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Management factors associated with farrowing rate in commercial sow herds in Ontario

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Abstract — The objectives of this study were to determine associations between low farrowing rate and various management factors in sow herds. In 30 sow herds, a management survey, breeding observations, semen evaluation, and semen storage temperature monitoring were completed. Herds with an average farrowing rate of < 85% were classified as low farrowing rate herds while those with an average farrowing rate of ≥ 85% were classified as good farrowing rate herds. Low farrowing rate herds were more likely than good farrowing rate herds to move boars into gilt pens for estrus detection, breed a high proportion of sows by artificial insemination (AI) only, start heat detection 3 d post-weaning, wipe the vulva prior to breeding, and use "hands-free" AI devices.

Résumé — Facteurs de gestion associés aux taux de mise bas chez les troupeaux commerciaux de truies en Ontario. Les objectifs de cette étude étaient de déterminer les associations entre les faibles taux de mise bas et les divers facteurs de gestion chez les troupeaux de truies. Une enquête de gestion, des observations d'élevage, l'évaluation du sperme et la surveillance de la température d'entreposage du sperme ont été réalisées pour 30 troupeaux de truies. Les troupeaux avec un taux moyen de mise bas de < 85 % étaient classés dans une catégorie avec un faible taux de mise bas tandis que ceux avec un taux moyen de ≥ 85 % étaient classés dans une catégorie avec un bon taux de mise bas. Il était plus probable que dans les troupeaux avec un faible taux de mise bas les verrats circulent dans des enclos de cochettes pour la détection de l'œstrus, une proportion élevée de truies mettent bas suite à l'insémination artificielle (IA) seulement, la détection des chaleurs commence 3 jours après le sevrage, la vulve est essuyée avant l'accouplement et des dispositifs IA «mains libres» sont utilisés.

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Introduction

An important and commonly used measure of sow herd reproductive performance is farrowing rate (1), which is defined as the proportion of females served that farrow (2). It is generally accepted that a farrowing rate of 85% is an appropriate target under commercial conditions (3). For herds that are trying to achieve 30 pigs/sow/year, it has been suggested that a farrowing rate of 85% to 90% is an appropriate target (4,5). However, surveys of sow herd productivity have found that the farrowing rate in North American herds is below these target values (6–8). The average farrowing rate from 2003 to 2007 for Canadian herds taking part in a benchmarking program was 83.8% (9).

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Factors such as estrus detection, lactation length, parity, mating type, timing and frequency of matings, and semen quality have been shown to impact farrowing rate (1,2,10). Despite the great deal of research into the factors associated with farrowing rate, identifying the cause(s) of a farrowing rate problem in a herd remains a difficult and often frustrating task. The purpose of this study was to determine the management factors associated with low farrowing rate in commercial sow herds in Ontario.

Materials and methods

The study was advertised through swine producer meetings and through contact with herds involved with other University of Guelph research projects. This resulted in a convenience sample of 30 Ontario swine producers willing to participate in the project.

Each herd was visited and a survey that covered a wide variety of management topics was completed in a face-to-face interview with the herd owner or manager. Management categories that were covered in the survey included: herd demographics (herd type, number of animals, percent purebred animals); weaning management (average lactation length, minimum and maximum weaning age, number of weanings/wk); sow housing (proportion of sows housed in stalls and pens, number of times animals are moved during gestation); estrus detection (frequency and timing of estrus detection, methods of heat detection used);

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Table 1. Selected descriptive characteristics for good (≥ 85%) and low (< 85%) farrowing rate (FR) herds from a herd evaluation completed on 30 commercial sow herds in Ontario

Parameter	Good FR herds	Low FR herds
Farrowing rate	87.3%	76.2%[a]
Average number of sows in herd	392	642
Average percent purebred sows in herd	2.5	15.2
Percent farrow-to-finish herds	83	50
Percent farrow-to-feeder herds	0	8
Percent farrow-to-wean herds	17	42

[a] Significantly different at a level of $P < 0.05$.

sow breeding management (proportion of sows bred using AI or natural breedings, frequency and timing of breedings, numbers of animals bred in a single day, hormone usage); semen management (frequency of semen collection and/or delivery, maximum age of extended semen used for AI breeding, routine for monitoring semen storage temperatures); gilt management (quarantine management, target age/weight for first breeding, timing and frequency of estrus detection and breeding); disease management (presence of reproductive diseases in the herd, vaccine usage); and nutrition (frequency of feeding lactating, weaned and gestating animals; mycotoxin testing). The survey questions were designed to be answered on a continuous or dichotomous (yes/no) scale with the option to provide additional information [other (please specify)] if the answers provided by the survey were not adequate.

All breedings, both natural and artificial, that occurred on the day of the visit were observed. During the breeding observation, a second survey that included information such as heat detection, breeding and semen handling techniques used, numbers of animals bred and length of time taken to breed was completed by the observer. When 1 breeding technician was present, all matings done by that technician were observed. When more than 1 technician was present, an equal number of matings by each technician was observed. To avoid bias, the same person conducted the observations on all farms. This person was familiar with proper heat detection methods, breeding techniques and signs of standing estrus.

In herds where artificial insemination (AI) was used, 2 further farm visits were made. The first visit was made on a day that a fresh batch of semen was delivered to or collected on the farm. One dose of the fresh semen was transported to a lab where it was evaluated for volume, motility, concentration, morphology, and total viable sperm/dose using a computer-assisted semen analysis system (Spermvision; Minitube Canada, Ingersoll, Ontario). Minimum acceptable values for semen quality were chosen after reviewing the literature (11–14). Semen doses in which motility < 60%, abnormal morphology > 30%, sperm concentration $< 25 \times 10^6$/mL, volume of dose < 70 mL and/or total viable sperm $< 2.5 \times 10^9$/dose were classified as poor quality. These herds were revisited 72 h later and a second dose of semen from the same batch that was initially examined was evaluated in the same manner as the first dose. Producers received the results of the semen evaluation by mail at a later date so the results did not influence whether or not the batch of semen was used for breeding.

On the initial herd visit, the average farrowing rate over the year leading up to the visit was determined for all herds by examining herd records and through discussion with the producer. Based on industry standards determined by consulting with swine veterinarians and a review of the available literature, a farrowing rate of 85% was chosen as the threshold value for grouping participating herds for statistical analysis. Herds with a farrowing rate of ≥ 85% were classified as good while those with a farrowing rate < 85% were classified as low.

All statistical analyses were performed using computer software (Statistix version 1.0; Analytical Software, Tallahassee, Florida, USA). Student's *t*-test was used to determine differences in management factors measured on a continuous scale from the survey and breeding observations (Table 1) as well as differences in farrowing rate between good and low farrowing rate herds. The Fisher Exact test was used to determine differences in management factors measured on a dichotomous scale from the survey, breeding observation, semen evaluation, and storage temperature evaluation between good and low farrowing rate herds (Table 2).

Results

Farrowing rate

The average farrowing rate of the 30 herds was 78.7% with a range of 54.7% to 92.4%. Six herds were classified as good farrowing rate herds and 24 herds were classified as low farrowing rate herds. The average farrowing rate of good farrowing rate herds was higher than that of low farrowing rate herds (Table 1).

Management survey

The management survey was completed on all 30 farms but not all questions were answered by all producers as not all questions were applicable to all herds. For example, producers who did not use AI in their herds were not able to answer the survey questions pertaining to AI. Both groups used direct boar contact to check for estrus in a similar proportion of gilts but, fewer gilts were checked for estrus by moving them into the boar pen in low farrowing rate herds than in good farrowing rate herds (Table 2). Also, more gilts were checked for estrus by moving the boar into the gilt pen in the low farrowing rate herds than in the good farrowing rate herds (Table 2). Low farrowing rate herds bred more sows with AI exclusively and bred fewer sows with a combination of natural and artificial matings than did the good farrowing rate herds (Table 2). Good farrowing rate herds began post-weaning heat checks an average of 1 d later than low farrowing rate herds (Table 2). All other factors examined under the categories of herd demographics, weaning management, sow housing, estrus detection, sow breeding management, semen management, gilt management, disease management, and nutrition were not significant.

Breeding observation

Breeding observations could not be completed on 1 farm, and this herd fell into the low farrowing rate category. Because of differences in herd size, the number of breedings observed/farm ranged from 5 to 28. All natural breedings that were observed were hand matings that occurred in a designated breeding pen.

Table 2. Average values of selected parameters for good (≥ 85%) and low (< 85%) farrowing rate (FR) herds from a herd evaluation completed on 30 commercial sow herds in Ontario

	Good FR herds			Low FR herds			
Parameter	Average	*s*	N	Average	*s*	N	P^a
Number of sows in herd	391.7	251.43	6	641.9	429.05	24	0.18
Percent purebred sows in herd	2.5	4.18	6	15.2	31.73	24	0.07
Percent gilts heat checked by direct boar contact	61.7	49.16	6	58.5	50.12	24	0.89
Percent gilts heat checked with boar in gilt pen	4.2	10.21	6	35.6	47.58	24	0.01
Percent gilts heat checked with gilt in boar pen	54.2	51.03	6	14.6	34.51	24	0.03
Percent sows bred by AI only	47.0	45.68	5	83.9	29.40	22	0.03
Percent sows bred naturally only	22.5	39.21	6	12.0	29.20	24	0.47
Percent sows bred both naturally and by AI	46.0	44.94	5	12.5	28.33	22	0.04
Average number of natural breedings/day	6.0	7.24	6	2.2	3.23	24	0.26
Number of sows bred by AI by 1 person/day	9.0	4.24	5	14.0	7.04	21	0.14
Number of days post-weaning heat checking starts	4.2	0.41	6	3.2	1.16	24	0.002
Number of sows/gestation pen	8.3	5.38	4	16.4	17.36	21	0.10

N = number of herds, *s* = standard deviation.
[a] Student's *t*-test used to determine statistical differences.

Table 3. Proportion of herds with selected parameters in good (≥ 85%) and low (< 85%) farrowing rate (FR) categories from a herd evaluation completed on 30 commercial swine farms in Ontario

		Good FR herds		Low FR herds		
Evaluation step	Parameter	Percent positive	N	Percent positive	N	P^b
Herd survey	Feed tested for mycotoxins	100.0	6	61.9	21	0.14
	Gestating sows fed 2×/day	50.0	6	16.7	24	0.12
	Weaned sows fed 2×/day	66.7	6	25.0	24	0.18
	Weaned sows fed gestation ration	0.0	6	41.7	24	0.14
	Weaned sows fed lactation ration	66.7	6	29.2	24	0.16
	Swollen vulva used as sign to detect estrus	83.3	6	34.8	23	0.06
	Vaginal mucus used as sign to detect estrus	16.7	6	52.2	23	0.18
	Hormones[a] used to induce estrus in weaned sows	100.0	6	60.9	23	0.14
	Erysipelas present in herd	33.3	6	70.8	24	0.16
	PRRSv vaccine used in breeding herd	100.0	6	62.5	24	0.14
Breeding observation	Hands-free AI used	0.0	5	60.0	20	0.04
	Vulvas wiped before breeding	20.0	5	75.0	20	0.04
Semen evaluation	Poor quality fresh semen	0.0	5	38.8	18	0.15
	Poor quality stored semen	40.0	5	55.5	18	0.64

[a] Pregnant mare serum gonadotrophin and human chorionic gonadotrophin (P.G. 600; Intervet Canada, Whitby, Ontario).
[b] Fisher's exact test used to determine statistical differences.

Breeding technicians in low farrowing rate herds were more likely to wipe the sow's vulva before breeding and use "hands-free" AI equipment during breeding than in good farrowing rate herds (Table 3). All other heat detection, breeding, and semen handling technique variables were not significant.

In addition to the information recorded on the survey during breeding, in 4/29 herds, problems with breeding were noted. All 4 of these herds were in the low farrowing rate category. In 3/4 herds, large volumes of semen leaked onto the floor during insemination. The reasons for the heavy leakage included improper AI catheter placement and failure to monitor sows while using "hands-free" AI. In the 4th herd, approximately 20% of the sows (5/24) that were bred did not appear, to the observer, to be in standing estrus.

Semen evaluation

Semen evaluation was performed on 23/30 farms because 3 herds did not use AI and 4 producers declined semen evaluation. Semen evaluations for 5 good and 18 low farrowing rate herds were included. When fresh semen samples were examined, there was a tendency for more poor quality samples to be found in low farrowing rate herds than in good farrowing rate herds (Table 3). After 72 h of on-farm storage, similar numbers of poor quality semen samples were found in both good and low farrowing rate herds (Table 3).

Discussion

The average farrowing rate across all herds in this study (78.7%) was somewhat lower than the average farrowing rate for 13 Canadian herds using a computerized record-keeping system in 2007 (84.5%) (9). Not all herds participating in this study were using computer-based records systems. Herds using computerized records may be under a higher level of management and therefore may be more productive than herds that choose not to use a computer-based records program.

Others have also reported a relationship between the use of AI and low farrowing rate. The rate of sows returning to estrus post-breeding is inversely proportional to farrowing rate (15). One

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study showed that AI resulted in a higher return rate than did natural mating (15). Another study found that herds in which mainly natural services were used had a lower incidence of sows returning to estrus post-breeding than herds that used mainly AI. The greater the use of AI in a herd, the higher the incidence of returns to estrus post-breeding (16). Artificial insemination matings likely decrease reproductive performance because there are many more management steps during which errors can be made when AI is used than when natural breeding is used (17).

In the current research, low farrowing rate herds bred fewer sows with a combination of artificial and natural matings than did the good farrowing rate herds. Research focusing on the effects of combination mating on reproductive performance is limited. One study found that gilts that received 1 natural mating and 1 artificial mating had higher farrowing rates than gilts that received 2 natural matings (18). There was no difference in farrowing rate between gilts that received a combination of natural and artificial matings and those that received 2 artificial inseminations. The researchers speculated that AI may be less stressful for gilts than natural breeding, because they are not required to support the weight of the boar, leading to a better reproductive outcome (18). However, this is an area that must be further examined.

Low farrowing rate herds were less likely to check gilts for estrus by moving them into the boar pen than were good farrowing rate herds. The low farrowing rate herds were also more likely to move the boar into the gilt pen for estrus detection. A previous study found that moving gilts into a corridor in front of a boar improved estrus detection rates over leaving the gilts in their own pen for estrus detection (19). The decreased ability of technicians to identify heat in gilts while in their own pen may explain the association between this method of heat detection and low farrowing rate. However, in the study by Hemsworth et al (19), the gilts that were checked for estrus in their own pen were separated from the boars by a corridor and so did not have direct boar contact during estrus detection. In our study, both methods of heat detection provided the gilts with direct boar contact.

The boar pheromone, 5α-androstenone, is the most effective inducer of the standing reflex in estrous sows (20). It may be that the concentration of this pheromone is very high in pens in which a boar has been residing and, when a gilt is introduced to this pen, she may respond to the high concentration of pheromone and display a standing response. Another potential explanation is that, when moving gilts to the boar pen for heat detection, observed technicians tended to move only 1 or a very small number of gilts at one time. This gave the boar ample opportunity to check each gilt for estrus and perhaps also made it easier for the technician to identify gilts in heat. When boars were moved into the gilt pen for estrus detection, they were often exposed to many gilts at one time and, due to the large numbers of animals they had observe at once, technicians may have found it more difficult to identify all gilts in standing estrus.

On average, good farrowing rate herds began estrus detection at 4 d post-weaning, whereas the low farrowing rate herds began at 3 d post-weaning. Timing of breeding plays a very important role in reproductive performance. The optimal time to inseminate sows is between 24 h before and 4 h after ovulation (21,22). In sows, ovulation is linked to estrus duration with ovulation occurring approximately 70% of the way through estrus (21,22). Estrus duration is dependent on wean-to-estrus interval — the shorter the wean-to-estrus interval, the longer the duration of estrus (21,23–25). If sows are detected in estrus at 3 d post-weaning and bred as soon as they are found, it is possible that these sows are being bred too early. By the time ovulation occurs, viable semen may no longer be present in the reproductive tract of the sow. This may help to explain why beginning estrus detection at 3 d versus 4 d post-weaning was associated with a low farrowing rate.

Vulvar hygiene during breeding is considered an important factor in reducing the incidence of reproductive tract infection, which can cause reductions in farrowing rate (20,26). Many recommend removing fecal material from the vulvar area prior to mating (26). Most of the producers observed during breeding used a new cloth or paper towel to wipe the vulva of each sow. However, some technicians were observed to use the same washcloth to clean the vulva of more than one sow. In dairy cattle, using shared washcloths for cleaning teats and udders is a risk factor for mastitis as the shared washcloth can spread bacteria from cow to cow (27,28). It is not known if using the same washcloth on more than one sow increases the risk of reproductive tract infection but this may be one explanation for the apparent association between vulvar washing and low farrowing rate.

In this study, a wide variety of "hands-free" devices were observed in use in participating herds. These devices included saddle bags placed on the sow's back, belts fastened around the sow's abdomen, and plastic or metal devices that clamped over the sow's back. Some were purchased commercially while other devices were homemade. However, all of these devices served a similar purpose in that they had an attachment for the semen container and catheter, so the breeding technician did not have to hold them while mating was completed. This allowed the technician to breed more than 1 sow at a time. No peer-reviewed scientific evaluation of the effects of hands-free AI on reproductive outcome has been published. Further research examining the effects of these devices on sow performance and the effectiveness of different models of hands-free devices should be undertaken. During our breeding observations, excessive leakage of semen was seen when hands-free devices were used, particularly if the sows were not being monitored by the breeding technician. Excessive backflow with the use of hands-free insemination devices has been reported by others (29,30), and may help to explain the association between their use and low farrowing rate. Close sow supervision is recommended when using hands-free AI devices to minimize semen leakage (30).

Only 23 farms participated in the semen evaluation portion of the study, which reduced the power to find a difference between good and low farrowing rate herds. However, when fresh semen was evaluated, there was a tendency for poor quality semen to be associated with a low farrowing rate. Other research has found an association between semen quality and farrowing rate and has estimated that poor semen quality resulted in an average decrease in farrowing rate of 17% (10). The fact that the proportion of low and good farrowing rate herds with poor quality stored semen did not differ suggests that evaluation of stored semen quality should be performed in all sow herds, not just those experiencing low farrowing rate problems. Also, it should be noted that, because only 1 batch of semen was evaluated for each herd, it may not necessarily have accurately reflected the overall quality of semen that was used on the farm during the year for which the average herd farrowing rate was determined.

In conclusion, moving the boar into the gilt pen for estrus detection, breeding a high proportion of sows by AI only, starting heat detection at 3 d post-weaning, wiping the vulva prior to breeding, and using "hands-free" AI devices were highly associated with low farrowing rate in Ontario sow herds participating in this project. Evaluation of stored semen doses should be performed in all herds, not only those experiencing a low farrowing rate.

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