Effects of intrauterine and cervical artificial-insemination catheters on farrowing rate and litter size

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Summary

Objectives: To determine the effects of type of artificial-insemination catheter on litter size and farrowing rate and to evaluate the economic differences between the two catheters on the basis of the differences observed in reproductive performance.

Materials and methods: Three hundred eighty-nine sows were allotted into two experimental groups by parity, body condition score, and breed-of-sire influence. Sow matings were performed using a disposable foam-tipped intrauterine catheter (IU, n = 193) or a cervical catheter (IC, n = 196). Total number of piglets born per litter was recorded, and farrowing rates were calculated after all sows had farrowed or returned to estrus.

Results: Farrowing rates were 67.8% and 66.3%, while total numbers of piglets born (mean ± SE) were 9.39 ± 0.55 and 9.74 ± 0.53 per litter for the IU and IC groups, respectively. Numbers of piglets born alive were 8.97 ± 0.54 and 9.29 ± 0.52 per litter for the IU and IC groups, respectively. Total numbers of piglets born per litter and farrowing rates in the IU and IC groups were not significantly different ($P > .05$). Estimated costs (US$) per pregnant sow, per pig born, and per pig born alive were $3.68, $0.36, $0.38, respectively, for the IU catheter and $0.60, $0.06, $0.06, respectively, for the IC catheter.

Implications: No performance difference is observed between groups inseminated using IU or IC methods. Since IU catheters are more expensive, the IC method of artificial insemination has an economic advantage under the conditions of this study.

Keywords: swine, artificial insemination, intrauterine insemination

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Resumen – Efectos de los cateters de inseminación artificial cervical e intrauterino en el porcentaje de fertilidad y tamaño de camada

Objetivos: Determinar los efectos del tipo de cateter de inseminación artificial en el tamaño de la camada y porcentaje de fertilidad y evaluar las diferencias económicas entre los dos cateters en base a las diferencias observadas en el desempeño reproductivo.

Materiales y métodos: Trescientos ochenta y nueve hembras fueron asignadas a dos grupos experimentales selecciónadas por paridad, calificación de condición corporal, e influencia de la raza del semental. Las inseminaciones de las hembras se realizaron utilizando un catéter intrauterino desechable con punta de espuma (IU, n = 193) o un catéter cervical (IC, n = 196). Se registró el número total de lechones nacidos por camada y se calculó el porcentaje de fertilidad después que todas las hembras hubieron parido o regresado al estro.

Resultados: Los porcentajes de fertilidad fueron 67.8% y 66.3%, mientras que el número de lechones nacidos totales (promedio ± SE) fueron 9.39 ± 0.55 y 9.74 ± 0.53 por camada para los grupos IU e IC, respectivamente. El número de lechones nacidos vivos fueron 8.97 ± 0.54 y 9.29 ± 0.52 por camada para los grupos IU e IC, respectivamente. El número de lechones nacidos totales por camada y el porcentaje de fertilidad en los grupos IU e IC no fueron significativamente diferentes ($P > .05$). Los costos estimados (US$) por hembra inseminada, por cerdo nacido, y por cerdos nacido vivo fueron de $3.68, $0.36, $0.38, respectivamente, para el catéter IU y de $0.60, $0.06, $0.06, respectivamente, para el catéter IC.

Implicaciones: No se observaron diferencias en el desempeño entre grupos inseminados utilizando los métodos IU o IC. Ya que los cateters IU son más costosos, el método IC de inseminación artificial tiene una ventaja económica bajo las condiciones de este estudio.

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Résumé – Effets de l'utilisation de cathéters intra-utérins et cervicaux lors d'insémination artificielle sur les taux de mise-bas et la taille des portées

Objectifs: Déterminer les effets du type de cathéter utilisé lors d'insémination artificielle sur la taille des portées et le taux de mise-bas et évaluer les différences économiques entre les deux cathéters en fonction des différences observées dans les performances de reproduction.

Matériels et méthodes: Trois cent quatre-vingt-neuf truies ont été réparties en deux groupes expérimentaux selon la parité, le pointage de l'état de chair, et l'influence de la race du père. Les saillies des truies ont été effectuées en utilisant soit un cathéter intra-utérin jetable à extrémité en mousse (IU, n = 193) ou un cathéter cervical (IC, n = 196). Le nombre total de porcelets nés par portée a été noté, et les taux de mise-bas ont été calculés après que toutes les truies aient mise-bas ou soient retourné en oestrus.

Résultats: Les taux de mise-bas étaient de 67.8% et 66.3%, alors que le nombre total de porcelets nés (moyenne ± SE) étaient 9.39 ± 0.55 et 9.74 ± 0.53 par portée pour les groupes IU et IC, respectivement. Le nombre de porcelets nés vivants étaient respectivement de 8.97 ± 0.54 et 9.29 ± 0.52 par portée pour les groupes IU et IC. Il n'y avait pas de différence significative ($P > .05$) entre les groupes IU et IC quant au nombre total de porcelets nés par portée et les taux de mise-bas. Les coûts estimés (en US$) par truie gestante, par porcelet né, et par porcelet né vivant étaient, respectivement, $3.68, $0.36, $0.38 pour le cathéter IU et de $0.60, $0.06, $0.06 pour le cathéter IC.

Implications: Aucune différence dans les performances de reproduction n'a été notée entre les groupes inséminés par les méthodes IU ou IC. Dans le contexte de la présente étude, la méthode d'insémination artificielle IC possède un avantage économique étant donné que les cathéters IU sont plus dispendieux.

The use of artificial insemination (AI) on large and small swine operations has increased over the past 20 years,[1] and the demand for new AI technology can be attributed to increased use in commercial swine operations. Producers have become proficient in using AI to achieve desired reproductive performance.[2] Furthermore, producers are willing to adopt AI technology if it increases profit or improves efficiency in their swine operations. One AI catheter technology innovation involves application of intrauterine (IU) insemination. A pipette or balloon within the catheter travels through the cervix and allows the sperm to be deposited into the posterior portion of the sow's uterine body. If this technology improves the number of viable sperm reaching the oviducts by placing the spermatozoa closer to the site of insemination, farrowing rate and number of piglets born alive may increase. Furthermore, if IU catheters reduce spermatozoa backflow, the total number of spermatozoa used per mating per sow may be reduced, thus increasing the number of sows bred per ejaculate and per boar. New and "improved" types of AI catheters have been introduced, claiming improved reproductive performance. However, very few peer-reviewed trials have reported an increase in litter size, farrowing rate, or both, to justify the additional expense of the "new" types of AI catheters in commercial settings.

The objectives of this study were to quantify the differences in farrowing rate and litter size when commercially available IU and cervical AI catheters are used with spermatozoa[3] concentration 3×10^9 per 100 mL per insemination dose, and to evaluate the economic differences between the two catheters on the basis of the differences observed in reproductive performance.

Materials and methods

Three hundred eighty-nine Yorkshire × Landrace and Duroc × (Yorkshire × Landrace) sows were allotted into two experimental groups, with 193 assigned to the experimental IU catheter group and 196 to the traditional cervical (IC) catheter group. At weaning, sows were randomly assigned to groups on the basis of parity, body condition score, and breed-of-sire influence of the sows. Sow parity was categorized as either first parity (P1), second parity (P2), third through sixth parities (P4), and seventh or greater parity (P7), equally allotted into treatments. Body condition score was evaluated using a 15-point scoring system by dividing the 1-to-5 categorical scale described in the Tri-State Nutrition Guide[4] into three subcategories (eg, 1^-, 1, 1^+, 2^-, 2, 2^+), and breed-of-sire influence was evaluated in sows as either containing or not containing Duroc influence. Confounding of parity and breed of sow by treatment group was completely avoided.

This trial was performed under field conditions in a 2400-head commercial sow operation. Sow matings were performed from March until April, with subsequent farrowings from July to August. All animal procedures followed guidelines published in the National Pork Board Swine Care Handbook.[5] All sows were observed twice daily by employees for injury or disease, and the herd veterinarian was consulted for diagnosis and treatment as needed.

Sows were administered one 12-mL dose of equine chorionic gonadotropin (50 IU per mL; D&D Serum, Fort Scott, Kansas) approximately 3 hours before weaning. Sows were weaned into pens (3.05 m × 3.66 m; 10 sows per pen) on Thursday mornings, and estrus detection was performed once each day beginning the following Monday. Estrus was defined as the first observed standing estrus reflex in the presence of mature boars. Sows detected in estrus were moved into a breeding barn and randomly placed in gestation crates (0.61 m × 2.44 m). Three technicians with similar AI training and experience were provided detailed training on the use of the IU catheter. All three technicians had practiced breeding with the IU catheter for 1 week prior to initiating the trial. Technicians were not assigned specific sows for each mating, and the same technician may or may have not performed both matings on individual sows. Hence, no attempt to remove technician effects was made when the data were evaluated.

Two matings per sow were performed for each female in both treatment groups at approximately 7 ± 1 and 31 ± 1 hours after initial detection of estrus.

Semen from terminal Duroc boars was collected and processed on site daily and used the day collected or the following day. After collection, semen from two or more boars was pooled and extended to 3×10^9 spermatozoa per 100 mL per dose with Beltsville thawing solution (IMV Technologies, Minneapolis, Minnesota). Extended semen (100 mL) was placed in the appropriate container for the IU and IC treatment groups and excess extended semen was stored overnight at 17°C.

Sows were mated according to their group protocol. The cervical catheter (IC), a rounded, foam-tipped catheter, was inserted through approximately two folds of the cervix where semen is deposited during AI. The IU catheter was similar in appearance to the IC catheter, ie, both rounded and foam-tipped; however, it differed in function and site of semen deposition. The IU catheter deposited the semen directly into the uterine body. The technician applied pressure to the semen bottle, causing the permanently attached rubber inner balloon catheter to evert and extend through the cervix. If it was not possible to properly penetrate the cervix, the balloon catheter herniated, increasing the diameter of the cervix and allowing the balloon catheter to pass through the cervix into the uterus.

A boar was not present for insemination of either group because the sows were placed in gestation crates for breeding. Once the IC catheter was inserted, semen was deposited by gravity and uterine contractions as a result of technician-applied back pressure on the sow. Once the semen bag was within 5.0 mL of empty, the IC catheter was removed and the insemination was defined as successful. The protocol for the IU catheter differed from that for the IC catheter in two ways. First, when the IU catheter was used, more time elapsed between catheter insertion and semen administration, and secondly, back pressure was not applied to the sow during insemination. The IU catheter was inserted into the cervix of each sow in much the same manner as the IC catheter. After catheter insertion, the sow was allowed sufficient time (approximately 1 to 3 minutes) to relax before the semen was administered. The additional time allowed cervical contractions to calm prior to extending the balloon portion of the catheter through the cervix. After this time had elapsed and the sow appeared to be at least moderately relaxed (ie, drinking water, minimal flagging of the ears, calm movements), forceful squeezing was applied to the bottle by the technician, increasing fluid pressure inside the catheter and expelling the balloon catheter through the cervix. A mating using the IU catheter was defined as successful if the balloon catheter was fully extended when the entire catheter was removed from the sow. If the balloon catheter did not extend through the cervix, one additional attempt was immediately made to inseminate the sow. If the second attempt was not successful, the sow was not included in the experiment. Both types of catheters were non-reusable and were discarded after a single insemination.

Females were evaluated for pregnancy by ultrasound (Bantam; E. I. Medical, Loveland, Colorado) at approximately 30 days after the second insemination. The farrowing date, number born alive, stillborn piglets, and mummified piglets (not reported) were recorded at each farrowing. Total number of piglets born alive was counted for each sow approximately 12 hours post farrowing. Stillborn and total number of pigs born alive were included only as part of the total number of piglets born.

Farrowing rate was calculated after all sows in the study had farrowed or returned to estrus ([sows farrowed ÷ sows mated] × 100.0). The chi-squared component of the FREQ procedure of SAS version 9.1 (SAS Institute Inc, Cary, North Carolina) was used to calculate differences between the IU and IC group farrowing rates. An analysis of variance using the MIXED procedure of SAS version 9.1 was utilized to evaluate treatment differences in total piglets born, number of piglets born alive, and number of stillborn piglets. The model used to assess treatment differences included breed, parity, and sow body-condition score (evaluated at weaning of the previous litter, before mating for the experiment) as fixed effects. Least squares means were calculated for treatment, breed, and parity for each independent variable.

Costs (US$) per pregnant sow, per pig born, and per pig born alive were calculated by summing the catheter cost of each mating (two inseminations per mating) and dividing the total cost by the number of pregnant sows, number of pigs born, and number of pigs born alive, respectively.

Results

Of the 389 total sows included in the trial, 193 sows were inseminated using the IU catheter and 196 using the cervical catheter. Overall, no differences were observed in farrowing rate between the IU (67.8%) and IC groups (66.3%) ($P > .05$; chi-squared analysis).

Both experimental groups contained similar numbers of Duroc-influenced sows: 24 in the IU group (12.4%) and 23 in the IC group (11.7%).

Table 1 shows the parity distribution of sows by treatment group and farrowing rate. The largest percentage of sows were in P4 and the smallest percentage were in P1. Farrowing rate was lowest in P7 sows and highest in P2 sows.

Farrowing-rate performances by treatment and initial body-condition score are shown in Table 2. The average body-condition score (mean ± SD) for the entire research population was 2.9 ± 0.5. Overall, 17.0% of sows had a condition score of $\leq 2^+$, and 11.6% of sows had a condition score of $\geq 4^-$. Thus, body condition scores of 28.6% of sows were outside the range considered optimal for normal reproductive performance.

No significant treatment differences ($P > .05$) were observed between IU and IC treatments in the least squares means for total piglets born, number of piglets born alive, or stillborn piglets (Table 3). Least squares means for each component of litter size was numerically greater in the IC treatment group than in the IU group. The sows' breed of sire tended to be a source of variation for total number of piglets born

Table 1: Distribution of sows by parity* and treatment† in a study comparing two methods of artificial insemination

	Parity			
	P1	P2	P4	P7
IU catheter (N = 193)				
No. of sows	5	22	126	40
Parity distribution (%)	2.6	11.4	65.3	20.7
Farrowing rate (%)	60.0	72.7	68.3	65.0
IC catheter (N = 196)				
No. of sows	10	22	134	30
Parity distribution (%)	5.1	11.2	68.4	15.3
Farrowing rate (%)	70.0	72.0	70.1	44.3
All sows (N = 389)				
No. of sows	15	44	260	70
Parity distribution (%)	3.9	11.3	66.8	18.0
Farrowing rate (%)	66.7	72.7	69.2	55.7

* Sows were assigned to treatments by parity. Results are presented for the sow's parity when inseminated at trial initiation. P1, first parity; P2, second parity; P4, third through sixth parities; P7, seventh or greater parity.

† Sows inseminated either with a catheter that deposited semen into the uterine body (IU catheter) or a catheter that deposited semen into the cervix (IC catheter).

(P = .08), but not for total piglets born alive or stillborn piglets. Total number of piglets born, number of piglets born alive, and stillborn piglets increased numerically with parity.

The technicians reported that in approximately 10 sows (7.5%), the balloon catheter would not extend through the cervix, and these sow were excluded from the trial.

Each IU catheter cost $1.25 and each IC catheter cost $0.20 (Swine Genetics International, Ltd, Cambridge, Iowa). Costs per pregnant sow, per pig born, and per pig born alive for the IU catheter were $3.68,

Table 2: Distribution of sows' body condition scores (BCSs)* by treatment† in a study of two methods of artificial insemination

	BCS								
	2-	2	2+	3-	3	3+	4-	4	4+
IU catheter (N = 193)									
No. of sows	4	4	23	48	64	23	16	9	2
BCS distribution (%)	2.07	2.07	11.92	24.87	33.16	11.92	8.29	4.66	1.04
Farrowing rate (%)	75.00	25.00	60.87	70.83	64.06	78.26	75.00	66.67	100.00
IC catheter (N = 196)									
No. of sows	3	11	21	47	66	30	12	4	2
BCS distribution (%)	1.53	5.61	10.71	23.98	33.67	15.31	6.12	2.04	1.02
Farrowing rate (%)	100.00	54.55	66.67	68.09	72.73	50.00	66.67	75.00	50.00
All sows (N = 389)									
No. of sows	7	15	44	95	130	53	28	13	4
BCS distribution (%)	1.80	3.86	11.31	24.42	33.42	13.62	7.20	3.34	1.03
Farrowing rate (%)	85.71	46.67	63.64	69.47	68.46	62.26	71.43	69.23	75.00

* Body condition score was evaluated using a 15-point scoring system by dividing the 1-to-5 categorical scale described in the Tri-State Nutrition Guide[4] into three subcategories (ie, 1^-, 1, 1^+, 2^-, 2, 2^+). At weaning of the previous litter, sows were randomly assigned to IU or IC treatment groups on the basis of parity, body condition score, and breed-of-sire influence.

† Sows inseminated either with a catheter that deposited semen into the uterine body (IU catheter) or a catheter that deposited semen into the cervix (IC catheter).

Table 3: Least squares means (± SE) of reproductive traits of sows that farrowed by treatment,* influence of sows' breed-of-sire, and parity in a study of two methods of artificial insemination

	N	Reproductive traits		
		Total born	Born alive	Stillborns
Treatment				
IU catheter	131	9.39 ± 0.55	8.97 ± 0.54	0.43 ± 0.20
IC catheter	130	9.74 ± 0.53	9.29 ± 0.52	0.46 ± 0.19
Breed†				
Duroc influence	31	9.08 ± 0.69[a]	8.73 ± 0.67	0.35 ± 0.25
No Duroc influence	230	10.06 ± 0.46[b]	9.53 ± 0.45	0.54 ± 0.17
Parity				
P1	10	8.87 ± 1.04	8.68 ± 1.02	0.19 ± 0.39
P2	32	9.30 ± 0.66	8.85 ± 0.65	0.46 ± 0.24
P4	180	9.91 ± 0.50	9.37 ± 0.49	0.54 ± 0.18
P7	39	10.20 ± 0.62	9.61 ± 0.60	0.59 ± 0.22

* Sows inseminated either with a catheter that deposited semen into the uterine body (IU catheter) or a catheter that deposited semen into the cervix (IC catheter). Sows were assigned to treatments by parity at the time of insemination.

† Duroc influence, sows 1/2 Duroc × (1/4 Landrace × 1/4 Yorkshire); No Duroc influence, sows 1/2 Landrace × 1/2 Yorkshire.

[ab] Values with different superscripts tend to differ (P = .08; analysis of variance).

$0.36, and $0.38, respectively. Costs per pregnant sow, per pig born, and per pig born alive for the IC catheter were $0.60, $0.06, and $0.06, respectively.

A post hoc power analysis was conducted using standard deviations for litter size and odds ratio for farrowing rate traits acquired from this study. This study had sufficient power (80%) to detect a treatment difference of one pig born per litter and a 12% difference in farrowing rate.

Discussion

The litter size and sow performance results of this study are supported by those previously reported by Rozeboom and coworkers.[6] That study reported no significant difference ($P > .05$) between IU and IC inseminations for farrowing rate (94.4% vs 88.2%), total number of piglets born (11.0 vs 11.6), or number of piglets born alive (10.5 vs 10.8) when similar spermatozoa concentrations were used per semen dose (4×10^9). However, when suboptimal (0.5×10^9) spermatozoa concentration per semen dose was used with the IU catheter, the observed farrowing rate was 16.4% less ($P < .05$) than when the 4×10^9 spermatozoa concentration was used. All farrowing rates and litter sizes (except litter sizes with suboptimal spermatozoa concentrations) reported were greater than those found in the present study.

A study performed by Martinez et al[7] reported litter size (approximately 10.0 piglets per litter) similar to that in the present study when 3×10^9 spermatozoa per insemination were utilized. However, the 87.5% farrowing rate for the control group (3×10^9 spermatozoa per insemination) was greater than that observed in the present study.[7]

Results from this study are also supported by a study performed by Serret and coworkers,[8] who compared IU and IC insemination methods at different spermatozoa concentrations. In that study, farrowing rate and litter size did not differ between AI methods when 3.5×10^9 spermatozoa per insemination were used for IC insemination, and 2.0, 1.0, and 0.5×10^9 spermatozoa per insemination for IU insemination.

In contrast, previous work by Roberts and Bilkei[9] reported 2.1 more total pigs born per litter ($P < .01$) for sows after IC insemination than after IU insemination. However, IC and IU treatment groups did not significantly differ for farrowing rate, which is similar to the present findings.

Many factors contribute to farrowing rate differences between farms. Employee training, boar stimulation of sows, subclinical health challenges, seasonal effects, or any combination could explain overall farrowing-rate differences observed in this study and might contribute to the differences in results between this study and previous reports. However, the objective of this study was not to evaluate the environmental effects impacting farrowing rate or litter size, which were assumed to be similar across the two treatments evaluated.

In this study, sows having Duroc breed-of-sire influence tended to have a smaller total number of piglets born than sows with no Duroc breed-of-sire influence in their ancestry. The Duroc breed, especially Durocs selected for the terminal traits, is known to average smaller litters than breeds known for their maternal performance (ie, Yorkshire and Landrace).[10,11]

Parity was not a significant source of variation for farrowing rate or litter size. To find parity differences for these traits, many more observations per parity-treatment subclass would have been required. Because the objective of the study was not to evaluate the effect of parity on reproductive performance, sows from different parities were evenly distributed across treatments, which should have minimized parity differences when reproductive performance was evaluated for the two AI catheters.

Body condition score was measured a maximum of 2 days before weaning. At this time, it is common for sow condition scores to be poorer than at the beginning of lactation[12,13] because of the catabolism of muscle and fat reserves used to produce large litters of heavy piglets during the 21-day lactation period. Those conditions cause some sows to lose a relatively large amount of body condition. Sows with condition score > 3 or < 3 may have poorer subsequent reproductive performance.

The farm technicians on the farm where this study was conducted had previous experience using the IC catheter, and found the experimental IU catheter was more difficult to use, ie, technicians were unable to inseminate a small percentage of sows on the first attempt or on both attempts. Therefore, part of the difference in ease or comfort of use may be due to the AI technicians' familiarity with the IC catheter. The frequency of sows that could not be inseminated with the IU catheter was similar to the frequencies observed by Rozeboom et al[6] and Watson and Behan,[14] who reported that the technicians were unable to penetrate the cervix in 6% and < 10% of the IU services in their study, respectively. Similarly, Martinez et al[15] found that the deep IU catheter was incapable of penetrating the cervix in 18 of 390 sows (4.6%). Martinez et al[15] used a flexible fiberoptic endoscope that deposited semen deep in the uterus. Even with video imaging inside the cervix, the investigators had difficulty inserting the endoscope through the cervix in two of the 33 sows (6%). Further, in a previous study evaluating nonsurgical IU insemination, Martinez et al[7] reported that when gentle and steady pressure was applied, the endoscope easily passed through all but the last two cervical folds. At this point, slight bleeding into the cervical canal was observed in three sows, an event that may have an adverse impact on conception.

For this study, each IU catheter cost $1.05 more than each IC catheter. In a swine operation averaging two inseminations per sow per estrus and 100 sows inseminated per week (approximately a 2400-sow operation farrowing 2.2 litters per sow per year), use of the IU catheter would cost $210 more per week ($10,920 per year). Although unsuccessful matings by the IU catheter were not evaluated in this study, this would further increase the costs per pregnant sow, per pig born, and per pig born alive. There appears to be an economic advantage to using the traditional IC catheter over the IU catheter when no improvement in sow performance is observed with use of the IU catheter. To recover costs associated with using the more expensive IU catheter and any other necessary equipment, an increase in farrowing rate by a minimum of 0.75%, an increase in number born alive by a minimum of 0.07 pigs per litter, or a combination of the two, would be required. These calculations are based on assuming a 2001-2005 average of $32.00 per weaned pig,[16] 12% pre-weaning mortality,[17] and 10.5 piglets born alive (pigs weaned per litter breakeven = ($2.10 additional cost per litter ÷ $32.00 per weaned pig) ÷ 88% weaning percent).

The technicians were given a week to practice using the IU catheters and had become quite proficient by the beginning of the trial. If this catheter is to be more widely adopted by commercial producers, technician training will be an integral component to becoming confident in using the technique. The process of implementing new technologies may cause farm personnel to temporarily focus on attention to detail, thereby temporarily improving performance. Nonetheless, the results of the present study revealed no performance advantage, and hence no economic advantage to using the IU method of insemination compared to the less expensive regular method of insemination. These results were obtained from a single herd, and many factors play a role in reproductive performance. Producers should implement new technologies and evaluate their effectiveness on their own farms.

Implications

- Under the conditions of this study, use of the IU insemination catheter does not increase farrowing rate, total piglets born, or numbers of piglets born alive or stillborn piglets.
- Costs are higher with use of the IU catheter than the IC catheter.
- Sow-herd managers should carefully evaluate the use of alternative insemination rods when mating by artificial means.
- Training is an integral component to becoming confident in using the technique required for IU insemination.
- As many factors play a role in reproductive performance, producers should implement new technologies and evaluate their effectiveness on their own farms.

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