The second litter syndrome in sows; causes, consequences and possibilities of prevention

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Abstract
Second parity sows may have suboptimal farrowing rate and litter size, resulting from relatively high weight losses during first lactation. Sows with low performance in second parity on average also have a lower performance in later parities and increased chances of early culling. To overcome this reduced second parity reproductive performance, feed intake during first lactation needs to be improved. To realise this, both pre-farrowing and lactational –nutritional- management needs to be optimised. On the other hand, also post-weaning management strategies can influence second parity performance. Improved follicle recovery prior to insemination can be achieved by applying either skip-a-heat, or daily altrenogest treatments. These both postpone insemination time after oestrus, resulting in improved performance.

1 Introduction

Around 19% of the reproductive sows in a herd are second parity sows, e.g. sows after first weaning. Their reproductive performance, i.e. farrowing rate and litter size, therefore has a large impact on farm productivity. Many sows show an equal or lower litter size in second parity than in first parity (Saito et al. 2010), which negatively influences reproductive efficiency of second parity sows and thereby farm productivity. Since reproductive failure is one of the main reasons for culling in young sows (Lucia et al. 2000), improving second parity reproductive performance might also increase sow longevity and thereby decrease replacement costs.

2 Causes of suboptimal reproductive performance in second parity sows

Suboptimal litter sizes or farrowing rates in second parity sows are often related to (excessive) weight loss during (first) lactation (Schenkel et al. 2010). Since litter sizes and number of piglets weaned have increased in the last decade, the metabolic demands on first litter sows have also increased, whilst feed intake did not. This can result in more weight loss. Furthermore, selection on short weaning to oestrus interval (WOI) has been successful and most sows come in oestrus 4-5 days after weaning. This period, however, might not be sufficient for sows to recover from high lactation weight losses. Both the higher weight loss and short WOI can negatively influence follicle and oocyte development and/or embryonic survival and make sows more at risk for reduced litter sizes or farrowing rates in second parity.

Feed intake during lactation is often not sufficient to cover the energetic demands for milk production, maintenance and growth (Bergsma 2011). In practise feed allowance is often calculated based on the assumption that the daily energetic demands of sows are 1% of body weight for maintenance and 0.5 kg of feed per piglet for milk production (NRC recommendation). For a 200 kg sow, weaning 11.7 piglets this means a feed intake of 7.8 kg. However, average feed intake rarely exceeds 6 to 7 kg per day (Kruse et al. 2011). First litter sows might even eat less than 6 kg per day (Bergsma, 2011).

Even though some weight loss is acceptable, high body reserve losses, e.g. more than 10-12% weight loss or more than 10% protein loss, have been reported to negatively affect weaning to insemination interval, ovulation rate and follicle and oocyte quality (Zak et al. 1997b, Clowes et al. 2003). First litter sows are considered to be especially sensitive for negative effects of body reserve losses, since they are physically immature at first farrowing and thus only have limited body reserves and still need energy for growth and further development.

Up to the mid-nineties, negative effects of severe feed and protein restriction during lactation were mainly expressed as a prolonged weaning-to-oestrus interval (WOI), while more recent studies mainly show negative effects on ovulation rate and embryonic survival. The shift from prolonged WOI to reduced embryonic survival and ovulation rate is probably due to genetic selection for a short WOI (Quesnel 2009). When sows with (a high) lactation weight loss return to oestrus shortly after weaning, follicle and oocyte quality can be compromised since these follicles develop during a period of negative energy balance (reviewed by (Quesnel 2009) and are recruited immediately after weaning. If WOI is substantially prolonged, follicles and oocytes develop during a period of positive energy balance, which benefits their quality. Compromised follicle development can lead to lower quality oocytes and less developed corpora lutea (CL), causing increased embryonic losses (Zak et al. 1997a) and eventually lower litter sizes and farrowing rates.

In practise, sows are often fed (close to) ad libitum and variations in lactation weight loss are mainly due to variation in voluntary feed intake. (Hoving et al. 2012b) investigated consequences of weight loss during lactation in mildly restricted first parity sows (feed allowance 1% of sow body weight + 0.4 kg/piglet to a maximum of 7 kg daily) for reproductive performance on day 35 of second gestation. After weaning, the first parity sows were retrospectively assigned to a high (> 13.8%, n=24) or low (≤ 13.8%, n=23) lactation weight loss group. This experiment confirms that lactational weight loss in primiparous sows negatively influences embryonic survival, also at mild feed restriction; low weight loss sows had a higher pregnancy rate (96% (22/23) and embryo survival rate (77.4 ± 2.9%) compared to high weight loss sows (75% (18/24) and 65.6 ± 3.4, respectively).

3 Consequences of suboptimal reproductive performance in second parity sows

Around 50% of the second parity sows show a lower litter size in second compared with first parity. The reduced reproduction decreases the reproductive efficiency of second parity sows but might also lead to early culling.(Hoving et al. 2011a) studied relations between failure to farrow and litter size in second parity with reproductive performance in later parities in 45,000 sows. In these data, a total of 15.7% of the sows inseminated in second parity became repeat breeders. Being a repeat breeder in second parity did not affect litter size in subsequent parities, but it decreased farrowing rate in parity 3 (-4.1%) and 4 (-3.4%). Repeat breeders in second parity were on average culled 2 parities earlier compared with non-repeat breeders (parity 5 vs. 7, respectively). Analyses of relations of second parity litter size with subsequent performance showed that sows with a low litter size in second parity also had a lower litter size in parity 3 and up compared with sows with a medium or high litter size in second parity. These data show that a large part of the sows with poor reproductive performance in second parity can be expected to have a poor reproductive performance in subsequent parities, also affecting culling rates.

4 Solving suboptimal reproductive performance in second parity sows

4.1 Pre-weaning solutions

Since lactational weight loss is the crucial factor influencing reproductive performance in second parity sows, any management solution that leads to higher lactational feed intake or reduced milk production should benefit the reproductive performance of second parity sows. These solutions include gilt management (development and feed intake capacity), nutritional strategies during lactation (e.g. ad libitum water intake, gradual increase in feed intake, low room temperature) and lactational strategies (piglet numbers, lactation length). These factors have been reviewed before (Kemp and Soede 2004).

4.2 Post-weaning solutions

4.2.1 Delaying oestrus

One approach to allow the first litter sow to recover from lactation is to inseminate the sow at the second heat after weaning instead of the first one (skip a heat). Skipping the first heat can improve pregnancy rates by 15% and subsequent litter sizes by 1.3 to 2.5 piglets (Clowes et al. 1994); (Vesseur 1997); (Werlang et al. 2011). This improved reproductive performance is largely attributed to higher embryo survival rates (Clowes et al. 1994). The downside of skip-a-heat is that it increases the number of non-productive days by 21 days and that detection of the second oestrus can be a management challenge. Providing a shorter recovery period than a full cycle length by providing a progesterone analogue post-weaning may improve reproductive performance while limiting the effect on non-productive days and preventing the issue of poor detection of second oestrus. This approach has been found to positively affect subsequent ovulation rate (Koutsotheodoros et al. 1998, Patterson et al. 2008), early embryonic development (Martinat-Botté et al. 1995), fetal development (Patterson et al. 2008), farrowing rates (Martinat-Botté et al. 1995) and litter size (Martinat-Botté et al. 1995). However, some reports show no or negative effects of altrenogest treatments after weaning (Werlang et al. 2011).

Studies that investigated consequences of duration of altrenogest treatment for fertility (Table 1) consistently show that 10 to 14 days of altrenogest treatment resulted in a 1.8 to 2.6 piglet increase in total litter size compared to non treated controls. Shorter periods of application give variable or non-significant results.

Table 1 Reproductive performance after post weaning altrenogest treatement (Alt) compared to untreated controls.

Treatment			Parity	Lactation	Farrowing rate		Litter size (n)		ref
start	dose	length		length	C	Alt	C	Alt	
Before weaning									
-48h	15	7	2-7	18	-	-	11.8	ns	1
-48h	15	14	2-7	18	-	-	11.8	+1.8	1
-24h	20	4	1	20	89	Ns	11.9	ns	2
-24h	20	8	1	20	89	Ns	11.9	ns	2
-24h	20	15	1	20	89	Ns	11.9	+2.5	2
-24h	20	8	1	21	88	Ns	11.9	+1.5	3
-24h	20	8	2-3	21	93	Ns	13.7	ns	3
After weaning									
0h	20	3	1	35	-	-	10.5	ns	4
0h	20	7	1	35	-	-	1-.5	ns	4
0h	20	7	1	28	46	+22	8.9	ns	5
0h	20	7	1	35	-	-	10.7	ns	6
+3h	20	5	1	21	84	-14	11.1	-1.7	7
+3h	20	5	1	21	97	-30	10.7	ns	7
+24h	20	12	1	12	-	-	10.3	+2.6	8
+24h	20	5	1	21	-	-	12.3	ns	9

[1](Patterson et al. 2008), [2](van Leeuwen et al. 2011a), [3](Van Leeuwen et al. 2011b) [4](Boland 1983) [5](Stevenson et al. 1985) [6](Kirkwood et al. 1986) [7](Werlang et al. 2011) [8](Koutsotheodoros et al. 1998) [9](Fernandez et al. 2005)

Van Leeuwen et al. (2011ab) studied hormone profiles and follicle development during and after altrenogest treatments and related this to the reproductive performance of these sows. They essentially showed that follicle size increases for the first 6 days of treatment, and then stabilises, which suggests that the reason that treatments should be longer than 6-8d might be due to ageing of follicles and oocytes with shorter treatment periods.

It is concluded that in modern hybrid primiparous sows with high lactation weight losses and short weaning-to-oestrus intervals, extending the period from weaning to first ovulation seems a promising route to improve reproductive performance.

4.2.2. Feed intake in early pregnancy

Besides a delay in insemination time after weaning, another solution might be to increase feed intake during subsequent pregnancy. During the first two-thirds of gestation, the energetic demands for litter growth are low and young sows can use this period to recover from lactation.(Hoving et al. 2011b) investigated if an increased feed or protein level during the first 4 weeks of second or third gestation would improve sow recovery from lactation losses and also litter size and farrowing rate. From d 3 to 32 after the first insemination, sows were fed either 2.5 kg/d of a standard gestation diet (Control, n = 49), 3.25 kg/d (+30%) of a standard gestation diet (Plus Feed, n = 47) or 2.5 kg/d of a gestation diet with 30% greater ileal digestible amino acids (Plus Protein, n = 49). Sows in the Plus Feed group gained 10 kg more body weight during the experimental period compared with those in the Control and Plus Protein group. Litter size from first insemination was larger for sows in the plus feed group (15.2 ± 0.5 total born) compared with those in the control and plus protein groups (13.2 ± 0.4 and 13.6 ± 0.4 total born, respectively). Thus, an increased feed intake (+30%) during the first month of gestation improved sow body weight recovery and increased litter size in the subsequent parity. However, a follow-up experiment, designed to investigate the physiological background of the improved litter size (Hoving et al. 2012a), did not reveal increased embryo numbers at Day 35 of pregnancy, neither were effects found on reproductive hormones (progesterone, LH) or metabolic parameters (NEFA, IGF-1, urea). The combined data on effects of high feed levels during early pregnancy on reproductive performance suggest that they can aid in restoring body development and may be beneficial for litter size in subsequent parity. However the physiological mechanisms behind the improved litter sizes remains unclear.

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