Review Article

Management strategies in farrowing house to improve piglet pre-weaning survival and growth

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Abstract

Post-partum and lactation are the most complex periods in the swine production chain. Newborn pigs are highly vulnerable due to relatively low body weight at birth and physiological immaturity. Most of the management strategies performed in farrowing houses are oriented to ensure a proper level of colostrum intake by the piglets. Colostrum is essential as an energy source and to provide passive immunity to piglets. Different farrowing supervising protocols have been comprehensively investigated to reduce early mortality as well as to assist newborn piglets in obtaining an optimal amount of colostrum and milk. However, little is known of the benefits of oral supplementation in newborn piglets. Cross-fostering is also widely performed in general swine commercial herds to deal with highly prolific sows and has a strong impact on piglet survival. In order to prepare piglets for weaning, creep feeding is provided after the first week of lactation. Although the number of animals that actually consume the creep feed is not clear, creep feed consumption might influence feed intake after weaning. Finally, the attitude and skills of a stockperson might play an important role in the piglet's ability to cope with stressors. Positive and gentle human contact with newborn piglets might positively influence the piglets' emotional response to human handling and thus their welfare. The objective of this review was to present the most relevant management strategies performed in farrowing houses (i.e. oral supplementation, farrowing supervision, cross-fostering, creep feeding, and human-animal interaction) and their effect on piglet pre-weaning mortality and growth.

Keywords: colostrum, cross-fostering, lactation, mortality, oral supplementation, pig

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Introduction

With the use of highly prolific sows in commercial herds, high piglet pre-weaning mortality (PWM) remains an unsolved problem in pig production. Recent reports have shown average piglet PWM rates of 12.9%, 9.4%, and 12.2% in the European Union, the Philippines and Thailand, respectively (Bureau of Agricultural Statistical of Philippines, 2012; Interpig, 2014; Nuntapaitoon and Tummaruk, 2013). On the other hand, the mortality rate recorded during the rearing and finishing phases reached 3.3 and 2.8%, respectively (Interpig, 2014). Moreover, piglet PWM is one of the major reproductive components affecting herd productivity in the swine industry. It has been demonstrated that a 1% reduction in piglet mortality increased the sow annual output by €7.1 in a highly productive country such as the Netherlands (Chris et al., 2012). Therefore, the mortality of piglets in the suckling period is a major welfare and an economic problem in the swine industry which still needs to be addressed.

Neonatal piglets are very vulnerable at birth. They are characterised by a high surface to body mass ratio, limited reserves and poor immunity status. Among the different causes of early death, low colostrum intake is probably the most influential (Muns et al., 2016[b]). Colostrum intake is crucial for piglet growth since it provides piglets with the energy and passive immunity necessary at a very early stage (Quesnel et al., 2012). Moreover, piglets have to compete with littermates for a teat to suckle. Among other factors, alterations of piglet body weight (BW) at birth associated with an increased litter size might lead to high PWM. The use of highly prolific sows resulted in increased crowding in the uterine horns during gestation (Rutherford et al., 2013). Intra-uterine crowding may result in some piglets experiencing intra-uterine growth restriction or reduced BW at birth, therefore increasing litter birth weight variation (Yuan et al., 2015). Within-litter variation in birth weight strongly affects PWM, especially during the first 72 hours of life (Alonso-Spilsbury et al., 2007). In addition, a high ambient temperature around farrowing negatively affects the sow's welfare and performance, with a negative impact on piglet weaning weight (Muns et al., 2016[a]). Many management routines are performed in a farrowing house during the first two days post-partum to enhance piglet survival. In countries with a tropical climate such as Thailand such practices are of great importance for herd performance. In practice, during the peri-partum period, management is focused on helping piglets to minimise heat loss and maximise colostrum intake.

Colostrum: Colostrum is secreted by the mammary gland starting shortly before parturition and for a time interval of approximately 12-24 hours in most sows (Quesnel et al., 2012). Piglets obtain colostrum freely for 0-24 hours after farrowing. After 24-48 hours post-partum, the physiologic cyclical pattern of suckling and milk ejection is established (De Passillé and Rushen, 1989). Colostrum is a source of highly digestible nutrients and various forms of bioactive compounds such as immunoglobulins, hydrolytic enzymes, hormones, and growth factors (Rooke and Bland, 2002; Wu et al., 2010). Additionally, colostrum is the first and only food available for piglets after birth. Colostrum is crucial in providing energy for thermoregulation and body growth (Devillers et al., 2011; Herpin et al., 2005; Le Dividich et al., 2005). In addition, passive immunity supply in pigs mainly occurs from immunoglobulin G (IgG) in colostrum, providing newborn animals with passive humoral immune protection. Newborn piglet absorption of IgG happens before gut closure (Quesnel et al., 2012), which takes place at approximately 24 hours of age (Rooke and Bland, 2002). Therefore, the first 12-24 hours after birth are crucial for the piglet's colostrum intake.

However, colostrum yield is limited. Colostrum yield was shown to be independent of litter size, but moderately influenced by piglet BW and BW variability at birth (Devillers et al., 2007). Moreover, colostrum yield and IgG concentrations were shown to be highly variable among sows, even within sows from the same unit (Devillers et al., 2011; Quesnel, 2011). In addition, it was observed that the amount of colostrum ingestion during the first 24 hours after birth was highly variable among littermates. In one study, the average colostrum intake varied from 250-300 grams, but ranged from zero to 700 grams (Quesnel et al., 2012). Newborn piglets directly compete with their littermates for access to a mammary gland, preferably the anterior and middle glands. The posterior mammary glands may produce fewer beneficial proteins than the anterior glands (Wu et al., 2010). Additionally, piglets from the same litter indirectly compete for milk intake during lactation, and piglets that are better at draining, massaging and stimulating the teat will favour local blood flow together with hormonal and nutrient investment, thus increasing the teat's milk production (Algers, 1993). Therefore, management of the litter is important to ensure that all piglets have proper colostrum intake.

Farrowing supervision: Most of the management routines studied in literature consist of practices performed around farrowing, including farrowing supervision, and are oriented to cope with two main challenges: piglet thermoregulation capacity and piglet colostrum intake. Drying piglets at birth has proven useful in commercial herds. Christison et al. (1997) observed that survival was improved when piglets were dried or placed under a heating lamp immediately after birth. Vasdal et al. (2011) compared different protocols around farrowing in loose housed sows and found that drying newborn piglets and placing them at the udder were the winning management combination with greatest reduction in piglet mortality. Practices to ensure colostrum intake by piglets have also been studied. Andersen et al. (2007) compared records of an entire year from 39 farms in Norway. They observed that placing the piglets at the udder and assisting them to find a teat reduced mortality, but shutting the piglets inside the creep area while feeding the sow did not improve survival. Improved survival during the first day of life, reduction in the number of stillbirths at farrowing and increased weaning weights were obtained with more

complex protocols that included drying the newborn piglets, oral administration of 12 ml of bovine colostrum and oxygen administration through an oral mask (White et al., 1996). Good supervision when farrowing also improved pre-weaning survival (Holyoake et al., 1995). On the other hand, split nursing (i.e. removing the larger piglets in a litter for a set period of time, allowing the smaller piglets free access to the udder) is another practice performed on commercial farms to enhance colostrum intake in low birth BW piglets. Yet, this practice has little impact on litter performance. Donovan and Dritz (2000) found no effect on IgG plasma concentration or mortality rate when performing 2-hour split nursing of the heaviest 50% of the piglets in the litter. Donovan and Dritz (2000) only observed a decrease in the variation of piglet average daily gain in litters with more than nine pigs. Thorup (2006) did not obtain a drop in low birth BW piglet mortality through split nursing either. Dewey et al. (2008) observed an increase in pre-weaning growth and survival when combining oral administration of 12-20 ml of colostrum with split nursing in a 'maximal care treatment'. More recently, Muns et al. (2014) found that supplementing low birth BW piglets after birth with 15 ml of the sow's colostrum improved piglet IgG levels on day four compared to a control group. However, it only tended to improve growth and survival of small piglets at weaning in non-homogenised litters at the time of cross-fostering, but not in homogenised litters. In another study, Muns et al. (2015[a]) only observed improvement in BW at 24 hours of life in low birth BW piglets born from primiparous sows after being supplemented with 15 ml of the sow's colostrum. But such effect was not maintained at weaning. In the same study, they found no effect of colostrum supplementation on low birth BW piglets born from multiparous sows, suggesting that piglets born from primiparous sows might have a higher need for colostrum intake than piglets born from multiparous sows. More recently, Viehmann et al. (2015) observed that daily supplementation of piglets with bovine colostrum during the first three days after birth extended life in low birth BW piglets but did not influence pre-weaning survival. Similarly, Declerck et al. (2016) observed that providing direct energy (commercial energy booster) through oral supplementation to small neonatal piglets (< 1 kg of birth BW) reduced their mortality without improving colostrum intake.

Cross-fostering: Cross-fostering is an important and common management practice performed on commercial farms. Cross-fostering has become indispensable to deal with highly prolific sows delivering large litters at farrowing. There are many reasons to perform cross-fostering (Baxter et al., 2013) including to foster surplus piglets when a sow has more piglets than functional teats, to foster small piglets to create litters with similar birth weights or to create litters with low weight variation, death of a sow at farrowing, and when a sow attacks its own offspring. Concurrently, cross-fostering can be performed at a minimum extent (transferring as few piglets as possible), in order to adjust litters by the number of piglets according to the number of functional teats. On the contrary, cross-fostering can be performed at a greater extent (transferring a high number of piglets and involving most of the litters in the batch), adjusting litters by BW of the piglets, transferring animals based on parity of the dams (piglets from gilts transferred to middle-aged sows), etc.

Cross-fostering should be performed after piglets ingest colostrum from their biological dams, but before teat order is established in the litter (Heim et al., 2012). As previously stated, colostrum decreases after 12 hours post-partum. After the initial phase of continuous colostrum ejection, cyclical milk let-down instauration progressively occurs. Thereafter, within the first week after birth, a stable teat order among littermates is established (De Passillé and Rushen, 1989). Consequently, technical recommendations and routine farm procedures aim to perform cross-fostering between 12 and 24 hours after farrowing. Moreover, during the first day after farrowing, sows accept alien offspring without disrupting their litter suckling patterns, without impairing piglet or sow welfare and without becoming aggressive towards the adopted piglets (Robert and Martineau, 2001).

In literature, cross-fostering has been widely studied, with diverse results. Heim et al. (2012) observed that survival and growth were not impaired in fostered piglets. They also observed that litters composed exclusively of adopted piglets had no impairment of behaviour, survival or growth. Bierhals et al. (2011) found that piglets nursed by primiparous sows had lower BW at day 21 of lactation than piglets nursed by parity 5 sows. Akdag et al. (2009) and Milligan et al. (2002) associated increased birth weight variation with low survival rate, whereas other studies did not (Bierhals et al., 2011; Milligan et al., 2001). Deen and Bilkei (2004) found that mortality of low birth BW piglets increased when they were cross-fostered with high birth BW piglets. They also stated that low birth BW piglets had a higher chance of survival in small litters irrespective of the birth BW of their littermates. On the contrary, Muns et al. (2014) found that standardisation of litters at cross-fostering (adjusting litters by BW of the piglets) did not prevent them from having the same BW variability at weaning compared to non-standardised litters. They also found that non-standardised litters did not impair the growth or survival of small piglets compared to small piglets in standardised litters. On the other hand, Robert and Martineau (2001) observed that repeated cross-fostering through lactation reduced the weight gain of both adopted and resident piglets and increased the sow's aggression towards alien piglets.

It is a common practice on different farms to synchronise and induce farrowing, especially in multiparous sows, in order to concentrate and optimise tasks. With synchronised farrowing, cross-fostering becomes easier to perform. Nonetheless, the advantages and disadvantages of farrowing induction are outside the scope of this review and have recently been documented (Kirkden et al., 2013). Finally, cross-fostering might lead to transfer of pathogens from one litter to another; moreover, it can be critical for the success of immune transfer (humoral immunity and cell-mediated immunity) from a biological dam to newborn piglets if performed too early. However,

long-term impact of cross-fostering on piglet health and immunity has not been well examined (Bandrick et al., 2011).

Creep feeding: Once producers have focused on enhancing the early survival of newborn piglets by ensuring optimal colostrum intake, and once cross-fostering has been performed, all efforts are oriented to maximise piglet BW at the end of lactation and to prepare the animals for weaning (transition from milk consumption during the suckling period to a solid feed diet after weaning). For that purpose, after the first week or ten days of lactation, piglets are frequently given a highly palatable and highly digestible diet (creep feeding). The creep feed intake of piglets is usually not very high and it is inversely related to the sow's milk production. Consequently, creep feed offered during the lactation period does not have a high impact on sow performance or piglet growth at weaning (Bruininx et al., 2004; Sulabo et al., 2010[a]). It was observed that only a low proportion of piglets consumed feed during lactation (Sulabo et al., 2010[b]). It was also observed that creep feed intake was variable between and within litters (Bruininx et al., 2002; Wattanakul et al., 2005). Nevertheless, piglets that consume creep feed during lactation improved post-weaning performance through a shortened onset of feed consumption (Bruininx et al., 2002) and an increased feed intake and BW gain during the first days after weaning (Bruininx et al., 2004; Sulabo et al., 2010[a]; van den Brand et al., 2014). Early introduction of creep feeding influences the proportion of piglets eating creep feed. Sulabo et al. (2010[b]) observed a lower feed intake and lower number of eaters in litters offered creep feed for two days, and a lower feed intake in litters offered creep feed for six days, when compared to litters offered creep feed for 13 days. In addition, lactation length seems to influence creep feed intake. Callesen et al. (2007[b]) observed an increase in creep feed consumption of between 137 and 266% in piglets weaned at 33 days of age compared to piglets weaned at 27 days of age. Subsequently, they found that creep feed might benefit post-weaning growth of piglets after longer lactation. A number of researchers have studied strategies to improve creep feed consumption and the proportion of piglets eating creep feed. van den Brand et al. (2014) observed that piglets younger than 18 days of age preferred pellets with a large diameter (10-12 mm vs. 2 mm diameter pellet). Despite lowering the weaning BW, performance of intermittent suckling increased creep feed intake and improved growth in the first week after weaning in piglets that ate creep feed (Kuller et al., 2004, 2007). As suggested by Wattanakul et al. (2005), the method of creep feed presentation is very important in the initiation of feeding behaviour. Accordingly, offering creep feed with different flavours or using a feeder that stimulates piglet exploratory behaviour are strategies that might enhance creep feed intake during lactation (Adeleye et al., 2014, Kuller et al., 2010). A recent study has suggested that providing liquid milk replacement to piglets during lactation might have a positive influence on post-weaning survival (Park et al., 2014).

In addition to the management practices mentioned above (colostrum supplementation, cross-fostering and creep-feeding), weaning age is also an important factor determining future performance of the animals. In past experiments, lactation of 21 days increased wean-to-finish average daily gain and survival compared to shorter lactation (Main et al., 2004), and lactation of 33 days improved piglet growth after weaning compared to lactation of 27 days (Callesen et al., 2007[a]). It is known that longer lactation increases weight and physiologic maturity of piglets at weaning (Main et al., 2004). However, with the current multisite pig production system and its specific pig-flow, little decision capacity is left concerning weaning age.

Human-animal interaction: Intensive husbandry and housing practices in animal production also affect the nature and amount of human contact that the animals receive. Compared to other phases, lactation demands more human handling of sows and piglets. Implementation of good practices by trained employees and positive experiences with human interactions may have powerful influences. Good practices and positive experiences might have an effect not only on the productivity and welfare of the animal, but also on how the animal responds to aversive routine practices (Hemsworth and Coleman, 2011; Muns et al., 2015[b]). On one hand, the negative effects of negative emotional states such as fear on the welfare of animals are well known (Gonyou et al., 1986; Hemsworth et al., 1981, 1987, 1989). Routine interactions between stockpeople and their animals can result in farm animals becoming highly fearful of humans and, through stress, their productivity and welfare might be impaired (Hemsworth, 2003). The attitude and behaviour of stockpeople when handling and interacting with sows and piglets may have implications on both the productivity and stress physiology of the animals (Gonyou et al., 1986; Hemsworth and Coleman, 2011; Hemsworth et al., 1989). In addition, it was observed that handling pigs early in life might influence their subsequent behavioural responses to humans (Hemsworth and Barnett, 1992). On the other hand, there are limited data indicating the impact of positive emotional responses of farm animals in the presence of humans on subsequent experiences when in the presence of humans. Precisely, Muns et al. (2015[b]) observed that positive human contact after birth reduced piglet escape behaviour at subsequent stressful events. Early handling of piglets (tactile stimulation performed daily from day 5 to day 35 of age) resulted in piglets that were more active and less fearful in a novel environment, and less fearful of people in general (de Oliveira et al., 2015). Zupan et al. (2016) also observed that handling (tactile stimulation performed daily from day 5 to day 35 of age) increased piglet locomotor play and handling half of the litter increased social exploratory behaviour of the entire litter. They suggested that handling all or half of the piglets in the litter might be beneficial for the piglets' emotional state after weaning, thus increasing their welfare. However, the mechanisms underlying the influence of positive early contact are unclear. Additionally, secondary management practices commonly performed in farrowing facilities (e.g. castration, iron

administration, vaccination, ear clipping, tail docking, etc.) might have an impact on piglet and sow welfare and performance. Therefore, they should also be considered when planning or suggesting a protocol for management routines in the farrowing house. Finally, environmental factors (e.g. facility design, housing system, climatic conditions, etc.) also play an important role in the success of the management performed in the farrowing house.

Conclusion

Most of the management protocols studied so far are too complex and laborious, or they need to be performed too close to farrowing to be effective. Two of the simplest practices that have been studied, drying piglets at birth and placing them at the udder or under a heating lamp, successfully reduced mortality. While the importance of proper colostrum intake by piglets is completely assumed, very few studies have been performed under farm conditions regarding oral supplementation of piglets. Oral administration of colostrum (with manually milked sow colostrum obtained from the same herd) to low birth BW piglets guarantees a proper level of IgG, while direct energy supplementation reduces the mortality of low birth BW piglets. Therefore, a combination of oral supplementation using sow colostrum and a commercial energy booster might enhance both piglet energy and immunity status. Such management practices could reduce on-farm PWM and should be further studied. On the other hand, cross-fostering has been proven to strongly influence PWM. However, more conclusive studies are needed to clearly understand the effect of cross-fostering on piglet performance, especially on the reduction in litter weight variation. In addition, more studies of the effect of cross-fostering combined with other husbandry practices (e.g. oral supplementation) are necessary. Concerning the use of creep feeding, there is a lack of knowledge about whether the more vigorous or the smaller piglets are consuming creep feed during lactation. Recent studies have suggested that creep feed consumption can be enhanced by stimulating piglet exploratory behaviour and/or by modifying creep feed presentation. Further studies of the motivation that leads piglets to consume creep feed are of great interest and could help enhance post-weaning piglet adaptation. Furthermore, recent studies have suggested the benefits of positive human handling on piglet welfare, behaviour, and fear response. Given the amount of management and manipulation that piglets suffer during lactation, better understanding of the piglet emotional response to human handling could become an important tool to improve pig welfare and handling during lactation and after weaning. Indeed, improved knowledge of the piglet emotional response to human handling could strongly influence the producers' approach to the skills and attitudes of stockpeople, as well as lactation management planning. Finally, it would be of great interest to study the impact of the reviewed management strategies on farms differing in their sanitary status or on farms under different climatic conditions, thereby comparing the impact of similar management strategies in different countries or continents.

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บทคัดย่อ

กลยุทธ์การจัดการโรงเรือนคลอดเพื่อปรับปรุงการอยู่รอด และการเจริญเติบโตของลูกสุกรก่อนหย่านม

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ระยะหลังคลอดและระยะการให้นมเป็นช่วงเวลาที่มีความซับซ้อนมากที่สุดช่วงหนึ่งในกระบวนการผลิตสุกร ลูกสุกรแรกคลอดมีความเปราะบางมากเนื่องจากมีน้ำหนักตัวแรกคลอดที่ค่อนข้างต่ำและระบบสรีระวิทยาของร่างกายยังเจริญไม่สมบูรณ์ กลยุทธ์ในการจัดการส่วนใหญ่ที่ทำในโรงเรือนคลอด มีวัตถุประสงค์เพื่อให้ลูกสุกรได้รับปริมาณน้ำนมเหลืองที่เพียงพอ น้ำนมเหลืองมีความจำเป็นเนื่องจากเป็นแหล่งพลังงานและส่งผ่านภูมิคุ้มกันจากแม่สุกรสู่ลูกสุกร กระบวนการในการเฝ้าคลอดในรูปแบบต่างๆถูกนำมาศึกษาค้นคว้าอย่างกว้างขวางเพื่อลดการตายของลูกสุกรในระยะแรกและช่วยเหลือลูกสุกรให้ได้รับน้ำนมเหลืองและน้ำนมแม่สุกรอย่างเพียงพอ อย่างไรก็ดีการศึกษาเกี่ยวกับผลของการป้อนสารอาหารเสริมให้กับลูกสุกรแรกคลอดยังมีน้อยมาก การย้ายฝากเป็นการจัดการที่ทำกันอย่างกว้างขวางในฟาร์มสุกรเชิงพาณิชย์ทั่วไปเพื่อรองรับแม่สุกรที่มีลูกดกซึ่งมีผลกระทบอย่างมากต่อการรอดชีวิตของลูกสุกร เพื่อเตรียมลูกสุกรสำหรับการหย่านม อาหารเลียรางจะถูกจัดเตรียมไว้ให้ลูกสุกรภายใน 1 สัปดาห์แรกหลังคลอด ถึงแม้ว่าจะไม่เป็นที่ทราบแน่ชัดว่าลูกสุกรมากน้อยเพียงใดที่ได้รับอาหารเลียราง ปริมาณอาหารเลียรางที่ลูกสุกรกินได้อาจมีอิทธิพลต่ออัตราการกินอาหารของลูกสุกรหลังหย่านม ท้ายที่สุดทัศนคติและทักษะของผู้เลี้ยงอาจมีบทบาทสำคัญต่อความสามารถของลูกสุกรในการทนต่อความเครียด การสัมผัสลูกสุกรแรกคลอดที่ดีและนุ่มนวลของคนเลี้ยงอาจมีอิทธิพลต่ออารมณ์ของลูกสุกรและพฤติกรรมการตอบสนองของลูกสุกรต่อคนเลี้ยง ซึ่งสอดคล้องกับหลักจริยธรรมในการเลี้ยงสัตว์ วัตถุประสงค์ของบทความปริทัศน์ฉบับนี้ เพื่อแสดงให้เห็นกลยุทธ์การจัดการที่สำคัญในโรงเรือนคลอด (ได้แก่ การป้อนอาหารเสริม การเฝ้าคลอด การย้ายฝาก การให้อาหารเลียราง และปฏิสัมพันธ์ระหว่างคนและสัตว์) และผลกระทบของสิ่งต่างๆเหล่านี้ต่ออัตราการตายของลูกสุกรก่อนหย่านมและการเจริญเติบโต โดยข้อมูลทั้งหมดได้จากศึกษาวิจัยอย่างเป็นวิทยาศาสตร์

คำสำคัญ: น้ำนมเหลือง การย้ายฝาก การให้นม การตาย การป้อนอาหารเสริม สุกร

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