[Kansas Agricultural Experiment Station Research Reports](https://newprairiepress.org/kaesrr)

Volume 0
Issue 10 *Swine Day (1968-2014)*

Article 1220

2013

Stimulation of estrus and ovulation in lactating sows

H L. Frobose

K M. Gourley

Michael D. Tokach

See next page for additional authors

Recommended Citation

Frobose, H L.; Gourley, K M.; Tokach, Michael D.; DeRouchey, Joel M.; Dritz, Steven S.; Goodband, Robert D.; Nelssen, Jim L.; and Davis, Duane L. (2013) "Stimulation of estrus and ovulation in lactating sows," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 10. https://doi.org/10.4148/2378-5977.7060

Stimulation of estrus and ovulation in lactating sows

Abstract

A total of 53 sows were used to determine the effects of a lactational estrus stimulation strategy on reproductive and litter growth performance. Treatment differences within parity group, multiparous and primiparous, were also considered. Litter size was equalized to 11.6 Â± 1.2 pigs at d 2 postfarrowing. At d 18 of lactation, sows were allotted to the control or an altered suckling method (ALT). The ALT sows were placed in adjacent pairs within parity so pigs could be moved between litters by temporarily lifting the divider between the two litters. On d 18, all but the 5 lightest weight pigs from each ALT litter were weaned. The 5 lightweight pigs for each pair of litters formed a combined litter that nursed each sow of the pair 12 h/d from d 18 to 25. Therefore, pigs had nursing access 24 h/d, but each ALT sow was suckled only 12 h/d. Boar exposure was provided to ALT sows for 15 min/d by removing sows to a pen outside the farrowing room. Control and ALT sows were weaned at d 21 and d 25, respectively. Sow weights and litter growth performance during lactation was similar between treatments, although ALT sows had 16% greater total feed intake (P < 0.01) due to the extended lactation length. Primiparous sows lost a greater percentage (7.4 vs. 3.4%) of BW and consumed less feed (P < 0.01) than multiparous sows. A total of 26 ALT sows (93%) were detected in estrus and mated in lactation. Although duration from initiating ALT to estrus was greater (P < 0.001) than the wean-to-estrus interval for controls, ALT sows were in estrus earlier (23.0 vs. 24.6 d; P < 0.001) than controls postfarrowing, with primiparous sows responding more slowly (5.4 vs. 3.8 d; P < 0.01) than multiparous sows for both treatments. Pregnancy rate and subsequent reproductive performance were similar between treatments. In conclusion, ALT sows expressed lactational estrus and performed reproductively similar to sows with conventionally weaned litters.; Swine Day, Manhattan, KS, November 21, 2013

Keywords

Swine day, 2013; Kansas Agricultural Experiment Station contribution; no. 14-044-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1092; Boar exposure; Lactating sow; Lactational estrus; Split weaning; Swine

Creative Commons License

Authors

H L. Frobose, K M. Gourley, Michael D. Tokach, Joel M. DeRouchey, Steven S. Dritz, Robert D. Goodband, Jim L. Nelssen, and Duane L. Davis

Stimulation of Estrus and Ovulation in Lactating Sows

H.L. Frobose, K.M. Gourley, M.D. Tokach, J.M. DeRouchey, S.S. Dritz[1], R.D. Goodband, J.L. Nelssen, and D.L. Davis

Summary
A total of 53 sows were used to determine the effects of a lactational estrus stimulation strategy on reproductive and litter growth performance. Treatment differences within parity group, multiparous and primiparous, were also considered. Litter size was equalized to 11.6 ± 1.2 pigs at d 2 postfarrowing. At d 18 of lactation, sows were allotted to the control or an altered suckling method (ALT). The ALT sows were placed in adjacent pairs within parity so pigs could be moved between litters by temporarily lifting the divider between the two litters. On d 18, all but the 5 lightest weight pigs from each ALT litter were weaned. The 5 lightweight pigs for each pair of litters formed a combined litter that nursed each sow of the pair 12 h/d from d 18 to 25. Therefore, pigs had nursing access 24 h/d, but each ALT sow was suckled only 12 h/d. Boar exposure was provided to ALT sows for 15 min/d by removing sows to a pen outside the farrowing room. Control and ALT sows were weaned at d 21 and d 25, respectively. Sow weights and litter growth performance during lactation was similar between treatments, although ALT sows had 16% greater total feed intake ($P < 0.01$) due to the extended lactation length. Primiparous sows lost a greater percentage (7.4 vs. 3.4%) of BW and consumed less feed ($P < 0.01$) than multiparous sows. A total of 26 ALT sows (93%) were detected in estrus and mated in lactation. Although duration from initiating ALT to estrus was greater ($P < 0.001$) than the wean-to-estrus interval for controls, ALT sows were in estrus earlier (23.0 vs. 24.6 d; $P < 0.001$) than controls postfarrowing, with primiparous sows responding more slowly (5.4 vs. 3.8 d; $P < 0.01$) than multiparous sows for both treatments. Pregnancy rate and subsequent reproductive performance were similar between treatments. In conclusion, ALT sows expressed lactational estrus and performed reproductively similar to sows with conventionally weaned litters.

Key words: boar exposure, lactating sow, lactational estrus, split weaning

Introduction
Sows experience a period of lactational anestrus driven by suckling-induced suppression of gonadotropin secretion. The sow's reproductive tract requires a minimum of 14 to 21 d for uterine involution and resumption of reproductive activity; consequently, weaning currently takes place at least 2 weeks after parturition and has moved closer to 3 weeks to support better performance of the weaned pigs.

Producers have significant economic incentives to shorten the interval from farrowing to conception. One approach to circumvent the negative impact of early weaning is to uncouple weaning and breeding by breeding during lactation. In theory, this could reduce sow non-productive days while simultaneously increasing lactation length to the

[1] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

benefit of the litter. Another potential advantage would be easing the transition into group gestation housing. Shifting the breeding procedures to the farrowing facility also may help reassign duties and improve preweaning survival.

Several strategies have been evaluated to elicit a fertile estrus in lactating sows. Although results have been inconsistent, separating the sow from the litter for longer than 6 hours/d and exposure to a boar clearly are important stimuli. Researchers in Europe[2] and Australia[3] have recently revisited these ideas to address welfare and production issues in modern production systems. This recent work suggests that some maternal sow genotypes are more responsive to temporary litter separation and boar exposure than previously thought.

We designed a treatment that combined early weaning of the heavier pigs in each litter and created combined litters to give small pigs access to 24 h/d nursing but restricted sows to 12 h/d of sucking. We also provided boar exposure. This unique treatment was compared with conventionally weaned sows. We assigned the sows to treatment by parity (multiparous vs. primiparous) in anticipation that the primiparous sows would be less likely to respond with lactational estrus.

Procedures

Animals and housing

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The trial was conducted at the Kansas State University Swine Teaching and Research Center in Manhattan, KS. A total of 53 sows (PIC 1050) were used in two farrowing groups. Parity ranged from 1 to 5 and averaged 2.6 ± 1.5. Prior to farrowing, pregnant sows were moved into a single farrowing room (29 individual farrowing crates; 7.0 × 2.0 ft for the sow and 7.0 × 5.2 ft for pigs). Sows not farrowing by d 115 of gestation were induced to farrow by injecting Lutalyse (dinoprost tromethamine, 10 mg; Zoetis Animal Health, Florham Park, NJ). Litter size at birth varied from 3 to 18 live pigs and was equalized within 2 d after farrowing by cross-fostering pigs within each parity group, resulting in an average litter size of 11.6 ± 1.2 pigs. Within 1 d after farrowing, piglet BW was determined and pigs were individually ear-notched and injected with 2 mL iron dextran and 1 mL of antibiotic (Naxcel (ceftiofur sodium); Zoetis Animal Health). Male pigs were castrated approximately 7 d after birth. The day on which most of the litters were born was considered d 0 of lactation for the group, and all treatment procedures were performed on the same calendar day for all litters in the farrowing group. Litters were born from 4 d before to 3 d after d 0. Sows were fed a common lactation diet (1,472 kcal/lb, 21.6% CP, and 0.97% lysine) based on corn, soybean-meal, and 20% DDGS, which was provided ad libitum beginning the day after farrowing. Lactation feed was delivered using individual Gestal Solo (JYGA Technologies, St-Nicolas, Quebec, Canada) electronic sow feeders. Water was available ad libitum. Creep feed was not offered during lactation.

---

[2] Kemp, B., and N.M. Soede. 2012. Should weaning be the start of the reproductive cycle in hyper-prolific sows? A Physiological view. Reprod. Dom. Anim. 47:320–326.

[3] Downing, J.A., and L.R. Giles. 2009. Induction of estrus in lactating sows. Australian Pork CRC Report. 2009.

Treatments

Sows were allotted to treatments within parity group on d 18 of lactation with BW. Suckled litter size and date farrowed equalized as nearly as possible. A total of 25 control sows (16 multiparous and 9 primiparous) and 28 ALT sows (20 multiparous and 8 primiparous) were used. Per normal farm procedures, control sows were continuously suckled by their litters until weaning. The ALT sows were placed in adjacent pairs within parity group such that two litters could be combined and switched between sows by temporarily lifting the separating divider. On d 18, all but the 5 lightest-weight pigs from each ALT litter were split-weaned and moved to the nursery. The remaining 5 lightweight pigs on paired ALT litters were combined to form a new litter of 10 pigs. These combined litters were rotationally suckled between paired sows at 12-h intervals (0600 and 1800), such that pigs had access to a sow 24 h/d, but each ALT sow was suckled for only 12 h/d. Lights were left on for 24 h/d throughout lactation.

The ALT sows were provided daily exposure to a boar by moving the sow to a pen adjacent to the farrowing room. Each sow received approximately 5 min of nose-to-nose contact followed by 5 min of full physical contact and a final 5 min of nose-to-nose contact with a boar. To maximize stimulation, one of three mature boars was used for full physical contact on each day with a second boar providing nose-to-nose contact, and boars were rotated each day to minimize individual boar effects. Boar exposure was from d 18 of lactation until ovulation or at weaning on d 25. Control sows were weaned on the afternoon of d 21. At weaning, sows were moved into a group pen environment, but sows were moved into individual gestation stalls each day for transrectal ultrasound. Estrus detection was also performed at this time in the presence of a boar.

Measurements

Sow BW and backfat (BF) were recorded at entry, after farrowing, and on d 18, 21, and 25 postfarrowing. Pigs were weighed at d 18, on the afternoon of d 21, and on d 25. Feed disappearance was also measured in sows from their individual farrowing date until weaning.

Standing estrus was confirmed using a back-pressure test in the presence of a boar. Sows were artificially inseminated at first observed estrus and again 24 h later. Starting on d 17, transrectal ultrasound was performed using an Aloka 500V ultrasound with a 5.0-MHz probe (Aloka, Wallingford, CT). Ultrasound was performed daily for ALT sows and every other day for control sows until d 21, after which all sows were scanned daily until ovulation, defined as 12 h prior to the ultrasound exam where fewer than 4 total intact follicles remained on the ovaries. The number of follicles per ovary were recorded along with the follicle diameter, calculated by the average diameter of the three largest follicles on each ovary.

A blood sample was obtained by jugular venipuncture from all sows on d 18, 21, and 25. Two additional samples were collected 8 to 12 and 18 to 21 d postestrus to verify ovulation and confirm establishment of pregnancy, respectively. Serum from these samples was assayed for concentrations of progesterone (P4). Progesterone concentrations greater than 4.0 ng/mL at d 8 to 12 after estrus confirmed ovulation and at d 18 to 21 confirmed the establishment of pregnancy. Pregnancy was confirmed approximately 28 d after insemination by ultrasound examination. Farrowing rate, total born, number born live, stillbirths, mummies, and birth weights were recorded for all resulting litters.

Statistical analysis

All normally distributed data were analyzed using the MIXED procedure of SAS, version 8.1 (SAS Institute, Inc., Cary, NC). Sow was the experimental unit and farrowing replicate was included in the model as a random effect. Pregnancy and farrowing rate were evaluated by chi-square analysis using the LOGISTIC procedure of SAS. Statistical significance and tendencies were set at $P < 0.05$ and $P < 0.10$.

Results and Discussion

No treatment × parity group interactions were observed for sow or piglet growth performance. The ALT sows were heavier and had greater BF ($P < 0.01$) at d 25, which probably resulted from feed restriction for control sows after weaning on d 21, whereas ALT sows continued to have ad libitum access to feed until d 25 (Table 1). Control and ALT sows had similar BW and backfat losses during lactation. Average daily feed intake was similar between treatments, but ALT sows had 16% greater ($P < 0.01$) total feed intake during lactation due to a longer lactation length. Despite different weaning times between and within treatments, pig BW remained similar at d 18, 21, or 25, and no differences were detected in piglet mortality during the 7-d experimental period.

Primiparous sows had lighter ($P < 0.001$) BW than multiparous sows before farrowing and remained lower throughout lactation (Table 2). Primiparous sows also lost a greater ($P < 0.01$) percentage of BW during lactation and tended ($P < 0.06$) to lose more BW than multiparous sows. Both ADFI and total feed intake decreased ($P < 0.001$) for primiparous sows compared with multiparous sows, but no backfat differences were detected during lactation. Moreover, pigs nursing primiparous sows were similar in BW to pigs from multiparous sows at d 18, 21, and 25, and their postweaning performance is reported in a separate paper (see "Effects of an Altered Suckling Method on Piglet Performance during Late Lactation and the Nursery Period," pp. 27).

The wean-to-estrus interval was shorter (3.6 vs. 5.0; $P < 0.001$) for controls than the time from initiation of ALT to estrus, but when expressed as the day in estrus postfarrowing, ALT sows were detected in estrus more quickly (23.0 vs. 24.6 d: $P < 0.001$) than controls (Table 3). Of the 28 ALT sows, 26 were detected in estrus and mated during lactation, including all 20 multiparous sows and 6 of 8 primiparous sows (Table 4). The remaining 2 primiparous ALT sows were detected in estrus and mated at 9 and 12 d after the initiation of the ALT treatment (2 and 5 d after weaning). For controls, 15 of 16 multiparous and all 9 primiparous sows were detected in estrus and mated postweaning. The remaining multiparous control sow had more than 4 follicles with diameter greater than 15 mm without ovulating for 3 d and appears to have had cystic ovarian follicles. For both treatments, primiparous sows were in estrus later (5.4 vs. 3.8 d; $P < 0.01$) than multiparous sows. Figure 1 shows the estrus response comparison between treatments, whereas Figure 2 illustrates the cumulative percentage of sows in estrus by treatment over time. Analysis of P4 in sows at 8 to 12 and 18 to 21 d postestrus explained that a total of 2 sows failed to establish pregnancy after ovulation. No treatment differences were detected for pregnancy rate.

Ultrasound observations of follicular development matched observed estrus differences between treatments and parity groups (Table 5). The ALT sows reached maximum follicle diameter and ovulated more quickly than control sows after initiation of ALT or weaning. The growth of follicles between control and ALT sows is shown in Figure 3, and the delayed follicular development of primiparous versus multiparous sows is illustrated in Figure 4.

For subsequent farrowing traits, a total of 20 control and 20 ALT sows were retained and farrowing data were collected (Table 6). Reproductive performance was similar for control and ALT sows. There was a tendency for a treatment × parity interaction ($P < 0.07$) for the percentage of mummified fetuses, but the limited number of sows and variation in this trait make interpretation unclear. Pigs farrowed by formerly primiparous sows also tended ($P < 0.08$) to be lighter than pigs from multiparous sows.

Our results provide evidence that the ALT treatment can induce estrus in lactating sows at rates comparable to conventionally weaned sows with no detrimental effects on farrowing rate or litter size. The lactational estrus we observed is greater than many reports in the literature, and this may be due to the sow line and unique aspects of the ALT treatment. In addition to reduced hours of nursing each day, the ALT sows were nursed by a combined litter of foreign and own pigs that were lightweight compared with the litter nursing before treatment. These foreign pigs may be perceived in a way that contributes to the occurrence of estrus, but further work will be required to evaluate individual components of the treatment. Another objective of this work was to benefit the lightweight pigs, and that is the subject of another report in this publication (see "Effects of an Altered Suckling Method on Piglet Performance during Late Lactation and the Nursery Period," p. 27).

The ALT sows were detected in estrus more quickly after farrowing than the controls. Previous lactational estrus work with primiparous sows is limited, and the present data suggest that estrus in lactation also can be stimulated in these sows; moreover, the altered suckling method did not affect litter performance prior to weaning.

Additional research may help develop practical protocols that allow breeding during lactation, but additional work is necessary to confirm these results in larger populations of sows and to determine the most effective and practical presentation of stimuli. Treatment similar to this study may benefit lightweight pigs in large litters, and breeding during lactation could help enhance group sow housing management. Because individual farrowing stalls are more accepted for the welfare advantages to the nursing pigs, this last benefit is worth exploring; groups in Australia and Europe are also researching treatments to induce lactational estrus for this reason.

Table 1. The effects of boar exposure and an altered suckling method (ALT) on the growth of lactating sows and their litters[1]

Item	Control	ALT	SEM
Sows, n	25	28	
Parity	2.44	2.68	
Litter size at d 18	11.60	11.54	0.44
Sow BW, lb			
Entry	548.4	560.5	22.92
Farrowing	525.3	530.7	24.59
d 18	503.6	513.9	15.39
d 21	499.0	507.3	18.35
d 25	453.1[a]	502.4[b]	16.86
Lactation BW loss, lb[2]	26.2	28.3	6.77
Lactation BW loss, %	5.19%	5.89%	1.106
Backfat, mm			
Entry	14.1	14.4	0.85
d 18	13.1	13.1	0.57
d 21	13.2	12.6	0.62
d 25	11.6[a]	13.5[b]	0.55
Backfat loss, mm[2]	0.82	0.84	1.179
Sow ADFI, lb[3]	12.12	11.85	0.490
Sow intake, lb	254.6	304.0	13.60
Pig BW[4]			
d 18	12.43	12.46	0.340
d 21	14.21	13.59	0.363
d 25	15.57	15.67	0.358

[a, b] Means without a common superscript differ $P < 0.05$.

[1] Data were collected from a total of 53 sows (PIC 1050) across two replicate farrowing groups. Sows were allotted to treatments on d 18 (average 18.8 d) of lactation. Control sows were weaned on d 21, whereas the altered suckling method (ALT) consisted of split-weaning (SW) all but the 5 lightest-weight pigs on d 18. The ALT sows were then paired, and the lightweight pigs from 2 litters were combined and rotationally suckled between the pair of sows at 12-h intervals until weaning on d 25.

[2] Lactation weight and backfat loss were measured from d 0 to 21 for control sows and 0 to 25 for ALT sows.

[3] Incorporates feed intake from actual farrowing date for each sow.

[4] Litter size was similar ($P > 0.78$) at d 18, and no differences in pig mortality were detected ($P > 0.94$) between treatments.

Table 2. The interactive effects of an altered suckling method (ALT) and parity group on the growth of lactating sows and their litters[1]

	Control		ALT			Probability, $P <$[2]	
Item Parity:[3]	Mult	Prim	Mult	Prim	SEM	Trt	Parity
Sows, n	16	9	20	8			
Parity	3.3	1.0	3.4	1.0			
Sow BW, lb							
Entry	580.8	491.0	591.6	482.6	23.42	0.82	<0.001
Farrowing	559.4	464.6	561.4	454.1	24.98	0.86	<0.001
Lactation d 18	537.9	442.4	546.4	432.6	15.89	0.88	<0.001
Lactation d 21	534.8	435.6	542.7	418.9	18.80	0.97	<0.001
Lactation d 25	483.8	398.6	536.4	405.4	17.84	0.01	<0.001
Lactation BW loss, lb[4]	24.7	29.0	25.0	48.7	6.77	0.85	0.06
Lactation BW loss, %	4.26%	6.13%	3.08%	8.69%	1.110	0.98	<0.01
Backfat, mm							
Entry	13.3	15.4	14.2	14.8	0.86	0.62	0.13
d 18	12.7	13.8	13.3	12.6	0.60	0.99	0.80
d 21	12.6	14.4	12.6	12.8	0.65	0.53	0.27
d 25	11.3	12.3	13.8	12.6	0.58	0.02	0.97
Backfat loss, mm[4]	0.72	1.00	0.35	2.17	1.201	0.11	0.56
Sow ADFI, lb[5]	12.87	10.79	12.7	9.5	0.50	0.32	<0.001
Sow total intake, lb	270.4	226.5	324.1	246.4	13.78	0.00	<0.001
Pig BW[6]							
d 18	12.59	12.14	12.64	12.01	0.360	0.98	0.29
d 21	14.37	13.91	13.79	13.10	0.385	0.20	0.29
d 25	15.80	15.15	15.84	15.20	0.377	0.94	0.16

[1] Data were collected from a total of 53 sows (PIC 1050) across two replicate farrowing groups. Sows were allotted to treatments on d 18 (average 18.8 d) of lactation. Control sows were weaned on d 21, whereas the altered suckling method (ALT) consisted of split-weaning all but the 5 lightest-weight pigs on d 18. The ALT sows were then paired, and the lightweight pigs from 2 litters were combined and rotationally suckled between the pair of sows at 12-h intervals until weaning on d 25.

[2] No interactions were detected ($P > 0.11$) between treatment and parity group.

[3] Multiparous (Mult) or primiparous (Prim).

[4] Lactation weight and backfat loss were measured from d 0 to 21 for control sows and 0 to 25 for ALT sows.

[5] Incorporates feed intake from actual farrowing date for each sow.

[6] Litter size was similar ($P > 0.26$) across treatment and parity at d 18, and no differences in pig mortality were detected ($P > 0.24$).

Table 3. The effects of boar exposure and an altered suckling regimen (ALT) on the reproductive performance of lactating sows[1]

Item	Control	ALT	SEM
Weaning or beginning of ALT to estrus, d	3.6[a]	5.0[b]	0.54
Day in estrus after farrowing	24.6[b]	23.0[a]	0.54
Inseminated in lactation, %	---	89.3%	---
Inseminated after weaning, %	96.0%	10.7%	---
Pregnancy rate, %[2]	92.0%	89.0%	---

[a, b] Means without a common superscript differ $P < 0.05$.
[1] Data were collected from 53 sows (PIC 1050) used across two replicate farrowing groups. Sows were allotted to treatments on d 18 (average 18.8 d) of lactation. Control sows were weaned on d 21, whereas the altered suckling method (ALT) consisted of split-weaning all but the 5 lightest-weight pigs on d 18. The ALT sows were then paired, and the lightweight pigs from 2 litters were combined and rotationally suckled between the pair of sows at 12-h intervals until weaning on d 25.
[2] Chi-square analysis was conducted using PROC LOGISTIC in SAS (SAS Institute, Inc., Cary, NC) to compare treatment means. Transabdominal ultrasound (Aloka 500V, 5.0 MHz) was used for pregnancy detection at approximately 28 d after mating.

Table 4. The interactive effects of an altered suckling method (ALT) and parity group on the reproductive performance of lactating sows[1]

	Control		ALT			Probability, $P <$[2]	
Item Parity:[3]	Mult	Prim	Mult	Prim	SEM	Trt	Parity
Sows, n	16	9	20	8			
Parity	3.25	1.00	3.35	1.00	0.468	0.82	<0.001
Litter size at d 18	11.8	11.3	11.6	11.3	0.44	0.78	0.26
Weaning or beginning of ALT to estrus, d	3.1	4.4	4.5	6.4	0.54	<0.001	<0.001
Day in estrus after farrowing	24.1	25.4	22.5	24.4	0.54	<0.001	<0.01
Mated in lactation, %	---	---	100.0%	75.0%	---	---	---
Mated after weaning, %	93.8%	100.0%	0.0%	25.0%	---	---	---
Pregnancy rate, %[4]	93.8%	88.9%	90.0%	86.0%	---	0.71	0.69
Progesterone, ng/mL[5]							
8 to12 d postestrus, % >4 ng/ml	93.8%	100.0%	100.0%	100.0%			
	(15/16)	(9/9)	(20/20)	(8/8)			
18 to 21 d postestrus, % >4 ng/ml	100.0%	88.9%	95.0%	100.0%			
	(16/16)	(8/9)	(19/20)	(8/8)			

[1] Data were collected from a total of 53 sows (PIC 1050) across two replicate farrowing groups. Sows were allotted to treatments on d 18 (average 18.8 d) of lactation. Control sows were weaned on d 21, whereas the altered suckling method (ALT) consisted of split-weaning all but the 5 lightest-weight pigs on d 18. The ALT sows were then paired, and the lightweight pigs from 2 litters were combined and rotationally suckled between the pair of sows at 12 h intervals until weaning on d 25.
[2] No interactions were detected ($P > 0.54$) between treatment and parity group.
[3] Multiparous (Mult) or primiparous (Prim).
[4] Chi-square analysis was conducted using PROC LOGISTIC in SAS (SAS Institute, Inc., Cary, NC) to compare treatment means. Transabdominal ultrasound (Aloka 500V, 5.0 MHz) was used for pregnancy detection at approximately 28 d after mating.
[5] Samples were collected at 8 to 12 and 18 to 21 d postestrus to confirm ovulation and establishment of pregnancy, respectively. 4 ng/mL was used as a qualitative threshold to signify the presence of a functional corpus luteum.

Table 5. Follicle development and ovulation response of sows with ovulation within 7 d after initiation of boar exposure and an altered suckling method (ALT) or weaning[1]

	Control			ALT		
Item Parity:[2]	Mult	Prim	Total	Mult	Prim	Total
Follicle development[3]						
Initial follicle diameter, mm	4.0	5.0	4.3	3.9	3.6	3.8
Maximum follicle diameter, mm	8.3	8.4	8.3	8.4	7.9	8.3
Follicle diameter at ovulation, mm	8.0	8.0	8.0	8.2	7.5	8.0
Day of max. follicle diameter after ALT or weaning	2.9	4.7	3.6	5.0	6.6	5.4
Day of max. follicle diameter after farrowing	23.9	25.7	24.6	23.0	24.6	23.4
Time to ovulation after ALT or weaning, h[4]	92.0	137.3	109.0	135.6	183.4	148.0

[1] Data shown from the 24 control and 24 ALT sows that ovulated within 7 d after weaning or initiation of ALT treatment.
[2] Multiparous (Mult) or primiparous (Prim).
[3] Daily transrectal ultrasound (500V, 5.0 MHz; Aloka, Wallingford, CT) measurements were collected from d 17 until 7 d postweaning. Follicle diameter reported as the average of the three largest follicles on each ovary.
[4] Time of ovulation was defined as 12 h prior to the ultrasound exam when fewer than 4 follicles remained between both ovaries.

Table 6. The effects of boar exposure and an altered suckling method (ALT) on subsequent reproductive performance of sows[1]

	Control		ALT			Probability, *P* <		
Item Parity:[2]	Mult	Prim	Mult	Prim	SEM	Trt × parity	Trt	Parity
Sows retained, n[3]	13	7	14	6				
Total born	13.6	12.1	13.4	12.2	1.58	0.90	0.66	0.32
Number born live	12.8	11.4	12.1	11.7	1.54	0.83	0.63	0.42
Stillbirths, %	6.1%	5.3%	7.8%	3.3%	3.93	0.58	0.87	0.44
Mummies, %	2.1%	4.0%	4.3%	0.0%	1.95	0.07	0.97	0.50
Piglet BW, lb	3.03	3.47	3.25	3.48	0.232	0.59	0.40	0.08
Litter weight, lb	38.70	39.67	39.23	40.64	4.091	0.65	0.74	0.85

[1] Data were collected from a total of 53 sows (PIC 1050) across two replicate farrowing groups. Sows were allotted to treatments on d 18 (average 18.8 d) of lactation. Control sows were weaned on d 21, whereas the altered suckling method (ALT) consisted of split-weaning all but the 5 lightest-weight pigs on d 18. The ALT sows were then paired, and the lightweight pigs from 2 litters were combined and rotationally suckled between the pair of sows at 12-h intervals until weaning on d 25.
[2] Multiparous (Mult) or primiparous (Prim).
[3] Following pregnancy confirmation by transabdominal ultrasound at 25 to 35 d post-artificial insemination, sows were culled or retained according to the operation's normal culling procedures.

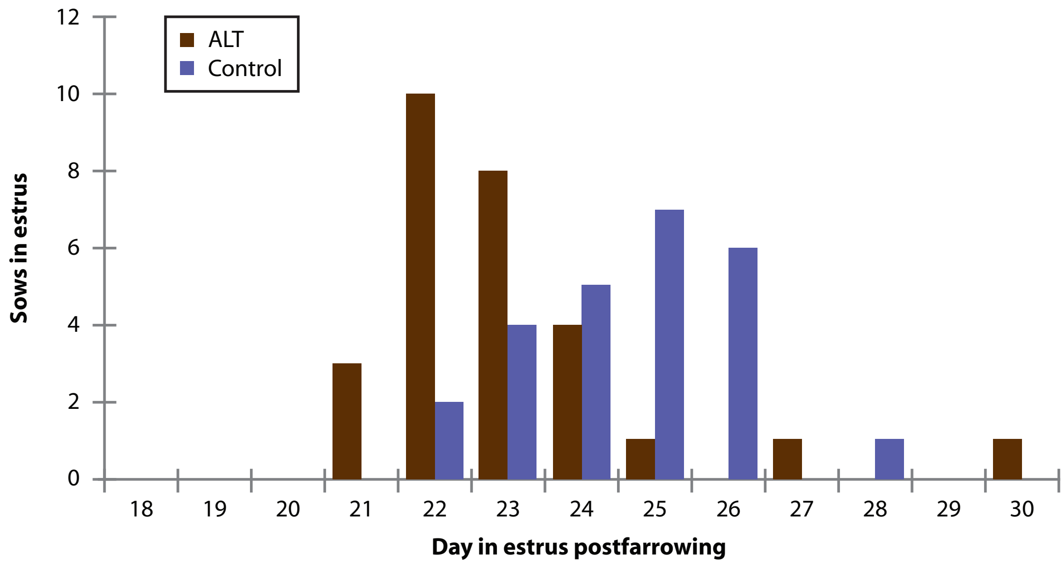

Figure 1. The day of first detected estrus for control sows and sows given boar exposure and an altered suckling method (ALT).

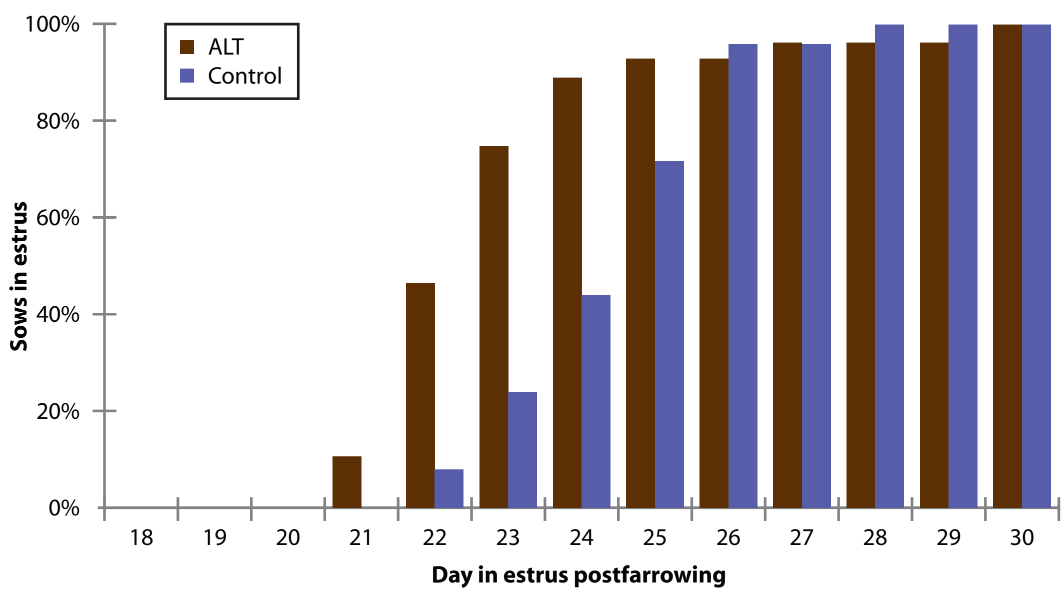

Figure 2. The cumulative percentage of sows in estrus postfarrowing between control sows and sows given boar exposure and an altered suckling method (ALT).

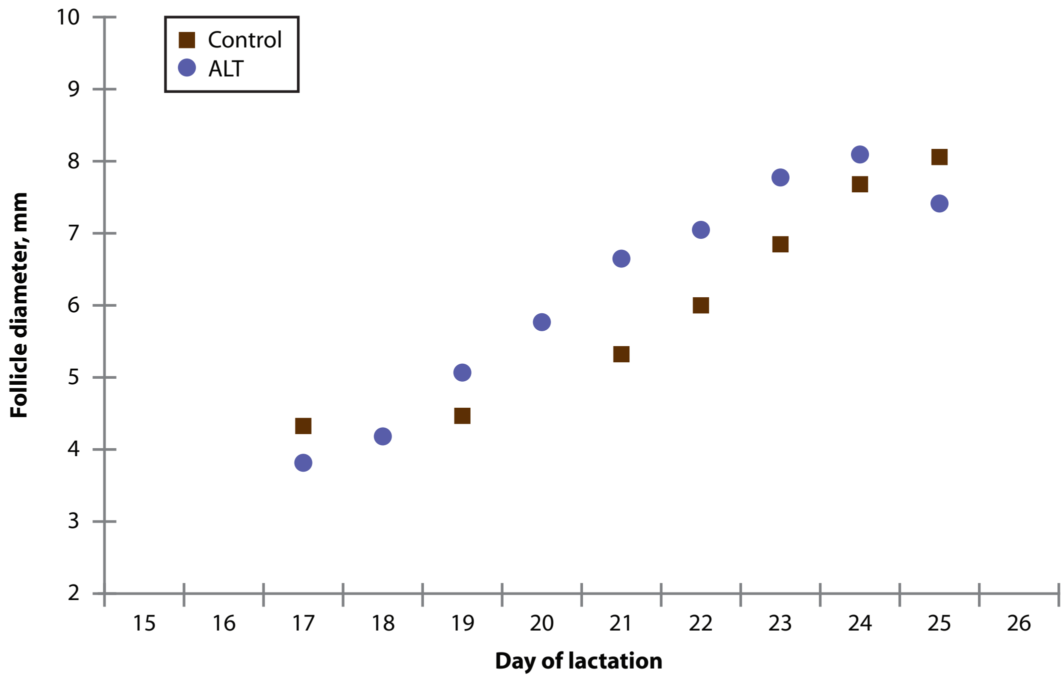

Figure 3. Change in mean follicle diameter of the largest follicles after treatment (d 18 of lactation) for control sows and sows given boar exposure and an altered suckling method (ALT). Control sows were not ultrasounded on d 18 or 20.

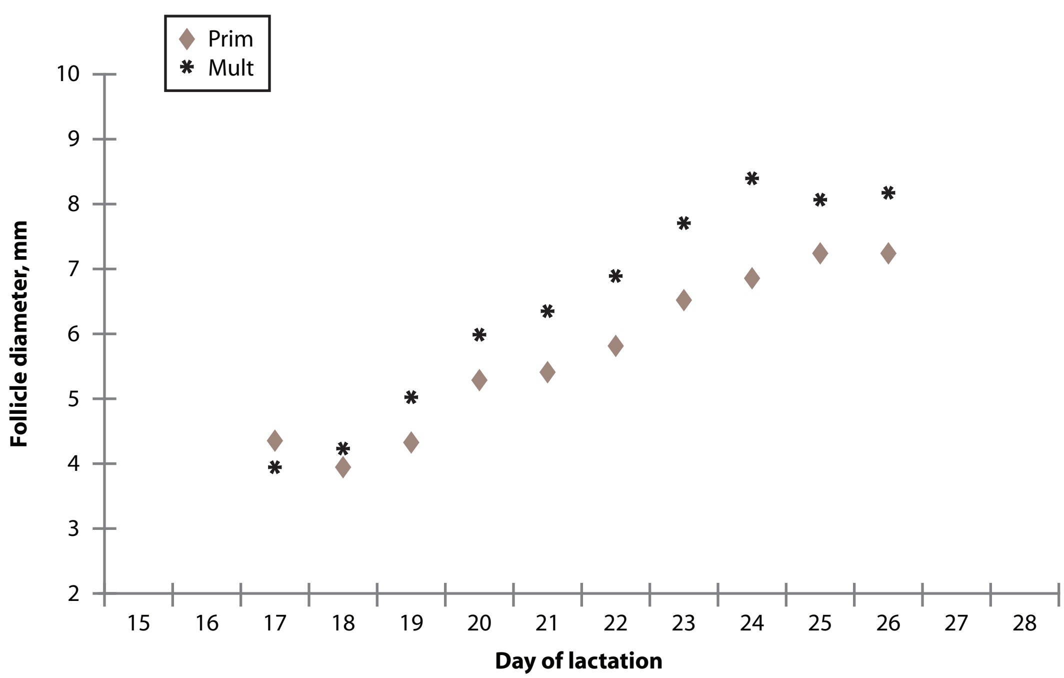

Figure 4. Change in mean follicle diameter of the largest follicles after treatment (d 18 of lactation) for multiparous (Mult) and primiparous (Prim) sows.