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for Animal Welfare *Pigs*

Managing large litters - Short review

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1 Summary

This review gives an overview of the development in litter size and its consequences for sow and pig welfare. Selection for large litters has resulted in sows giving birth to several pigs exceeding the number of functional teats available at the sow's udder. Pigs develop a stable teat order within 24 h after birth where each pig suckle from and defend a preferred teat. The sow lets down milk in a synchronised pattern with milk let down approximately 1 time per hour with milk accessible for only 15-25 sec. When the number of pigs exceeds the number of functional teats, the nursing-suckling pattern in pigs is disturbed to an extent where interventions are necessary. Interventions include split suckling, cross fostering and use of nurse sows, milk supplement and artificial rearing. Even though interventions are necessary to keep surplus pigs alive, they all come with a price in terms of reduced welfare for both pigs and sows. Reduced welfare in pigs in hyper prolific litters is due to increased mortality rate, decreased birth weight and viability, increased competition and fighting, impaired internal biosecurity and in many cases lack of space in the farrowing pen. Reduced welfare in sows is due to high metabolic demands, prolonged farrowing and longer time being crated. Considering the health and welfare problems related to the suggested mitigation strategies, as well as the lack of trained work force experienced throughout EU, using less prolific sow lines seems important to improve pig and sow welfare in the farrowing unit.

2 Background

During the past 30 years breeding companies globally have strived to increase litter size in their breeding goals for the maternal line. Therefore, litter size has increased markedly for most genetic lines. As an example the litter size in Denmark increased from around 11 in 1994 to 20 total born pigs in average per litter in 2022 with sows having on average 14 teats. Combined with a weaning age between 21 and 28 days (minimum required weaning age according to the Council directive 2008/120/EC ((Council of the European Union 2008, Chapter II C)), and intensive management interventions, this has resulted in an increase in sow productivity from 11 pigs weaned per litter in 1994 to 15,3 pigs in 2022. However, with the increase in litter size and despite the use of intensive management practises around birth, the mortality of suckling pigs also gradually increased from 17,3 in 1994 to 23,3 % of total born pigs in 2022.

The Council Directive 98/58/EC concerning the protection of animals kept for farming purposes provide in chapter 20 and 21 a section regarding breeding. In Chapter 20 it is stated that "*Natural or artificial breeding or breeding procedures which case or are likely to cause suffering or injury to any of the animals concerned must not be practised*" followed by "*This provision shall not preclude the use of certain procedures likely to cause minimal or momentary suffering or injury, or which might necessitate interventions which would not cause lasting injury, where these are allowed by national provisions*". In Chapter 21 it is stated that "*No animal shall be kept for farming purposes unless it can reasonably be expected, on the basis of its genotype or phenotype, that it can be kept without detrimental effect on its health or welfare*".

There is no specific regulation related to pig genetics in the council directive concerning the protection of pigs.

3 Species-specific nursing-suckling pattern of pigs

Pigs have evolved a unique nursing and suckling pattern. At birth, newborn pigs receive frequent colostrum bouts in the first 6-12 hours after birth, ensuring a continuous supply of colostrum. Newborn pigs quickly reach the udder and start ingesting colostrum within 20 minutes. It is essential for newborn pigs to ingest as much colostrum as possible, as it is their sole source of antibodies at birth. In addition, colostrum provides immediate energy important for thermoregulation (Algers and Uvnäs Moberg, 2007). The amount of antibodies in colostrum decreases over time, with a 50% reduction already 12 hours after birth of the first piglet. After this initially period the sow's milk letdown pattern changes from frequent bouts to a synchronized and cyclic pattern. Thus, from approx. 24 h after farrowing, nursing bouts occurs hourly with milk let-down lasting for only 10-20 sec. The nursing is vocally signalled by the sow to draw the attention of all pigs to gather at the udder. Pigs intensively massage the udder for a few minutes both prior to and after milk let down. The intensity of the vocal signal announces the exact time of milk let-down assuring that all pigs have a teat in the mouth at the exact time of milk let-down. If a pig is not positioned at the udder at the moment of milk let-down, they will miss the milk let down and must wait another hour to feed. Due to this specific nursing-suckling pattern, pigs need to establish a stable teat order at the udder to maximize each individual's milk intake as fighting will inevitably lead to reduced milk intake for some individuals. When a stable teat order is present pigs can suckle without competition. This evolutionary-shaped pattern balances the sow's provision of milk equally to all offspring (Fraser, 1980), but also means that if there are more offspring than functional teats, some pigs may be at risk of starvation.

4 Welfare threats in large litters

4.1 Metabolic challenge of the sow

It is normal for a sow to lose weight during lactation. However, due to the high demand for milk production, hyper prolific sows face greater metabolic challenges than less prolific sows. Calcium and phosphorus are particularly important during lactation, as hyper prolific sows require increased mineral intake. In hyper prolific litters, the allocation of resources to pre-natal growth and later to milk production is high. There is evidence that resources are prioritized to offspring growth resulting in a risk of insufficient growth for young females potentially compromising bone strength and leg health, which increases the risk of culling or mortality (Prunier et al., 2010).

4.2 Prolonged farrowing

Observations across many studies during the last 20-30 years show that farrowing duration has increased from 1.5-2 h to 7-8 h while litter size increased from 10 to 20 pigs (Oliviero et al., 2019). In prolonged farrowings, hormones controlling the farrowing process may be insufficient, leading to weakened contractions and muscle strength, which can impede the expulsion of pigs. This is posing a risk of sows feeling pain (Algers and Uvnaës Moberg, 2007). In addition, sow welfare is at risk also after birth due to prolonged parturition being associated with health impairments for the sow such as PDS and even sudden death (Peltoniemi et al., 2016; Björkman et al., 2018; Kongsted et al., 2021). A prolonged farrowing also increases the risk of pigs suffering from respiratory stress during the birth, which increase the risk of stillbirth. Pigs

surviving birth-related respiratory stress ingest less colostrum, experience impaired growth, and are at greater risk of dying due to cold stress, starvation, and disease (Pedersen et al., 2011; Langendijk et al., 2028).

4.3 Reduced birth weight and more growth retarded pigs

There is a strong relationship between the total number of pigs born and birth weight, as many foetuses sharing the same resources in the uterus lead to a reduction in individual birth weights. The increased competition can result in severely growth-retarded pigs, also known as IUGR (Intrauterine Growth Restriction) syndrome. IUGR pigs exhibit impaired growth, compromised physiological functioning, and altered behaviour, as well as distinctive physical characteristics. These include a dolphin-like forehead, bulgy eyes, and wrinkles above the nose (Baxter et al., 2020). Low birth weight pigs and IUGR pigs have reduced survival rate due to difficulties overcoming the respiratory challenge of birth and reduced ability to thermoregulate and ingest colostrum at birth (reviewed by Farmer and Edwards, 2020).

4.4 Increased competition over access to milk

As the average number of born pigs for some prolific lines has reached 20, the competition for access to colostrum and milk is high. As a result, smaller pigs from large litters may receive less colostrum than similar sized pigs in smaller litters, compromising their immune protection from birth (Quesnel et al., 2011; reviewed by Olivero, 2022). In contrast to colostrum, the later milk production is increased when more pigs perform udder massage pre- and post-milk let-down. However, if the teat order is unstable, pigs engage in intense fighting prior to milk let-down. This may cause the sow to disrupt the nursing event, effectively stopping pigs from performing udder massage and reducing milk production over time. In addition, if there are more pigs than functional teats during a milk letdown, some pigs may not receive access to a teat and eventually die.

4.5 Reduced space in the farrowing pen

In many cases, current farrowing pens were designed to accommodate a sow and a litter of 10-12 pigs, rather than 14-15 as is the current situation on farms using high prolific sow lines. The EU Directive 2001/93/EC emphasizes the importance of providing sufficient space for animals to rest together. According to this directive, "*a part of the total floor must be solid or covered with a mat or littered with straw or other suitable material to allow animals to rest together*". According to a review by Pedersen et al. (2013) each pig at 4 weeks of age lying in a simi-lateral position requires approximately 0.11 m^2 of space. Consequently, a litter of 14 pigs at 4 weeks of age would need a solid floor of at least 1.54 m^2, considering the space requirements of each pig.

5 Interventions to mitigate mortality in large litters

5.1 Management around the time of birth

Diets low in fibres increase the risk of constipation. As constipation is associated with birth problems and is a risk factor for low milk production and poor udder health, mitigating constipation is important. This can be done by providing fibres in the diet of late gestating sows as it improves intestinal activity (Oliviero et al.,

2009). If fibres are provided as roughage, it can also be used as nest material to facilitate nesting activity. In addition, a study also suggest that frequent daily feeding (thrice daily) can improve energy status and farrowing process (Feyera et al. 2018). In conventional systems, the tradition is not to provide roughage for sows, in contrast, sow diets are generally low in fibre to meet the need for energy for growth of pigs and for the farrowing process.

Farrowing length exceeding 3-4 hours is considered a risk for both sow health and pigs survival (Peltoniemi et al., 2016). During farrowing, continuous birth surveillance combined with birth assistance can reduce the risk of stillborn pigs and avoid that some pigs are born depleted from oxygen and thus in risk of dying early (White et al., 1996; Christison et al., 1997; Andersen et al., 2009; Peltoniemi et al., 2016). Birth assistance includes assisting the birth of pigs where intervals since last born pigs exceed 1 hour (Peltoniemi et al., 2016) and drying and warming pigs at birth, and/or moving them to the teats and even providing bolus of colostrum or energy (White et al., 1996; Christison et al., 1997; Andersen et al., 2009). Monitoring the births cannot be limited to the daytime as the sows often begin farrowing at the end of the day and first at night. The sows must be checked at least every 30 minutes to provide a rough estimate of birth time and farrowing duration (See also Q2E-pigs-2023-005 "Birth monitoring intervals").

5.2 Split suckling during birth

To ensure enough maternally derived colostrum for all offspring, the caretaker can enclose the first-born and strongest pigs in a heated area of the pen (e.g., creep or heated solid floor) for up to two hours. This will allow weaker and late-born pigs to ingest more colostrum as these otherwise may have difficulties getting to the udder. Furthermore, as the immunoglobulin level in colostrum rapidly declines, the last-born pigs need to ingest increased amounts of colostrum to ensure sufficient immune protection. Some studies have shown positive effects of split suckling during birth on survival rate in general (Rosvold et al., 2017; Holyoake et al., 1995), or specifically for smaller pigs (Huser et al., 2015). However, no studies have shown clear improvements in colostrum intake (Vandaele et al., 2020; Huser et al., 2015; Morton et al., 2017).

5.3 Cross fostering and nurse sow systems

It is essential to ensure that all pigs have access to a functional teat within the first 24 hours after birth. To ensure this, litter equalization at birth by cross-fostering pigs between small and large newborn litters can be an effective solution to increase pig survival and uniform body weight within litters. However, frequent cross-fostering impair growth, teat fidelity and increases physiological indicators of stress particularly when cross fostering is performed later than day one (Zhang et al., 2021, Robert and Martineau, 2001). Cross-fostering beyond the initial litter equalization at birth has been found to be associated with an increased prevalence of diarrhoea and an increase in antibiotic treatments (Nielsen et al (2022)). Ensuring that pigs receive adequate colostrum from their biological mother before being cross fostered is important (reviewed by Baxter et al., 2013). Pigs must suckle colostrum from their own mother for at least 6-12 hours before being cross fostered, as this is necessary for optimal immune development. For these reasons, it is recommended to use cross-fostering as limited as possible and primary during the first 12-36 hours after birth.

If there are surplus pigs within a farrowing batch that cannot be handled through litter equalization of newborn, other cross-fostering methods must be adopted. One approach is to establish so-called nurse sows

from the previous farrowing batch after they have weaned their own pigs. Newborn surplus pigs from different litters can then be fostered by these sows who then nurse them for another 3 weeks. Alternatively, a selected number of sows nurse their own pigs for only 7-10 days of age and then receive surplus newborn pigs from other litters. Her own pigs are then fostered by another sow from the previous batch after her pigs are weaned after approximately 3 weeks of suckling. This is referred to as a two-step nurse sow system. By establishing one of these systems, it is possible to wean several pigs per litter exceeding the number of functional teats of the sow. When using nurse sows the weaning age of the pigs tends to be reduced while the number of days a sow nurse pigs tend to increase with 1-3 weeks extra. Data suggests impaired welfare and growth in litters raised by a nurse sow compared to the nurse sows' own litter (the litter she raised prior to being a nurse sow) (Kobek-Kjeldager et al., 2020d). In addition, the risk of facial lesions increases as pigs engage in teat fights, and studies have shown increased prevalence of lesions in sow and pigs involved in nurse sow systems (Sørensen et al., 2015).

An increase in infectious disease is expected when pigs are mingled between sows and batched, as the internal biosecurity is disrupted (McCaw et al., 2000). The social instability caused by increased competition in large litters has also been linked to increased risk of non-aggressive tail biting behaviour in pigs (Prunier et al., 2020). Furthermore, there are welfare consequences for the nurse sows, including prolonged periods of confinement, increased metabolic load which may results in low body condition at the end of the nursing period and thus increased risk of shoulder ulcers, along with increased risk of udder lesions caused by pigs engaging in teat fights when moved between litters (reviewed by Baxter et al., 2020).

5.4 Supplementary milk

An alternative or supplement to the nurse sow system is to allow the sow to nurse more pigs than she has teats and supplement the litter with milk replacer through a cup system. This system delivers milk through pipes continuously as pigs remove milk from the cup. Studies have shown that the survival rate of pigs increases when supplemental milk is provided, particularly in litters of 17 compared to 14 pigs (Kobek-Kjeldager et al., 2020a). However, the studies also found that access to milk replacer did not reduce teat fighting as all pigs try to access the teats during the sow's milk let-down, regardless of supplemental milk. This led to increased teat fighting and increased risk of udder lesions in sows and facial lesions in pigs.

While supplemental milk can increase survival rates, it does not provide sufficient support for small pigs with low suckling success. In fact, behavioural observations showed that larger pigs with high suckling success were more likely to drink supplemental milk than smaller pigs, resulting in large within litter weight variation (Kobek-Kjeldager et al., 2020b,c). Thus, supplemental milk increased survival in large litters but did neither reduce within litter weight variation nor reduce teat fighting.

Figure 5.4.1: Piglets provided with drinking supplemental milk from an automated cup system (©Aarhus University).

5.5 Artificial rearing

In some countries, surplus or weak pigs are removed from their mother and raised in specialized cages or boxes using milk replacer. These are sometimes referred to as 'rescue decks'. This can happen either straight after they have ingested colostrum or after they have been weaned from their mother at 2-7 days of age. This allows the farmer to use the sow as a nurse sow for newborn pigs.

This form of artificial rearing can have negative consequences for pig welfare. Pigs that are raised artificially show signs of distress including increased vocalization, growth impairment, and abnormal behaviour. One of the main issues with artificial rearing is that the milk provided is not sow milk, which can have significant impacts on growth, gut health, and immune protection.

Furthermore, artificial rearing can lead to early deprivation from maternal care, which can have negative impact on pig welfare due to inability to perform social behaviour. Deprived behaviours include absence of natural suckling pattern including vocal signalling, synchronised feeding and resting, drinking rather than suckling a teat, as well as the absence of pre- and post-massage

While the importance of maternal care and sow-piglet bond has not been extensively studied in pigs, there is evidence that abnormal behaviour is increased in pigs that are artificially reared. Additionally, there may be indications that early separation from the mother can also influence HPA axis function, cognition, and other neurological and behavioural processes. Further details on this topic can be found in a review by Baxter et al. (2020).

Figure 5.5.1: Pigs in a cage for artificial rearing (©Aarhus University).

5.6 Managing large litters with a challenged staff situation

Independent of the chosen method, managing hyper prolific sows is a challenge which requires skilled and experienced staff persons. Recruiting and retaining staff for pig herds are currently ongoing challenges across EU countries. Often the staff consists of migrant workers with limited skills in the used language and no education in caretaking of pigs (Kongsted and Mc Loughlin, 2023). In this situation, using less prolific sow lines seems a more suitable solution than having sows' that require a very high level of management.

6 Conclusions

Increasing litter size in pig breeding has led to several welfare threats, including metabolic challenges for the sow, prolonged farrowing, reduced birth weight of pigs, increased competition over access to milk and often breaches in biosecurity due to cross fostering and nurse sow systems. These issues result in compromised welfare, and increased risk of mortality and morbidity for both sows and pigs as compared to production using less prolific breeding lines. Therefore, purchasing high prolific sows that give birth to a number of pigs that a sow cannot raise herself will challenge on farm animal welfare; not least if the farm has low labour input and/or employed staff in the farrowing unit with limited skills and education.

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7 References

Algers, B., & Uvnäs-Moberg, K. (2007). Maternal behavior in pigs. *Hormones and behavior*, *52*(1), 78-85. https://doi.org/10.1016/j.yhbeh.2007.03.022

Andersen I. L., Haukvik, I. A., & Bøe, K. E. (2009). Drying and warming immediately after birth may reduce piglet mortality in loose-housed sows. *Animal*, *3*(4), 592-597. https://doi.org/10.1017/S1751731108003650

Baxter, E. M., Rutherford, K. M. D., D'eath, R. B., Arnott, G., Turner, S. P., Sandøe, P., ... & Lawrence, A. B. (2013). The welfare implications of large litter size in the domestic pig II: management factors. *Animal Welfare*, *22*(2), 219-238. https://doi.org/10.7120/09627286.22.2.219

Baxter, E. M., Schmitt, O., & Pedersen, L. J. (2020). Managing the litter from hyperprolific sows. In *The suckling and weaned piglet* (pp. 347-356). Wageningen Academic Publishers. https://doi.org/10.3920/978-90-8686-894-0

Björkman, S., Oliviero, C., Kauffold, J., Soede, N. M., & Peltoniemi, O. A. T. (2018). Prolonged parturition and impaired placenta expulsion increase the risk of postpartum metritis and delay uterine involution in sows. *Theriogenology*, *106*, 87-92.https://doi.org/10.1016/j.theriogenology.2017.10.003

Christison, G. I., Wenger, I. I., & Follensbee, M. E. (1997). Teat seeking success of newborn pigs after drying or warming. *Canadian Journal of Animal Science*, *77*(2), 317-319. https://doi.org/10.4141/A96-119

Farmer, C., & Edwards, S. A. (2020). The neonatal pig: developmental influences on vitality. In *The suckling and weaned piglet* (pp. 649-653). Wageningen Academic Publishers. https://doi.org/10.3920/978-90-8686-894-0

Feyera, T., Pedersen, T. F., Krogh, U., Foldager, L., & Theil, P. K. (2018). Impact of sow energy status during farrowing on farrowing kinetics, frequency of stillborn pigs, and farrowing assistance. *Journal of animal science*, *96*(6), 2320-2331. https://doi.org/10.1093/jas/sky141

Fraser, D. (1980). A review of the behavioural mechanism of milk ejection of the domestic pig. *Applied Animal Ethology*, *6*(3), 247-255. https://doi.org/10.1016/0304-3762(80)90026-7

Holyoake, P. K., Dial, G. D., Trigg, T., & King, V. L. (1995). Reducing pig mortality through supervision during the perinatal period. *Journal of animal science*, *73*(12), 3543-3551. https://doi.org/10.2527/1995.73123543x

Huser, J. S., Plush, K. J., Pitchford, W. S., Kennett, T. E., & Lines, D. S. (2015). Neonatal split suckling improves survival of small pigs. *Animal Production Science*, *55*(12), 1477-1477. https://doi.org/10.1071/ANv55n12Ab079

Kobek-Kjeldager, C., Moustsen, V. A., Theil, P. K., & Pedersen, L. J. (2020a). Effect of litter size, milk replacer and housing on production results of hyper-prolific sows. *Animal*, *14*(4), 824-833. https://doi.org/10.1017/S175173111900260X

Kobek-Kjeldager, C., Moustsen, V. A., Theil, P. K., & Pedersen, L. J. (2020b). Effect of large litter size and within-litter differences in piglet weight on the use of milk replacer in litters from hyper-prolific sows under two housing conditions. *Applied Animal Behaviour Science*, *230*, 105046. https://doi.org/10.1016/j.applanim.2020.105046

Kobek-Kjeldager, C., Moustsen, V. A., Theil, P. K., & Pedersen, L. J. (2020c). Effect of litter size, milk replacer and housing on behaviour and welfare related to sibling competition in litters from hyper-prolific sows. *Applied Animal Behaviour Science*, *230*, 105032. https://doi.org/10.1016/j.applanim.2020.105032

Kobek-Kjeldager, C., Moustsen, V. A., Theil, P. K., & Pedersen, L. J. (2020d). Managing large litters: Selected measures of performance in 10 intermediate nurse sows and welfare of foster pigs. *Applied Animal Behaviour Science*, *233*, 105149. https://doi.org/10.1016/j.applanim.2020.105149

Kongsted, H., & Mc Loughlin, E. T. (2023). Lowering antibiotic usage and phasing out pharmaceutical zinc oxide in Danish pig herds: Pig farmers' and veterinarians' experiences and perceptions. *Livestock Science*, *273*, 105260. https://doi.org/10.1016/j.livsci.2023.105260

Kongsted, H., Haugegaard, S., Juel, A. S., Salomonsen, C. M., & Jensen, T. K. (2021). Causes of spontaneous sow deaths in the farrowing units of 10 Danish sow herds. *Research in Veterinary Science*, *139*, 127-132. https://doi.org/10.1016/j.rvsc.2021.07.021

Langendijk, P., Fleuren, M., Van Hees, H., & Van Kempen, T. (2018). The course of parturition affects piglet condition at birth and survival and growth through the nursery phase. *Animals*, *8*(5), 60. https://doi.org/10.3390/ani8050060

McCaw, M. B. (2000). Effect of reducing cross fostering at birth on piglet mortality and performance during an acute outbreak of porcine reproductive and respiratory syndrome. *Journal of Swine Health and Production*, *8*(1), 15-21. https://www.aasv.org/shap/issues/v8n1/v8n1p15.pdf

Morton, J., Langemeier, A., Rathbun, T., & Davis, D. L. (2017). Split suckling, birth order, and birth weight affects colostrum intake and pre-weaning weight gain. *Kansas Agricultural Experiment Station Research Reports*, *3*(7), 7. https://doi.org/10.4148/2378-5977.7460

Nielsen, C. L., Krogh, M. A., Sørensen, J. T., & Kongsted, H. (2022). A field trial on the effect of cross-fostering on performance, clinical health and antibiotic usage during the suckling period of pigs. *Preventive Veterinary Medicine*, *205*, 1-8. https://doi.org/10.1016/j.prevetmed.2022.105678

Oliviero, C. (2023). Offspring of hyper prolific sows: Immunity, birthweight, and heterogeneous litters. *Molecular Reproduction and Development*, *90*(7), 580-584. https://doi.org/10.1002/mrd.23572

Oliviero, C., Junnikkala, S., & Peltoniemi, O. (2019). The challenge of large litters on the immune system of the sow and the pigs. *Reproduction in Domestic Animals*, *54*, 12-21. https://doi.org/10.1111/rda.13463

Oliviero, C., Kokkonen, T., Heinonen, M., Sankari, S., & Peltoniemi, O. (2009). Feeding sows with high fibre diet around farrowing and early lactation: impact on intestinal activity, energy balance related parameters and litter performance. *Research in veterinary science*, *86*(2), 314-319. https://doi.org/10.1016/j.rvsc.2008.07.007

Pedersen, L. J., Berg, P., Jørgensen, G., & Andersen, I. L. (2011). Neonatal piglet traits of importance for survival in crates and indoor pens. *Journal of Animal Science*, *89*(4), 1207-1218. https://doi.org/10.2527/jas.2010-3248

Pedersen, L. J., Malmkvist, J., & Andersen, H. M. L. (2013). Housing of sows during farrowing: a review on pen design, welfare and productivity. *Livestock housing: Modern management to ensure optimal health and welfare of farm animals*, 285-297. https://doi.org/10.3920/978-90-8686-771-4

Peltoniemi, O. A. T., Björkman, S., & Oliviero, C. (2016). Parturition effects on reproductive health in the gilt and sow. *Reproduction in Domestic Animals*, *51*, 36-47. https://doi.org/10.1111/rda.12798

Prunier, A,. Heinonen, M., & Quesnel, H. (2010). High physiological demands in intensively raised pigs: impact on health and welfare. *Animal, 4*(6), 868-898. https://doi.org/10.1017/S175173111000008X

Prunier, A., Averos, X., Dimitrov, I., Edwards, S. A., Hillmann, E., Holinger, M., ... & Camerlink, I. (2020). Early life predisposing factors for biting in pigs. *Animal*, *14*(3), 570-587. https://doi.org/10.1017/S1751731119001940

Quesnel, H. (2011). Colostrum production by sows: variability of colostrum yield and immunoglobulin G concentrations. *Animal*, *5*(10), 1546-1553. https://doi.org/10.1017/S175173111100070X

Robert, S., & Martineau, G. P. (2001). Effects of repeated cross-fostering on preweaning behavior and growth performance of pigs and on maternal behavior of sows. *Journal of Animal Science*, *79*(1), 88-93. https://doi.org/10.2527/2001.79188x

Rosvold, E. M., Kielland, C., Ocepek, M., Framstad, T., Fredriksen, B., Andersen-Ranberg, I., ... & Andersen, I. L. (2017). Management routines influencing piglet survival in loose-housed sow herds. *Livestock Science*, *196*, 1-6. https://doi.org/10.1016/j.livsci.2016.12.001

Sørensen, J. T., Rousing, T., Kudahl, A. B., Hansted, H. J., & Pedersen, L. J. (2016). Do nurse sows and foster litters have impaired animal welfare? Results from a cross-sectional study in sow herds. *animal*, *10*(4), 681-686. https://doi.org/10.1017/S1751731115002104

Vandaele, M., Van Kerschaver, C., Degroote, J., Van Ginneken, C., & Michiels, J. (2020). Piglet performance and colostrum intake in litters either or not split-suckled during the first day or during the first three days of life. *Livestock Science*, *241*, 104265. https://doi.org/10.1016/j.livsci.2020.104265

White, K. R., Anderson, D. M., & Bate, L. A. (1996). Increasing piglet survival through an improved farrowing management protocol. *Canadian journal of animal science*, *76*(4), 491-495. https://doi.org/10.4141/cjas96-075

Zhang, X., Wang, M., He, T., Long, S., Guo, Y., & Chen, Z. (2021). Effect of different cross-fostering strategies on growth performance, stress status and immunoglobulin of pigs. *Animals*, *11*(2), 499. https://doi.org/10.3390/ani11020499

EU Reference Centre for Animal Welfare *Pigs*

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- **Legal aspects**
  European pig welfare legislation that has to be complied with and enforced by EU Member States;
- **Welfare indicators**
  Animal welfare indicators, including animal based, management based and resource based indicators, that can be used to verify compliance with the EU legislation on pigs;
- **Training**
  Training activities and training materials for inspectors, including bringing forward knowledge about ambivalence in relation to change;
- **Good practices**
  Good and best practice documents visualising the required outcomes of EU legislation;
- **Demonstrators**
  Farms, transport companies and abattoirs demonstrating good practices of implementation of EU legislation.

Partners

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- Wageningen Livestock Research, The Netherlands
- Aarhus University, Denmark
- Friedrich-Loeffler-Institut, Germany

WAGENINGEN UNIVERSITY & RESEARCH

AARHUS UNIVERSITY

FRIEDRICH-LOEFFLER-INSTITUT
FLI
Bundesforschungsinstitut für Tiergesundheit
Federal Research Institute for Animal Health

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