Recent advances in pig reproduction: 1. Shorter weaning-to-oestrus interval

Recentes avanços na reprodução suína: 1. Intervalos mais curtos da desmama-estro

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Abstract

In the past 30 years, sows have been successfully selected for a shorter weaning-to-oestrus interval and increased litter size. This review discusses the consequences of this selection for the reproductive physiology of sows, including the consequences for litter characteristics at birth. It also discusses breeding and management opportunities to deal with these modern genetics.

Keywords: Sow, litter size, weaning-to-oestrus interval, genetic selection, management.

Introduction

As the economic success of sow husbandry relies very much,– but not solely, on the ability of sows to produce a high number of piglets per sow per year, breeding companies have, among others, selected against long weaning-to-oestrus intervals (WOI). Before the 1990-ies, lactational weight loss often resulted in increased WOI, especially in first litter sows (see e.g. Table 1), but that no longer seems to be the case. However, concomitantly with these shorter WOI, primiparous sows started showing impaired fertility in terms of farrowing rate and litter size (second litter syndrome, Morrow et al., 1989; Hoving et al., 2010) and more multiparous sows started showing lactational oestrus.

In this review we discuss aspects of selection against prolonged WOI. We first describe the consequences for sow fertility, then we discuss potential physiological explanations and lastly, we discuss potential breeding and/or management solutions to optimize fertility in the modern hybrid sow. Since consequences and physiology of selection on WOI differ between primiparous and multiparous sows, these will be discussed separately. This paper is largely based on Kemp et al. (2018).

Selection for shorter weaning-to-oestrus interval: consequences for primiparous sows

Consequences for fertility

Before the 1990's, sows with extended WOI after a regular 3 to 4 week lactation period were usually the sows that had a high lactation weight loss. Extended WOI was most pronounced in primiparous sows, due to the low feed intake capacity during first lactation, to the relative limited body reserves (fat, protein) and because these sows still have to grow to adult weight. In Table 1, experimental data are summarized on effects of low vs high feeding levels during first and second lactation. In the 1990-ies, WOI was generally longer and low lactation feeding levels resulted in longer WOI, but no effects of low lactation feeding levels were found on subsequent ovulation rate or embryo mortality. Later studies found that low feed intake during lactation does not affect the –much shorter- WOI anymore, but results in a reduced ovulation rate and embryo survival, thereby offering an explanation for the so-called second litter syndrome (lower pregnancy rates, reduced litter sizes and increased culling rates in the second parity sow (Hoving et al., 2012).

Physiological explanation

The length of WOI is primarily controlled by the hypothalamus/pituitary/ovarian system (see Kemp et al., 1998, for review). The episodic release of luteinising hormone (LH) shifts after weaning from a pattern predominated by low frequency / high amplitude pulses to one characterized by high frequency/ low amplitude pulses which results in recruitment of an antral follicle pool that is present at this moment to grow to ovulatory sizes. In sows with a short WOI, the change in LH release pattern takes place immediately after weaning whereas in sows with extended WOI, this pattern is less pronounced or even absent (Shaw and Foxcroft, 1985; Van den Brand et al., 2000). In sows with short WOI, recruitment of follicles takes place from the available follicle pool at the moment of weaning; Quesnel et al. (1998) and Zak et al. (1997) found that first litter sows fed low feed levels during lactation have a compromised follicle pool in terms of follicle size and developmental capacity of the oocytes in these follicles, which may consequently cause the lower embryo survival in primiparous sows with high lactation weight loss and thereby the second litter syndrome. In a review, Quesnel (2009) concluded that 'the physiological

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mechanisms by which information on the metabolic changes is transmitted to the hypothalamus-pituitary-ovary axis are not fully understood in the sow, although glucose, insulin and leptin are the most likely signals'. That the quality of the follicle pool may indeed be comprised in these first litter sows is further substantiated by studies in which large positive effects were found on pregnancy rate and litter size when first litter sows were not inseminated during the first, but during the second oestrus after weaning (skip-a-heat) or when oestrus was postponed by feeding a progesterone analogue for 12 to 15 days post weaning (reviewed by Kemp and Soede (2012b). Thus, shorter WOI has stimulated LH release from the hypothalamus pituitary system at weaning, which, in primiparous sows, not only resulted in a short WOI, but also in an increased chance of selecting compromised follicles.

Table 1. Effects of high or low lactation feed or protein allowance on weaning to oestrus interval (WOI), ovulation rate and embryonic survival rate at day 28/35 of pregnancy[1]. Adapted from (Kemp and Soede 2012c).

Reference	Parity	Lactation length (d)	WOI (d)		Ovulation Rate		Embryo Survival (%)	
			High	Low	High	Low	High	Low
King and Williams (1984b)	1	32	7.6[b]	19.9[a]	14.4	13.4	70[4]	72[4]
King and Williams (1984a)	1	32	14.2[a]	17.9[b]	12.3	12.6	62[4]	61[4]
Kirkwood et al. (1987)	2	35	4.3[a]	5.8[b]	18.2	18.7	83[a]	68b
Kirkwood et al. (1990)	2	28	6.9[a]	8.9[b]	17.6	17.7	79[a]	72[b]
Baidoo et al. (1992)	2	28	5.9[a]	7.3[b]	16.4	17.2	81[a]	67[b]
Zak et al. (1997) L: wk1-3[2]	1	28	3.7[a]	5.6[b]	19.9[a]	15.4[b]	88[a]	87
Zak et al. (1997) L: wk4	1	28		5.1[b]		15.4[b]		64[b]
Zak et al. (1998)	1	28	4.2[a]	6.3[b]	14.4	15.6	83	72
Quesnel et al. (1998)	1	24	5.7	5.9	19.2	20.7	-	-
Van den Brand et al. (2000)	1	21	5.1	5.7	18.2[a]	16.2[b]	88[a]	64[b]
Vinsky et al. (2006)	1	21	5.3	5.4	18.3	18.2	79[a]	68[b]
Patterson et al. (2011) L: wk3[3]	1	20	5.0	5.3	19.7	20.2	71.2	70.3

[1]High ~ ad libitum allowance; Low ~ 50-75% of ad libitum allowance; [ab]difference between High and Low feed allowance $P < 0.05$; [2] L:wk Weeks of lactation in which feed intake treatment was applied; [3] Embryonic weight was significantly lower in restricted sows (1.46 g vs 1.56 g); [4]Percentage of piglets born of the ovulation rate assessed with laparoscopy at wk 2 of pregnancy.

Management opportunities

Strategies to overcome the decrease in fertility associated with lactational weight loss in first litter sows focuses on three tracks (see also Soede and Kemp (2015) and are briefly summarised here.

Stimulate feed intake

It should be noted that first litter sows that nurse 10 to 14 piglets during a 21 to 28 d lactation cannot avoid losing weight during the lactation period, as their feed intake capacity is usually not sufficient to meet the requirements for milk production and maintenance (Eissen et al., 2003). Some weight loss can be tolerated, as several studies have shown that a weight loss of up to 10 to 12% does not affect subsequent fertility (e.g. Thaker and Bilkei, 2005). Nevertheless, sufficient feed intake is often not reached, which may be related with: insufficient gilt development at farrowing, controllability of ambient temperature (preferably 20°C), feed (quality and pattern of allowance) and water allowance (should be fresh and ad libitum).

Reduce intensity of suckling

Reducing the intensity of suckling during the last part of lactation can be achieved by either removing a part of the litter a few days before final weaning (so-called split weaning) or by reducing the number of hours per day that piglets suckle in the last 1 to 2 weeks of lactation (so-called 'intermittent or interrupted suckling'). In 1997, Vesseur et al. studied effects of split weaning in young sows and found that a reduction in litter size from 10 to 6 at week 3 of a 4-wk lactation indeed reduced the WOI and, in the first parity sow, increased subsequent farrowing rate by 10%. Unfortunately, no recent data on the use of split weaning are available. Intermittent suckling for 10 to 12h per day has been used in a series of experiments to investigate if this would allow ovulation and thereby insemination during – extended - lactation. In fact, intermittent suckling would allow a higher weaning age of piglets, thereby improving their health and welfare (e.g. Berkeveld et al., 2009). Some of these experiments have included first litter sows. The percentage of first litter sows that show oestrus within 1 week of intermittent suckling varies (e.g. 23% Soede et al., 2012; 52% Terry et al., 2014; 72%;Chen et al., 2017) while subsequent farrowing rate and litter size was similar to that of weaned first litter controls (Chen et al., 2017), suggesting that responsive sows had good follicle development.

Postponing the timing to oestrus

Postponing the timing of oestrus after weaning can prevent the second litter syndrome. Kemp and Soede (2012b) reviewed the consequences of daily progesterone analogue feeding after weaning to postpone oestrus and concluded the following. Once a day treatment with the progesterone analogue altrenogest results in an increase in follicle size during the first 4-6 days of the treatment, probably due to the fact that LH pulsatility is suppressed for only 12 h, not 24 h, after feeding the progesterone analogue. After 4-6 days of treatment, follicle size decreases again, suggesting turnover of the old follicle population. When altrenogest treatment is stopped after 4-7 days, sows show poor subsequent reproductive performance in terms of farrowing rate and litter size. This might be related to the fact that the ovulated follicles have aged and so have their oocytes. When altrenogest treatment continues for 10 to 14 days after weaning, subsequent farrowing rate and litter size were high. This suggests a successful follicle turnover, resulting in good oocyte quality.

Selection for shorter weaning-to-oestrus interval: consequences for older parity sows

Consequences for fertility

Older parity sows generally have short weaning to oestrus interval and the effects of weight loss on subsequent reproduction are less obvious or absent (Bergsma, 2011). Currently, however, older parity sows with extended weaning-to-oestrus intervals are more likely to be sows that have had an ovulation during lactation, followed by a 21 day cycle. As farmers are not focussed on signs of oestrus during lactation and no boar is present, during lactation usually occurs unnoticed. However, when oestrus detection is done with a boar, lactational oestrus has similar intensity and duration as post-weaning oestrus (Soede et al., 2012). Recent Dutch and Australian studies (van Wettere et al., 2017) concluded that *"the capacity of modern sows, of various genotypes, to spontaneously ovulate during a 21- to 28-day lactation period is clearly high",* although most likely, spontaneous ovulations will take place more towards the end of a 28-day lactation.

Physiological explanation

Short weaning-to-oestrus intervals not only results is increased pulsatile LH release immediately after weaning but also in a faster restoration of pulsatile LH release during lactation (see e.g .Shaw and Foxcroft (1985), Tokach et al., 1992).

Selection for short weaning-to-oestrus intervals probably has made sows more responsive to external stimuli like e.g. boar exposure, split weaning and stress in terms of pulsatile LH release by the hypothalamus/pituitary system during lactation (Kemp et al., 1998), allowing sows to recruit, select and ovulate follicles during lactation. Also, when sows are inseminated during lactational ovulation, high subsequent litter sizes and farrowing rates are seen, comparable to weaned controls (Chen et al., 2017; Soede et al., 2012), which shows that also the quality of follicle development was restored during ongoing lactation.

Management solutions

Hardly anything is known about the occurrence or risk factors of lactational oestrus on sow farms. Sigmarsson and Kauffold (2016) used daily boar spray in the last week of lactation to detect oestrus and found oestrus in a relatively low 4.2% of the 1563 lactating sows, but the variation between batches of sows was large, between 0% and 12.6%. As both suckling intensity and negative energy balance of sows contribute to lactational anoestrus (Quesnel and Prunier 1995), it seems likely that especially older parity sows with a low percentage of lactational body weight loss are more prone to show lactational follicle growth and their further ovulation. Terry et al. (2013) found that induction of lactational oestrus was more successful when sows suckled 7 piglets compared to 10 piglets. On the other hand, Sigmarsson and Kauffold (2016) did not see clear parity effects on the incidence of lactational oestrus. Another important risk factor may be the general restlessness in the farrowing room as management stressors such as mixing, transport and relocation are known to stimulate oestrus in responsive females, as is well known for gilts (Hughes 1982).

Diagnosis of lactation ovulation can be done using ultrasound scanning of the ovaries after weaning, to verify the presence of growing follicles. Analyses of sow records can also be performed to verify if extended WOI mostly occur in higher parity sows or in those with a low number of piglets weaned or with a low weight. Avoiding the factors mentioned above should limit the occurrence of lactational oestrus and decrease the percentage of older parity sows with extended intervals to oestrus.

Concluding remarks

Selection for shorter WOI has been very successful. In young sows, however, it might have resulted in an increased chance of selecting compromised follicles at weaning, thereby contributing to the so-called second litter syndrome. In older sows, selection for shorter WOI has come with a higher chance of lactational oestrus. This can be seen as an opportunity for sow husbandry systems with longer lactation lengths, as sows can be inseminated during lactation (Kemp and Soede 2012a).

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