# Equine chorionic gonadotrophin and porcine luteinizing hormone to shorten and synchronize the wean-to-breed interval among parity-one and parity-two sows

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## Summary

**Objective:** To determine the efficacy of an estrus and ovulation synchronization protocol utilizing equine chorionic gonadotropin (eCG) and porcine luteinizing hormone (pLH) on the wean-to-breed interval (WBI), farrowing rate, and litter size in parity-one and parity-two sows.

**Materials and methods:** Parity-one (n = 1167) and parity-two sows (n = 1196) from a total of eleven farms across Canada were each randomly assigned either to a treatment (596 parity-one and 599 parity-two sows) or control group (571 parity-one sows and 597 parity-two sows). Treated sows received 600 IU eCG intramuscularly (IM) at weaning and 5 mg pLH IM at observed estrus. Detection of estrus behaviour was facilitated by twice daily boar exposure for 20 minutes beginning 24 hours after weaning. All sows were inseminated at 12 and 32 hours after the onset of behavioural estrus.

**Results:** On average, the WBI was lower by approximately 1 day among treated parity-one sows, and by 0.3 day among treated parity-two sows. In addition, the overall breeding period was shorter among treated sows, especially among parity-one sows. There was no treatment effect on farrowing rate or litter size.

**Implications**: Administration of exogenous eCG and pLH with subsequent timed double insemination may shorten the WBI in weaned parity-one and parity-two sows, allowing for more predictable crate utilization and a narrower range in gestational age in the farrowing room.

**Keywords:** swine, equine chorionic gonadotropin, porcine luteinizing hormone, ovulation synchronization, wean-to-breed interval

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**Resumen - Utilización de gonadotropina coriónica equina y hormona luteinizante porcina para acortar y sincronizar el intervalo de destete a servicio entre hembras de paridad uno y paridad dos**

**Objetivo:** Determinar la eficacia de un protocolo de sincronización de estro y ovulación, utilizando gonadotropina coriónica equina (eCG por sus siglas en inglés) y hormona luteinizante porcina (pLH por sus siglas en inglés), en el intervalo de destete a servicio (WBI por sus siglas en inglés), porcentaje de fertilidad, y tamaño de camada en hembras de paridad uno y de paridad dos.

**Materiales and métodos:** Hembras de paridad uno (n = 1167) y paridad dos (n = 1196) de un total de once granjas a lo largo de Canadá fueron asignadas cada una al azar a un grupo tratamiento (596 hembras de paridad uno y 599 hembras de paridad dos) o grupo control (571 hembras de paridad uno y 597 hembras de paridad dos). Las hembras tratadas recibieron 600 IU de eCG intramuscularmente en el destete y 5 mg de pLH intramuscularmente cuando se observó el estro. La detección de la conducta de estro se facilitó por medio de la exposición diaria dos veces a un macho durante 20 minutos iniciando 24 horas después del destete. Todas las hembras se inseminaron 12 y 32 horas después del inicio de la conducta de estro.

**Resultados:** En promedio, el WBI fue menor por aproximadamente 1 día en las hembras de paridad uno tratadas, y por 0.3 de día entre las hembras de paridad dos tratadas. Además, el periodo total de servicio fue más corto en hembras tratadas, especialmente en la hembras de paridad uno. No hubo efecto del tratamiento en el porcentaje de fertilidad ni en el tamaño de la camada.

**Implicaciones:** La administración de pLH y eCG exógenas con la subsiguiente inseminación doble programada puede acortar el WBI en hembras destetadas de paridad uno y de paridad dos, permitiendo una utilización más predecible de las jaulas y un rango más cerrado en la edad de gestación en la sala de partos.

**Résumé - Utilisation de la gonadotrophine chorionique équine et de l'hormone lutéinisante porcine pour raccourcir et synchroniser l'intervalle sevrage-saillie chez les truies de première et deuxième parité**

**Objectif:** Déterminer l'efficacité d'un protocole de synchronisation de l'œstrus et de l'ovulation en utilisant la gonadotrophine chorionique équine (eCG) et l'hormone lutéinisante porcine (pLH), sur l'intervalle sevrage-saillie (WBI), le taux de mise-bas, et la taille des portées chez les truies de première et deuxième parité.

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**Matériels et méthodes:** Des truies de première (n = 1167) et deuxième parité (n = 1196) provenant d'un total de 11 fermes réparties à travers le Canada ont chacune été assignées au hasard au groupe traitement (596 truies de première parité et 599 truies de deuxième parité) ou au groupe témoin (571 truies de première parité et 597 truies de deuxième parité). Les truies traitées ont reçu 600 UI d'eCG par voie intramusculaire (IM) au sevrage et 5 mg de pLH IM au moment observé de l'œstrus. La détection du comportement de l'œstrus était facilitée par l'exposition deux fois par jour pour une durée de 20 minutes à un verrat débutant 24 heures après le sevrage. Toutes les truies étaient inséminées 12 et 32 heures après le début du comportement de l'œstrus.

**Résultats:** Chez les truies de première parité traitées, le WBI était moindre d'environ 1 jour en moyenne et d'environ 0,3 jour chez les truies de deuxième parité. De plus, chez les truies traitées la période totale d'accouplement était plus courte, surtout chez les truies de première parité. Il n'y avait pas d'effet traitement sur le taux de mise-bas ou la taille de la portée.

**Implications:** L'administration d'eCG et de pLH exogène suivie d'une double insémination calculée peut réduire le WBI chez les truies de première et deuxième parité dont les porcelets sont sevrés, permettant ainsi une utilisation plus prévisible des cages de mise-bas et un écart plus restreint dans les âges de gestation des truies dans la salle de mise-bas.

The overall productivity of a commercial swine farm is affected by the wean-to-breed-interval (WBI).[1] If the WBI is variable or longer than average, it may be a barrier to achieving consistent breeding targets, especially for producers employing batch farrowing or all-in, all-out management systems. Variation in the WBI also affects the weaning age of pigs.

Various pharmacological intervention strategies exist to induce ovarian development and estrus behaviour in weaned sows,[2,3] including altrenogest early in the post-weaning period of the primiparous sow,[4] and equine chorionic gonadotropin (eCG) plus human chorionic gonadotropin (hCG) in primiparous and multiparous sows.[5,6] Although estrus behavior may be effectively synchronized, the timing of ovulation is not more predictable in sows treated with eCG plus hCG than in untreated sows, because the time of ovulation relative to the onset of estrus is still dependent upon the wean-to-estrus interval.[5] This observation may limit the use of altrenogest and eCG plus hCG in timed-breeding programs, in which sows are bred at their optimal time of insemination, 24 to 4 hours before ovulation.[6] The timing of ovulation can be predicted when porcine luteinizing hormone (pLH) is incorporated into an ovulation induction protocol.[7] Among sows treated with eCG at weaning and with or without pLH 80 hours later, 90% to 100% ovulated within 36 to 38 hours after pLH treatment, while only 20% to 40% ovulated during that time when treated with eCG alone.[7]

The objectives of this study were to determine the efficacy of an estrus and ovulation synchronization protocol on WBI, farrowing rates, and litter sizes in parity-one and parity-two sows.

## Materials and methods

This study involved eleven farms from across Canada (Alberta, Manitoba, Ontario, and Quebec) that were selected by eight veterinarians who considered the selected farms to have good production results, knowledgeable staff, excellent record-keeping practices, and animal care practices that gave due regard to the welfare of the animals.

Parity-one and parity-two sows were assigned to two groups (control and treatment) on the basis of the results of a coin toss at the time of weaning. Treated sows were given 600 IU eCG (Pregnecol 5000; Bioniche Animal Health, Belleville, Ontario, Canada) by IM injection at weaning, followed by 5 mg pLH (Lutropin-V; Bioniche Animal Health) IM at the first observed sign of estrus. Farm staff administered all doses of gonadotrophins. Sows assigned to the control group remained untreated. On all farms, estrus detection was facilitated by twice-daily boar exposure for 20 minutes, beginning 24 hours after weaning. Treated sows were inseminated twice at fixed times after pLH administration, first at 12 hours and then at 32 hours. Control sows were inseminated at 12 then 32 hours after the onset of standing estrus. All sows were artificially inseminated with insemination doses formulated to contain a minimum of $3 \times 10^9$ sperm per dose.

Data recorded for sows included farm, parity, treatment group, previous lactation length, weaning date, date of breeding, actual farrowing date, and subsequent litter size (total and born alive). Any sow that had a recorded lactation length of ≤ 10 days or ≥ 30 days was not included in the analysis.

Descriptive analyses were performed and the effects of treatment and parity (controlling for farm and previous lactation length) on the WBI and litter size (total and born alive) were analyzed using linear mixed effect models (PROC MIXED, SAS 9.1.3; SAS Institute, Inc, Cary, North Carolina). To improve normality of the WBI response, a $\log_{10}$ transformation was used. Furthermore, for the WBI and litter-size outcomes, sows not bred by 21 days were excluded from analyses, as inclusion of these data might skew the results, and these sows were not in the main population of interest. The effects of treatment and parity (controlling for farm and previous lactation length) on farrowing rate and on the proportions of sows bred by 5, 7, and 10 days after weaning were assessed using logistic regression (GLIMMIX macro, SAS 9.1.3; SAS Institute, Inc). Adjusted farrowing rate was defined as number of sows farrowed divided by number of sows bred by 21 days, excluding sows that were culled for any reason. For all analyses, treatment, parity, and previous lactation length were modeled as fixed effects, and farm was considered a random effect. The interaction between treatment effect and parity was considered throughout. A $P$ value of < .05 was considered statistically significant. Model assumptions were assessed by examining residuals for normality and homogeneity.

## Results

In total, 2372 sows were involved in the study: 1172 control sows and 1200 treated sows (49% parity one and 51% parity two). Parity values were missing for nine sows (five treated and four controls), which were excluded from calculations that were based on parity. Of the 2302 sows bred, 2219 (96.4%) were bred by 21 days. The distributions of WBI for parity-one and parity-two sows are presented in Figure 1. The effect of treatment on the WBI, controlling for previous lactation length and random farm effects, are described in Table 1. Wean-to-breed interval was shorter for treated sows than for controls. Because of a significant treatment-parity interaction effect ($P < .05$), results are presented separately for each parity. Although the difference in the least squares (LS) means for WBI (ie, controlling for farm and previous lactation length) was more pronounced for parity-one sows (0.84 days) than for parity-two sows (0.36 days), the effects were significant for both parity groups (Table 1). Furthermore, as demonstrated in Figure 1 and confirmed by examining the variances of the model residuals, treatment was associated with less variation in WBI. Among parity-one sows, the log-transformed WBI variance estimate among treated sows (0.014) was approximately 50% of that of control sows (0.030). The effect of treatment on the WBI was also assessed by examining the proportions of sows bred by 5, 7, and 10 days (while controlling for lactation and farm effects). Results are provided in Table 2. Treatment was associated with significantly more parity-one sows bred by 5 days (difference approximately 20%), 7 days (difference approximately 10%), and 10 days (difference approximately 7%). Treatment was also associated with significantly more parity-two sows bred by 5 days (5%).

Adjusted farrowing rates and litter sizes (total and live births) for all treatment-parity groups were consistently high (Table 3). Although adjusted farrowing rates and litter sizes were significantly associated with parity, after controlling for previous lactation length and random farm effects, treatment had no significant effect on these production parameters.

## Discussion

The production parameter with the greatest influence on the number of pigs weaned per female per year and per lifetime is the number of nonproductive sow days, defined as the number of days when a breeding female is neither gestating nor lactating.[8] The most common factors contributing to nonproductive sow days are reproductive failure[9] and the length of time from weaning to rebreeding[10] in sows of all parities, but especially in those of lower parities.[11] This study demonstrated that in good production farms, an estrus synchronization protocol employing eCG, followed by ovulation induction with pLH, can reduce both WBI and variability of the WBI, without impacting farrowing rates and litter size, with the treatment effect most pronounced among parity-one sows.

**Figure 1:** Distributions of wean-to-breeding interval (WBI) among parity-one sows (panel A) and parity-two sows (panel B) in a study of the effect of treatment with equine chorionic gonadotropin (eCG) and porcine luteinizing hormone (pLH). Treated sows (596 parity-one and 599 parity-two sows) were treated with 600 IU eCG (Pregnecol 5000; Bioniche Animal Health, Belleville, Ontario, Canada) by IM injection at weaning, followed by 5 mg pLH (Lutropin-V; Bioniche Animal Health) IM at the first observed sign of estrus. Treated sows were inseminated 12 hours and 32 hours after pLH administration. Control sows (571 parity-one and 597 parity-two sows) were inseminated 12 and 32 hours after the onset of standing estrus. Only sows bred by 21 days post weaning were included in these distributions.

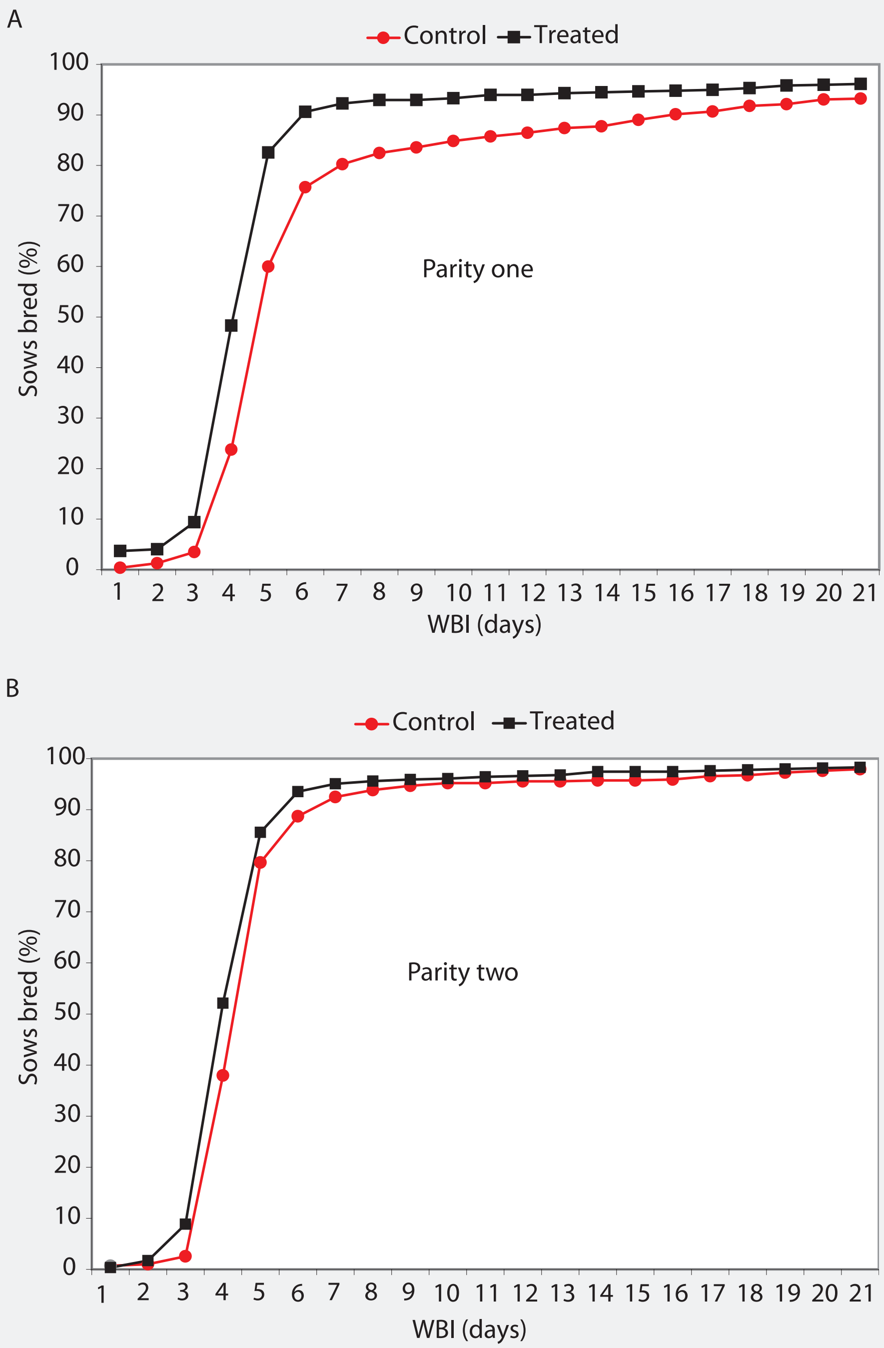

**Table 1:** Wean-to-breed intervals* in parity-one and parity-two sows either treated with eCG and pLH to induce and synchronize estrus (Treated), or not treated (Controls)†

| | Parity-one sows | | | Parity-two sows | | |
|---|---|---|---|---|---|---|
| | n | LS mean (days) | 95% CI (days) | n | LS mean (days) | 95% CI (days) |
| Treated | 596 | 4.59[a] | 4.29 – 4.90 | 599 | 4.32[a] | 4.05 – 4.62 |
| Controls | 571 | 5.43[b] | 5.06 – 5.83 | 597 | 4.68[b] | 4.37 – 5.01 |

* Least squares (LS) means controlled for lactation and farm effects.

† Parity-one and parity-two sows on a total of 11 Canadian farms were randomly assigned to treatment. Treated sows were treated with 600 IU eCG (Pregnecol 5000; Bioniche Animal Health, Belleville, Ontario, Canada) by IM injection at weaning, followed by 5 mg pLH (Lutropin-V; Bioniche Animal Health) IM at the first observed sign of estrus. Treated sows were inseminated 12 hours and 32 hours after pLH administration. Control sows were inseminated 12 and 32 hours after the onset of standing estrus.

[ab] Values within a column with different superscripts are significantly different (linear mixed effect models; $P < .05$).

eCG = equine chorionic gonadotropin; pLH = porcine luteinizing hormone.

**Table 2:** Proportions of parity-one and parity-two sows bred by 5, 7, and 10 days among sows either treated with eCG and pLH or not treated*

| | Proportion of sows affected (%)† | | | |
|---|---|---|---|---|
| | Parity one | | Parity two | |
| | LS mean | 95% CI | LS mean | 95% CI |
| **Bred by 5 days** | | | | |
| Treated | 82.7[a] | 76.2 – 87.7 | 89.2[a] | 84.5 – 92.6 |
| Controls | 62.5[b] | 53.1 – 71.1 | 84.6[b] | 78.6 – 89.2 |
| **Bred by 7 days** | | | | |
| Treated | 90.1[a] | 86.7 – 92.8 | 95.4[a] | 93.2 – 96.9 |
| Controls | 80.0[b] | 74.8 – 84.4 | 93.4[a] | 90.6 – 95.4 |
| **Bred by 10 days** | | | | |
| Treated | 91.2[a] | 87.8 – 93.7 | 96.2[a] | 94.1 – 97.6 |
| Controls | 84.6[b] | 79.7 – 88.4 | 95.6[a] | 93.4 – 97.2 |

* Treatments described in Table 1. Analysis included 596 treated and 571 control parity-one sows and 599 treated and 597 control parity-two sows.

† Least squares (LS) means controlled for lactation and farm effects.

[ab] Values with different superscripts within a column and breeding period are significantly different (logistic regression; $P < .05$).

The average WBI was approximately 1 day shorter in treated than in control parity-one sows, and approximately 0.3 day shorter in treated than in control parity-two sows. In addition, the overall breeding period was shorter in treated sows, especially among parity-one sows. Larger proportions of treated sows were bred by 5, 7, and 10 days, and the variability in the WBI was lower among treated sows. It is reported that the administration of eCG decreases the wean-to-estrus interval;[12,13] however, not all sows respond equally. As demonstrated in our study, parity-one sows were more likely than parity-two sows to respond to exogenous eCG.

Stimulation of behavioral estrus after weaning and having more sows bred by 7 days has been achieved by others through use of eCG and hCG.[2] However the endogenous hormone profiles associated with treating weaned sows with eCG plus hCG[13] or eCG alone[14] are similar to those observed naturally, in that the duration of estrus behavior is inversely proportional to the wean-to-estrus interval.[15] This observation has been confirmed by ultrasound examination of the ovaries,[3] and suggests that even when exogenous gonadotrophins are used, insemination protocols still need to consider the wean-to-estrus interval to ensure that spermatozoa are deposited within the female tract 24 to 4 hours before ovulation.[4]

The additional step of using exogenous pLH in this study's protocol was an attempt to induce ovulation 36 to 38 hours after pLH administration, independent of the wean-to-estrus interval or duration of estrus.[5-7,16] Knowing when ovulation will occur minimizes unnecessary inseminations and associated labor costs.[17] Furthermore, ovulation synchronization allows for development of an insemination program to optimize the time of insemination relative to the time of pLH injection. Maximal oocyte fertilization

**Table 3:** Farrowing rate and litter size in parity-one and parity-two sows either treated with eCG and pLH or not treated*

| | Parity one | | Parity two | |
|---|---|---|---|---|
| | LS mean | 95% CI | LS mean | 95% CI |
| **Farrowing rate (%)†** | | | | |
| Treated | 92.2 | 85.0 – 96.1 | 96.9 | 93.2 – 98.6 |
| Controls | 90.7 | 82.4 – 95.3 | 96.8 | 93.2 – 98.5 |
| **Total litter size†** | | | | |
| Treated | 11.73 | 11.10 – 12.35 | 12.47 | 11.85 – 13.09 |
| Controls | 11.91 | 11.29 – 12.54 | 12.70 | 12.08 – 13.32 |
| **Live births†** | | | | |
| Treated | 10.87 | 10.25 – 11.50 | 11.53 | 10.91 – 12.16 |
| Controls | 11.13 | 10.50 – 11.77 | 11.69 | 11.06 – 12.31 |

* Treatments described in Table 1. Analysis included 1167 parity-one sows (596 treated and 571 control) and 1196 parity-two sows (599 treated and 597 control).

† Least squares (LS) means controlled for lactation and farm effects. Values did not differ significantly between treatment groups.

rates can be achieved[4] and the number of inseminations per sow can be tailored to one[5] or two[6] without compromising farrowing rates or litter sizes. In this study, farrowing rates and litter sizes were not affected by the ovulation-synchronization and timed-insemination program. These data suggest that a combination of eCG and pLH may be helpful in minimizing the labor devoted to rebreeding weaned sows.

A major advantage of this protocol is that both estrus and ovulation are synchronized. Labor can be directed to optimal times of estrus detection based around the time of pLH administration, and semen usage can be standardized to two (or perhaps one) inseminations per sow, without having any detrimental effect on production parameters. Results of this study suggest that this treatment protocol can improve breeding synchronization (especially among first-parity sows), and the majority of sows can be bred by day 5 after weaning.

## Implications

- Under the conditions of this study, administration of exogenous eCG and pLH with subsequent timed double insemination shortens the WBI in weaned parity-one and parity-two sows.
- Use of this estrus- and ovulation-synchronization protocol could allow for more predictable crate utilization and narrow the range in gestational age of sows in the farrowing room.


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## References:


*1. Estill CT. Current concepts in estrus synchronization in swine. *Proc Am Soc Anim Sci*. 1999.

2. Kirkwood RN, Aherne FX, Foxcroft GR. Effect of PG600 at weaning on reproductive performance of primiparous sows. *J Swine Health Prod*. 1998;6:51–55.

3. Knox RV, Rodriguez-Zas SL, Miller GM, Willenburg KL, Robb JA. Administration of PG600 to sows at weaning and the time of ovulation as determined by transrectal ultrasound. *J Anim Sci*. 2001;79:796–802.

4. Nissen AK, Soede NM, Hyttel NM, Schmidt M, D'Hoore L. The influence of time of insemination relative to the time of ovulation on farrowing frequency and litter size in sows, as investigated by ultrasonography. *Theriogenology*. 1997;47:1571–1582.

5. Cassar G, Kirkwood RN, Poljak Z, Bennett-Steward K, Friendship RM. Effect of single or double insemination on fertility of sows bred at an induced estrus and ovulation. *J Swine Health Prod*. 2005;13:254–258.

*6. Cassar G, Kirkwood RN, Bennett-Steward K, Friendship RM. Towards fixed time insemination in sows. *Proc AASV*. Toronto, Ontario. 2005;353–355.

7. Bennett-Steward K, Cassar G, Plante C, Friendship R, Zak L. Fine tuning of ovulation induction protocol using exogenous eCG and LH in the weaned sow. *J Swine Health Prod.* 2007;15:194–197.

8. Wilson MR, Friendship RM, MacMillan I, Hacker RR, Pieper R, Swaminathan S. A survey of productivity and its component interrelationship in Canadian swine herds. *J Anim Sci.* 1986;62:576–582.

9. Koketsu Y, Dial GD. Interactions between the effects of parity, lactation length, and weaning-to-conception interval on subsequent litter size in herds using early weaning. *Prev Vet Med*. 1998;37:113–120.

10. Correa MN, Lucia T Jr, Afonso JAB, Deschamps JC. Reproductive performance of early-weaned female swine according to their estrus profile and frequency of artificial insemination. *Theriogenology*. 2002;58:103–112.

11. Lucia T Jr, Dial GD, Marsh WE. Lifetime reproductive performance in female pigs having distinct reasons for removal. *Livestock Prod Sci*. 2000;63:213–222.

12. Sechin A, Deschamps JC, Lucia T Jr, Aleixo JA, Bordignon V. Effect of equine chorionic gonadotropin on weaning-to-first service interval and litter size of female swine. *Theriogenology*. 1999;51:1175–1182.

13. Lucia T Jr, Correa MN, Deschamps JC, Peruzzo IA, Matheus JEM, Aleixo JAG. Influence of equine gonadotropin on weaning to estrus interval and estrus duration in early weaned primiparous female swine. *J Anim Sci*. 1999;77:3163–3167.

14. Johnson RK, Neilson MK, Casey DS. Response in ovulation rate, embryonal survival and litter traits in swine to 14 generations of selection to increase litter size. *J Anim Sci*. 1999;77:541–557.

15. Caetano AR, Johnson RK, Ford JJ, Pomp D. Microarray profiling for differential gene expression in ovaries and ovarian follicles of pigs selected for increased ovulation rate. *Genetics*. 2004;168:1529–1537.

*16. Viana CHC, Candini PH, Gama RD, Carbone SA, Santos ICC, Viana WL, Barnabe RC. Evaluation of a synchronization of ovulation protocol in cyclic sows. *Proc 17th IPVS.* Ames, Iowa. 2002;678.

17. Ruiz-Flores A, Johnson RK. Direct and correlated responses to two-stage selection for ovulation rate and number of fully formed pigs at birth in swine. *J Anim Sci*. 2001;79:2286–2297.

*Non-refereed references.

## Weights and measures conversions

| Common (US) | Metric | To convert | Multiply by |
|---|---|---|---|
| 1 oz | 28.35 g | oz to g | 28 |
| 1 lb (16 oz) | 453.59 g | lb to kg | 0.45 |
| 2.2 lb | 1 kg | kg to lb | 2.2 |
| 1 in | 2.54 cm | in to cm | 2.54 |
| 0.39 in | 1 cm | cm to in | 0.39 |
| 1 ft (12 in) | 0.31 m | ft to m | 0.3 |
| 3.28 ft | 1 m | m to ft | 3.28 |
| 1 mi | 1.6 km | mi to km | 1.6 |
| 0.62 mi | 1 km | km to mi | 0.6 |
| 1 sq in | 6.5 $cm^2$ | sq in to $cm^2$ | 6.5 |
| 0.15 sq in | 1 $cm^2$ | $cm^2$ to sq in | 0.15 |
| 1 sq ft | 0.09 $m^2$ | sq ft to $m^2$ | 0.09 |
| 11.11 sq ft | 1 $m^2$ | $m^2$ to sq ft | 11 |
| 1 cu ft | 0.03 $m^3$ | cu ft to $m^3$ | 0.03 |
| 35.32 cu ft | 1 $m^3$ | $m^3$ to cu ft | 35 |
| 1 c (cup) | 0.24 L | c to L | 0.24 |
| 4.1667 c | 1 L | L to c | 4.2 |
| 1 gal (128 fl oz) | 3.8 L | gal to L | 3.8 |
| 0.264 gal | 1 L | L to gal | 0.26 |
| 1 qt (32 fl oz) | 946.36 mL | qt to L | 0.95 |
| 33.8138 oz | 1 L | L to qt | 1.1 |

## Temperature equivalents

$°F = (°C \times 9/5) + 32$

$°C = (°F - 32) \times 5/9$

| °C | °F |
|---|---|
| 0 | 32 |
| 10 | 50 |
| 15.5 | 60 |
| 16 | 61 |
| 18.3 | 65 |
| 21.1 | 70 |
| 23.8 | 75 |
| 26.6 | 80 |
| 28 | 82 |
| 29.4 | 85 |
| 32.2 | 90 |
| 38.8 | 102 |
| 39.4 | 103 |
| 40.0 | 104 |
| 40.5 | 105 |
| 41.1 | 106 |
| 100 | 212 |

## Conversion chart, kg to lb

| Pig size | Kg | Lb |
|---|---|---|
| Birth | 1.5 – 2.0 | 3.3 – 4.4 |
| Weaning | 3.5 | 7.7 |
| | 5 | 11 |
| | 10 | 22 |
| Nursery | 15 | 33 |
| | 20 | 44 |
| | 25 | 55 |
| | 30 | 66 |
| Grower | 45 | 99 |
| | 50 | 110 |
| | 60 | 132 |
| Finisher | 90 | 198 |
| | 100 | 220 |
| | 105 | 231 |
| | 110 | 242 |
| | 115 | 253 |
| Sow | 135 | 300 |
| | 300 | 661 |
| Boar | 360 | 800 |

1 tonne = 1000 kg

1 ppm = 0.0001% = 1 mg/kg = 1 g/tonne

1 ppm = 1 mg/L