst the piglets are contained in the creep, rather than walking into the pen and transferring potential disease. Additionally, the Maternity Ring allows for the right thermal environment (via the creep) for the piglets from the day that they are born, resulting in less temperature fluctuations that can often result in neonatal scours.

The SunPork group uses PIC Australia genetics, with most sites producing their own replacement gilts. Although the gilts are not specifically prepared for the Maternity Ring in a different way to the farrowing crate, Kate recommends that gilts are dispersed throughout the farrowing room, rather than keeping them all together. i.e. gilts are integrated with the rest of the herd from farrowing, that way they are not disrupting each other. Additionally, in herds that are transitioning and have half Maternity Ring pens and half farrowing crates, gilts that have farrowed in a Maternity Ring pen are always returned to a Maternity Ring pen for their subsequent litters. In that way, older parity sows that have always farrowed in a crate, stay in the crate, but gilts and early parity sows are identified to ensure they come through the new pen system. Younger sows should be the priority of the herd, and using this strategy ensures that the younger sows are exposed to the Maternity Ring, which assists in the transition process if a herd is installing the Maternity Ring in stages. It is also really important to be on top of the parity management and culling strategy of sows that are not performing- since they will bring the performance of the system down, which can be amplified in free farrow systems.

Aggression of sows to piglets nor staff has been experienced in the Maternity Ring- it is observed that sometimes there is some chatter between the sows when first loaded into the pens since the pen design allows for social contact, but after the first day it generally subsides when they are used to their neighbour. As the Maternity Ring allows for the sow to have 360° view of her surroundings, she has complete visual access compared to the restriction in farrowing crates, which Darryl attributes to a calmer sow to work with. One of their biggest concerns when developing a confinement free farrowing system was for staff safety, but Darryl highlighted that the people that are now working in these systems are the absolute advocates of how calm the sows are to work with, more so than in crates. Visitors to the sites have noticed this too, with sows often jumping up in the crates to try and see

what is happening, whereas the Maternity Ring sows often do not even stand, which has also been able to be demonstrated via startle tests.

Sows are sometimes protective of their piglets in the first few days after farrowing- though Kate describes their approach to training of the stockpeople is to recognise that this behaviour is not aggression, but rather a reactive sow, who is just a mum being a mum by protecting her piglets. This behaviour almost exclusively subsides the day after farrowing. All sow medication is administered via slapshots and conducted whilst the sow is preoccupied by eating- usually this is given in the rump, not only protecting the safety of the stockperson but also minimising the negative experience of the sow. To further highlight the calmness of the sows in the system, only one minor injury has ever been recorded across all sites and did not result in any lost time from work.

1.33 Learning to Work in the System

SunPork are currently developing their Certificate 4 training module specifically for stockpeople to learn to work in the Maternity Ring. Once completed, this will be available for delivery to the wider Australian industry.

When learning to work in the Maternity Ring system in Kate's experience, good farrowing attendants in crates step up really quickly to working in a free farrowing pen. Labour that already exists on the farm for other tasks that are not specialised in the farrowing room will generally take longer to adjust. In this way, it is better to have competent staff in the farrowing unit in the first days of the piglet's life- acknowledging that the attraction and retention of such skilled labour is a challenge for Australian and indeed global pig production. Darryl described that to work successfully in the Maternity Ring, you actually have to be a stockperson. You cannot just run a checklist in the way that you can in a farrowing crate- each sow must be approached as an individual animal- observe what she and her piglets' needs are and adjust the approach to tasks accordingly.

Like most Australian pig farms, a significant part of the labour force in SunPork is sourced from foreign labour, with staff usually coming from countries where there are no free farrowing systems. These stockpeople are heavily trained and experienced in crated production- so it is natural to observe that in sites that have both farrowing crates and Maternity Ring pens, there is a bias towards working in a crate. Kate explained that in the initial stages of a site's transition, often the Maternity Ring pens were not getting the attention that is required from the stockpeople, simply as they would prioritise spending time in the crates where they were comfortable with the tasks as sows were confined. However, Kate also noted that in the site where there is 100% conversion, or where there are good stockpeople doing experimental work, they actually end up preferring to work with free farrowing production and can observe some of SunPork's best stockpeople now thriving in the Maternity Ring.

Spending time in the farrowing weeks with together with the stockpeople that are learning to work in the Maternity Ring is important- this gives the stockperson the ability to relax and learn, knowing that there is an experienced person there to help them with working instructions that can be provided visually in the initial stages of training. This has so far been SunPork's approach to the training- to be side by side with the stockpeople until they are confident to carry out the tasks on their own, with follow up visits to the sheds to help continue their confidence and development. It is a matter of experience and confidence to get to that point, which varies from person to person. Darryl has observed that this has a positive effect- that there is a natural hesitancy to working in the system, but paired with someone that knows the system to guide them, then performance improves and

stockpeople are able to relax more and grow their confidence. Each time an expert is visiting the sites thereafter, their confidence is developing as they are getting more used to working in the system. The feedback from stockpeople that have learned to work in the Maternity Ring pen is that there are some tasks that they prefer, such as the weaning process (as sows are let out of the pen first, and then the piglets) and feeding (as less feed wastage means there is less likely to be mouldy or stale feed to clean out). On the other hand, staff do not like medicating the sow and piglets or scraping dung each day in the Maternity Ring, since they felt this was easier managed in the farrowing crates.

To share knowledge and learn from each other, SunPork has a ring pen management group that is attended by all farrowing managers and farm managers that have Maternity Ring pens installed at their farm, plus any potential new people that would be soon working with the system. This has operated as an open forum where people can share and learn from each other's experiences, discuss issues that they were facing and continue the pen development. This approach has been successful in solving issues and making the performance improvements that the group had aimed for.

1.34 Advice to farmers considering transitioning

For SunPork, once the decision was made by the board that they would convert to the Maternity Ring, this became the equivalent of a commitment, as there was no alternative and only one direction in which to move. When the option to think about if it was a good idea during the trialling phase shifted to the implementation, then the attitude and mindset of staff also pivoted into a more solutions-oriented view of how to make the system work in production. They have experienced three stages when sites are transitioning being; initial excitement, disillusion and then management- and it can take over a year to get to the third stage. Like all farms that have transitioned, they experience a drop in productivity (disillusion stage), whereby there are a lot of management decisions that need to be corrected- bringing in the correct number of gilts, getting rid of poor performers early, getting stockpeople comfortable working in the system- once these are mastered, then people have a renewed confidence in the system and are able to manage it.

Kate highlighted that being honest with the staff that making the conversion would be a big change- both for them and the animals was a key for the conversion process to be successful. That they should expect a transition period- but to be ready to hold on and production would turn around and be potentially better than before once they are through to the third stage. Training and knowledge sharing therefore becomes very important to the success in managing this system, being able to support staff through this change to the way that they are working, so that they can get through the disillusioned feeling when the farm performance isn't great. Her advice to farmers considering a conversion is to go and experience the system for a few days with an open mind to see and feel how it can work. It is not enough to just install a few pens on the farm, since it will not give enough insight into how it can be managed- not only for the animals that would not return to farrow the next cycle in the pen, but also as staff would likely avoid working in the system.

Darryl could compare it to the adoption cycle that was seen when the industry moved to loose gestation housing. Farrowing rates crashed, with some farmers reporting farrowing rates of 55-60 %- though those same farmers now believe that it is the best thing that they have implemented, and although it is a big change to the system to manage, it can be done. He believes that it is a myth that we as an industry have perpetuated, as we wanted to defend farrowing crates- they allowed for the management of aggressive sows, protection of piglets and staff- and this has now become gospel. But the truth is that as an industry we haven't really taken the time to check if that is truly the case or not,

and in reality SunPork can demonstrate that free farrowing systems can work under commercial conditions, providing higher welfare for animals and their caretakers.

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