MANAGING LARGE LITTERS

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Introduction

In the course of domestication, selective breeding has delivered more than 100% increase in litter size in pigs. Denmark has seen the most dramatic progress in this trait; an increase in total born per litter of four pigs has occurred over a 13 year period (Rutherford et al. 2013) with current born alive per litter averaging 16.3 compared with a general commercial benchmark of 13.8 in Europe (SEGES 2016; AHDB Pork, 2016). However, large litter size has a number of associated welfare challenges for both piglets and sows (Rutherford et al., 2013; Baxter et al., 2013). There is a general consensus that larger litters have higher piglet mortality (see Baxter and Edwards 2018 for review). The occurrence of stillbirths has increased, which is in part linked to the longer farrowing durations associated with super-prolific breeds. For live-born piglets, large litter size is a risk factor due to an associated increased proportion of low birth weight piglets being born (Kerr and Cameron, 1995; Roehe, 1999; Sorensen et al., 2000), and the concomitant higher risk of mortality in small piglets. The impacts of large litter sizes on sow welfare involve issues related to the process of carrying, delivering and raising a large litter (Rutherford et al., 2013).

When litter size routinely exceeds the ability of individual sows to successfully rear all the piglets (i.e. viable piglets outnumber functional teats) there are significant management challenges for staff that must intervene to raise these extra piglets. Interventions include split suckling; cross-fostering; use of nurse sow systems and early weaning, including split weaning; and use of artificial rearing systems. These interventions require diligent stockpersonship and there are risks to the health and welfare of both piglets and sows (Baxter et al. 2013), particularly if performed poorly. This paper will discuss the different interventions and the potential to optimise management and nutrition to mitigate for the health and welfare concerns associated with large litters.

Optimising management

Colostrum intake and fostering
Piglets must ingest colostrum as soon as possible after birth. Colostrum increases core body temperature and is important for both energy balance and immune protection. Piglets will have access to colostrum continuously for approximately 12 hours from the start of farrowing before cyclical let-down of milk occurs every 20 minutes. Immature organ development will impact upon the piglet's ability to process any milk it obtains and there is a finite amount of time before gut closure commences (approximately 48h) when it is important for the piglet to obtain and process colostrum (Cranwell, 1995). Getting to the udder, commanding a functional teat and suckling colostrum quickly not only aids thermoregulation and the acquisition of immunoglobulins and nutrients, but also aids gut closure. Major factors in being able to achieve this are the behaviour of the mother and the level of competition at the udder (i.e. the litter size). If the sow is calm during farrowing, adopting a lateral lying posture and exposing her udder, piglets will have safe to passage to suckle colostrum. Reducing stress in the periparturient sow will help achieve this desired passive state and improve farrowing progression. Ensuring appropriate sow condition, minimising heat stress and providing enrichment to allow nest-building behaviour and reduce frustration (Thodberg *et al.* 1999; Jarvis *et al.* 2001, 2002; Damm *et al.* 2005) are all important management factors. However even if maternal behaviour and physiology are optimised additional interventions are necessary when litter size exceeds functional teat number and when there is a greater number of low vitality, growth-retarded piglets (Baxter *et al.* 2013).

Giving assistance to low vitality piglets will improve survival outcomes. For example, Muns et al. (2014) demonstrated that providing an oral supplementation of sow colostrum to piglets weighing less than 1.35 kg within 4 h of birth increased IgG levels at d4 postpartum. Other interventions include split suckling and cross-fostering to achieve litter equalisation or standardisation (i.e. similar size piglets).

Split suckling and cross-fostering:
Split suckling is a technique employed on the initial sows farrowing in a batch when fostering opportunities are limited. It involves dividing the litter into two groups and allowing each group a

specified period of non-competitive time at the udder to ingest colostrum. This can be labour intensive and careful time management is needed to ensure piglets on this regime are attended to regularly and alternated correctly. Therefore, if fostering opportunities are available, it is the preferred option. If performed correctly, cross-fostering enhances piglet survival (English et al., 1977; Cecchinato et al., 2008) and can reduce the need for further management interventions for piglets that would otherwise suffer from remaining in a large litter, or those low birth weight piglets that are failing to compete for a productive teat with their larger littermates. However, there are various welfare concerns associated with some fostering practices. These concerns relate to the time after birth when fostering occurs and the problems with over-fostering (Baxter et al., 2013). Moving too early (i.e. before 6 h old) may deprive the piglet of access to colostrum, whilst moving too late (i.e. after 24-48 h old) results in greater fighting, more disrupted suckling episodes and a greater chance of rejection by the foster mother (Price et al., 1994). Some farm managers will repeatedly cross-foster piglets, moving them from sow to sow in an attempt to achieve more homogenous weaning weights. However, such practices are very disruptive for both the sow and piglets and thus counter-productive, with continuously cross-fostered piglets failing to suckle regularly, acquiring facial lacerations and showing no improvement in weaning weights (Robert and Martineau, 2001).

Nurse sow strategies:
The use of nurse sows as a solution to the challenges of large litters is now close to ubiquitous in countries such as Denmark and the Netherlands. On average 15% of weaned sows in Danish herds are used as nurse sows after having nursed their own litter for 1-3 weeks (Pedersen, 2015). However, such systems have yet to be widely used in other countries. There are two main types of management process that involve using nurse sows; namely, one-step and two-step. One-step management involves weaning piglets which are at least 21 d old from a “chosen” nurse sow and then fostering on surplus piglets from newly farrowed sows when the piglets are at least 12 h old. The nurse sow then rears this second litter to at least 21 d of age, when they are weaned, and she returns to a dry sow facility for service. Two-step management, sometimes called “cascade fostering” involves the use of two lactating sows. An intermediate sow (interim sow) is identified and her litter is weaned at 28 d of age (or at least 21 d old) and then a second-step nurse sow is identified whose piglets are 4-7 d old. These piglets are all fostered onto the intermediate sow. The second-step sow is then given surplus, large, newly farrowed piglets (for full details see Baxter et al., 2013). Though there are welfare concerns for nurse sows relating to both the behavioural restriction associated with extended periods in a farrowing crate to raise an extra litter (Baxter et al. 2018) and also to potential physical damage such as shoulder lesions (e.g. Sørensen *et al.* 2016), piglet survival can be improved. The success relies on careful selection and management of the nurse sows (e.g. consider her mothering abilities (e.g. milk quality and yield, number and quality of teats, attentiveness in lying down, lack of aggressiveness toward the piglets…).

Artificial rearing:
Artificial rearing systems are now widely used in the Netherlands, the USA and increasingly in Germany, to deal with surplus piglets. For example, the Rescue Deck system is a specially designed unit that is recommended to sit above the farrowing crates and houses either surplus or low viability piglets. The decks are fully slatted, heated and lit and have artificial milk, water and, when piglets are older, a creep feeding system. Piglets are typically housed there from 3-20 d old and often this system does indeed “rescue” piglets that would otherwise die. However, scientific evidence regarding the advantages and disadvantages of artificial rearing systems in terms of welfare and the long-term survival prospects of “rescued” piglets is sparse. The limited evidence available suggests there are significant welfare compromises for piglets (Rzezniczek et al. 2015). If such practices are to be adopted, they require further investigation.

Optimising nutrition

Mothers matter – feeding for farrowing fitness and high lactational feed intake:

Preparing the peri-parturient sow for the exhaustive process of parturition and lactation is an important component of ensuring piglet survival, as well as good sow health and welfare. For the modern super-prolific sow, parturition is a marathon event; it is not uncommon for sows carrying large litters to have farrowings lasting 9h (Hales et al. 2015), where 4-5h was previously classified as a long farrowing (Olivierio et al. 2010). Longer farrowing duration increases the risk of both maternal and uterine fatigue leading to stillbirth or a live-born piglet compromised by hypoxia (Alonso-Spilsbury et al. 2005). Sows are also under increased metabolic pressure when attempting to meet the nutrient needs for high milk production during lactation. If they are unable to meet these requirements from feed intake, they will catabolise their own body tissues to supply the necessary nutrients and rapidly lose body condition which can have detrimental outcomes (for instance shoulder lesions, loss of body condition and lower residual reproductive output and thus shorter longevity (Ocepek *et al.*, 2017). Getting things right at the time of farrowing depends on a correct preparation during gestation (Mullan and Williams, 1989). Sows need to enter the farrowing accommodation neither too thin, limiting body reserves to draw on during the immediate post-farrowing period when feed intake is low, nor too fat, as this make sows more clumsy and liable to crush piglets and will reduce their voluntary food intake during the lactation period. A high fibre diet during gestation will help to promote intake in lactation, by accustoming the gut to higher volume of feed (Quesnel et al., 2009). Inclusion of fibre in the immediate pre-farrowing period will also help to reduce constipation which can occur at the time of farrowing and predispose sows to health problems such as MMA (Oliviero et al., 2009; Farmer et al., 1995), which can seriously impair welfare of both the sow and her litter. Fibre inclusion can also reduce sow restlessness in the post farrowing period (Peltoniemi and Oliviero, 2015) and promote greater and prolonged uptake of energy from the gastrointestinal tract (see Theil 2015 for review).

After farrowing, nutrient intake from feed needs to increase dramatically to keep pace with the requirements for milk production. To achieve this, the sow needs both a palatable and nutrient dense diet. Giving too much feed too soon after farrowing, however, can in some circumstances predispose sows to problems of MMA (Papadopoulus *et al.*, 2010) and a phased increase over the first days before feeding fully to appetite may be necessary. This ensures that feed is always fresh and of good hygenic quality, rather than accumulating in the trough and becoming stale or mouldy in warm farrowing house conditions. Ensuring plentiful water availability is also very important as the newly farrowed sow is unwilling to work hard to obtain water from drinkers with a low flow rate, and will reduce both water and feed intake to suboptimal levels under these conditions (Leibbrandt *et al.*, 2001). Drinkers should be able to supply two litres per minute and the quality of the water is also important. Another common problem which reduces feed intake is a high ambient temperature. Whilst a warm farrowing environment is important for piglet survival, it imposes stress on the sow who will reduce voluntary intake by 0.17kg for every 1°C increase in temperature above 16°C (Black et al, 1993). Reducing farrowing room temperatures as piglets start to use locally heated creep areas, from the 22-20°C which is common at the time of farrowing to 18-16°C which is more comfortable for the sow, will have large benefits for feed intake. Avoiding heat stress can be a major challenge in some parts of the world, where ambient temperatures in summer often greatly exceed these values. In these circumstances, nutrient intake can be aided by providing feed little and often and at cooler times of the day and providing localised cooling for the sow through water drip systems or cooling plates will also help (McGlone *et al.*, 1988).

Feeding for piglet robustness:

Given the importance of birth weight for piglet survival, nutritional interventions have focussed on ways to improve embryo quality and subsequent birth weight and uniformity, including use of fermentable ingredients in sow' diets prior to breeding (Van den Brand et al. 2009), and essential amino acids at the time of placental development (Wu et al. 2004). More recently efforts have been focused at how best to deal with the increasing population of intrauterine growth retarded (IUGR) piglets; Amdi et al. (2013) found that piglets born with severe IUGR had less brain sparing if their mothers were fed palm acid distillate, whilst essential fatty acid supplementation in late gestation can increase piglet vitality (Rooke et al. 2001; Bontempo and Jiang, 2015). Campos et al. (2012) published a recent review on these offspring benefits, whilst Meunier-Salaün et al. (2001) and De Leeuw et al. (2008) discussed the influence of nutritional interventions on sow welfare. Table 1 summarises examples of nutritional interventions to improve piglet and sow outcomes.

Table 1. Examples of sow nutritional interventions to improve piglet survivability

Nutritional intervention	Stage administered	Outcome	Reference
Fermentable substrates - dextrose	Lactation and pre-service	↑ BW, ↑ litter uniformity, ↓ total mortality	Van den Brand *et al.* 2009
Arginine supplementation	Throughout gestation	↑ embryo survival, ↑ placental vascularisation	Hazeleger *et al.* 2007

		↑ BW	Mateo *et al.* 2007
Carnitine supplementation	Throughout gestation	↑ BW ↓ % non-viable piglets	Eder *et al.* 2001 Eder & Brandsch 2002
DHA supplementation	Last 4wks of gestation Last 4wks of gestation + lactation	↓ stillbirths ↑ piglet vitality	Adeleye *et al.* 2012
High fibre diets (e.g. unmolassed sugar beet pulp)	Transition period immediately before farrowing Lactation (last 2wks) Pre-mating	↓ constipation ↓ sow restlessness ↑ energy uptake from GIT ↑ litter size ↑ embryo survival Improved sow welfare (↓ stereotypies, ↑ fermentation, ↑ gut distension, ↓ hunger, ↓ aggression)	Oliviero et al., 2009; Farmer et al., 1995; Oliviero et al. 2015; Theil 2015 Ferguson *et al.* 2003, 2004, 2006 Vestergaard 1997, De Leeuw *et al.* 2004 Quesnel et al., 2009
Fish oil	Day 60-115 gestation	↓ latency to suckle ↑ survival	Rooke *et al.* 2001, 2003
Palm acid distillate	Day 100-110 gestation	↓ brain sparing in IUGR piglets	Amid et al. 2013
Dietary fat	Late gestation	↑ colostrum yield ↑ lipid and lactose content in colostrum ↑ colostral IGF-1 conc.	Hansen et al. 2012 Farmer and Quesnel 2009 Quesnel et al. 2015

Feeding for enhanced colostrum yield

Lactational output of the sow is a vital aspect of determining how much colostrum the piglets receive. A variety of dietary interventions can affect the composition of colostrum and therefore piglet survival. For example high fibre gestation diets (Quesnel et al. 2015) and dietary fat inclusion late in gestation may improve colostrum yield (Hansen et al. 2012) and increase total lipid and lactose content in colostrum, as well as colostral IGF-1 concentration (Farmer and Quesnel 2009). Bontempo et al. (2015) demonstrated that dietary conjugated linoleic acid affected fatty acid composition and positively affected immunologic variables in colostrum, and could be transferred to the offspring via the dam during suckling (Bee, 2000).

Conclusions

Though the multifactorial nature of piglet mortality means single causal factors are difficult to identify, the recent focus on genetic selection strategies to increase litter size, and the associated negative impacts on survival, is a likely contributing factor hindering any substantial advances. These super-prolific breeding programmes to achieve production targets of 35-40 piglets per sow per year are likely to persist. However such targets challenge both the sow and piglets, with both immediate and long-term outcomes on health, welfare and survival.

The link between litter size and mortality can be influenced by a more balanced selection policy, incorporating survival traits as well as litter size traits in the breeding index and assigning appropriate weightings to each (Su et al. 2007; Nielsen et al. 2013). It can also be influenced by optimised nutritional programmes for sows during gestation and lactation which enhance fetal development, neonatal vigour and sow welfare, and changed management practices on the farm to provide additional support for supernumerary piglets. This demands a high level of both time and skill to be successful.

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