REPRODUCTIVE PROBLEMS IN PRIMIPAROUS SOWS

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INTRODUCTION

Primiparous sows are the problem category in most sow herds. Field data analyses show that these sows have the highest risk of having a prolonged weaning to estrus interval. Therefore a lot of these sows are treated with cycle stimulating hormones like PG600, sometimes even as a standard at the day of weaning. Vesseur et al. (1994) showed that in first parity sows, treated with PG600 15 days after weaning, the percentage of PG600 treated sows was between 25.0 and 37.5 %. In older parity sows, which were treated with PG600 on day 8 after weaning, the percentage of PG600 treated sows was below 3%.

A second problem of the first litter sow is low pregnancy rates after insemination. This is particularly evident from analyses of culling data around the world. Analyses within parity show that failure to become pregnant represent 40-50% of all culling in first litter sows (Gill, 2000).

A third problem which can be attributed to malfunctioning of the first litter sows is the second litter syndrome. This means that the number of piglets in the second litter of the sows is similar to or lower than that in the first litter. Morrow et al. (1992) showed that 40% of the herds in a North American database suffered from the second litter syndrome. Most likely, the low second litter size and the poor pregnancy rates are caused by a low ovulation rate or an increased embryonic mortality.

In this review causes of reproductive failure of the first litter sows will be discussed. Also a physiological explanation for different reproductive problems (extended weaning to estrus interval, low litter size and conception failure) will be provided. Also potential ways to improve reproductive performance of sows during and after lactation will be discussed.

CAUSES OF REPRODUCTIVE FAILURE OF FIRST LITTER SOWS

Causes of reproductive failure are predominantly found in the preceding lactation period. Factors that make lactation for a first litter sows a heavier burden than for older parity sows are that first parity sows still have significant nutrient needs for growth to maturity, a lower feed intake capacity and lower metabolizable fat and protein stores.

Lower feed intake capacities make the catabolic state more dramatic and the lower metabolizable stores restrict the contribution from maternal stores to milk production.

To quantify the gab between actual needs and feed intake capacity of first litter sows, Everts et al. (1995) calculated energy and protein requirements for lactating sows based on a factorial approach. In this approach energy and protein demands for maintenance and milk production are taken into account. Based on these calculations a first litter sow weighing 175 kg and nursing 10 piglets (drinking 9.3 kg of milk per day) should be fed 85.9 MJ Metabolisable Energy (ME), 875 g of Crude Protein (CP) and 58 g of total lysine (Lys) per day to keep her protein and fat reserves in equilibrium (which is about 6.6 kg of diet per day containing 12.9 MJ ME, 13.3% CP, 8.8 g Lys).

Many first litter sows will not meet these requirements due to a low feed intake capacity. If sows have a true intake which lies 25% below these demands (that is: 5.0 kg/d, 64 MJ ME ,656 g of CP and 44 g Lysine), they will mobilize about 11.6 kg of fat and 4.4 kg of protein during a 28 day lactation period. A sow of 175 kg has about 28 kg of protein and 33 kg of fat in her body (Everts et al. 1994). This means that body protein and fat are seriously depleted during lactation. In terms of weight loss, she will loose about 11.6 + 4.4* 4.4 (water/protein ratio is about 1:3.4)= 31 kg of weight during a 28 day lactation period which is quite a realistic figure for a first litter sow.

EFFECTS OF A REDUCED FEED INTAKE ON REPRODUCTION IN THE FIRST LITTER SOW

1. Effects on weaning to estrus interval

If first litter sows have a lower feed intake than required for maintenance and milk production this will result in weight loss during lactation. First litter sows seem to be more sensitive to weight loss during lactation as compared to older parity sows (Hughes, 1989, Vesseur et al., 1994). E.g. Vesseur et al. (1994) showed that weight loss during lactation has a far more pronounced effect on onset of cyclicity after weaning in first parity sows as compared to older parity sows (see Table 1).

Table 1 - The relation between body weight loss during lactation (as a percentage of the body weight at farrowing) within parity on weaning to estrus interval and the percentage of sows treated with hormones to induce estrus (adapted from Vesseur et al. (1994))

Parity		**Weight loss during lactation (%)** **<12.5**	 **>12.5**
1	N	165	122
	WOI[x]	10.8 [a]	14.7 [b]
	% treated	22.3 [a]	43.4 [b]
2	N	148	109
	WOI	7.4 [a]	8.5 [b]
	% treated	7.3 [a]	23.9 [b]
3-5	N	540	168
	WOI	6.3	6.5
	% treated	2.7	6.0
>=6	n	208	35
	WOI	6.2	6.0
	% treated	0.8	0.0

[a,b] Significant difference (P<0.05)
[x] First parity sows, treated with PG600 15 days after weaning and older parity sows were treated on day 8 after weaning, is they failed to show heat before these days.

Reduced feed intake during lactation has been shown to affect the weaning to oestrus interval in first litter sows in many studies. In the literature reviewed by Hughes (1989), first litter sows receiving high amounts of energy and protein during lactation, had mean weaning to oestrus intervals of 10.3 to 12.7 days whereas those receiving low energy and protein levels had weaning to oestrus intervals of 14.6 to 19.3 days. In older parity sows, however, the effects of reduced feed intake on weaning to mating interval (which was found to be about 4 to 7 days, Hughes, 1989) are mostly absent or very small (see Hughes, 1989; Whittemore, 1996, for review). Overall, it is clear that underfeeding in terms of energy as well as protein during lactation causes an extension of the weaning to mating interval, especially in first litter sows.

2. Effects on ovulation rate

Hughes (1989) and Whittemore (1996) concluded from their reviews that feed intake during lactation has little effect on ovulation rate. However, Zak et al. (1997a, see Table 3) and Van der Brand (2000a, see Table 2) demonstrated that the mean ovulation rate of primiparous sows, subjected to a period of reduced feed intake during lactation, was reduced. In these experiments, the effects of undernutrition on weaning to oestrus interval were very small and the weaning to oestrus interval was short (about 4-5 days). It seems plausible that the effects of undernutrition during lactation on ovulation rate are less marked or absent when the weaning to oestrus interval is extended.

Table 2 - Effect of feeding level during lactation on weaning to estrus interval and ovulation rate in primiparous sows (Van der Brand et al. 2000a)

Metabolisable energy intake/day	**62.8**	**47.1**
Weaning to estrus interval (h)	123	136
Ovulation rate	18.1[a]	16.2 [b]

[a,b] Significant differences P < 0.05

Older parity sows often have ovulation rates of about 24 eggs (Soede et al. 1995) which is well above the uterine capacity for embryos/foetuses during pregnancy. Therefore effects of nutrition on ovulation rate have to be substantial to expect effects on litter size. However in first litter sows ovulation rate is substantially lower and therefore relatively modest effects on ovulation rate may affect litter size.

3. Effects on embryonic mortality

Hughes (1989) and Whittemore (1996) concluded that low feeding levels during lactation may adversely influence subsequent embryonic survival in gilts and sows. The literature reviewed by Hughes (1989) suggested that low feeding levels as compared to high feeding levels during lactation resulted in a 10 % (range 0-15%) lower embryonic survival. More recently van den Brand et al. (2000b) found no effect of feed restriction during lactation on embryo survival but Zak et al. (1997a) found a 20% lower embryo survival when first litter sows were restricted in the last week of lactation.

From these data one can conclude that low feeding levels (energy or protein levels that result in a catabolic state of the animal) during lactation can affect weaning to estrus interval, embryonic survival and ovulation rate.

PHYSIOLOGICAL EXPLANATIONS FOR REPRODUCTIVE FAILURE IN FIRST LITTER SOWS

To shed more light on the mechanisms that cause the reproductive failure in primiparous sows the following paragraphs will provide an overview of mechanisms explaining problems with weaning to estrus interval and problems like small litter size and failure of conception.

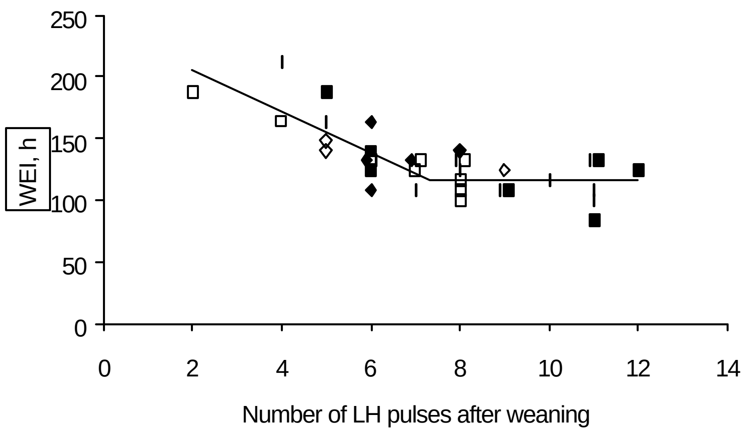
1. A physiological explanation for an extended weaning to estrus interval

Especially LH released from the pituitary gland (induced by GnRH release from the hypothalamus) seems to be an important regulating factor explaining variation in weaning to oestrus interval. Several studies have shown that LH levels and pulse frequencies at weaning are inversely related to weaning to oestrus interval (Shaw and Foxcroft, 1985; Tokach et al., 1992; Patterson and Pearce, 1994; Kemp et al., 1995). Directly after weaning, in good reproductive sows, LH production is characterized by a high frequency/low amplitude pulse frequency which induces recruitment of the then existing population of large follicle. A part of these follicles will grow out and ovulate at about 4 to 5 days after weaning and another part of the follicles will go into atresia. When this typical LH pattern is mimicked by exogenous pulsatile treatment with GnRH during lactation, ovulation has been shown to occur between 90 and 123 h after onset of treatment (Britt el al., 1985).

If the GnRH pulse generator fails to induce this typical high frequency/low amplitude LH release from the pituitary after weaning, sows will show a prolonged weaning to oestrus interval (Shaw and Foxcroft, 1985). Van der Brand et al. (2000a) showed, in primiparous sows, that the relation between LH pulse frequency at the day of weaning and weaning to estrus interval is a linear plateau relationship. Animals with 8 or more pulses per 12 h directly after weaning showed a short weaning to estrus interval (4.5 days) regardless of the number of pulses. Animals with less than 8 pulses per 12 h after weaning showed a linear relation between the number of LH pulses and weaning to estrus interval; a low number of pulses resulted in an extended interval (see Figure 1). It appears that sows need a minimum number of LH pulses directly after weaning to have a short weaning to estrus interval.

Some studies show that LH levels and pulsatility directly after weaning are related to restoration of LH pulsatility and levels during lactation (Tokach et al. 1992, Kemp et al. 1995, Van der Brand, 2000a). LH pulsatility and levels are reduced during early lactation and in sows in which restoration of LH pulsatility and levels was seen during the course of lactation, also showed high LH levels and pulse frequency directly after weaning and short weaning to oestrus intervals. Sows in which LH pulsatility was not restored during lactation showed impaired LH levels and pulse frequencies directly after weaning and a prolonged weaning and estrus interval. It seems therefore that the ability of sows to increase levels of LH during lactation is important for a short weaning to estrus interval.

Figure 1: Relationship between LH pulse frequency the first 12 h after weaning and the weaning to estrus interval in primiparous sows (Van der Brand et al. 2000a).



In primiparous sows fed different energy and protein levels during a 28 day lactation period, Tokach et al. (1992) demonstrated that average daily protein intake and energy intake affected mean LH concentration on d 21 of lactation in an interactive manner. At a low Metabolizable Energy (ME) intake, increasing lysine intake had little effect on mean LH. The influence of lysine intake on LH secretion increased as energy intake increased. These results reveal that mean LH at day 21 of lactation is reduced by restrictions of either lysine or energy intake. Similar effects on LH pulse frequency and LH concentration have also been reported by King and Martin (1989) who used protein restriction during lactation and Quesnel et al (1998) and Van der Brand et al (2000a) using energy restriction during lactation. It seems therefore clear that nutritional effects on weaning to oestrus interval exert their effect via a reduced LH production during and after lactation.

2. A physiological explanation for small litter size and conception failure

An insufficient release of LH during lactation and after weaning can satisfactory explain the prolonged weaning to estrus intervals in first litter sows but offers no explanation for reproductive problems like the second litter syndrome and failure to become pregnant.

As mentioned above, the causes of these problems can be found in low ovulation rates or a high embryonic mortality. To explain how lactational management or feeding can affect ovulation rate or embryonic mortality more information is required on follicular growth dynamics during lactation.

During the course of lactation a gradual increase in follicle development is seen. In serial slaughter experiments, Kunavongkrit et al. (1982) showed that while lactation progresses more follicles are found in larger size categories (see Figure 2). Quesnel et al (1998) showed that feeding first litter sows at a level of 50% of ad libitum as compared to ad libitum resulted in smaller follicles at weaning and at two days after weaning. At day 2 after weaning the average number of follicles larger than 4 mm was 6.8±2.7 for the restricted fed sows as compared to 12.2±1.3 for the ad lib fed sows. Restricted feeding seems to restrict follicle growth during lactation with consequently affects follicle development after lactation.

Figure 2: Percentage of total follicles in various size categories during lactation of sows. Each mean represents 2 or 3 sows. After Kunavongrit et al. (1982)

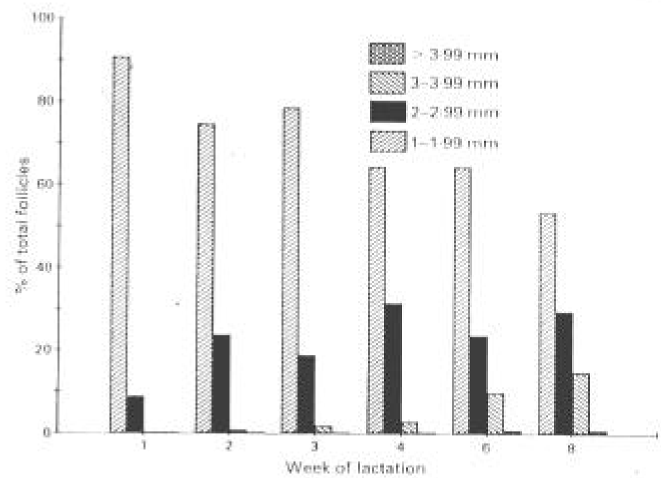


Fig. 2. Percentage of total follicles in various size categories during lactation of sows. Each mean represents 2 or 3 sows. After Kunavongkrit *et al.* (1982).

Using a gilt model, Almeida et al. (2000) fed gilts 2.1 times maintenance during the first 7 days of the luteal phase and 2.8 times maintenance in the second 7 days or 2.8 times maintenance in the first 7 days of the luteal phase and 2.1 times maintenance in the second 7 days of the luteal phase. The control group was fed 2.8 times maintenance throughout the luteal phase. They found no effects of treatment on ovulation rate but embryo mortality was lower in gilts fed 2.1 times maintenance in the last 7 days of the luteal phase (68.3 % vs 83.6% for the controls). The lack of effect of treatments on ovulation rate may be explained by the relative mild feed restriction. In an other gilt model, Soede et al., (unpublished results) restricted feed intake of gilts during the last week of a 3-week period of altrenogest treatment (controls were fed 2.8 times maintenance and restricted fed animals were fed 1.5 times maintenance). Restricted feeding for 1 week resulted in smaller follicles. After this restricted feeding period for 1 week all gilts were refed to a level of 2.8 times maintenance and the progesterone treatment was stopped allowing the gilts to start the follicular phase. Gilts which were fed restricted for 1 week under progesterone dominance (resulting in a depressed follicle growth) also showed a significant lower ovulation rate as compared to controls (14.7 vs 17.2, respectively). No differences in embryonic mortality were found at day 10 of pregnancy. These gilt models seem to show that restriction of feed intake impairs follicle growth which can have lasting effects on subsequent ovulation rate and embryonic mortality.

Table 3 - Weaning to estrus interval (WEI), ovulation rate (OR) and embryo survival rate (ESR) at Day 28 of pregnancy of sows with different pattern of feed intake during a 28 day lactation period (Zak et al. 1997a)

	Feeding pattern[x]		
	AA	AR	RA
WEI (h)	88.7[a]	122.3[b]	134.7[b]
OR	19.9[a]	15.4[b]	15.4[b]
ES	87.5[a]	64.4[b]	86.5[b]

[x]AA= sows receiving at lib feeding, AR= Ad lib the first 21 days, 50% of ad lib the last 7 days, RA= 50% of ad lib the first 21 days, ad lib the last 7 days.
[ab]Signif icant difference.

Similar effects are also found in first litter sows. Zak et al. (1997a) studied first litter sows, which were subjected to different feeding regimes, during a 28 day lactation period. The control group was fed ad libitum, one group was f ed restricted (50% of ad lib) during the first 3 weeks of lactation and one group was fed restricted during the last week of lactation. Both restricted groups had a lower ovulation rate after weaning and the group fed restricted during the last week of lac tation also showed a lower embryonic survival as compared to control (Table 3). In a subsequent experiment Zak et al. (1997b) used similar treatment groups and studied the ovaries at 38 h before expected estrus. In sows fed restricted during the last week of lactation (that were expected to have a low embryo survival) had a lower number of large follicles and the in vitro maturation capacity of eggs from these follicles proved to be reduced. Also the quality of the follicular fluid of these follicles seemed lower, because slaughterhouse eggs, in vitro matured in follicular fluid from these sows also showed an impaired maturation.

Collectively, these data suggest that low feeding levels during lactation impair follicle development during and after lactation resulting in a lower number of follicles recruitable for ovulation (which results in a lower ovulation rate) and an impaired quality of eggs and follicular fluid (which may explain increased embryonic mortality). A lower ovulation rate and an increased embryonic mortality may both result in lower litter sizes at weaning. When ovulation rate is low or embryonic mortality is high, the number of embryos may be below the minimum of two per uterine horn. This minimum is required around day 10-15 of pregnancy for maternal recognition of pregnancy. In that case sows will not remain pregnant an return to estrus after 21 days..

POTENTIAL WAYS TO IMPROVE REPRODUCTIVE PERFORMANCE OF FIRST LITTER SOWS

Since first litter sows seem to be more responsive to nutritional or litter management factors as compared to older parity sows these factors need extra attention. The logical way to prevent reproductive problems is by prevention of excessive weight loss during lactation. This can be achieved by optimizing feed or nutrient intake during lactation.

Several potential ways to improve nutrient intake are listed below.

1. Feed intake during pregnancy

Several studies have shown that increasing feed intake during pregnancy decreases the voluntary feed intake during lactation (e.g. Mullan and Williams, 1989, Yang et al., 1989, Dourmand, 1991). However, Yang et al. (1989) showed that insufficient feed intake during pregnancy (resulting in thin sows) can not be compensated by increased voluntary feed intake during lactation in first litter sows and thus results in prolonged interval weaning to estrus. Therefore, gilts should fed according to their requirements for maintenance, reproduction and growth but not be overfed. Everts et al. (1994) advise an energy intake of 24.8 and 36.1 MJ Metabolisable Energy (ME) per day at the beginning and end of pregnancy, respectively. With regard to reproductive performance Yang et al. (1989) advice a target backfat thickness (P2) at first parturation of 20 mm.

2. Ambient temperature

Thermal requirements for lactating sows are considerably lower than temperature requirements for piglets. New born piglets have a lower critical temperature of about 32-35^{0}C which gradually lowers to a temperature of 24-27^{0}C at 4 weeks of age. For sows, the upper critical temperature is not studied in detail but is probably lower than 22 to 25^{0}C. Above the upper critical temperature sows will lower their feed intake to prevent overheating. Black et al. (1993) calculated on basis of 9 experiments that for each degree C elcius above 16^{0}C, the daily voluntary feed intake decreased by 2.4 MJ Digestible Energy (a normal lactating sow diet provided about 13.8 MJ DE/kg). Therefore high ambient temperatures can significantly reduce feed intake during lactation. Skin wetting, d rip cooling and snout coolers may increase lactation feed intake of sows at high ambient temperatures (see Makkink en Schrama, 1998, for review)

Normally, stable temperatures during lactation are often well above 22^{0}C and supplemental heating is provided to the piglets by means of floor heating or radiant heat (lamps).

Effects of low ambient temperatures on piglets are most severe during the first days after birth, while negative effects of high ambient temperature on the sow are predominant during mid and late lactation when milk production and feed intake are high. Therefore, it might be beneficial to have high temperatures during the first week of lactation and if possible, lower temperatures thereafter. According to Makkink and Schrama (1998), room temperatures in late lactation may even be as low as 16^0 C when a good microclimate is available for piglets. However, good experimental data on this are missing. Low ambient temperatures will increase feed intake of sows during lactation and will therefore be helpful in preventing reproductive problems in first litter sows.

3. Feed intake pattern

Some reports show that feeding lactating sows more than 2 times a day will improve feed intake. Also when using ad lib feeding systems sometimes better feed intakes are found. E.g. Hoofs et al. (1993) found a 10% higher feed intake when using self feeders in stead of feeding twice a day. Generally, it is advisable to remove feed from the trough once daily when using ad lib feeding to prevent the feed to mould and become sour.

Koketsu et al. (1996a,b) characterized feed intake patterns during the course of lactation and studied the effect on reproductive output. Sows showing a rapid increase in feed intake with no drop during the course of lactation and sows with a gradual increase with no a drop during the course of lactation showed the best reproductive performance. If sows are overfed at the onset of lactation sometimes a drop in feed take is seen later in lactation. In those sows, reproductive output is lower. Therefore it is advised to increase feed intake gradually in the first days of lactation. E.g. Everts et al. (1995) advice 2 kg of diet at farrowing and a stepwise increase of feed intake of 0.5 kg per day until the recommended feed intake is reached.

4. High fat diets

Another approach that has been followed to reduce mobilisation of body stores is increasing the dietary fat content. When feeding high fat diets a reduction of feed intake is often seen in sows. However in a review on high fat diets, Drochner (1989) showed that in older parity sows total ME intake was still increased by about 3-32% (as a mean 12 %). Fat as an energy source also seems to increase milk fat content and in some cases total milk output (Pettigrew, 1981; Drocher, 1989). Van den Brand et al. (2000c) measured energy and protein balances in primiparous, isocalorically fed sows with diets containing 13.5 % fat as compared to diets with 3.4 % fat at two different feeding levels. Results are shown in Table 4. At high feeding levels the fat rich diet resulted in an increased milk fat content and a significant higher body fat loss from the sows. Over a 21 day lactation period this means that the fat rich diet results in 3.8 kg (see table 4: (584-401)* 21 days) more loss of fat reserves as compared to the starch rich diet. At low feed intake levels losses of body condition were similar for both diets.

Table 4 - Effect of feeding level and fat level of the diet on partitioning of energy in first litter sows during a 21 day lactation period (Van den Brand et al., 2000c)

Energy intake/day:	**62.8 MJ ME**		**47.1 MJ ME**	
Diet:	**Fat**	**Starch**	**Fat**	**Starch**
Milk production (l/d)	9.6 [a]	9.9 [a]	8.0 [b]	8.6 [b]
Milk fat content (%)	8.4 [a]	6.9 [b]	7.6 [ab]	7.8 [ab]
Growth of piglets (g/d)	256 [a]	261 [a]	206 [b]	224 [b]
Losses in the sow:				
Protein losses (g/d)	50	31	69	75
Fat losses (g/d)	584 [a]	401 [b]	511 [a]	521 [a]

[ab] Significant difference ($P < 0.05$)

Fat rich diets may be beneficial in a hot climate since heat production of sows is lower when fat is used for milk production instead of carbohydrates. However the milk fat driving effect of the fat rich diet makes it unlikely that fat rich diets will help the sow to prevent loss of body condition even when the energy intake is higher. It is therefore also questionable whether high fat diets are beneficial for prevention of reproductive problems in the primiparous sow.

The aim of the work of Van den Brand (2000) was to study if carbohydrate rich diets would positively influence reproductive characteristics of sows during lactation. Carbohydrate rich diets stimulate insulin production and insulin is believed to stimulate LH release from the pituitary gland and to stimulate growth of follicles (see Kemp, 1998, for review). In the catabolic first litter sow, however, insulin stimulating diets fed during lactation failed to improve reproductive characteristics like LH release during and after lactation, peri-ovulatory reproductive hormone profiles, ovulation rate and embryonic survival (Van den Brand 2000a,b). Therefore, application of insulin stimulating diets during lactation seems to be of limited value to stimulate reproductive performance in sows.

REDUCTION OF THE SUCKLING STIMULUS

Another approach to relieve the first litter sows from the burden of lactation is through reduction of the suckling stimulus. Reducing the number of piglets during (part of) the lactation may help to reduce milk production from the sow and may also reduce the inhibition of the sucking induced suppression of LH release by endogenous opioids. Low numbers of piglets during lactation have been shown to improve reproductive performance of sows but the reduction has to be substantial, partly because piglets in smaller litters will consume more milk per piglet. E.g. Yang et al. (1989) found no difference in weaning to estrus interval between first litter sows nursing either 6 or 12 piglets.

Matte et al. (1992) reviewed data on the effects of interrupted suckling (a daily temporary removal of the whole litter) or split weaning (a permanent removal of part of the litter a few days before completing weaning) on subsequent reproduction. In general, effects of such techniques on weaning to estrus interval are variable and relatively small. E.g. Vesseur et al. (1997) found only a small influence of split weaning on weaning to oestrus interval in first litter sows and no effect on subsequent litter size.

A drawback of the use of these techniques can be the substantial number of lactational estruses that occur when applying these techniques. Lactation estrus is often poorly expressed by the sow and occurs at unpredictable times. Therefore lactational estrus should be prevented.

Generally, the effects of reduction of the suckling stimulus on reproductive performance of first litter sows are conflicting and risks for lactation estrus are present. Some farmers however use these techniques successfully.

POTENTIALS FOR POST LACTATION REPAIR

The cause of reproductive problems in the first litter sow seems to be found in the limited feed intake capacity during lactation in combination with limited body reserves which can be mobilised for lactation.

In general effects of post weaning feeding and management on weaning to estrus interval are only found in sows with longer weaning to estrus intervals after lactation. E.g. Fahmy and Dufor (1976) found that ad lib feeding after weaning as compared to restricted increased the percentage of sows in heat within 7 days after weaning from 52 to 62%. Van den Brand et al. (2001) showed that feeding of carbohydrate rich diets after weaning in stead of a fat rich diet resulted in a shorter weaning to estrus interval. In this study carbohydrate rich diets increased the average percentage of first litter sows in estrus within 9 days after weaning from 52 to 67%. Also intensive boar contact after weaning improved the percentage of sows showing heat within 9 days post weaning from 30 to 51% (Langendijk et al., 2000). In these studies no effects were found on ovulation rate or embryonic survival.

The use of PG600 directly after weaning results in an improvement of the weaning to estrus interval in many studies but sometimes this results in lower pregnancy rate or lower litter sizes (Kirkwood, 1999).

Epidemiological data showed that a short weaning to estrus interval is a risk factor for the second litter syndrome. Sows with longer weaning to estrus intervals have a low chance of producing a small second litter (Morrow et al., 1992; Lucbert and Lavorel,1984). Perhaps, therefore, ovulation rate or embryo survival can be improved by allowing the sow to recover for a longer period after lactation. One way to do that is to give the sows a progesterone analogue (Regumate) after weaning to artificially extent the weaning to estrus interval. Application of Regumate after weaning results in increased ovulation rate and/or embryo survival (Martinat-Botte et al. 1995, Koutsotheodores et al. 1998) and pregnancy rate and litter size (Johnston et al. 1992, Forgerit et al. 1995).

Another approach to allow the first litter sow to recover from the previous lactation is to inseminate the sow at the second heat after weaning in stead 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). When using this approach intense heat checking is important to make sure that the sow will show a second heat.

Whether or not these techniques should be applied is a matter of economic calculations. The costs of an extended weaning to service interval should be weighed against the benefits of improved pregnancy rates and litter sizes.

On can conclude that post weaning treatments to improve weaning to estrus interval are limited to sows showing long intervals weaning to estrus. Extending the time of first service after weaning by using regumate or skipping a heat improves pregnancy rate and litter size.

CONCLUSION

In conclusion one can state that energy and protein needs during lactation are substantial and since many primiparous sows have a limited feed intake capacity, energy and fat reserves are severely depleted. This results in a suppressed follicle development and LH release during and after lactation which explains occurring problems like prolonged intervals weaning to estrus, lower ovulation rates and higher embryonic mortality.

An adequate feed intake preventing high losses of body stores is therefore important. Feed intake can be stimulated through good management in which attention should be given to ambient temperatures in the farrowing stable, feeding systems, feeding pattern during lactation and feeding during pregnancy. Prevention of the negative energy and protein balance by using high fat diets, is not always successful in prevention of loss of body stores because milk production and milk fat content are also affected. Reducing the number of piglets during (part of) the lactation can be successful in improving reproductive results after lactation but a risk is the occurrence of lactation estrus.

Post weaning feeding or management to improve weaning to estrus interval is limited to sows showing long weaning to estrus intervals. Extending the time of first service after weaning by using regumate or skipping a heat improves pregnancy rate and litter size.

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