A retrospective analysis of seasonal growth patterns of nursery and finishing pigs in commercial production

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Summary

Objective: Determine seasonal patterns of nursery and finisher growth performance in 3 commercial US production systems located in the midwest.

Materials and methods: Five years of production records, including 5039 nursery and 5354 finisher production batches, were collected from 3 production systems. Explanatory variables include system, site, pig-flow type, feeder type, batch size, week of placement, average days-on-feed, fill length, number of sow farm sources, dietary energy, mortality, and initial body weight. Week of placement served as the unit for seasonal patterns. Nursery and finisher performance (average daily gain [ADG], average daily feed intake [ADFI], and gain to feed ratio [G:F]) were analyzed in separate datasets using multi-level linear mixed models. A guided stepwise selection approach was used to select fixed variables and their interactions. Seasonality curves were generated using rolling averages of least squares means with a 5-week window and 1-week step-size.

Results: For nursery, the seasonality effect was significant ($P < .001$) for ADG, ADFI, but not for G:F. Nursery ADG and ADFI decreased as week of placement progressed from the 1st to 20th week of a year but increased thereafter. All finisher growth responses were affected by week of placement ($P < .001$) but the pattern and magnitude of seasonal variability differed among systems (system × week interactions, $P < .02$).

Implications: Seasonal variability of nursery and finisher performance can be quantified using production records in a multi-level linear mixed model. Seasonality effects on finisher performance were system dependent, while nursery seasonality shared more similarity among investigated systems.

Keywords: swine, seasonality, growth performance, nursery, finisher

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Resumen – Análisis retrospectivo de modelos de crecimiento estacional de cerdos de destete y finalización en producción comercial

Objetivo: Determinar los modelos estacionales en el desempeño del crecimiento en el destete y la finalización en 3 sistemas de producción comercial del medio oeste de los EUA.

Materiales y métodos: Se recolectaron cinco años de registros de producción, incluyendo 5039 grupos de producción de destete y 5354 grupos de producción de finalización, de 3 sistemas de producción. Las variables descriptivas incluyeron el sistema, tipo de flujo de cerdos, tipo de comedero, tamaño del grupo, semana de llegada, promedio de días en alimento, duración de llenado, número de granjas origen, energía dietética, mortalidad, y peso corporal inicial. La semana de colocación sirvió como la unidad para los modelos estacionales. Se analizó el desempeño de destete y finalización (ganancia diaria promedio [ADG por sus siglas en inglés], consumo de alimento diario promedio [ADFI por sus siglas en inglés], y ganancia a alimento [G:F por sus siglas en inglés]) en grupos separados de datos utilizando un modelo multi-nivel lineal mixto. Se utilizó un método de selección paso a paso guiado para seleccionar variables fijas y sus interacciones. Se generaron curvas estacionales utilizando promedios móviles con bloques de cinco 5 semanas y un paso de 1 semana.

Resultados: En destete, el efecto de temporada fue significativo ($P < .001$) para ADG, ADFI pero no para G:F. La ADG y ADFI en destete disminuyó al avanzar la semana de llegada de la 1ra a la 20ava semana del año pero se aumentó a partir de entonces. Todas las respuestas del crecimiento en finalización fueron afectadas por la semana de llegada ($P < .001$) pero el modelo y la magnitud de la variabilidad de temporada difirieron entre los sistemas, (sistema × interacción de la semana, $P < .02$).

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Implicaciones: La variabilidad de estación del desempeño del destete y finalización pueden cuantificarse utilizando registros de producción con un modelo multi-nivel lineal mixto. Los efectos de estación en el desempeño de finalización fueron dependientes del sistema, mientras que los efectos estacionales en destete compartieron una mayor semejanza entre los sistemas investigados.

Résumé – Analyse rétrospective des patrons de croissance saisonnière de porcs en pouponnière et en finition dans une production commerciale

Objectif: Déterminer les patrons saisonniers des performances de croissance de porcs en pouponnière et en finition dans trois systèmes de production commerciale américains situés dans le midwest.

Matériels et méthodes: Les relevés de production d'une période de 5 ans, incluant 5039 et 5354 lots de production de porcs en pouponnière et en finition, respectivement, ont été prises de trois systèmes de production. Les variables descriptives incluaient le système, le site, le type de flux des porcs, le type de mangeoire, la taille du lot, la semaine de placement, la moyenne de jours nourris, le temps de peuplement, le nombre de ferme d'origine des truies, l'énergie alimentaire, le taux de mortalité, et le poids corporel initial. La semaine de placement a servi d'unité pour les patrons saisonniers. Les performances en pouponnière et en finition (gain moyen quotidien [ADG], consommation alimentaire moyenne quotidienne [ADFI], et ratio gain sur nourriture [G:N]) ont été analysées dans bases de données séparées en utilisant des modèles linéaires mixtes à niveaux multiples. Une approche de sélection progressive guidée a été utilisée pour sélectionner les variables fixes et leurs interactions. Les courbes saisonnières ont été générées en utilisant les moyennes de roulement des moyennes des moindres carrés avec une fenêtre de 5 semaines et une progression de 1 semaine.

Résultats: Pour la pouponnière, l'effet saisonnier était significatif ($P < .001$) pour le ADG et la ADFI, mais pas pour le G:N. En pouponnière, le ADG et la ADFI ont diminué à mesure que les semaines de placement progressaient de la semaine 1 à la semaine 20 d'une année mais ont augmenté par la suite. En finition, toutes les réponses de croissance étaient affectées par la semaine de placement ($P < .001$) mais le patron et la magnitude de variation saisonnière différaient parmi les systèmes (système × interactions semaine, $P < .02$).

Implications: La variabilité saisonnière des performances en pouponnière et en croissance peut être quantifié en utilisant les données de production dans un modèle linéaire mixte à niveaux multiples. Les effets saisonniers sur les performances en finition étaient dépendants du système, alors que les effets saisonniers en pouponnière partageaient plus de similarité parmi les systèmes étudiés.

It is widely documented that pig production has seasonal variations.[1-3] Pigs have a limited ability to thermoregulate, thus extreme temperatures result in increased reproductive difficulties, reduced growth performance, and elevated mortality.[1] Seasonal heat stress loss estimates indicate a nearly $300 million annual cost to the US swine industry.[4]

An accurate estimate of seasonal variability in feed consumption and growth rate is essential for commercial producers to estimate feed usage and marketing projections. Coarse estimations of the seasonality curve are sometimes generated based on raw means of weekly production performance. However, the precision of this method may be questioned as it does not account for factors confounded with seasonality. For instance, some nutritional programs feed pigs with increased dietary energy during the summer to counteract the decreased feed intake. Additionally, pigs grow slower and, therefore, producers likely extend their feeding period and change their marketing strategy in the summer compared with other times of the year. These confounding factors along with other production variables, such as different pig flows, feeder types, ventilation designs, and stocking densities, are also known to cause variations in growth and, therefore, need to be accounted for in a seasonality analysis. In a retrospective study conducted in 1995 by Bahnson and Dial,[3] seasonal patterns of finisher average daily gain (ADG) and average daily feed intake (ADFI) in commercial swine production were determined using multiple linear regression models. However, the inference scope of this study is limited to a single production system and such seasonal patterns require validation and an update using current data from modern production systems.

The objective of this study was to develop a systematic modeling approach to estimate the seasonality effects (expressed as the week of placement in a year) on growth performance of nursery and finishing pigs using retrospective commercial production records.

Material and methods

Data collection

Five years of production records from January 2013 to December 2017 were collected from three swine production systems located in the midwestern United States. A total of 5039 nursery and 5354 finisher production batches representing nearly 28 million market pigs were included in the raw dataset. The dataset structure consists of three levels: system, site, and batch. The batch was defined as a cohort of pigs per airspace within a site. In most cases the airspace was defined at the barn level. Some sites consisted of multiple barns, of which production records were reported as separate batches; however, the size of sites (eg, number of barns per site or rooms per batch) was not available for analysis. There were 25, 49, and 126 nursery sites; 513, 142, and 126 finisher sites; and 398, 52, and 130 wean-to-finish sites in systems A, B, and C, respectively. Explanatory variables collected at the site level were types of pig flow and feeder design. Nursery flow types included conventional nursery (nursery), nursery phase of wean-to-finish flow (WF-nursery), and wean-to-finish facilities that only housed nursery flows (converted-nursery). Finisher flow types included conventional finishing (finishing) and finishing phase of wean-to-finish flow (WF-finishing). At the batch level, data collected included starting and ending inventory, start date, close date, average days on feed (DOF), length of fill period, number of sow farm sources (sowfarm), average dietary net energy (NE), mortality, initial body weight (BW), final BW, ADG, ADFI, and gain to feed ratio (G:F). The final BW of WF-nursery batches and the initial BW of WF-finishing batches were determined based on pigs that were loaded onto trucks, weighed, and transferred from the wean-to-finish barn to another finisher; it is assumed that the batch of pigs that stayed in the wean-to-finish barn had similar average BW as those that were transferred out. Start date and close date referred to the first and last day, respectively, that pigs of the batch were in the facility. Average DOF was calculated as the sum of pig days (defined as one live pig being fed for one day) divided by the total number of pigs started. Average dietary NE was calculated based on major ingredient usage per batch and estimated energy density of ingredients.

Data processing

The raw dataset was divided into two subsets for separate analysis of nursery and finisher performance. Because dietary NE data was only available since 2015 in system A, the finisher dataset analysis was limited to 3 years (2015 to 2017) of observations to avoid confounded effects between system and year. However, given that the nutritional programs of the three systems did not alter energy content of nursery diets over seasons, NE was not considered in the nursery models so that the nursery dataset could include 5 years of data and provide an increased number of replications for seasonality analysis.

Initial diagnosis was performed using scatter plots for each explanatory and outcome variable to identify outliers. Screening criteria and the number of observations removed are presented in Table 1. For the nursery dataset, observations with suspected errors in BW estimation (ie, ADG < 0), recorded feed usage (ie, G:F > 1000 g/kg), or date recording (ie, fill length > DOF) as well as inaccurate pig counts (ie, mortality < 0) were removed from the dataset. Additionally, observations were removed if DOF < 21 d or final BW > 50 kg because they did not represent the standard pig flow among the systems. For the finisher dataset, observations with suspected

Table 1: Screening criteria for exclusion of nursery and finisher batches from three swine production systems located in the midwestern United States from January 2013 to December 2017

	Production system		
Item	**A**	**B**	**C**
Nursery dataset			
Production batches in the raw dataset, No.	2632	1125	1282
Observation removal, No.			
Inaccurate pig counts*	1	1	9
Average DOF < 21 d	14	2	0
Final BW > 50 kg	26	0	2
Suspected BW estimation errors (ie, biologically abnormal ADG)	7	2	0
Suspected feed accounting errors (ie, G:F > 1000 g/kg)	11	1	0
Suspected date recording errors (ie, fill length > DOF)	1	2	0
Production batches in the final dataset, No.	2572	1117	1271
Value removal, No.			
Feed delivery recording errors†	45	0	4
Removal rate, %	4.0	0.7	1.2
Finisher dataset			
Production batches in the raw dataset, No.	2862	1076	1416
Observation removal, No.			
Unusual pig flow‡	2	0	1
Initial BW < 10 kg	9	1	1
Initial BW > 70 kg	30	1	0
Final BW < 100 kg	16	6	0
Final BW > 150 kg	1	0	0
Suspected feed accounting errors§	14	1	2
Production batches in the final dataset, No.	2790	1067	1412
Value removal, No.			
Feed delivery recording errors†	2	1	0
Suspected dietary energy recording errors¶	23	0	0
Removal rate, %	3.4	0.9	0.3

* Including batches with abnormal inventory and mortality < 0.
† Feed allocation was inaccurately recorded between consecutive batches resulting in abnormal variability in G:F. Only ADFI and G:F values were removed.
‡ Half of the total inventory was filled 90 days after filling of the first half.
§ Including batches with ADFI > 4 kg, ADFI < 1.5 kg, or G:F > 1000 g/kg.
¶ Only net energy values were removed.
DOF = days on feed; BW = body weight; ADG = average daily gain; G:F = gain to feed ratio; ADFI = average daily feed intake.

errors in recorded feed usage (ie, ADFI > 4 kg, ADFI < 1.5 kg, or G:F > 1000 g/kg) were removed. Finisher observations with initial BW < 10 kg or > 70 kg, or final BW < 100 kg or > 150 kg, were considered non-normal production flows and were removed from the dataset. Feed delivery recording errors were identified when feed allocation was inaccurately recorded between consecutive batches resulting in abnormal G:F variability (eg, G:F < 300 g/kg in a batch and G:F > 1000 g/kg in the subsequent batch due to carry over or misallocation of feed among batches or when there was an extreme high and extreme low value among batches within a site). The ADFI and G:F values of these observations were deleted, but ADG values were unchanged.

For each observation, week of placement (week; calendar year beginning January 1) was designated according to the start date and served as the unit for seasonality effect. Pig inventory counts were categorized to form batch size classes to avoid multicollinearity with fill length because batches with greater inventory often required a longer fill period. Sizes of nursery batches include < 3000, 3000 to 6000, and > 6000, and sizes of finisher batches include < 1500, 1500 to 3500, and > 3500. These inventory categories were selected to represent common commercial facility capacities. However, information regarding space allowance, stocking density, or pen or barn dimension was not available from every production system for analysis. In addition, feeder designs were categorized into 3 types: dry, tube, and wet-dry. Facilities equipped with mixed feeder types were assigned a missing value due to the limited number of observations (n = 137) with mixed types of feeders.

Statistical analysis

Nursery and finisher datasets were analyzed separately. Average daily gain, ADFI, and G:F were evaluated as response variables. System, flow, size, year, feeder type, and week were treated as categorical variables, while fill length, DOF, mortality, sowfarm, and dietary NE were treated as continuous variables. Quadratic terms of DOF and mortality were evaluated for potential non-linear effects on pig growth responses. Dietary NE was only available for finisher models. In the nursery dataset, converted-nursery was exclusive to system A, resulting in confounded effects between system and flow. Thus, the system and flow variables were merged in the nursery dataset to form a 7-category variable termed system-flow.

For each response variable, first-order ordinary least squares regression models, involving predictor variables of system (or system-flow in the nursery dataset), year, week, size, fill length, DOF, initial BW, mortality, NE (only for finisher dataset), and feeder type, were constructed for regression diagnostics following procedures described by Chen et al.[5] Observation leverage was estimated and evaluated in a leverage versus residual squared plot to identify influential observations. Suspected observations were assessed for biological accuracy and recorded in the screening list if removed from the dataset (Table 1). Multicollinearity among predictor variables was tested using variance inflation factor (VIF); variables with VIF values greater than 6 were further diagnosed using two-way scatter plots. There was evidence showing multicollinearity between finisher initial BW and DOF due to a strong, negative linear correlation (r = -0.83). Because the alteration of DOF was often considered a part of the seasonality change in finishing pig production (eg, pigs raised during the summer had a longer feeding period than in the winter), initial BW was included in the finisher models instead. However, DOF of nursery batches did not vary significantly over seasons and thus was used in the nursery models. Studentized residuals versus fitted values and studentized residuals versus each categorical descriptive variable plot were examined for heteroscedasticity. Heteroscedasticity was found among systems as observations from system A had consistently greater residual variance compared with systems B and C across all response variables; therefore, a dummy variable ("variance group"; variance group = 1 if system = A, variance group = 0 if system = B or C) was created and accounted for in the analysis.

Multi-level linear mixed models for each response variable were constructed with batch serving as the observational unit, site as a random effect, and system (system-flow in nursery dataset) as a fixed effect. A random residual term of batch within variance group was included in all models to account for heterogeneous variance among systems. A guided stepwise selection approach was employed to select variables and their interaction terms. Specifically, a saturated first-order model was first fit involving all candidate fixed variables. This model was then reduced in a stepwise manner based on variable significance level (P > .10) and improvement in Bayesian information criterion (BIC). Possible two-way interactions among remaining fixed variables were introduced to form a saturated two-way model. The final model was achieved by stepwise removal of interaction terms based on their significance level (P > .10) and improvement in model BIC. Bayesian information criterion was used as an indicator of model suitability.[6] Restricted maximum likelihood method was used in the model selection to evaluate the significance of fixed effect terms. The Kenward-Roger's procedure was used to estimate degrees of freedom and adjust estimated SE for bias correction. Also, at each model selection step, studentized residuals were evaluated. All analyses were performed using Stata Statistical Software (Release 15; StataCorp LLC, College Station, Texas).

Least squares means for week of placement were generated using the margins command with "asbalanced" and "emptycells(reweight)" options.[7] To generate a smooth seasonality curve for each growth response, rolling averages of the least squares means were calculated using a centered 5-week window with step-size of 1 week. Rolling averages for weeks 1, 2, 51, and 52 were generated by recursive extension of the week series (eg, rolling average of week 1 represents the mean of weeks 51, 52, 1, 2, and 3). Finally, seasonal patterns were standardized using growth responses in week 1 as a benchmark and that of other weeks were expressed as changes in response relative to week 1.

Results

Descriptive statistics

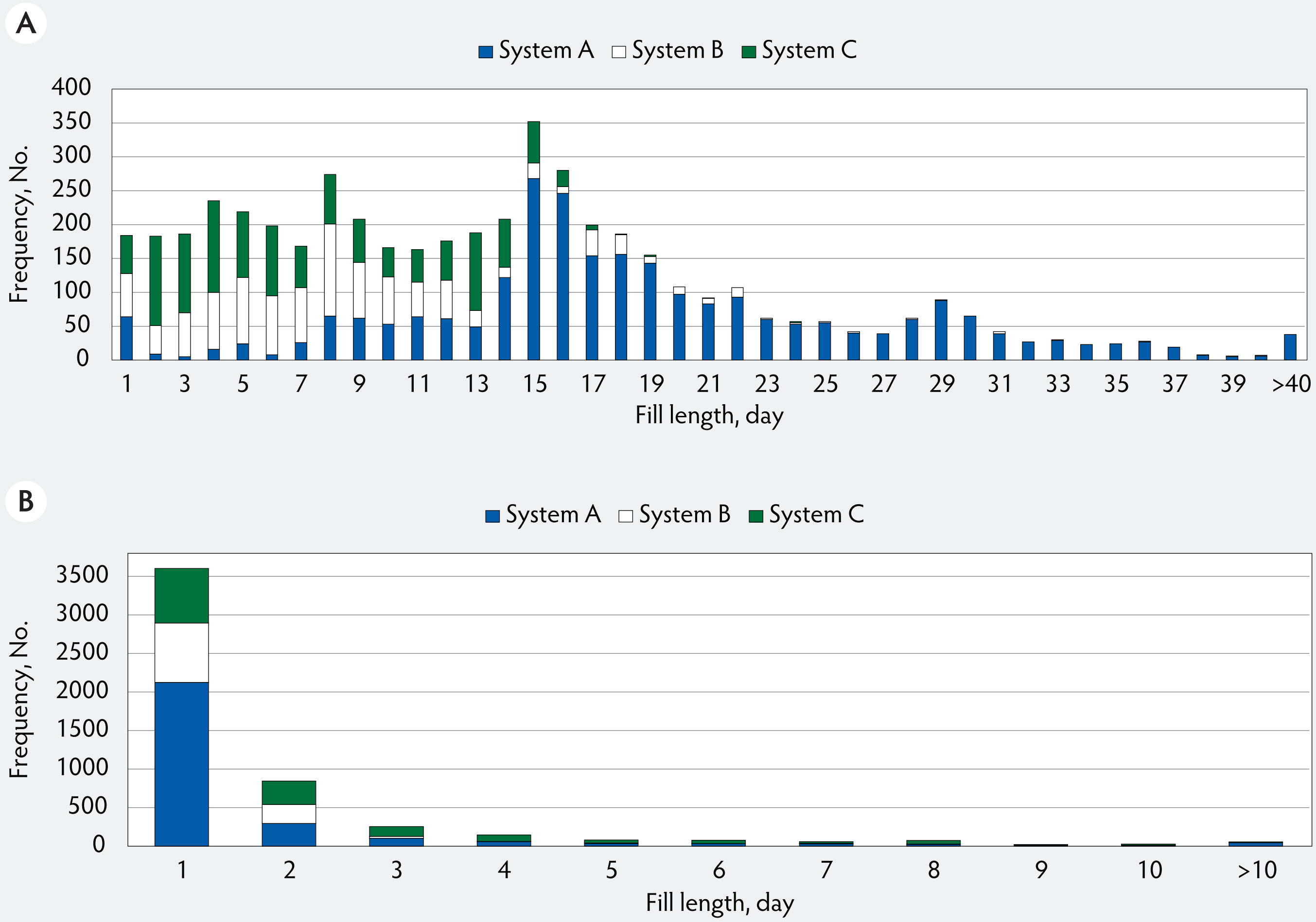
Explanatory variable frequencies and histograms are presented in Table 2 and Figures 1, 2, and 3. The majority (> 80%) of the nursery batches were filled within 20 days with system A having a longer average fill length than systems B and C. In contrast, the majority of finisher batches were filled within two days. In both nursery and finisher datasets, more than 65% of the production batches sourced pigs from a single sow farm, while about 30% of the batches obtained pigs from 2 to 6 sow farm sources. The number of observations per week of placement varied throughout the year and averaged 95 and 101 batches per week in nursery and finisher datasets, respectively. Descriptive statistics for initial and final BW, DOF, mortality, and growth responses along with US industry benchmarks[8] are shown in Table 3. The mean values of initial BW were 5.5 and 27.0 kg, final BW were 26.6 and 125.3 kg, DOF were 55.3 and 112.4 days, and mortalities were 4.1% and 4.0% in nursery and finisher datasets, respectively. The mean values of ADG were 370 and 871 g, ADFI

Table 2: Frequency of nursery and finisher batches from three swine production systems located in the midwestern United States from January 2013 to December 2017 for each explanatory variable

Item	Production system A	Production system B	Production system C
Nursery dataset			
Year			
2013	574	212	201
2014	401	211	235
2015	552	226	246
2016	562	222	279
2017	483	246	310
Type of pig flow			
Converted-nursery*	601	0	0
Nursery	816	802	619
WF-nursery†	1155	315	652
Batch size			
< 3000 pigs	1198	583	436
3000 to 6000 pigs	396	237	288
> 6000 pigs	978	297	547
Feeder type			
Dry	543	981	786
Tube	718	12	81
Wet-dry	965	27	295
Missing‡	346	97	109
Finisher dataset			
Year			
2015	908	343	442
2016	986	345	463
2017	896	379	507
Type of pig flow			
Finishing	2084	877	955
WF-finishing§	706	190	457
Batch size			
< 1500 pigs	45	115	143
1500 to 3500 pigs	1231	540	959
> 3500 pigs	1514	412	310
Feeder type			
Dry	95	598	664
Tube	634	289	283
Wet-dry	1787	85	378
Missing‡	274	95	87

* Wean-to-finish facilities that were used for traditional nursery pig flow.
† Nursery phase of wean-to-finish flow.
‡ Including missing information and facilities with mixed feeder types.
§ Finishing phase of wean-to-finish flow.
WF = wean-to-finish.

Figure 1: Frequency distribution of fill length for (A) nursery and (B) finisher batches from three swine production systems located in the midwestern United States from January 2013 to December 2017.



were 630 and 2436 g, and G:F were 602 and 358 g/kg in nursery and finisher, respectively. These growth responses were reasonably in line with average industry levels for the same time period.

Nursery seasonality

A total of 4960 nursery observations were used in the final model for ADG and 4365 observations were used in the ADFI and G:F models (observations with descriptive variables coded as missing values were unavailable for analysis if the descriptive variables were included in the model; Table 4). Effects of system-flow, size, year, week, fill length, DOF, mortality, sowfarm, and feeder type as well as some of their interactions significantly ($P < .10$) contributed to the variability in growth responses among observations. Parameter coefficients and statistics for each model are provided in the supplementary material. Because there was no evidence of system-flow × week or size × week interactions for ADG and ADFI ($P > .10$), only main effects of week ($P < .001$) were reported. Plots of week of placement least squares means for ADG (Figure 4A) and ADFI (Figure 5A) indicated considerable variation among contiguous weeks. Thus, a rolling average was adopted to describe the seasonal patterns (Figures 4B and 5B), similar to the approach of Bahnson and Dial.[3]

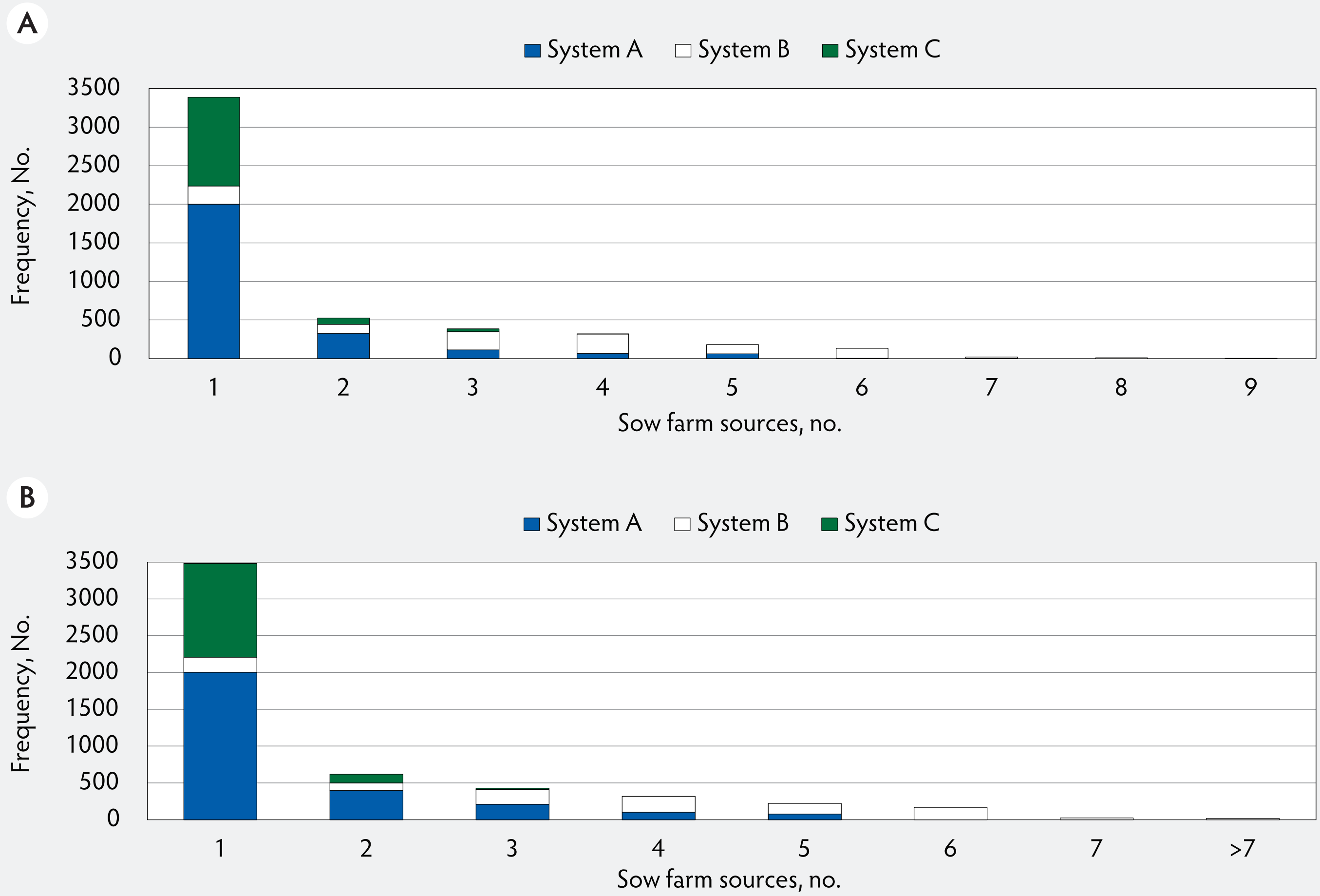
Nursery ADG and ADFI progressively decreased as the time of placement transitioned from the 1^{st} to 15^{th} week of the year. Both ADG and ADFI remained low during week 15 to 22 but increased thereafter and became equal to week 1 values by the 43^{rd} and 33^{rd} week of the year, respectively. Interestingly, a second but short period of decrease and recovery in both ADG and ADFI was observed during week 35 to 40 with a diminished magnitude. For G:F, there was no evidence of a week effect in nursery growth performance.

Finisher seasonality

A total of 4747 finisher observations were used in the final model for ADG and 4743 observations were used in the ADFI and G:F models (Table 5). Effects of system, flow, size, year, week, fill length, initial BW, mortality, sowfarm, feeder, and NE as well as some of their interactions significantly ($P < .10$) contributed to the finisher models. System × week interactions ($P < .001$) were observed for ADG, ADFI, and G:F (Figures 6, 7, and 8, respectively).

In system A, ADG decreased as the time of placement transitioned from week 1 to 15, remained low from week 15 to 20, and increased thereafter; shortly after a plateau around week 33, a second period of decrease and recovery in ADG was observed during week 33 to 45 with diminished magnitude. In systems B and C, ADG decreased during the first 10 weeks of the year, followed by a period of low ADG from week 10 to 20; thereafter, ADG increased, reached a plateau around week 30, and then decreased to the performance level observed in week 1.

Figure 2: Frequency distribution of number of sow farm sources for (A) nursery and (B) finisher batches from three swine production systems located in the midwestern United States from January 2013 to December 2017.



For ADFI, seasonal patterns were generally similar among systems. Average daily feed intake decreased as the time of placement transitioned during the first 15 weeks of a year, increased for pigs placed from week 20 to 35, reached a plateau, and then decreased to week 1 level. However, the magnitude of the first period of decrease was greater in system B compared with systems A and C (200, 140, and 120 g, respectively). Moreover, the plateau of the ADFI curve remained longer in system C (approximately 15 weeks from week 35 to 50) compared with systems A and B (approximately 7 weeks occurring primarily around weeks 35 to 40).

Distinct seasonal patterns for G:F were observed among systems. In system A, two short periods of G:F decrease and recovery was observed from week 10 to 25 and from week 30 to 50, with the magnitude of decrease smaller during the first than the second period. In systems B and C, G:F increased during the first 20 to 25 weeks of the year and then decreased to the week 1 level by week 35.

Discussion

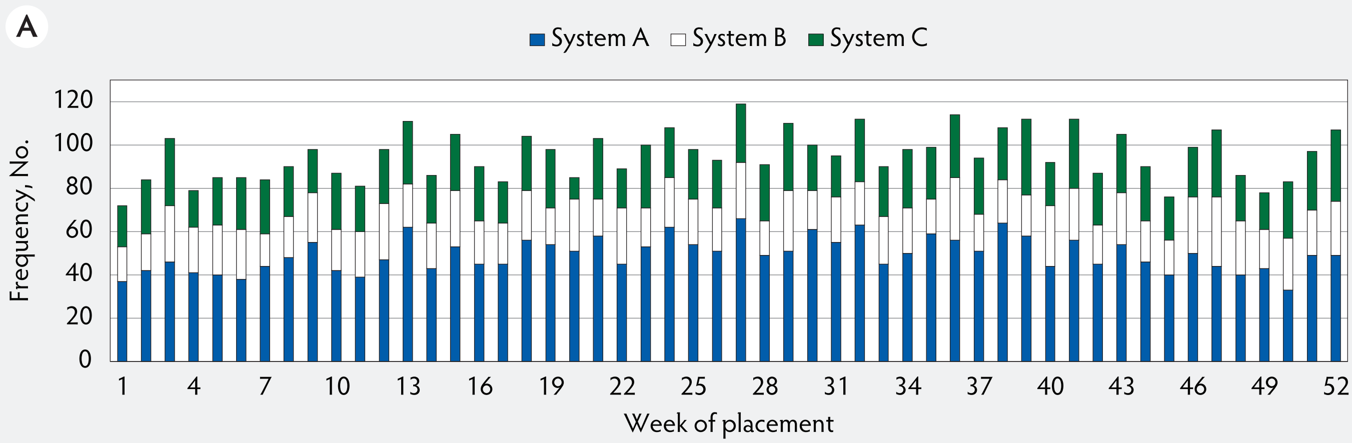
Seasonal variations have been widely observed in swine production, primarily due to the seasonal changes in environmental temperature.[1-3] In this study, we constructed a multilevel linear mixed model that determined the seasonal patterns of ADG, ADFI, and G:F in three US production systems while controlling for variability in growth performance resulting from differences in system, type of pig flow, batch size, year, strategy of barn filling, feeder type, and dietary NE. Because the three systems were generally located nearby and within the midwestern United States, geographic factors were not considered in the model due to data availability and similar seasonal patterns among systems were initially hypothesized. In addition, because genetic information was not available at the batch level for analysis, it was assumed that genetic lines and rate of improvement were consistent within system and the genetic variability could be controlled by the fixed effects of system and year. It is also worth noting that even though our datasets provided a large number of observations per week (average 95 and 101 batches per week in nursery and finisher datasets, respectively), within-site replication per week was limited because relatively few sites are filled during the same week in multiple years. Therefore, site and week of placement were confounded, which might have contributed to the variability in least squares means among contiguous weeks (Figures 4A, 5A, 6A, 7A, and 8A). However, such differences among week of placement means were not always biologically significant from a production perspective.[2]

To evaluate the impact of increasing replications over year on the finisher seasonality models, a separate analysis was conducted using five years (2013 to 2017) of finisher data from systems B and C (system A was excluded because of lacking NE data from 2013 to 2014). Seasonality curves generated from the 5-year dataset (data not shown) followed similar patterns as those generated from the 3-year dataset. Moreover, ventilation design (tunnel versus curtain) was included in the 5-year (systems B and C only) models; there was no evidence that seasonal patterns for finisher growth performance were dependent on ventilation type (data not shown).

In this analysis, there were seasonal patterns in ADG and ADFI for both nursery and finisher datasets. In general, ADG decreased as the time of placement progressed during the first 15 weeks of the year and remained at that level for another 5 to 10 weeks, which was driven by a similar decrease in ADFI. In another retrospective study conducted in 1995, Bahnson and Dial[3] determined the seasonal growth patterns in a commercial swine production system located in the midwestern United States; interestingly, the seasonal changes in finisher ADG and ADFI reported by these authors shared a nearly identical pattern and magnitude as that in system A and was generally in agreement with the other two systems from the present study. It was not surprising that ADG and ADFI decreased as the time of placement transitioned from winter to spring, because the average ambient temperature likely increased during the corresponding feeding periods. For instance, pigs that were placed in the barn around week 10 to 20 would have experienced the summer weather during June, July, and August, corresponding to the hottest season of a year in that region. It has been well demonstrated that pigs reduce voluntary feed intake in response to high ambient temperature.[9-11] As expected, the seasonal ADG and ADFI curves reached the minimum approximately 5 weeks later in nursery than in finisher due to a shorter feeding length and delayed time of entry during the summer weather. However, finisher growth performance recovered faster than nursery and further increased beyond the week 1 level as the week of placement transitioned into fall (after week 25). Interestingly, a second period of decrease in nursery ADG and ADFI was observed from week 35 to 40; even though the magnitude of this decrease was marginal, it was consistently observed across systems. A similar pattern was also observed in finishing pigs from system A. Assuming a lactation period of 21 days, nursery pigs that were placed around week 35 to 40 would have been born and nursed during August and might have also experienced in-utero heat stress during June and July. It is possible that extreme temperatures during the summer may have negatively affected late-gestation and lactating sow performance and subsequently decreased growth performance of piglets. Heat stress during late gestation has been demonstrated to decrease the number of piglets born alive and piglet birth weight,[12] and many studies have reported decreased lactating sow feed intake and piglet weaning weight during lactation under heat stress.[13-15]

The magnitude of seasonal variability (difference between the highest and lowest performance of the year) represented approximately 5% of the mean ADG or ADFI in nursery pigs, in contrast to approximately 9% in finisher growth performance. A greater seasonality impact on finisher performance is

Figure 3: Frequency distribution of week of placement for (A) nursery and (B) finisher batches from three swine production systems located in the midwestern United States from January 2013 to December 2017.



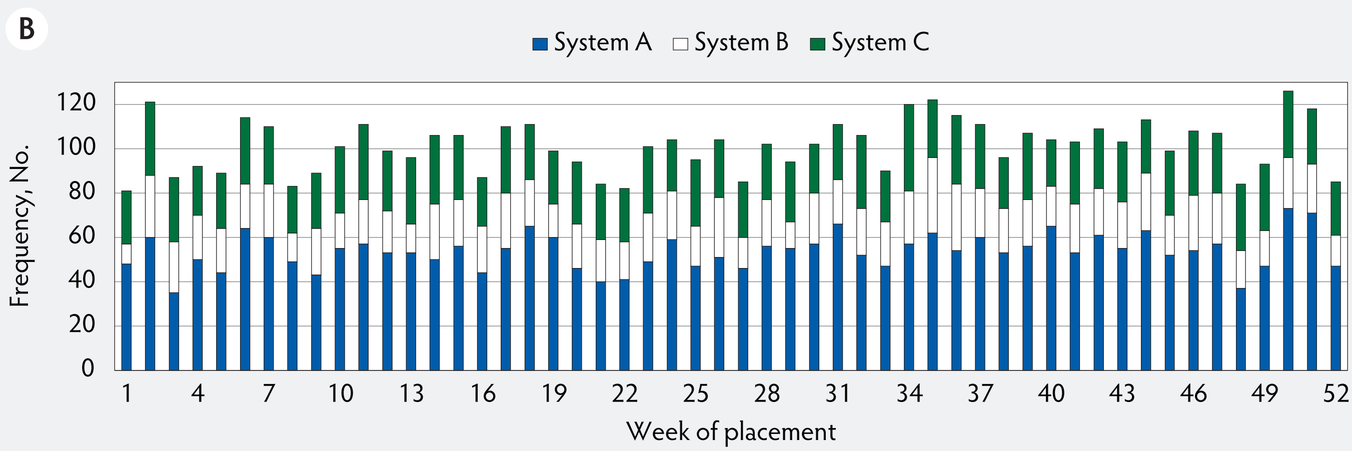


Table 3: Descriptive analysis of explanatory and outcome variables for nursery and finisher batches from three swine production systems located in the midwestern United States from January 2013 to December 2017

Item	N	Mean (SD)	Minimum	Median	Maximum	Industry average*
Nursery dataset						
Initial BW, kg	4960	5.5 (0.49)	2.8	5.4	9.1	NA
Final BW, kg	4960	26.6 (6.71)	8.0	26.2	49.6	23.6
Average DOF, No.	4960	55.3 (12.06)	22.8	53.4	115.2	46.3
Mortality, %	4960	4.1 (4.84)	0.0	2.6	53.4	4.8
ADG, g	4960	370 (67.5)	86	376	603	376
ADFI, g	4846	630 (140.8)	186	617	1270	570
G:F, g/kg	4846	602 (90.4)	185	617	974	660
Finisher dataset						
Initial BW, kg	5269	27.0 (8.1)	10.1	25.9	68.6	NA
Final BW, kg	5269	125.3 (3.87)	101.6	125.3	138.4	128.0
Average DOF, No.	5269	112.4 (14.8)	57.2	114.3	162.2	111.2
Mortality, %	5269	4.0 (2.57)	0.0	3.4	26.3	4.6
Dietary NE, kcal/kg	5191	2626 (144.8)	2423	2577	2949	NA
ADG, g	5269	871 (75.4)	594	862	1347	926
ADFI, g	5264	2436 (229.2)	1769	2413	3683	2386
G:F, g/kg	5264	358 (20.6)	255	359	471	388

* Average of US swine industry productivity from 2013 to 2016.[8]
BW = body weight; NA = not available; DOF = days on feed; ADG = average daily gain; ADFI = average daily feed intake; G:F = gain to feed ratio; NE = net energy.

expected because heavier pigs are more sensitive to high ambient temperature and express greater reduction in appetite and growth during the summer compared with nursery pigs.[1,9] Nevertheless, seasonality effects on G:F were observed in finisher but not in nursery pigs. In systems B and C, G:F increased in finishing pigs fed during the summer. This observation is consistent with findings of another retrospective study using data from nearly 60,000 commercial gilts over 2.5 years, where greater G:F was observed in pigs raised during the summer than winter (357 vs 312 g/kg, respectively).[2] Improved G:F during the summer may be attributed to the decreased voluntary feed intake and the potential for pigs to utilize less feed for fat deposition (thermal insulation) and maintenance of body temperature.[10] However, it merits further investigation on the reason why system A expressed less seasonal change in G:F compared with systems B and C.

Our models suggest that seasonal patterns for nursery responses were similar among systems and different pig-flow types, while finisher performance patterns were system dependent (system × week interaction). In nurseries, tight regulation of barn temperature and a relatively consistent diet regimen over time might have resulted in systems sharing similar seasonal patterns. In contrast, for finishers, different systems responded to seasonal change by employing different feeding strategies; for example, a considerable portion of pigs from systems A and C received summer diets with increased dietary NE, while system B did not change dietary NE over season. However, including dietary NE in the finisher models did not fully explain the differences in seasonal patterns among systems. Other factors that might have led to this interaction include management practice, marketing strategy, and other nutritional interventions (eg, addition of ractopamine). Moreover, it is possible that assumptions about the effects of genetic differences and geographical locations are negligible among systems may have been violated and partly contributed to the system × week interaction.

In commercial swine production, application of seasonality curves for growth performance include, but are not limited to, feed usage estimation and marketing projection. Users can predict ADFI of a production batch at the time of placement based on observed ADFI of pigs from a benchmark week along with the standardized differences among weeks presented as the rolling average curve. Total feed usage of a batch of pigs can be estimated by multiplying the predicted ADFI by pig inventory. Likewise, pig ADG can be estimated at the time of placement and thus the length of feeding period and marketing date can be determined by dividing the difference between targeted market weight and initial BW by the estimated ADG. For more precise estimation of growth responses, users need to adjust for other descriptive factors, eg, pig flow, dietary NE, feeder type, and pig initial BW, using the coefficients presented in the supplementary material.

In addition, caution is needed when applying a uniform seasonality curve to various finisher production systems because seasonal growth patterns of finishing pigs appear to be system dependent (system × week interaction). Systems that share little similarity (eg, geographic location) with the systems studied herein can generate their seasonal growth patterns using the methodology described in this study along with the code for the statistical analysis provided in the supplementary material.

Table 4: Multi-level linear mixed model components for nursery ADG, ADFI, and G:F in three swine production systems located in the midwestern United States from January 2013 to December 2017

	P value*		
Source of variation	**ADG (n = 4960)**	**ADFI (n = 4365)**	**G:F (n = 4365)**
System-flow†	< .001	< .001	< .001
Batch size	< .001	< .001	NS
Year	< .001	< .001	< .001
Week of placement (week)	< .001	< .001	NS
Length of fill period (fill)	.24	.017	NS
Average DOF	< .001	< .001	< .001
Mortality	< .001	< .001	< .001
Number of sow farm sources (sowfarm)	< .001	< .001	NS
Feeder type	NS	< .001	< .001
System-flow × size	NS	< .001	NS
System-flow × year	< .001	< .001	< .001
System-flow × fill	< .001	< .002	NS
System-flow × DOF	< .001	< .001	< .001
System-flow × mortality	< .001	< .001	< .001
Size × year	.004	NS	NS
Size × fill	NS	.02	NS
Size × sowfarm	< .001	< .001	NS

* Multi-level linear mixed models for nursery dataset; model components were selected using a guided stepwise selection method with $P < .10$ considered statistically significant.

† The system and flow variables were merged in the nursery dataset to form a 7-category variable termed system-flow: system A-converted_nursery, system A-nursery, system A-WF_nursery, system B-nursery, system B-WF_nursery, system C-nursery, and system C-WF_nursery.

ADF = average daily gain; ADFI = average daily feed intake; G:F = gain to feed ratio; NS = not selected by the model; DOF = days on feed; WF = wean-to-finish.

In summary, this retrospective analysis depicts the seasonal patterns of nursery and finisher growth performance in three commercial swine production systems located in the midwestern United States. Nursery ADG and ADFI expressed prominent seasonal variations and were similar among systems, whereas nursery G:F was not affected by season. Finisher ADG, ADFI, and G:F varied over seasons but the magnitudes and patterns of change were system dependent. This study also presents concepts underlying the implementation of a multi-level linear mixed model of production records to analyze seasonality and potentially other decision factors in commercial systems.

Implications

- Seasonal variabilities in pig growth performance were observed in both commercial nurseries and finishers and can be quantified using a modeling approach based on production records.
- Seasonal patterns for nursery growth performance were similar among investigated systems, while seasonality effects on finisher performance was system dependent.

Acknowledgements

Appreciation is expressed to Genus PIC for their support in data collection. Special appreciation is also expressed to Dr Leilei Shen for her support and expertise in statistical analysis.

Conflict of interest

None reported.

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Figure 4: Effect of week of placement on nursery ADG in three swine production systems located in the midwestern United States from January 2013 to December 2017. Values are presented as (A) least squares means with 95% confidence interval and (B) rolling average (window = 5, step size = 1) for changes in ADG relative to week 1. ADG = Average daily gain.

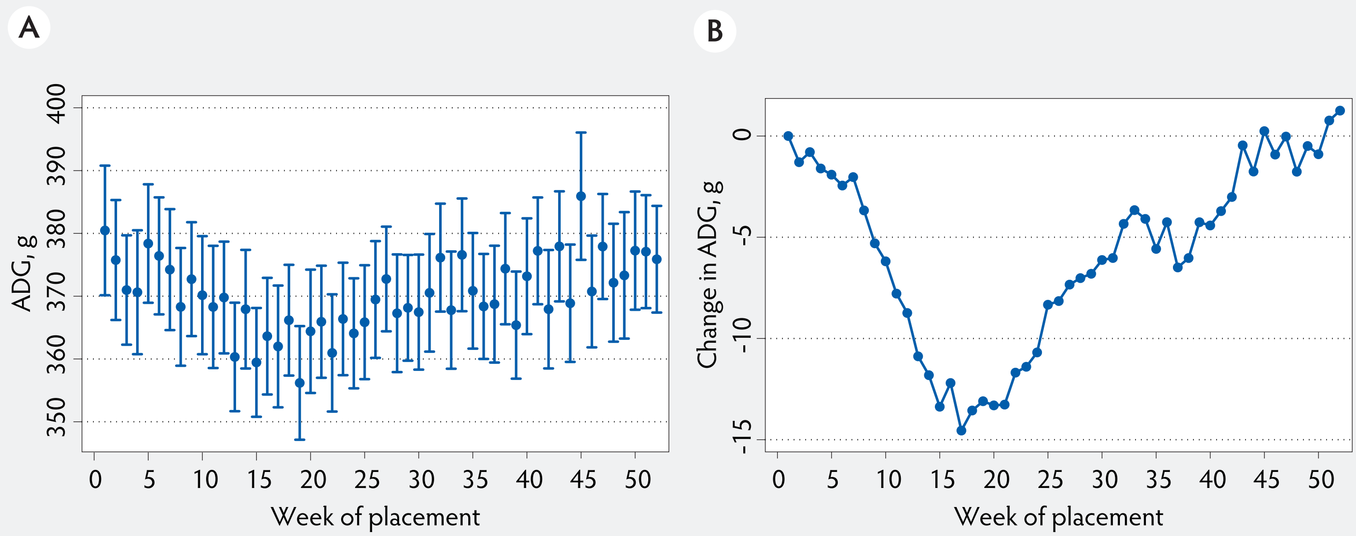
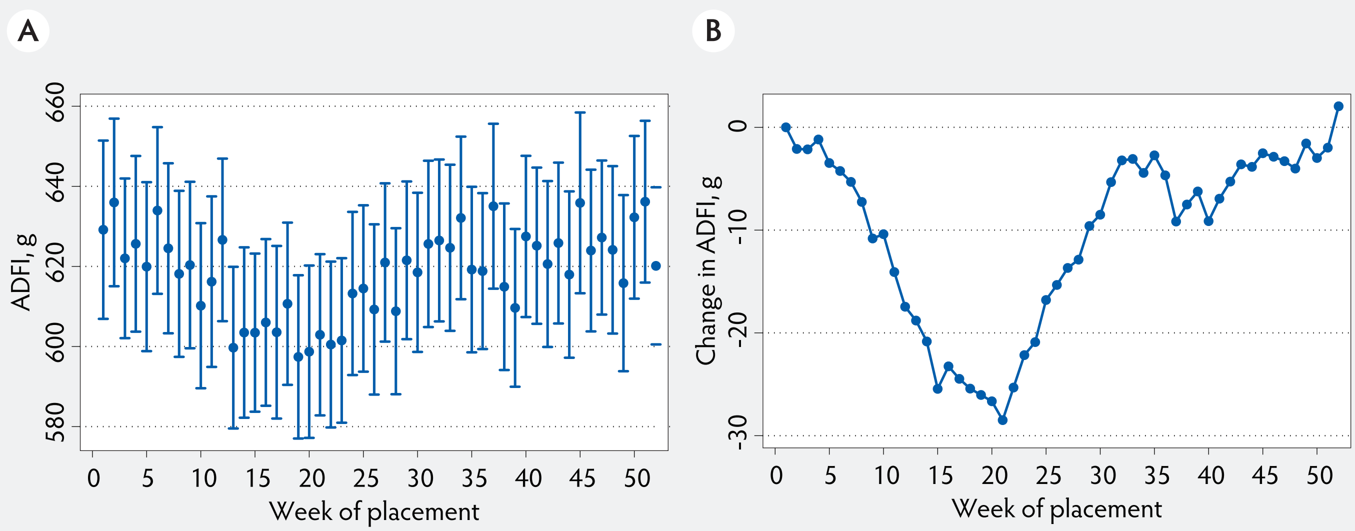


Figure 5: Effect of week of placement on nursery ADFI in three swine production systems located in the midwestern United States from January 2013 to December 2017. Values are presented as (A) least squares means with 95% confidence interval and (B) rolling average (window = 5, step size = 1) for changes in ADFI relative to week 1. ADFI = average daily feed intake.



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*Non-refereed references.

Table 5: Multi-level linear mixed model components for finisher ADG, ADFI, and G:F in three swine production systems located in the midwestern United States from January 2015 to December 2017

	P value*		
Source of variation	**ADG (n = 4747)**	**ADFI (n = 4743)**	**G:F (n = 4743)**
System	< .001	< .001	< .001
Flow	.002	.003	< .001
Batch size	.02	.018	.04
Year	< .001	.04	< .001
Week of placement (week)	< .001	< .001	< .001
Length of fill period (fill)	NS	.24	.99
Initial BW	< .001	< .001	< .001
Mortality	< .001	< .001	< .001
Number of sow farm sources (sowfarm)	.68	.11	< .001
Dietary NE	< .001	< .001	< .001
Feeder type	< .001	< .001	NS
System × flow	< .001	< .001	< .001
System × size	< .001	.018	< .001
System × year	.004	< .001	< .001
System × week	< .001	< .001	< .001
System × fill	NS	.095	< .001
System × initial BW	< .001	< .001	< .001
System × mortality	.01	NS	< .001
System × sowfarm	< .001	< .001	NS
System × NE	NS	< .001	< .001
System × feeder	.002	.004	NS
Flow × size	NS	NS	< .001
Flow × year	< .001	< .001	NS
Flow × fill	NS	< .001	NS
Flow × initial BW	.04	NS	NS
Flow × mortality	< .001	< .001	NS
Flow × sowfarm	NS	< .001	< .001
Flow × NE	.015	.002	NS
Size × fill	NS	.01	NS
Size × initial BW	NS	NS	NS
Size × mortality	NS	NS	.09
Size × sowfarm	.007	.006	.006
Size × feeder	NS	< .001	NS

* Multi-level linear mixed models for the finisher dataset; model components were selected using a guided stepwise selection method with $P < .10$ considered statistically significant.

ADG = average daily gain; ADFI = average daily feed intake; G:F = gain to feed ratio; NS = not selected by the model; BW = body weight; NE = net energy.

Figure 6: Effect of week of placement on finisher ADG in three swine production systems located in the midwestern United States from January 2015 to December 2017. Values are presented as (A) least squares means with 95% confidence interval and (B) rolling average (window = 5, step size = 1) for changes in ADG relative to week 1. ADG = average daily gain.

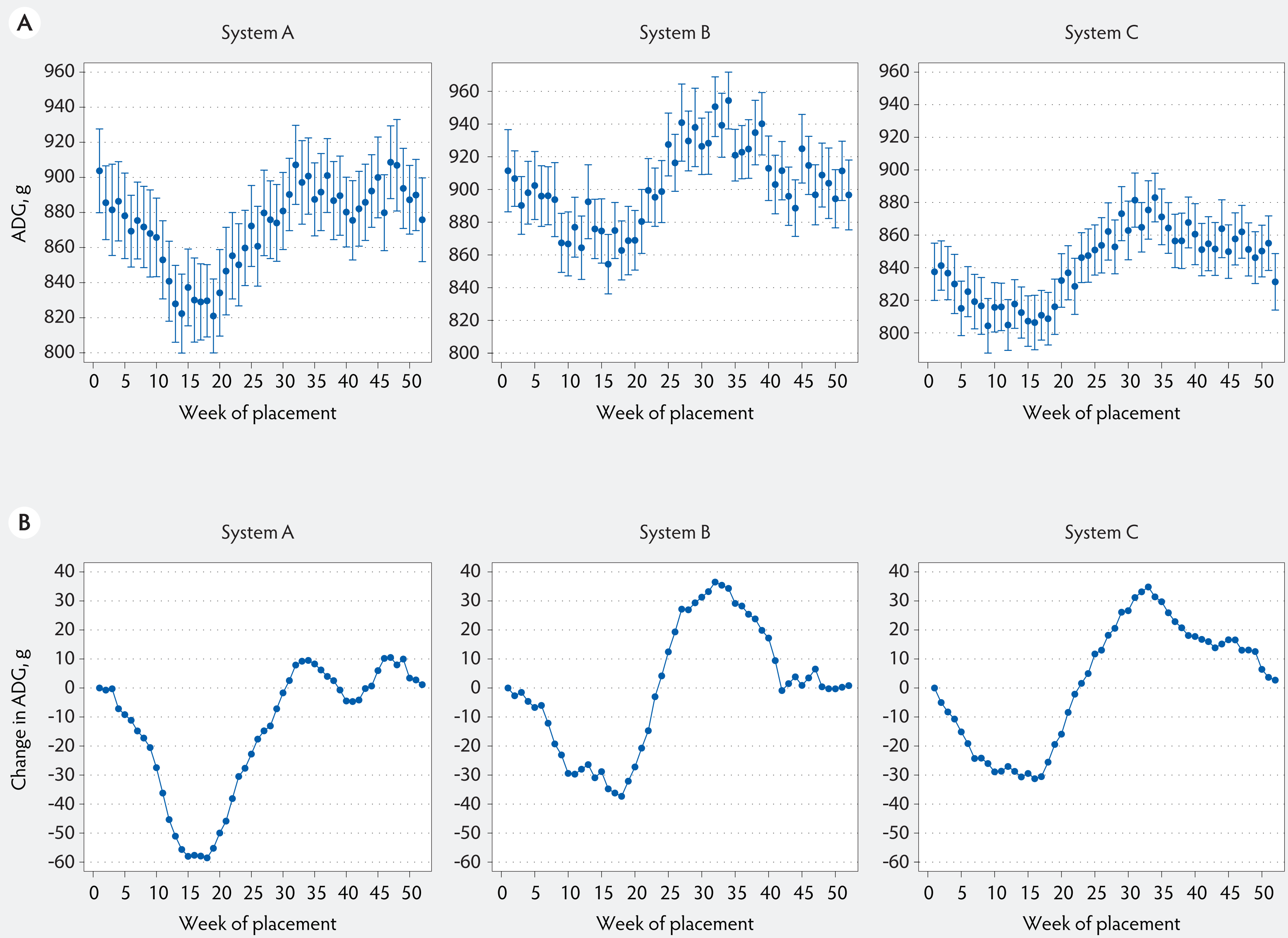


Figure 7: Effect of week of placement on finisher ADFI in three swine production systems located in the midwestern United States from January 2015 to December 2017. Values are presented as (A) least squares means with 95% confidence interval and (B) rolling average (window = 5, step size = 1) for changes in ADFI relative to week 1. ADFI = average daily feed intake.

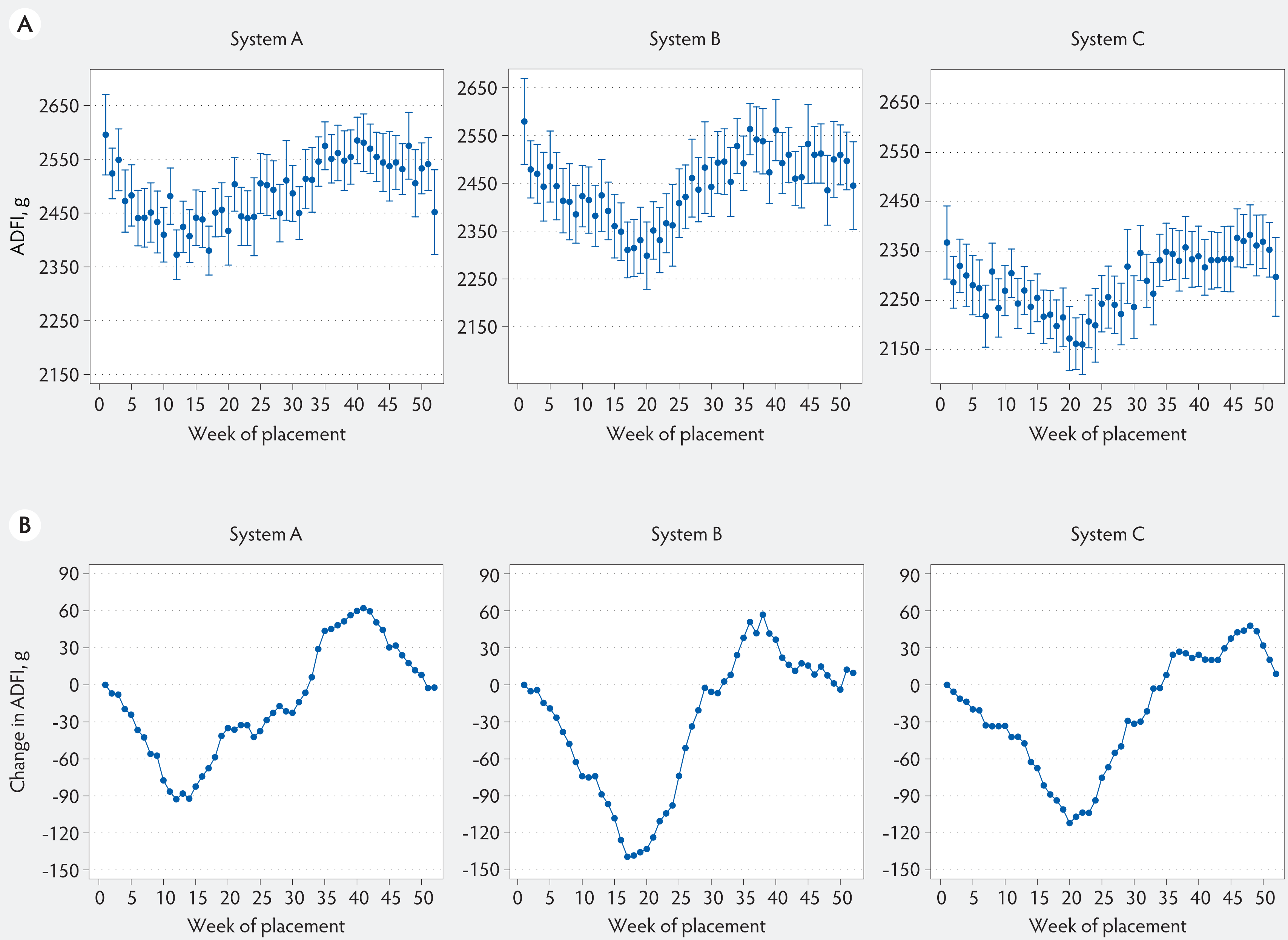
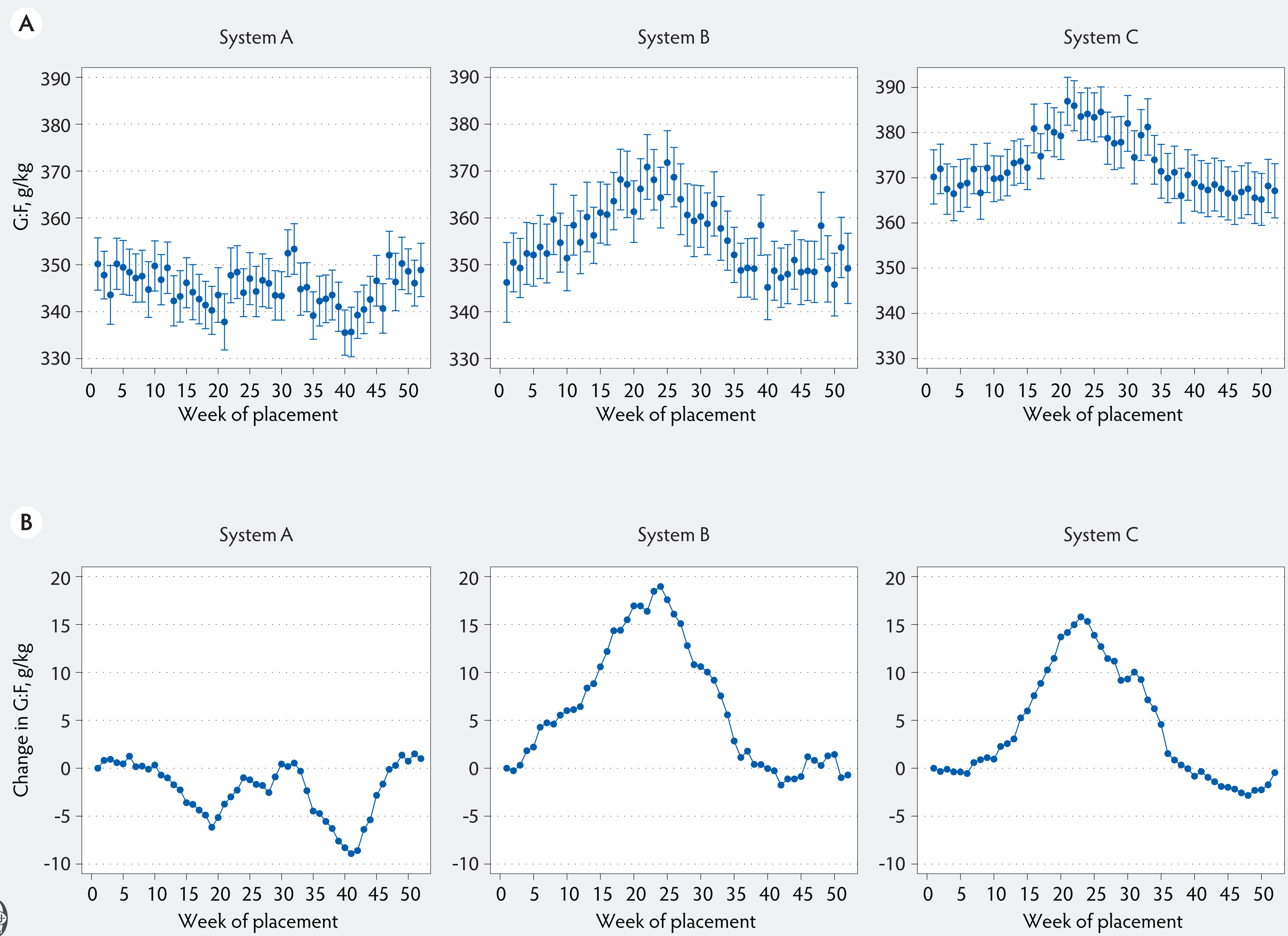


Figure 8: Effect of week of placement on finisher G:F in three swine production systems located in the midwestern United States from January 2015 to December 2017. Values are presented as (A) least squares means with 95% confidence interval and (B) rolling average (window = 5, step size = 1) for changes in G:F relative to week 1. G:F = gain to feed ratio.



Supplementary material

A retrospective analysis of seasonal growth patterns of nursery and finishing pigs in commercial production

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Code for statistical analysis

Nursery ADG

```
mixed adg fill avg_dof mortality sowfarm
i.sysflow i.size i.year i.startwk ///

i.sysflow#c.fill i.sysflow#c.avg_dof
i.sysflow#c.mortality i.sysflow#i.year ///

i.size#c.sowfarm i.size#i.year ///

|| site: || closeout: vargrp, nocons base reml
dfmethod(kroger)

estat ic
```

Nursery ADFI

```
mixed adfi fill avg_dof mortality sowfarm
i.sysflow i.size i.feeder i.year i.startwk
///

i.sysflow#c.fill i.sysflow#c.avg_dof
i.sysflow#c.mortality i.sysflow#i.size
i.sysflow#i.year ///

i.size#c.fill i.size#c.sowfarm ///

|| site: || closeout: vargrp, nocons base reml
dfmethod(kroger)

estat ic
```

Nursery G:F

```
mixed gf avg_dof mortality i.sysflow i.feeder
i.year ///

i.sysflow#c.avg_dof i.sysflow#c.mortality
i.sysflow#i.year ///

|| site: || closeout: vargrp, nocons base reml
dfmethod(kroger)

estat ic
```

Finisher ADG

```
mixed adg startwt mortality sowfarm NE
i.system i.flow i.size i.feeder i.year i.startwk
///

i.system#c.startwt i.system#c.mortality
        i.system#c.sowfarm i.system#i.flow
        i.system#i.size i.system#i.feeder
        i.system#i.year i.system#i.startwk
        ///

i.flow#c.startwt i.flow#c.mortality i.flow#c.
NE i.flow#i.year ///

i.size#c.sowfarm ///

|| site: || closeout: vargrp, nocons base reml
dfmethod(kroger)

estat ic
```

Finisher ADFI

```
mixed adfi fill startwt mortality sowfarm NE
i.system i.flow i.size i.feeder i.year i.startwk
///

i.system#c.fill i.system#c.startwt i.system#c.
        sowfarm i.system#c.NE i.system#i.
        flow i.system#i.size i.system#i.
        feeder i.system#i.year i.system#i.
        startwk ///

i.flow#c.fill i.flow#c.mortality i.flow#c.sow-
farm i.flow#c.NE i.flow#i.year ///

i.size#c.fill i.size#c.sowfarm i.size#i.feeder
///

|| site: || closeout: vargrp, nocons base reml
dfmethod(kroger)

estat ic
```

Finisher G:F

```
mixed gf fill startwt mortality sowfarm NE
i.system i.flow i.size i.year i.startwk ///

i.system#c.fill i.system#c.startwt i.system#c.
        mortality i.system#c.NE
        i.system#i.flow i.system#i.size
        i.system#i.year i.system#i.startwk
        ///

i.flow#c.sowfarm i.flow#i.size  ///

i.size#c.mortality i.size#c.sowfarm ///

|| site: || closeout: vargrp, nocons base reml
dfmethod(kroger)

estat ic
```

Table S1: List of variables and corresponding codes and descriptions used in multi-level linear mixed models for nursery and finisher ADG, ADFI, and G:F in 3 swine production systems located in the midwestern United States from January 2013 to December 2017.

Variable	Code	Description
Year	**year**	**2013-2017**
System	system	Commercial production system located in the midwestern United States
Pig flow	flow	Converted-nursery, Nursery, WF_nursery; Finisher, WF_finisher
System-pig flow	sys flow	One-way factor merged from system and flow variables
Site	site	Production sites, including single- and multi-barn sites
Batch	closeout	Cohort of pigs per airspace within a site
Batch size	size	Size of closeouts based on head counts
Feeder	feeder	Dry, tube, wet-dry
Dietary NE, kcal/kg	NE	Dietary net energy
DOF	avg_dof	Average days on feed
Fill length	fill	Length of fill period (continuous)
Sowfarm	sow farm	Number of sow farm sources (continuous)
Initial BW, kg	start wt	Average initial body weight
Final BW, kg	final wt	Average final body weight
Mortality, %	mortality	Percentage of mortality over initial inventory
ADG, g	adg	Average daily gain
ADFI, g	adfi	Average daily feed intake
G:F, g/kg	gf	Gain:feed ratio

WF = wean-to-finish; NE = net energy; DOF = days on feed; BW = body weight; ADG = average daily gain; ADFI = average daily feed intake; G:F = gain to feed ratio.

Table S2: Parameter coefficients and statistics for nursery ADG

ADG	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
fill	0.517	0.436	1.190	0.236	-0.338	1.372
average_DOF	3.845	0.226	17.030	0.000	3.402	4.288
mortality	-3.959	0.316	-12.530	0.000	-4.579	-3.339
sowfarm	-5.060	1.000	-5.060	0.000	-7.022	-3.099
sysflow						
A-Converted-Nursery	0.000	(base)				
A-Nursery	100.445	17.887	5.620	0.000	65.372	135.518
A-WF_nursery	142.460	16.725	8.520	0.000	109.663	175.256
B-Nursery	86.569	19.339	4.480	0.000	48.656	124.482
B-WF_nursery	111.032	22.433	4.950	0.000	67.053	155.012
C-Nursery	98.926	18.367	5.390	0.000	62.918	134.935
C-WF_nursery	70.956	19.518	3.640	0.000	32.692	109.221
size						
3000 - 6000	0.000	(base)				
< 3000	10.589	5.323	1.990	0.047	0.152	21.025
> 6000	-16.441	4.715	-3.490	0.000	-25.685	-7.196

Table S2 continued

ADG	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
year						
2013	0.000	(base)				
2014	-2.867	6.148	-0.470	0.641	-14.923	9.188
2015	-14.673	6.247	-2.350	0.019	-26.922	-2.424
2016	-7.128	7.563	-0.940	0.346	-21.958	7.701
2017	-34.449	9.381	-3.670	0.000	-52.845	-16.053
startwk						
1	0.000	(base)				
2	-4.710	6.826	-0.690	0.490	-18.092	8.672
3	-9.488	6.472	-1.470	0.143	-22.177	3.201
4	-9.840	6.926	-1.420	0.155	-23.419	3.739
5	-2.086	6.774	-0.310	0.758	-15.367	11.194
6	-4.051	6.748	-0.600	0.548	-17.280	9.178
7	-6.241	6.833	-0.910	0.361	-19.638	7.156
8	-12.170	6.737	-1.810	0.071	-25.378	1.038
9	-7.757	6.642	-1.170	0.243	-20.778	5.264
10	-10.312	6.744	-1.530	0.126	-23.533	2.909
11	-12.181	6.868	-1.770	0.076	-25.646	1.284
12	-10.680	6.566	-1.630	0.104	-23.553	2.193
13	-20.146	6.494	-3.100	0.002	-32.878	-7.414
14	-12.540	6.788	-1.850	0.065	-25.848	0.767
15	-21.015	6.521	-3.220	0.001	-33.799	-8.230
16	-16.837	6.725	-2.500	0.012	-30.022	-3.653
17	-18.471	6.867	-2.690	0.007	-31.934	-5.007
18	-14.293	6.543	-2.180	0.029	-27.121	-1.465
19	-24.281	6.648	-3.650	0.000	-37.315	-11.248
20	-16.061	6.898	-2.330	0.020	-29.584	-2.538
21	-14.540	6.587	-2.210	0.027	-27.453	-1.626
22	-19.505	6.753	-2.890	0.004	-32.746	-6.265
23	-14.097	6.607	-2.130	0.033	-27.050	-1.143
24	-16.386	6.542	-2.500	0.012	-29.211	-3.560
25	-14.614	6.652	-2.200	0.028	-27.656	-1.572
26	-10.996	6.730	-1.630	0.102	-24.190	2.198
27	-7.732	6.419	-1.200	0.228	-20.317	4.853
28	-13.189	6.757	-1.950	0.051	-26.436	0.058
29	-12.323	6.421	-1.920	0.055	-24.910	0.265
30	-13.006	6.677	-1.950	0.052	-26.097	0.085
31	-9.933	6.714	-1.480	0.139	-23.095	3.230
32	-4.330	6.482	-0.670	0.504	-17.038	8.378
33	-12.693	6.737	-1.880	0.060	-25.901	0.515
34	-3.888	6.615	-0.590	0.557	-16.856	9.080
35	-9.615	6.720	-1.430	0.153	-22.790	3.559

Table S2 continued

ADG	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
36	-12.100	6.411	-1.890	0.059	-24.670	0.470
37	-11.734	6.739	-1.740	0.082	-24.946	1.477
38	-6.088	6.561	-0.930	0.353	-18.951	6.774
39	-15.076	6.454	-2.340	0.020	-27.729	-2.423
40	-7.296	6.666	-1.090	0.274	-20.365	5.774
41	-3.251	6.433	-0.510	0.613	-15.863	9.361
42	-12.542	6.798	-1.840	0.065	-25.870	0.787
43	-2.534	6.535	-0.390	0.698	-15.347	10.279
44	-11.594	6.746	-1.720	0.086	-24.819	1.632
45	5.455	7.014	0.780	0.437	-8.296	19.206
46	-9.719	6.574	-1.480	0.139	-22.608	3.169
47	-2.559	6.419	-0.400	0.690	-15.143	10.025
48	-8.323	6.739	-1.240	0.217	-21.536	4.889
49	-7.153	6.999	-1.020	0.307	-20.876	6.569
50	-3.214	6.779	-0.470	0.636	-16.505	10.078
51	-3.377	6.628	-0.510	0.610	-16.373	9.618
52	-4.584	6.449	-0.710	0.477	-17.228	8.060
sysflow#c.fill						
A-Nursery	0.266	0.498	0.530	0.593	-0.711	1.243
A-WF_nursery	0.779	0.487	1.600	0.109	-0.175	1.733
B-Nursery	-1.874	0.544	-3.440	0.001	-2.940	-0.807
B-WF_nursery	-1.438	0.656	-2.190	0.028	-2.724	-0.152
C-Nursery	-0.270	0.633	-0.430	0.669	-1.511	0.971
C-WF_nursery	-0.312	0.624	-0.500	0.617	-1.535	0.911
sysflow#c.avg_DOF						
A-Nursery	-1.639	0.308	-5.330	0.000	-2.242	-1.036
A-WF_nursery	-2.207	0.259	-8.520	0.000	-2.715	-1.699
B-Nursery	0.061	0.341	0.180	0.858	-0.608	0.730
B-WF_nursery	-0.090	0.354	-0.250	0.800	-0.785	0.605
C-Nursery	-0.168	0.342	-0.490	0.624	-0.839	0.503
C-WF_nursery	0.445	0.341	1.300	0.192	-0.223	1.113
sysflow#c.mortality						
A-Nursery	1.554	0.548	2.840	0.005	0.480	2.628
A-WF_nursery	0.382	0.436	0.880	0.381	-0.473	1.237
B-Nursery	-1.104	0.581	-1.900	0.057	-2.242	0.034
B-WF_nursery	-5.405	1.257	-4.300	0.000	-7.869	-2.942
C-Nursery	-6.235	0.575	-10.840	0.000	-7.363	-5.108
C-WF_nursery	-5.529	0.523	-10.580	0.000	-6.554	-4.505
sysflow#year						
A-Nursery#2014	-13.915	9.407	-1.480	0.139	-32.359	4.529
A-Nursery#2015	-14.504	9.010	-1.610	0.108	-32.170	3.161
A-Nursery#2016	-35.093	9.969	-3.520	0.000	-54.639	-15.546
A-Nursery#2017	0.991	11.263	0.090	0.930	-21.094	23.077
A-WF_nursery#2014	5.343	8.724	0.610	0.540	-11.764	22.449

Table S2 continued

ADG	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
A-WF_nursery#2015	19.364	8.343	2.320	0.020	3.005	35.724
A-WF_nursery#2016	-1.733	8.965	-0.190	0.847	-19.312	15.846
A-WF_nursery#2017	3.730	10.607	0.350	0.725	-17.068	24.529
B-Nursery#2014	2.121	7.630	0.280	0.781	-12.837	17.080
B-Nursery#2015	10.004	7.737	1.290	0.196	-5.165	25.172
B-Nursery#2016	6.295	8.846	0.710	0.477	-11.047	23.637
B-Nursery#2017	48.058	10.370	4.630	0.000	27.727	68.390
B-WF_nursery#2014	-8.347	9.114	-0.920	0.360	-26.214	9.521
B-WF_nursery#2015	7.675	9.118	0.840	0.400	-10.200	25.551
B-WF_nursery#2016	9.846	10.206	0.960	0.335	-10.162	29.854
B-WF_nursery#2017	53.614	11.604	4.620	0.000	30.865	76.363
C-Nursery#2014	-10.391	8.682	-1.200	0.231	-27.411	6.629
C-Nursery#2015	-7.852	8.731	-0.900	0.369	-24.969	9.265
C-Nursery#2016	-7.356	9.682	-0.760	0.447	-26.337	11.625
C-Nursery#2017	33.872	10.899	3.110	0.002	12.503	55.240
C-WF_nursery#2014	-7.381	8.189	-0.900	0.367	-23.436	8.674
C-WF_nursery#2015	-6.175	8.168	-0.760	0.450	-22.187	9.838
C-WF_nursery#2016	-6.873	9.190	-0.750	0.455	-24.889	11.143
C-WF_nursery#2017	28.294	10.885	2.600	0.009	6.953	49.634
size#c.sowfarm						
< 3000	-8.088	2.541	-3.180	0.001	-13.072	-3.105
> 6000	2.857	1.198	2.380	0.017	0.507	5.206
size#year						
< 3000#2014	3.266	5.823	0.560	0.575	-8.150	14.682
< 3000#2015	9.668	5.788	1.670	0.095	-1.680	21.016
< 3000#2016	-3.193	5.818	-0.550	0.583	-14.599	8.214
< 3000#2017	-13.305	5.742	-2.320	0.021	-24.562	-2.048
> 6000#2014	6.963	5.030	1.380	0.166	-2.898	16.825
> 6000#2015	5.401	4.865	1.110	0.267	-4.136	14.938
> 6000#2016	0.332	4.775	0.070	0.945	-9.030	9.694
> 6000#2017	-8.695	4.716	-1.840	0.065	-17.940	0.550
Constant	156.441	14.510	10.780	0.000	127.992	184.891
Random-effects Parameters	**Estimate**	**SE**	**95% LCL**	**95% UCL**		
site: Identity						
var(cons)	256.660	33.000	199.487	330.218		
closeout: Identity						
var(vargrp)	1256.468	84.403	1101.469	1433.278		
var(Residual)	1264.230	39.659	1188.842	1344.399		
Model	**Observations**	***df***	**AIC**	**BIC**		
Nursery ADG	4960	123	51348.65	52149.28		

ADG = average daily gain; LCL = lower confidence limit; UCL = upper confidence limit; DOF = days on feed; WF = wean-to-finish; AIC = Akaike information criterion; BIC = Bayesian information criterion.

Table S3: Parameter coefficients and statistics for nursery ADFI

ADFI	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
fill	2.103	0.880	2.390	0.017	0.377	3.829
average_DOF	8.433	0.417	20.220	0.000	7.615	9.251
mortality	-1.950	0.574	-3.400	0.001	-3.075	-0.824
sowfarm	-6.592	1.926	-3.420	0.001	-10.369	-2.814
sysflow						
A-Converted-Nursery	0.000	(base)				
A-Nursery	1.957	51.250	0.040	0.970	-98.545	102.459
A-WF_nursery	163.937	34.072	4.810	0.000	97.123	230.751
B-Nursery	80.037	37.369	2.140	0.032	6.774	153.301
B-WF_nursery	58.301	40.538	1.440	0.150	-21.176	137.778
C-Nursery	142.040	34.979	4.060	0.000	73.463	210.617
C-WF_nursery	51.172	35.590	1.440	0.151	-18.603	120.948
size						
3000 - 6000	0.000	(base)				
< 3000	129.213	24.020	5.380	0.000	82.118	176.309
> 6000	-26.202	96.363	-0.270	0.786	-215.175	162.770
feeder						
Dry	0.000	(base)				
Tube	14.420	7.759	1.860	0.064	-0.829	29.668
Wetdry	25.641	6.427	3.990	0.000	13.002	38.280
year						
2013	0.000	(base)				
2014	-17.754	12.045	-1.470	0.141	-41.376	5.868
2015	-50.339	12.212	-4.120	0.000	-74.289	-26.389
2016	-36.115	14.363	-2.510	0.012	-64.282	-7.947
2017	-88.405	17.598	-5.020	0.000	-122.917	-53.893
startwk						
1	0.000	(base)				
2	6.812	11.831	0.580	0.565	-16.386	30.009
3	-7.143	11.267	-0.630	0.526	-29.234	14.948
4	-3.518	12.227	-0.290	0.774	-27.491	20.456
5	-9.222	11.889	-0.780	0.438	-32.534	14.089
6	4.805	11.780	0.410	0.683	-18.291	27.902
7	-4.635	11.924	-0.390	0.698	-28.013	18.744
8	-11.019	11.676	-0.940	0.345	-33.913	11.875
9	-8.818	11.695	-0.750	0.451	-31.748	14.113
10	-18.973	11.708	-1.620	0.105	-41.930	3.983
11	-12.973	12.023	-1.080	0.281	-36.546	10.600
12	-2.535	11.471	-0.220	0.825	-25.027	19.957
13	-29.450	11.432	-2.580	0.010	-51.864	-7.036
14	-25.675	11.973	-2.140	0.032	-49.151	-2.198

Table S3 continued

ADFI	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
15	-25.696	11.303	-2.270	0.023	-47.858	-3.534
16	-23.149	11.784	-1.960	0.050	-46.254	-0.044
17	-25.600	12.089	-2.120	0.034	-49.302	-1.898
18	-18.485	11.497	-1.610	0.108	-41.026	4.057
19	-31.751	11.576	-2.740	0.006	-54.449	-9.053
20	-30.457	12.105	-2.520	0.012	-54.191	-6.722
21	-26.232	11.461	-2.290	0.022	-48.703	-3.762
22	-28.670	11.747	-2.440	0.015	-51.702	-5.638
23	-27.650	11.664	-2.370	0.018	-50.520	-4.780
24	-15.919	11.575	-1.380	0.169	-38.615	6.776
25	-14.674	11.763	-1.250	0.212	-37.737	8.390
26	-19.906	11.971	-1.660	0.096	-43.376	3.565
27	-8.176	11.334	-0.720	0.471	-30.399	14.047
28	-20.352	11.848	-1.720	0.086	-43.582	2.878
29	-7.638	11.291	-0.680	0.499	-29.776	14.499
30	-10.644	11.671	-0.910	0.362	-33.527	12.239
31	-3.541	11.736	-0.300	0.763	-26.552	19.471
32	-2.680	11.537	-0.230	0.816	-25.300	19.940
33	-4.509	11.859	-0.380	0.704	-27.761	18.744
34	2.946	11.588	0.250	0.799	-19.774	25.666
35	-9.948	11.787	-0.840	0.399	-33.059	13.162
36	-10.329	11.274	-0.920	0.360	-32.434	11.775
37	5.867	11.773	0.500	0.618	-17.215	28.950
38	-14.239	11.823	-1.200	0.229	-37.420	8.943
39	-19.516	11.237	-1.740	0.083	-41.548	2.517
40	-1.678	11.505	-0.150	0.884	-24.236	20.881
41	-3.987	11.201	-0.360	0.722	-25.949	17.976
42	-8.564	11.836	-0.720	0.469	-31.771	14.644
43	-3.323	11.429	-0.290	0.771	-25.732	19.086
44	-11.196	11.750	-0.950	0.341	-34.234	11.842
45	6.704	12.546	0.530	0.593	-17.895	31.303
46	-5.198	11.547	-0.450	0.653	-27.838	17.443
47	-1.950	11.100	-0.180	0.861	-23.714	19.815
48	-5.022	11.827	-0.420	0.671	-28.211	18.167
49	-13.338	12.273	-1.090	0.277	-37.401	10.724
50	3.103	11.726	0.260	0.791	-19.888	26.093
51	7.004	11.544	0.610	0.544	-15.629	29.638
52	-9.022	11.235	-0.800	0.422	-31.050	13.006
sysflow#c.fill						
A-Nursery	-0.201	1.287	-0.160	0.876	-2.725	2.323
A-WF_nursery	0.171	1.115	0.150	0.878	-2.015	2.357

Table S3 continued

ADFI	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
B-Nursery	-3.284	1.074	-3.060	0.002	-5.389	-1.179
B-WF_nursery	-0.380	1.224	-0.310	0.756	-2.778	2.019
C-Nursery	-0.260	1.376	-0.190	0.850	-2.958	2.438
C-WF_nursery	-1.763	1.330	-1.330	0.185	-4.371	0.845
sysflow#c.avg_DOF						
A-Nursery	0.120	0.702	0.170	0.864	-1.257	1.497
A-WF_nursery	-1.791	0.477	-3.760	0.000	-2.727	-0.856
B-Nursery	0.667	0.609	1.100	0.273	-0.526	1.861
B-WF_nursery	1.437	0.604	2.380	0.017	0.252	2.621
C-Nursery	-0.751	0.605	-1.240	0.215	-1.938	0.435
C-WF_nursery	1.079	0.587	1.840	0.066	-0.072	2.230
sysflow#c.mortality						
A-Nursery	1.466	1.046	1.400	0.161	-0.585	3.517
A-WF_nursery	-0.554	0.791	-0.700	0.484	-2.106	0.998
B-Nursery	-5.035	1.359	-3.700	0.000	-7.700	-2.370
B-WF_nursery	-9.317	2.035	-4.580	0.000	-13.308	-5.326
C-Nursery	-10.818	0.969	-11.160	0.000	-12.719	-8.918
C-WF_nursery	-12.217	0.879	-13.890	0.000	-13.941	-10.493
sysflow#size						
A-Nursery# < 3000	-90.332	39.526	-2.290	0.022	-167.843	-12.821
A-Nursery# > 6000	8.100	99.575	0.080	0.935	-187.177	203.377
A-WF_nursery# < 3000	-134.303	24.941	-5.380	0.000	-183.213	-85.392
A-WF_nursery# > 6000	-12.275	93.779	-0.130	0.896	-196.187	171.638
B-Nursery# < 3000	-79.393	25.429	-3.120	0.002	-129.260	-29.525
B-Nursery# > 6000	29.081	95.349	0.300	0.760	-157.904	216.066
B-WF_nursery# < 3000	-51.644	35.313	-1.460	0.144	-120.964	17.676
B-WF_nursery# > 6000	26.455	95.119	0.280	0.781	-160.079	212.990
C-Nursery# < 3000	-87.459	23.538	-3.720	0.000	-133.610	-41.308
C-Nursery# > 6000	-11.116	95.361	-0.120	0.907	-198.126	175.894
C-WF_nursery# < 3000	-67.273	25.776	-2.610	0.009	-117.807	-16.738
C-WF_nursery# > 6000	10.669	95.096	0.110	0.911	-175.822	197.160
sysflow#year						
A-Nursery#2014	6.443	18.606	0.350	0.729	-30.046	42.933
A-Nursery#2015	15.495	18.007	0.860	0.390	-19.820	50.810
A-Nursery#2016	-23.042	19.846	-1.160	0.246	-61.964	15.879
A-Nursery#2017	39.221	21.796	1.800	0.072	-3.525	81.967
A-WF_nursery#2014	42.182	16.271	2.590	0.010	10.272	74.091
A-WF_nursery#2015	33.812	15.790	2.140	0.032	2.846	64.779
A-WF_nursery#2016	0.716	16.950	0.040	0.966	-32.525	33.957
A-WF_nursery#2017	69.773	19.910	3.500	0.000	30.727	108.819

Table S3 continued

ADFI	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
B-Nursery#2014	30.375	14.167	2.140	0.032	2.598	58.153
B-Nursery#2015	46.127	14.305	3.220	0.001	18.079	74.175
B-Nursery#2016	25.962	16.153	1.610	0.108	-5.710	57.634
B-Nursery#2017	99.122	19.080	5.200	0.000	61.710	136.534
B-WF_nursery#2014	8.694	15.749	0.550	0.581	-22.183	39.570
B-WF_nursery#2015	54.438	15.896	3.420	0.001	23.272	85.603
B-WF_nursery#2016	62.917	17.753	3.540	0.000	28.111	97.723
B-WF_nursery#2017	129.704	20.510	6.320	0.000	89.491	169.916
C-Nursery#2014	9.116	15.391	0.590	0.554	-21.059	39.291
C-Nursery#2015	22.222	15.309	1.450	0.147	-7.792	52.236
C-Nursery#2016	2.801	17.001	0.160	0.869	-30.532	36.134
C-Nursery#2017	66.045	19.584	3.370	0.001	27.646	104.444
C-WF_nursery#2014	2.477	14.102	0.180	0.861	-25.173	30.126
C-WF_nursery#2015	16.046	14.232	1.130	0.260	-11.859	43.951
C-WF_nursery#2016	13.532	16.070	0.840	0.400	-17.977	45.041
C-WF_nursery#2017	60.816	19.388	3.140	0.002	22.801	98.830
size#c.fill						
< 3000	-3.484	1.262	-2.760	0.006	-5.959	-1.010
> 6000	-0.646	0.741	-0.870	0.384	-2.099	0.808
size#c.sowfarm						
< 3000	-18.217	4.957	-3.670	0.000	-27.939	-8.496
> 6000	3.186	2.730	1.170	0.243	-2.168	8.539
Constant	125.627	28.608	4.390	0.000	69.531	181.722
Random-effects Parameters	**Estimate**	**SE**	**95% LCL**	**95% UCL**		
site: Identity						
var(cons)	1000.371	124.630	783.638	1277.047		
closeout: Identity						
var(vargrp)	4964.350	280.025	4444.762	5544.678		
var(Residual)	3076.755	99.856	2887.136	3278.828		
Model	**Observations**	***df***	**AIC**	**BIC**		
Nursery ADFI	4365	131	49477.22	50313.18		

ADFI = average daily feed intake; LCL = lower confidence limit; UCL = upper confidence limit; DOF = days on feed; WF = wean-to-finish; AIC = Akaike information criterion; BIC = Bayesian information criterion.

Table S4: Parameter coefficients and statistics for nursery G:F

G:F	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
average_DOF	-1.830	0.304	-6.020	0.000	-2.425	-1.234
mortality	-5.291	0.416	-12.710	0.000	-6.107	-4.475
sysflow						
A-Converted-Nursery	0.000	(base)				
A-Nursery	18.062	27.475	0.660	0.511	-35.817	71.940
A-WF_nursery	80.921	20.478	3.950	0.000	40.762	121.080
B-Nursery	107.901	24.097	4.480	0.000	60.658	155.144
B-WF_nursery	39.921	25.244	1.580	0.114	-9.570	89.412
C-Nursery	75.322	23.244	3.240	0.001	29.752	120.891
C-WF_nursery	119.219	23.440	5.090	0.000	73.266	165.173
feeder						
Dry	0.000	(base)				
Tube	-13.183	4.728	-2.790	0.006	-22.474	-3.892
Wetdry	-21.828	3.842	-5.680	0.000	-29.384	-14.271
year						
2013	0.000	(base)				
2014	15.040	8.538	1.760	0.078	-1.703	31.783
2015	29.496	8.619	3.420	0.001	12.593	46.399
2016	30.056	10.172	2.950	0.003	10.107	50.005
2017	46.027	12.610	3.650	0.000	21.298	70.757
sysflow#c.avg_dof						
A-Nursery	0.351	0.512	0.680	0.493	-0.653	1.355
A-WF_nursery	-1.106	0.344	-3.220	0.001	-1.780	-0.432
B-Nursery	-1.177	0.434	-2.710	0.007	-2.028	-0.326
B-WF_nursery	-0.529	0.431	-1.230	0.220	-1.374	0.316
C-Nursery	-0.205	0.436	-0.470	0.638	-1.060	0.649
C-WF_nursery	-1.052	0.425	-2.480	0.013	-1.885	-0.219
sysflow#c.mortality						
A-Nursery	0.316	0.746	0.420	0.672	-1.148	1.779
A-WF_nursery	2.240	0.574	3.900	0.000	1.114	3.367
B-Nursery	-0.333	0.878	-0.380	0.705	-2.055	1.390
B-WF_nursery	0.247	1.410	0.180	0.861	-2.516	3.011
C-Nursery	0.820	0.702	1.170	0.242	-0.556	2.197
C-WF_nursery	4.054	0.633	6.400	0.000	2.813	5.296
sysflow#year						
A-Nursery#2014	10.351	13.124	0.790	0.430	-15.386	36.089
A-Nursery#2015	6.006	12.529	0.480	0.632	-18.565	30.576
A-Nursery#2016	5.900	13.621	0.430	0.665	-20.812	32.613
A-Nursery#2017	-35.541	15.503	-2.290	0.022	-65.944	-5.139

Table S4 continued

G:F	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
A-WF_nursery#2014	-30.425	11.577	-2.630	0.009	-53.128	-7.723
A-WF_nursery#2015	-13.249	11.041	-1.200	0.230	-34.900	8.402
A-WF_nursery#2016	-25.476	11.893	-2.140	0.032	-48.799	-2.154
A-WF_nursery#2017	-88.069	14.141	-6.230	0.000	-115.801	-60.338
B-Nursery#2014	-20.443	10.125	-2.020	0.044	-40.294	-0.592
B-Nursery#2015	-26.531	10.153	-2.610	0.009	-46.437	-6.625
B-Nursery#2016	-21.127	11.492	-1.840	0.066	-43.659	1.405
B-Nursery#2017	-39.709	13.681	-2.900	0.004	-66.535	-12.883
B-WF_nursery#2014	-18.436	11.252	-1.640	0.101	-40.496	3.624
B-WF_nursery#2015	-33.821	11.301	-2.990	0.003	-55.977	-11.664
B-WF_nursery#2016	-45.574	12.653	-3.600	0.000	-70.380	-20.767
B-WF_nursery#2017	-54.968	14.708	-3.740	0.000	-83.804	-26.131
C-Nursery#2014	-27.759	10.965	-2.530	0.011	-49.256	-6.262
C-Nursery#2015	-29.893	10.903	-2.740	0.006	-51.270	-8.516
C-Nursery#2016	-27.638	12.081	-2.290	0.022	-51.324	-3.951
C-Nursery#2017	-44.041	14.031	-3.140	0.002	-71.553	-16.529
C-WF_nursery#2014	-9.770	10.062	-0.970	0.332	-29.497	9.958
C-WF_nursery#2015	-23.971	10.108	-2.370	0.018	-43.789	-4.152
C-WF_nursery#2016	-33.135	11.423	-2.900	0.004	-55.533	-10.738
C-WF_nursery#2017	-36.688	13.918	-2.640	0.008	-63.978	-9.399
Constant	697.724	17.562	39.730	0.000	663.285	732.163
Random-effects Parameters	**Estimate**	**SE**	**95% LCL**	**95% UCL**		
site: Identity						
var(cons)	284.8505	40.00879	216.3023	375.1223		
closeout: Identity						
var(vargrp)	2819.26	150.1316	2539.843	3129.417		
var(Residual)	1668.38	53.37558	1566.978	1776.343		
Model	**Observations**	***df***	**AIC**	**BIC**		
Nursery G:F	4365	54	47101.78	47446.38		

G:F = gain to feed ratio; LCL = lower confidence limit; UCL = upper confidence limit; DOF = days on feed; WF = wean-to-finish; AIC = Akaike information criterion; BIC = Bayesian information criterion.

Table S5: Parameter coefficients and statistics for finisher ADG

ADG	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
startwt	1.967	0.182	10.780	0.000	1.609	2.325
mortality	-9.689	0.574	-16.880	0.000	-10.814	-8.563
sowfarm	-0.726	1.776	-0.410	0.683	-4.208	2.756
NE	0.162	0.022	7.440	0.000	0.119	0.204
system						
A	0.000	(base)				
B	30.373	22.333	1.360	0.174	-13.410	74.157
C	-42.422	20.505	-2.070	0.039	-82.622	-2.222
flow						
Finishing	0.000	(base)				
WF_finishing	244.875	80.550	3.040	0.002	86.955	402.795
size						
1500 - 3500	0.000	(base)				
< 1500	-21.002	16.667	-1.260	0.208	-53.687	11.682
> 3500	-10.319	4.019	-2.570	0.010	-18.200	-2.437
feeder						
Dry	0.000	(base)				
Tube	-17.819	9.878	-1.800	0.071	-37.199	1.560
Wetdry	10.363	9.451	1.100	0.273	-8.178	28.904
year						
2015	0.000	(base)				
2016	4.593	3.483	1.320	0.187	-2.237	11.424
2017	21.709	4.753	4.570	0.000	12.389	31.029
startwk						
1	0.000	(base)				
2	-18.181	13.862	-1.310	0.190	-45.363	9.002
3	-22.222	15.840	-1.400	0.161	-53.283	8.840
4	-17.373	14.513	-1.200	0.231	-45.832	11.086
5	-25.651	15.134	-1.690	0.090	-55.329	4.027
6	-34.385	13.709	-2.510	0.012	-61.267	-7.502
7	-28.313	14.233	-1.990	0.047	-56.223	-0.403
8	-32.001	14.685	-2.180	0.029	-60.798	-3.204
9	-35.699	15.318	-2.330	0.020	-65.738	-5.660
10	-37.956	14.275	-2.660	0.008	-65.948	-9.964
11	-50.736	14.310	-3.550	0.000	-78.799	-22.674
12	-62.931	14.624	-4.300	0.000	-91.608	-34.253
13	-75.821	14.184	-5.350	0.000	-103.635	-48.007
14	-81.384	14.582	-5.580	0.000	-109.979	-52.789
15	-66.476	14.157	-4.700	0.000	-94.237	-38.715
16	-73.647	14.945	-4.930	0.000	-102.954	-44.340
17	-74.720	14.125	-5.290	0.000	-102.420	-47.021

Table S5 continued

ADG	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
18	-74.086	13.657	-5.420	0.000	-100.868	-47.304
19	-82.728	13.835	-5.980	0.000	-109.858	-55.599
20	-69.550	15.229	-4.570	0.000	-99.414	-39.686
21	-57.157	15.423	-3.710	0.000	-87.402	-26.913
22	-48.404	15.459	-3.130	0.002	-78.719	-18.088
23	-53.560	14.666	-3.650	0.000	-82.321	-24.799
24	-43.955	14.057	-3.130	0.002	-71.521	-16.389
25	-31.424	14.668	-2.140	0.032	-60.187	-2.660
26	-42.969	14.683	-2.930	0.003	-71.762	-14.176
27	-23.996	15.258	-1.570	0.116	-53.917	5.924
28	-27.858	14.337	-1.940	0.052	-55.972	0.255
29	-29.689	14.304	-2.080	0.038	-57.740	-1.638
30	-22.891	14.277	-1.600	0.109	-50.888	5.105
31	-13.472	13.679	-0.980	0.325	-40.296	13.352
32	3.396	14.498	0.230	0.815	-25.035	31.827
33	-6.605	15.015	-0.440	0.660	-36.049	22.840
34	-2.988	14.142	-0.210	0.833	-30.720	24.744
35	-16.268	13.890	-1.170	0.242	-43.507	10.970
36	-12.102	14.268	-0.850	0.396	-40.081	15.876
37	-2.688	13.957	-0.190	0.847	-30.057	24.681
38	-16.961	14.348	-1.180	0.237	-45.097	11.174
39	-14.147	14.487	-0.980	0.329	-42.557	14.262
40	-23.512	13.640	-1.720	0.085	-50.260	3.237
41	-28.212	14.623	-1.930	0.054	-56.887	0.464
42	-21.619	14.136	-1.530	0.126	-49.339	6.100
43	-17.943	14.247	-1.260	0.208	-45.881	9.995
44	-11.511	13.850	-0.830	0.406	-38.671	15.648
45	-3.748	14.671	-0.260	0.798	-32.518	25.021
46	-23.868	14.130	-1.690	0.091	-51.576	3.840
47	4.907	13.930	0.350	0.725	-22.409	32.222
48	3.169	15.961	0.200	0.843	-28.131	34.468
49	-10.006	14.687	-0.680	0.496	-38.807	18.795
50	-16.496	13.274	-1.240	0.214	-42.526	9.534
51	-13.782	13.506	-1.020	0.308	-40.266	12.703
52	-27.897	14.965	-1.860	0.062	-57.243	1.448
system#c.startwt						
B	-1.237	0.291	-4.250	0.000	-1.808	-0.666
C	0.041	0.292	0.140	0.887	-0.531	0.614
system#c.mortality						
B	-2.289	1.057	-2.160	0.030	-4.362	-0.216
C	-2.216	0.841	-2.640	0.008	-3.864	-0.568

Table S5 continued

ADG	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
system#c.sowfarm						
B	-2.086	1.774	-1.180	0.240	-5.564	1.393
C	-15.831	3.541	-4.470	0.000	-22.774	-8.889
system#flow						
B-WF_finishing	-24.930	9.558	-2.610	0.009	-43.669	-6.190
C-WF_finishing	-47.389	8.697	-5.450	0.000	-64.439	-30.339
system#size						
B# < 1500	72.233	17.442	4.140	0.000	38.027	106.440
B# > 3500	1.974	6.591	0.300	0.765	-10.957	14.905
C# < 1500	44.422	17.246	2.580	0.010	10.598	78.246
C# > 3500	8.774	5.898	1.490	0.137	-2.802	20.349
system#feeder						
B#Tube	14.820	11.154	1.330	0.184	-7.068	36.709
B#Wetdry	33.639	12.168	2.760	0.006	9.757	57.521
C#Tube	30.537	11.043	2.770	0.006	8.867	52.206
C#Wetdry	34.827	10.314	3.380	0.001	14.589	55.064
system#year						
B#2016	-6.132	4.438	-1.380	0.167	-14.832	2.569
B#2017	-7.985	5.192	-1.540	0.124	-18.163	2.194
C#2016	2.113	4.164	0.510	0.612	-6.051	10.277
C#2017	-10.622	5.355	-1.980	0.047	-21.122	-0.123
system#startwk						
B# 2	13.373	19.599	0.680	0.495	-25.051	51.798
B# 3	1.008	21.317	0.050	0.962	-40.785	42.801
B# 4	3.931	20.616	0.190	0.849	-36.488	44.350
B# 5	16.616	21.496	0.770	0.440	-25.528	58.760
B# 6	18.901	19.907	0.950	0.342	-20.126	57.929
B# 7	13.023	20.061	0.650	0.516	-26.307	52.353
B# 8	14.342	21.586	0.660	0.506	-27.979	56.663
B# 9	-8.383	21.039	-0.400	0.690	-49.631	32.864
B#10	-6.764	20.427	-0.330	0.741	-46.813	33.284
B#11	16.229	20.093	0.810	0.419	-23.163	55.622
B#12	15.866	20.807	0.760	0.446	-24.926	56.657
B#13	56.864	21.247	2.680	0.007	15.209	98.518
B#14	45.811	20.399	2.250	0.025	5.818	85.803
B#15	29.655	20.410	1.450	0.146	-10.360	69.670
B#16	16.549	20.729	0.800	0.425	-24.090	57.188
B#17	38.203	19.884	1.920	0.055	-0.780	77.186
B#18	25.383	19.851	1.280	0.201	-13.536	64.302
B#19	40.017	20.575	1.940	0.052	-0.321	80.355
B#20	27.039	20.822	1.300	0.194	-13.782	67.861

Table S5 continued

ADG	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
B#21	26.149	21.379	1.220	0.221	-15.765	68.064
B#22	36.388	21.188	1.720	0.086	-5.151	77.927
B#23	37.371	20.326	1.840	0.066	-2.480	77.222
B#24	31.227	20.226	1.540	0.123	-8.427	70.881
B#25	47.457	20.799	2.280	0.023	6.681	88.232
B#26	47.797	20.314	2.350	0.019	7.972	87.623
B#27	53.411	22.179	2.410	0.016	9.928	96.893
B#28	46.052	20.232	2.280	0.023	6.387	85.717
B#29	56.164	21.745	2.580	0.010	13.532	98.796
B#30	37.819	19.981	1.890	0.058	-1.355	76.993
B#31	30.317	19.982	1.520	0.129	-8.859	69.492
B#32	35.733	20.202	1.770	0.077	-3.873	75.340
B#33	34.396	21.015	1.640	0.102	-6.806	75.597
B#34	45.897	19.944	2.300	0.021	6.796	84.997
B#35	25.775	19.376	1.330	0.184	-12.212	63.762
B#36	23.446	19.923	1.180	0.239	-15.613	62.506
B#37	15.972	19.969	0.800	0.424	-23.178	55.121
B#38	40.281	20.677	1.950	0.051	-0.256	80.817
B#39	42.855	20.498	2.090	0.037	2.668	83.042
B#40	25.018	20.152	1.240	0.214	-14.490	64.526
B#41	19.788	20.421	0.970	0.333	-20.248	59.825
B#42	21.650	20.032	1.080	0.280	-17.623	60.923
B#43	2.369	20.007	0.120	0.906	-36.855	41.593
B#44	-11.341	19.728	-0.570	0.565	-50.018	27.335
B#45	17.195	21.130	0.810	0.416	-24.231	58.621
B#46	27.125	20.037	1.350	0.176	-12.158	66.408
B#47	-19.617	20.081	-0.980	0.329	-58.986	19.752
B#48	-5.810	21.632	-0.270	0.788	-48.221	36.600
B#49	2.365	21.336	0.110	0.912	-39.464	44.194
B#50	-0.623	19.423	-0.030	0.974	-38.703	37.456
B#51	13.704	19.681	0.700	0.486	-24.881	52.289
B#52	13.100	21.357	0.610	0.540	-28.771	54.971
C# 2	22.003	17.089	1.290	0.198	-11.501	55.506
C# 3	21.417	18.961	1.130	0.259	-15.758	58.593
C# 4	9.902	18.284	0.540	0.588	-25.944	45.749
C# 5	3.201	18.481	0.170	0.863	-33.032	39.434
C# 6	22.190	17.083	1.300	0.194	-11.301	55.682
C# 7	10.018	17.863	0.560	0.575	-25.004	45.040
C# 8	11.067	18.435	0.600	0.548	-25.076	47.209
C# 9	2.547	18.677	0.140	0.892	-34.071	39.164
C#10	16.146	17.480	0.920	0.356	-18.125	50.416

Table S5 continued

ADG	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
C#11	29.192	17.383	1.680	0.093	-4.889	63.272
C#12	30.287	17.856	1.700	0.090	-4.721	65.296
C#13	56.050	17.383	3.220	0.001	21.970	90.130
C#14	56.376	17.806	3.170	0.002	21.466	91.287
C#15	36.217	17.519	2.070	0.039	1.870	70.564
C#16	42.515	18.455	2.300	0.021	6.333	78.696
C#17	48.050	17.409	2.760	0.006	13.919	82.181
C#18	45.314	17.284	2.620	0.009	11.428	79.200
C#19	61.264	17.610	3.480	0.001	26.738	95.789
C#20	64.220	18.556	3.460	0.001	27.840	100.600
C#21	56.555	18.716	3.020	0.003	19.861	93.250
C#22	39.462	18.854	2.090	0.036	2.497	76.427
C#23	62.236	17.785	3.500	0.000	27.366	97.105
C#24	53.907	17.644	3.060	0.002	19.315	88.498
C#25	44.799	17.836	2.510	0.012	9.830	79.768
C#26	59.208	18.219	3.250	0.001	23.490	94.927
C#27	48.741	18.797	2.590	0.010	11.890	85.593
C#28	43.142	17.872	2.410	0.016	8.103	78.181
C#29	65.356	17.737	3.680	0.000	30.582	100.130
C#30	48.250	18.059	2.670	0.008	12.846	83.655
C#31	57.456	17.253	3.330	0.001	23.631	91.282
C#32	23.920	17.489	1.370	0.171	-10.369	58.208
C#33	44.543	18.647	2.390	0.017	7.984	81.103
C#34	48.532	17.156	2.830	0.005	14.896	82.168
C#35	49.970	17.430	2.870	0.004	15.797	84.142
C#36	38.985	17.513	2.230	0.026	4.649	73.320
C#37	21.615	17.412	1.240	0.215	-12.522	55.753
C#38	35.949	17.880	2.010	0.044	0.895	71.004
C#39	44.421	17.679	2.510	0.012	9.761	79.082
C#40	46.589	17.757	2.620	0.009	11.776	81.401
C#41	41.825	17.865	2.340	0.019	6.800	76.851
C#42	38.839	17.541	2.210	0.027	4.450	73.228
C#43	31.946	17.574	1.820	0.069	-2.508	66.400
C#44	37.927	17.611	2.150	0.031	3.400	72.454
C#45	16.129	17.927	0.900	0.368	-19.017	51.276
C#46	44.056	17.421	2.530	0.011	9.902	78.210
C#47	19.613	17.342	1.130	0.258	-14.386	53.613
C#48	10.561	19.064	0.550	0.580	-26.815	47.938
C#49	18.685	17.883	1.040	0.296	-16.376	53.746
C#50	29.219	16.745	1.740	0.081	-3.611	62.048
C#51	31.339	17.218	1.820	0.069	-2.417	65.095
C#52	21.732	18.412	1.180	0.238	-14.365	57.829

Table S5 continued

ADG	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
flow#c.startwt						
WF_finishing	-0.560	0.268	-2.090	0.037	-1.085	-0.035
flow#c.mortality						
WF_finishing	-3.846	0.859	-4.480	0.000	-5.530	-2.163
flow#c.NE						
WF_finishing	-0.072	0.030	-2.430	0.015	-0.130	-0.014
flow#year						
WF_finishing#2016	10.985	3.623	3.030	0.002	3.881	18.089
WF_finishing#2017	20.048	3.823	5.240	0.000	12.552	27.544
size#c.sowfarm						
< 1500	-7.124	2.285	-3.120	0.002	-11.605	-2.643
> 3500	-0.348	1.318	-0.260	0.792	-2.932	2.236
Constant	456.970	61.902	7.380	0.000	335.608	578.331
Random-effects Parameters	**Estimate**	**SE**	**95% LCL**	**95% UCL**		
site: Identity						
var(cons)	495.309	45.825	413.167	593.782		
closeout: Identity						
var(vargrp)	3006.807	133.037	2757.045	3279.195		
var(Residual)	1104.778	36.955	1034.671	1179.635		
Model	**Observations**	***df***	**AIC**	**BIC**		
Finisher ADG	4747	197	49797.57	51071.23		

ADG = average daily gain; LCL = lower confidence limit; UCL = upper confidence limit; BW = body weight; NE = net energy; WF = wean-to-finish; AIC = Akaike information criterion; BIC = Bayesian information criterion.

Table S6: Parameter coefficients and statistics for finisher ADFI

ADFI		Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
fill		-1.968	1.670	-1.180	0.239	-5.243	1.306
startwt		15.058	0.413	36.490	0.000	14.248	15.867
mortality		-13.305	1.100	-12.100	0.000	-15.462	-11.149
sowfarm		-7.022	4.375	-1.610	0.109	-15.599	1.555
NE		-0.196	0.061	-3.200	0.001	-0.316	-0.076
system							
A		0.000	(base)				
B		-1298.527	422.704	-3.070	0.002	-2127.358	-469.696
C		1016.912	346.882	2.930	0.003	336.760	1697.064
flow							
Finishing		0.000	(base)				
WF_finishing		617.974	205.392	3.010	0.003	215.293	1020.654
size							
1500 - 3500		0.000	(base)				
< 1500		16.071	47.284	0.340	0.734	-76.665	108.807
> 3500		-54.461	20.027	-2.720	0.007	-93.765	-15.157
feeder							
Dry		0.000	(base)				
Tube		-67.961	26.480	-2.570	0.010	-119.926	-15.995
Wetdry		43.020	26.080	1.650	0.099	-8.161	94.201
year							
2015		0.000	(base)				
2016		2.230	8.278	0.270	0.788	-14.003	18.464
2017		31.139	12.406	2.510	0.012	6.812	55.466
startwk							
	1	0.000	(base)				
	2	-28.215	32.667	-0.860	0.388	-92.275	35.845
	3	-26.351	37.308	-0.710	0.480	-99.511	46.810
	4	-45.905	34.212	-1.340	0.180	-112.995	21.185
	5	-53.822	35.654	-1.510	0.131	-123.739	16.095
	6	-73.646	32.403	-2.270	0.023	-137.189	-10.104
	7	-48.123	33.549	-1.430	0.152	-113.912	17.666
	8	-76.537	34.610	-2.210	0.027	-144.408	-8.667
	9	-70.522	36.104	-1.950	0.051	-141.322	0.278
	10	-118.421	33.637	-3.520	0.000	-184.383	-52.458
	11	-105.079	33.735	-3.110	0.002	-171.234	-38.924
	12	-169.234	34.479	-4.910	0.000	-236.847	-101.620
	13	-153.995	33.423	-4.610	0.000	-219.537	-88.453
	14	-170.957	34.386	-4.970	0.000	-238.388	-103.527
	15	-152.098	33.381	-4.560	0.000	-217.558	-86.638
	16	-151.791	35.254	-4.310	0.000	-220.924	-82.658
	17	-160.525	33.287	-4.820	0.000	-225.801	-95.249

Table S6 continued

ADFI	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
18	-141.591	32.189	-4.400	0.000	-204.714	-78.468
19	-156.029	32.628	-4.780	0.000	-220.012	-92.046
20	-142.850	35.907	-3.980	0.000	-213.264	-72.436
21	-63.385	36.329	-1.740	0.081	-134.627	7.857
22	-109.469	36.417	-3.010	0.003	-180.882	-38.055
23	-123.499	34.532	-3.580	0.000	-191.216	-55.781
24	-67.167	33.118	-2.030	0.043	-132.112	-2.222
25	-67.862	34.563	-1.960	0.050	-135.640	-0.085
26	-79.263	34.635	-2.290	0.022	-147.183	-11.344
27	-35.258	35.983	-0.980	0.327	-105.822	35.305
28	-36.655	33.780	-1.090	0.278	-102.897	29.586
29	-21.755	33.724	-0.650	0.519	-87.888	44.378
30	-1.086	33.694	-0.030	0.974	-67.159	64.987
31	-53.051	32.222	-1.650	0.100	-116.238	10.135
32	-14.104	34.141	-0.410	0.680	-81.055	52.848
33	27.628	35.325	0.780	0.434	-41.644	96.900
34	29.378	33.477	0.880	0.380	-36.271	95.027
35	41.732	32.736	1.270	0.203	-22.463	105.928
36	29.957	33.623	0.890	0.373	-35.978	95.891
37	45.149	32.850	1.370	0.169	-19.269	109.568
38	4.424	33.785	0.130	0.896	-61.828	70.676
39	28.328	34.141	0.830	0.407	-38.624	95.279
40	45.028	32.136	1.400	0.161	-17.990	108.047
41	40.928	34.502	1.190	0.236	-26.730	108.586
42	31.259	33.304	0.940	0.348	-34.050	96.569
43	32.638	33.553	0.970	0.331	-33.159	98.435
44	37.543	32.671	1.150	0.251	-26.524	101.611
45	12.469	34.563	0.360	0.718	-55.310	80.247
46	-2.229	33.301	-0.070	0.947	-67.532	63.075
47	-2.137	32.881	-0.060	0.948	-66.615	62.342
48	49.539	37.614	1.320	0.188	-24.222	123.301
49	-22.606	34.652	-0.650	0.514	-90.558	45.345
50	-25.952	31.286	-0.830	0.407	-87.303	35.399
51	-4.884	31.811	-0.150	0.878	-67.266	57.497
52	-44.670	35.284	-1.270	0.206	-113.861	24.521
system#c.fill						
B	4.864	3.934	1.240	0.216	-2.851	12.579
C	4.511	2.303	1.960	0.050	-0.004	9.027
system#c.startwt						
B	-2.476	0.781	-3.170	0.002	-4.006	-0.946
C	1.867	0.716	2.610	0.009	0.462	3.271

Table S6 continued

ADFI	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
system#c.sowfarm						
B	-13.635	4.464	-3.050	0.002	-22.387	-4.883
C	-48.629	9.876	-4.920	0.000	-67.994	-29.264
system#c.NE						
B	0.553	0.165	3.340	0.001	0.229	0.877
C	-0.513	0.138	-3.730	0.000	-0.783	-0.243
system#flow						
B-WF_finishing	-157.964	27.195	-5.810	0.000	-211.284	-104.644
C-WF_finishing	-102.061	22.487	-4.540	0.000	-146.146	-57.976
system#size						
B# < 1500	136.330	48.628	2.800	0.005	40.939	231.721
B# > 3500	-26.107	21.138	-1.240	0.217	-67.584	15.369
C# < 1500	88.044	44.868	1.960	0.050	0.037	176.051
C# > 3500	1.953	18.616	0.100	0.916	-34.585	38.491
system#feeder						
B#Tube	46.942	28.554	1.640	0.101	-9.102	102.987
B#Wetdry	75.933	31.508	2.410	0.016	14.082	137.784
C#Tube	98.361	28.528	3.450	0.001	42.370	154.352
C#Wetdry	73.824	27.203	2.710	0.007	20.435	127.213
system#year						
B#2016	-13.631	11.629	-1.170	0.241	-36.429	9.168
B#2017	-20.740	15.515	-1.340	0.181	-51.158	9.678
C#2016	-9.416	11.707	-0.800	0.421	-32.368	13.535
C#2017	-53.770	14.817	-3.630	0.000	-82.819	-24.721
system#startwk						
B# 2	-4.842	51.489	-0.090	0.925	-105.789	96.105
B# 3	-61.336	55.413	-1.110	0.268	-169.975	47.303
B# 4	-24.564	54.215	-0.450	0.651	-130.855	81.727
B# 5	-2.386	56.549	-0.040	0.966	-113.253	108.482
B# 6	-12.291	52.698	-0.230	0.816	-115.610	91.028
B# 7	-20.996	52.724	-0.400	0.690	-124.364	82.372
B# 8	-47.560	57.122	-0.830	0.405	-159.551	64.432
B# 9	-96.266	55.057	-1.750	0.080	-204.207	11.674
B#10	-31.231	53.871	-0.580	0.562	-136.849	74.387
B#11	-67.124	52.865	-1.270	0.204	-170.770	36.521
B#12	-21.759	54.775	-0.400	0.691	-129.148	85.630
B#13	13.445	56.400	0.240	0.812	-97.133	124.023
B#14	7.313	53.603	0.140	0.891	-97.780	112.405
B#15	-48.722	53.936	-0.900	0.366	-154.468	57.024
B#16	-101.395	54.255	-1.870	0.062	-207.764	4.975
B#17	-51.395	52.245	-0.980	0.325	-153.825	51.034

Table S6 continued

ADFI	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
B#18	-133.641	52.369	-2.550	0.011	-236.314	-30.967
B#19	-93.807	54.677	-1.720	0.086	-201.006	13.392
B#20	-75.967	54.395	-1.400	0.163	-182.611	30.677
B#21	-154.523	56.046	-2.760	0.006	-264.404	-44.642
B#22	-83.038	55.399	-1.500	0.134	-191.650	25.574
B#23	-56.585	53.185	-1.060	0.287	-160.858	47.687
B#24	-83.409	53.338	-1.560	0.118	-187.981	21.164
B#25	-57.265	54.649	-1.050	0.295	-164.408	49.878
B#26	-66.581	53.158	-1.250	0.210	-170.800	37.639
B#27	2.811	58.594	0.050	0.962	-112.066	117.688
B#28	-5.067	53.161	-0.100	0.924	-109.292	99.157
B#29	12.089	57.866	0.210	0.835	-101.364	125.541
B#30	-46.024	52.432	-0.880	0.380	-148.819	56.771
B#31	25.471	52.794	0.480	0.630	-78.036	128.978
B#32	8.399	52.916	0.160	0.874	-95.346	112.144
B#33	-43.636	55.047	-0.790	0.428	-151.558	64.286
B#34	31.178	52.494	0.590	0.553	-71.739	134.095
B#35	-59.300	50.865	-1.170	0.244	-159.024	40.424
B#36	7.151	52.320	0.140	0.891	-95.425	109.726
B#37	-17.801	52.539	-0.340	0.735	-120.807	85.206
B#38	42.021	54.526	0.770	0.441	-64.880	148.923
B#39	-24.243	53.924	-0.450	0.653	-129.965	81.478
B#40	-5.097	53.350	-0.100	0.924	-109.694	99.499
B#41	-67.811	53.588	-1.270	0.206	-172.873	37.251
B#42	-33.895	52.653	-0.640	0.520	-137.125	69.334
B#43	-83.403	52.584	-1.590	0.113	-186.499	19.692
B#44	-124.228	51.893	-2.390	0.017	-225.968	-22.488
B#45	19.379	55.748	0.350	0.728	-89.919	128.677
B#46	10.662	52.662	0.200	0.840	-92.585	113.909
B#47	-46.114	53.022	-0.870	0.385	-150.067	57.838
B#48	-123.583	56.324	-2.190	0.028	-234.008	-13.157
B#49	-8.819	56.400	-0.160	0.876	-119.395	101.757
B#50	-3.458	51.383	-0.070	0.946	-104.198	97.282
B#51	-38.672	52.005	-0.740	0.457	-140.631	63.286
B#52	-8.588	56.216	-0.150	0.879	-118.803	101.627
C# 2	22.595	43.471	0.520	0.603	-62.631	107.821
C# 3	37.279	47.820	0.780	0.436	-56.474	131.032
C# 4	49.839	46.790	1.070	0.287	-41.893	141.571
C# 5	1.019	46.856	0.020	0.983	-90.844	92.882
C# 6	48.902	43.727	1.120	0.263	-36.825	134.630
C# 7	-13.740	45.752	-0.300	0.764	-103.437	75.957

Table S6 continued

ADFI	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
C# 8	39.883	47.178	0.850	0.398	-52.611	132.376
C# 9	-22.402	47.552	-0.470	0.638	-115.629	70.824
C#10	66.132	44.702	1.480	0.139	-21.508	153.772
C#11	59.960	44.358	1.350	0.177	-27.005	146.925
C#12	85.582	45.635	1.880	0.061	-3.887	175.051
C#13	94.767	44.591	2.130	0.034	7.347	182.188
C#14	90.179	45.650	1.980	0.048	0.681	179.677
C#15	72.150	45.190	1.600	0.110	-16.447	160.746
C#16	22.135	47.446	0.470	0.641	-70.884	115.153
C#17	72.131	44.703	1.610	0.107	-15.511	159.772
C#18	18.891	44.748	0.420	0.673	-68.837	106.620
C#19	46.457	45.563	1.020	0.308	-42.870	135.784
C#20	83.868	47.400	1.770	0.077	-9.061	176.797
C#21	-27.137	47.774	-0.570	0.570	-120.799	66.525
C#22	-3.620	47.945	-0.080	0.940	-97.619	90.378
C#23	66.021	45.114	1.460	0.143	-22.426	154.467
C#24	12.616	45.403	0.280	0.781	-76.397	101.630
C#25	23.200	45.227	0.510	0.608	-65.467	111.868
C#26	40.258	46.507	0.870	0.387	-50.920	131.436
C#27	47.604	47.830	1.000	0.320	-46.166	141.375
C#28	31.589	45.564	0.690	0.488	-57.739	120.917
C#29	56.837	45.217	1.260	0.209	-31.812	145.486
C#30	-9.632	46.273	-0.210	0.835	-100.351	81.086
C#31	139.559	44.157	3.160	0.002	52.988	226.131
C#32	21.876	44.200	0.490	0.621	-64.779	108.530
C#33	-4.350	47.455	-0.090	0.927	-97.385	88.686
C#34	57.135	43.601	1.310	0.190	-28.345	142.616
C#35	30.614	44.586	0.690	0.492	-56.798	118.026
C#36	42.922	44.485	0.960	0.335	-44.292	130.136
C#37	-3.924	44.418	-0.090	0.930	-91.007	83.158
C#38	75.505	45.687	1.650	0.098	-14.065	165.075
C#39	49.901	44.909	1.110	0.267	-38.144	137.946
C#40	23.520	45.906	0.510	0.608	-66.479	113.520
C#41	6.383	45.451	0.140	0.888	-82.725	95.492
C#42	27.039	44.809	0.600	0.546	-60.809	114.887
C#43	16.096	44.750	0.360	0.719	-71.636	103.829
C#44	40.120	45.239	0.890	0.375	-48.572	128.811
C#45	39.621	45.593	0.870	0.385	-49.765	129.007
C#46	81.621	44.579	1.830	0.067	-5.777	169.018
C#47	90.955	44.271	2.050	0.040	4.161	177.750
C#48	11.162	48.150	0.230	0.817	-83.238	105.562

Table S6 continued

ADFI	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
C#49	72.141	45.396	1.590	0.112	-16.859	161.141
C#50	90.773	42.872	2.120	0.034	6.722	174.824
C#51	65.647	44.143	1.490	0.137	-20.896	152.191
C#52	46.383	46.811	0.990	0.322	-45.390	138.156
flow#c.fill						
WF_finishing	13.806	2.335	5.910	0.000	9.227	18.385
flow#c.mortality						
WF_finishing	-8.194	2.107	-3.890	0.000	-12.325	-4.063
flow#c.sowfarm						
WF_finishing	28.861	4.787	6.030	0.000	19.475	38.247
flow#c.NE						
WF_finishing	-0.235	0.075	-3.150	0.002	-0.382	-0.089
flow#year						
WF_finishing#2016	25.881	9.919	2.610	0.009	6.433	45.330
WF_finishing#2017	39.555	11.082	3.570	0.000	17.826	61.284
size#c.fill						
< 1500	-6.336	4.551	-1.390	0.164	-15.258	2.587
> 3500	4.035	1.784	2.260	0.024	0.538	7.533
size#c.sowfarm						
< 1500	-16.398	6.758	-2.430	0.015	-29.651	-3.145
> 3500	5.479	3.655	1.500	0.134	-1.687	12.646
size#feeder						
< 1500#Tube	-66.377	27.919	-2.380	0.018	-121.181	-11.573
< 1500#Wetdry	-6.019	34.354	-0.180	0.861	-73.463	61.426
> 3500#Tube	49.317	17.654	2.790	0.005	14.654	83.980
> 3500#Wetdry	14.617	19.328	0.760	0.450	-23.328	52.562
Constant	2716.176	172.736	15.720	0.000	2377.460	3054.892
Random-effects Parameters	**Estimate**	**SE**	**95% LCL**	**95% UCL**		
site: Identity						
var(cons)	3447.749	318.849	2876.181	4132.901		
closeout: Identity						
var(vargrp)	13410.910	761.781	11997.960	14990.260		
var(Residual)	9139.323	307.505	8556.068	9762.337		
Model	**Observations**	***df***	**AIC**	**BIC**		
Finisher ADFI	4,743	207	58351.92	59690.06		

ADFI = average daily feed intake; LCL = lower confidence limit; UCL = upper confidence limit; BW = body weight; NE = net energy; WF = wean-to-finish; AIC = Akaike information criterion; BIC = Bayesian information criterion.

Table S7: Parameter coefficients and statistics for finisher G:F

G:F		Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
fill		0.001	0.109	0.010	0.992	-0.212	0.214
startwt		-1.414	0.041	-34.650	0.000	-1.494	-1.334
mortality		-2.139	0.172	-12.450	0.000	-2.476	-1.803
sowfarm		1.286	0.266	4.830	0.000	0.764	1.809
NE		0.110	0.006	19.210	0.000	0.098	0.121
system							
A		0.000	(base)				
B		261.687	43.017	6.080	0.000	177.343	346.031
C		-22.978	35.524	-0.650	0.518	-92.630	46.675
flow							
Finishing		0.000	(base)				
WF_finishing		12.057	1.183	10.190	0.000	9.737	14.376
size							
1500 - 3500		0.000	(base)				
< 1500		-9.634	4.007	-2.400	0.016	-17.491	-1.776
> 3500		-1.646	1.568	-1.050	0.294	-4.720	1.427
year							
2015		0.000	(base)				
2016		1.838	0.784	2.340	0.019	0.301	3.375
2017		7.275	1.222	5.950	0.000	4.879	9.671
startwk							
	1	0.000	(base)				
	2	-2.365	3.260	-0.730	0.468	-8.757	4.027
	3	-6.584	3.741	-1.760	0.079	-13.920	0.751
	4	0.044	3.410	0.010	0.990	-6.644	6.732
	5	-0.715	3.531	-0.200	0.840	-7.640	6.210
	6	-1.754	3.216	-0.550	0.586	-8.061	4.553
	7	-2.990	3.294	-0.910	0.364	-9.450	3.469
	8	-2.590	3.416	-0.760	0.448	-9.288	4.108
	9	-5.442	3.586	-1.520	0.129	-12.475	1.590
	10	-0.418	3.338	-0.130	0.900	-6.963	6.127
	11	-3.344	3.359	-1.000	0.320	-9.931	3.243
	12	-0.804	3.435	-0.230	0.815	-7.539	5.931
	13	-7.855	3.359	-2.340	0.019	-14.442	-1.268
	14	-6.904	3.434	-2.010	0.044	-13.637	-0.170
	15	-4.001	3.343	-1.200	0.231	-10.557	2.554
	16	-6.006	3.557	-1.690	0.091	-12.982	0.969
	17	-7.489	3.328	-2.250	0.025	-14.014	-0.964
	18	-8.748	3.224	-2.710	0.007	-15.071	-2.426
	19	-9.881	3.263	-3.030	0.002	-16.280	-3.482
	20	-6.614	3.524	-1.880	0.061	-13.525	0.296

Table S7 continued

G:F	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
21	-12.349	3.608	-3.420	0.001	-19.425	-5.273
22	-2.410	3.594	-0.670	0.502	-9.457	4.636
23	-1.728	3.471	-0.500	0.619	-8.535	5.079
24	-6.119	3.273	-1.870	0.062	-12.537	0.298
25	-3.117	3.453	-0.900	0.367	-9.889	3.654
26	-5.863	3.423	-1.710	0.087	-12.575	0.850
27	-3.477	3.520	-0.990	0.323	-10.379	3.425
28	-4.127	3.363	-1.230	0.220	-10.722	2.468
29	-6.692	3.358	-1.990	0.046	-13.277	-0.108
30	-6.807	3.304	-2.060	0.040	-13.286	-0.327
31	2.306	3.221	0.720	0.474	-4.010	8.621
32	3.202	3.402	0.940	0.347	-3.468	9.872
33	-5.356	3.474	-1.540	0.123	-12.169	1.457
34	-4.944	3.334	-1.480	0.138	-11.482	1.595
35	-10.999	3.291	-3.340	0.001	-17.452	-4.546
36	-7.901	3.376	-2.340	0.019	-14.520	-1.281
37	-7.433	3.295	-2.260	0.024	-13.895	-0.972
38	-6.616	3.366	-1.970	0.049	-13.216	-0.016
39	-9.115	3.329	-2.740	0.006	-15.644	-2.587
40	-14.632	3.220	-4.540	0.000	-20.946	-8.317
41	-14.493	3.371	-4.300	0.000	-21.103	-7.882
42	-10.900	3.261	-3.340	0.001	-17.294	-4.505
43	-9.684	3.330	-2.910	0.004	-16.214	-3.154
44	-7.557	3.236	-2.340	0.020	-13.902	-1.212
45	-3.576	3.402	-1.050	0.293	-10.247	3.094
46	-9.477	3.365	-2.820	0.005	-16.075	-2.879
47	1.892	3.304	0.570	0.567	-4.587	8.370
48	-3.826	3.706	-1.030	0.302	-11.092	3.440
49	0.121	3.507	0.030	0.973	-6.756	6.998
50	-1.556	3.132	-0.500	0.619	-7.697	4.585
51	-4.075	3.160	-1.290	0.197	-10.272	2.122
52	-1.263	3.502	-0.360	0.718	-8.131	5.605
system#c.fill						
B	-0.329	0.372	-0.880	0.377	-1.059	0.401
C	-0.845	0.224	-3.770	0.000	-1.285	-0.405
system#c.startwt						
B	-0.151	0.080	-1.890	0.059	-0.309	0.006
C	-0.429	0.074	-5.770	0.000	-0.575	-0.284
system#c.mortality						
B	-1.546	0.308	-5.020	0.000	-2.150	-0.942
C	-0.944	0.248	-3.810	0.000	-1.429	-0.458

Table S7 continued

G:F	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
system#c.NE						
B	-0.101	0.017	-6.020	0.000	-0.134	-0.068
C	0.022	0.014	1.540	0.123	-0.006	0.049
system#flow						
B-WF_finishing	12.883	2.159	5.970	0.000	8.649	17.116
C-WF_finishing	-4.452	1.490	-2.990	0.003	-7.373	-1.530
system#size						
B# < 1500	10.682	4.180	2.560	0.011	2.485	18.880
B# > 3500	7.186	2.018	3.560	0.000	3.227	11.145
C# < 1500	4.372	4.078	1.070	0.284	-3.626	12.370
C# > 3500	3.666	1.755	2.090	0.037	0.224	7.109
system#year						
B#2016	-0.884	1.159	-0.760	0.446	-3.157	1.388
B#2017	-3.328	1.565	-2.130	0.033	-6.395	-0.260
C#2016	5.305	1.184	4.480	0.000	2.984	7.626
C#2017	2.036	1.491	1.370	0.172	-0.888	4.960
system#startwk						
B# 2	6.628	5.285	1.250	0.210	-3.734	16.991
B# 3	9.662	5.684	1.700	0.089	-1.482	20.806
B# 4	6.136	5.547	1.110	0.269	-4.739	17.012
B# 5	6.578	5.626	1.170	0.242	-4.452	17.608
B# 6	9.307	5.425	1.720	0.086	-1.329	19.944
B# 7	9.155	5.385	1.700	0.089	-1.403	19.712
B# 8	16.027	5.834	2.750	0.006	4.589	27.466
B# 9	13.923	5.623	2.480	0.013	2.898	24.948
B#10	5.603	5.563	1.010	0.314	-5.304	16.510
B#11	15.547	5.435	2.860	0.004	4.890	26.203
B#12	9.356	5.603	1.670	0.095	-1.628	20.340
B#13	21.810	5.804	3.760	0.000	10.432	33.188
B#14	16.948	5.460	3.100	0.002	6.243	27.652
B#15	18.899	5.482	3.450	0.001	8.151	29.646
B#16	20.480	5.612	3.650	0.000	9.478	31.483
B#17	24.829	5.389	4.610	0.000	14.264	35.394
B#18	30.691	5.412	5.670	0.000	20.081	41.301
B#19	30.801	5.635	5.470	0.000	19.754	41.849
B#20	21.716	5.578	3.890	0.000	10.780	32.652
B#21	32.301	5.683	5.680	0.000	21.161	43.442
B#22	27.039	5.691	4.750	0.000	15.881	38.196
B#23	23.629	5.491	4.300	0.000	12.863	34.394
B#24	24.210	5.393	4.490	0.000	13.637	34.783
B#25	28.671	5.627	5.100	0.000	17.639	39.703
B#26	28.308	5.428	5.220	0.000	17.667	38.950

Table S7 continued

G:F	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
B#27	21.213	5.845	3.630	0.000	9.753	32.673
B#28	18.516	5.472	3.380	0.001	7.788	29.245
B#29	19.820	5.849	3.390	0.001	8.352	31.287
B#30	20.866	5.386	3.870	0.000	10.305	31.426
B#31	10.202	5.413	1.880	0.060	-0.410	20.814
B#32	13.538	5.467	2.480	0.013	2.819	24.257
B#33	16.885	5.579	3.030	0.002	5.947	27.823
B#34	13.855	5.405	2.560	0.010	3.259	24.451
B#35	16.871	5.247	3.220	0.001	6.585	27.157
B#36	10.497	5.363	1.960	0.050	-0.017	21.010
B#37	10.541	5.426	1.940	0.052	-0.096	21.179
B#38	9.547	5.517	1.730	0.084	-1.269	20.364
B#39	21.337	5.453	3.910	0.000	10.646	32.028
B#40	13.599	5.508	2.470	0.014	2.800	24.397
B#41	16.988	5.472	3.100	0.002	6.260	27.716
B#42	11.903	5.409	2.200	0.028	1.297	22.508
B#43	11.452	5.399	2.120	0.034	0.867	22.038
B#44	12.323	5.301	2.320	0.020	1.930	22.716
B#45	5.772	5.592	1.030	0.302	-5.191	16.736
B#46	11.953	5.419	2.210	0.027	1.330	22.576
B#47	0.359	5.448	0.070	0.947	-10.321	11.040
B#48	15.929	5.782	2.750	0.006	4.593	27.266
B#49	2.763	5.738	0.480	0.630	-8.487	14.013
B#50	1.092	5.312	0.210	0.837	-9.323	11.506
B#51	11.529	5.357	2.150	0.031	1.027	22.032
B#52	4.261	5.809	0.730	0.463	-7.129	15.651
C# 2	4.130	4.375	0.940	0.345	-4.448	12.708
C# 3	3.888	4.803	0.810	0.418	-5.528	13.304
C# 4	-3.762	4.658	-0.810	0.419	-12.894	5.371
C# 5	-1.178	4.698	-0.250	0.802	-10.389	8.033
C# 6	0.402	4.391	0.090	0.927	-8.207	9.011
C# 7	4.717	4.518	1.040	0.297	-4.141	13.574
C# 8	-0.936	4.733	-0.200	0.843	-10.215	8.343
C# 9	7.438	4.776	1.560	0.119	-1.926	16.802
C#10	0.018	4.504	0.000	0.997	-8.812	8.847
C#11	3.089	4.446	0.690	0.487	-5.627	11.804
C#12	1.741	4.607	0.380	0.705	-7.290	10.772
C#13	10.932	4.523	2.420	0.016	2.065	19.798
C#14	10.373	4.553	2.280	0.023	1.447	19.300
C#15	6.057	4.550	1.330	0.183	-2.863	14.977

Table S7 continued

G:F	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
C#16	16.718	4.834	3.460	0.001	7.241	26.195
C#17	12.067	4.507	2.680	0.007	3.232	20.903
C#18	19.783	4.545	4.350	0.000	10.873	28.693
C#19	19.759	4.586	4.310	0.000	10.768	28.749
C#20	15.705	4.670	3.360	0.001	6.550	24.860
C#21	29.099	4.783	6.080	0.000	19.723	38.476
C#22	18.153	4.751	3.820	0.000	8.838	27.468
C#23	15.083	4.572	3.300	0.001	6.120	24.047
C#24	20.049	4.571	4.390	0.000	11.087	29.011
C#25	16.303	4.569	3.570	0.000	7.346	25.261
C#26	20.232	4.605	4.390	0.000	11.204	29.259
C#27	12.041	4.704	2.560	0.011	2.819	21.263
C#28	11.562	4.582	2.520	0.012	2.579	20.546
C#29	14.364	4.514	3.180	0.001	5.514	23.215
C#30	18.649	4.608	4.050	0.000	9.615	27.682
C#31	2.025	4.453	0.450	0.649	-6.704	10.755
C#32	6.054	4.454	1.360	0.174	-2.679	14.786
C#33	16.409	4.712	3.480	0.001	7.170	25.647
C#34	8.732	4.352	2.010	0.045	0.200	17.265
C#35	12.239	4.483	2.730	0.006	3.451	21.028
C#36	7.648	4.475	1.710	0.088	-1.126	16.423
C#37	8.448	4.453	1.900	0.058	-0.282	17.177
C#38	2.470	4.619	0.530	0.593	-6.585	11.525
C#39	9.540	4.475	2.130	0.033	0.768	18.313
C#40	13.256	4.579	2.890	0.004	4.279	22.233
C#41	12.324	4.533	2.720	0.007	3.438	21.210
C#42	8.001	4.452	1.800	0.072	-0.727	16.728
C#43	7.992	4.508	1.770	0.076	-0.845	16.829
C#44	4.948	4.515	1.100	0.273	-3.903	13.800
C#45	-0.081	4.527	-0.020	0.986	-8.956	8.793
C#46	4.824	4.520	1.070	0.286	-4.037	13.685
C#47	-5.222	4.493	-1.160	0.245	-14.031	3.587
C#48	1.196	4.781	0.250	0.803	-8.178	10.570
C#49	-4.718	4.595	-1.030	0.305	-13.726	4.290
C#50	-3.419	4.331	-0.790	0.430	-11.910	5.071
C#51	2.073	4.440	0.470	0.641	-6.632	10.778
C#52	-1.812	4.702	-0.390	0.700	-11.031	7.407
flow#c.sowfarm						
WF_finishing	-3.423	0.494	-6.930	0.000	-4.392	-2.454

Table S7 continued

G:F	Coefficient	SE	*t*	*P* > *t*	95% LCL	95% UCL
flow#size						
WF_finishing# < 1500	-9.362	3.495	-2.680	0.007	-16.215	-2.508
WF_finishing# > 3500	-3.493	1.338	-2.610	0.009	-6.115	-0.870
size#c.mortality						
< 1500	0.694	0.334	2.080	0.038	0.038	1.349
> 3500	0.213	0.208	1.030	0.304	-0.194	0.621
size#c.sowfarm						
< 1500	0.187	0.618	0.300	0.763	-1.025	1.398
> 3500	-1.098	0.367	-2.990	0.003	-1.817	-0.378
Constant	105.857	16.055	6.590	0.000	74.375	137.339
Random-effects Parameters	**Estimate**	**SE**	**95% LCL**	**95% UCL**		
site: Identity						
var(cons)	54.994	4.374	47.056	64.270		
closeout: Identity						
var(vargrp)	150.880	8.130	135.758	167.687		
var(Residual)	101.601	3.377	95.193	108.441		
Model	**Observations**	***df***	**AIC**	**BIC**		
Finisher G:F	5187	194	41777.78	43049.24		

G:F = gain to feed ratio; LCL = lower confidence limit; UCL = upper confidence limit; BW = body weight; NE = net energy; WF = wean-to-finish; AIC = Akaike information criterion; BIC = Bayesian information criterion.