ORIGINAL RESEARCH

Influence of weaning site, weaning age, and viral exposure on production performance in early-weaned nursery pigs

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Summary

Purpose: *To determine the effects of nursery site location and weaning age on feed intake, average daily gain, and feed efficiency in 888 nursery pigs.*

Methods: *Pigs on a 5000-sow production system with two sow sites and one offsite nursery location were assigned to one of two weaning-age groups: a younger weaning-age group (weaning at 8–13 days [3.33 kg; 7.33 lb]) or an older weaning-age group (weaning at 17–21 days [4.92 kg; 10.83 lb]). The pigs in the onsite locations were weaned into nursery facilities adjoining the farrowing sites. The pigs in the offsite location originated from both farrowing sites and were allocated by age block to two identical but separate offsite nursery buildings. Feed intake, average daily gain, and feed efficiency were measured. To monitor health status, nasal swabs and serum samples were obtained, and incidence of diarrhea was measured.*

Results: *Serological evidence via serum neutralization (SN) was detected for TGEV. Immunofluorescent-antibody titers (IFA) for PRRSV were also positive. The west farrowing site was diagnosed with TGEV 30 days prior to the start of this trial. Serological evidence generally revealed decreasing antibody titer to TGEV and PRRSV. The serology of tested pigs that remained onsite at the east farrowing site demonstrated a two- to fourfold rise of PRRSV titers in four of six pigs tested 42 days after weaning. Pigs moved offsite demonstrated decreasing titers to both TGEV and PRRSV. Both average daily gain and feed efficiency were improved in later weaning-age group pigs compared to early weaning-age group pigs.*

Implications: *Weight at weaning may be more of a factor than age at weaning (if < 21 days) in terms of subsequent growth performance. Site separation of pigs did not eliminate transmission of selected infectious agents as pigs at all sites were culture positive for* Streptococcus suis *and toxigenic* Pasteurella multocida*. Milk antibodies may prevent viral colonization and reduce the spread of viral disease when pigs are moved away from the sow herd.*

Keywords: *swine, segregated early weaning (SEW), weaning age, growth performance*

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Reports concerning the effects of weaning age on pig performance in the nursery and the ability to eliminate pathogens conflict. Wiseman, et al., suggested that the ability to successfully eradicate pathogens increases as weaning age declines.[1] Clark, et al., observed that isolating pigs was as effective as medication and vaccination and they varied weaning age protocols in controlling the transmission of the pathogens (except for *Haemophilus parasuis*) that were investigated.[2]

The first goal of our experiment was to evaluate the performance of two age blocks within three nursery site locations. A second goal was to serologically monitor pigs in all nursery rooms to evaluate passive titer decline and possible active titer rise for transmissible gastroenteritis virus (TGEV) and porcine reproductive and respiratory syndrome virus (PRRSV), because one of the farrowing sites was diagnosed with TGEV 30 days prior to the beginning of this study. Sows had been vaccinated for TGEV prior to farrowing and PRRSV prior to breeding.

Materials and methods

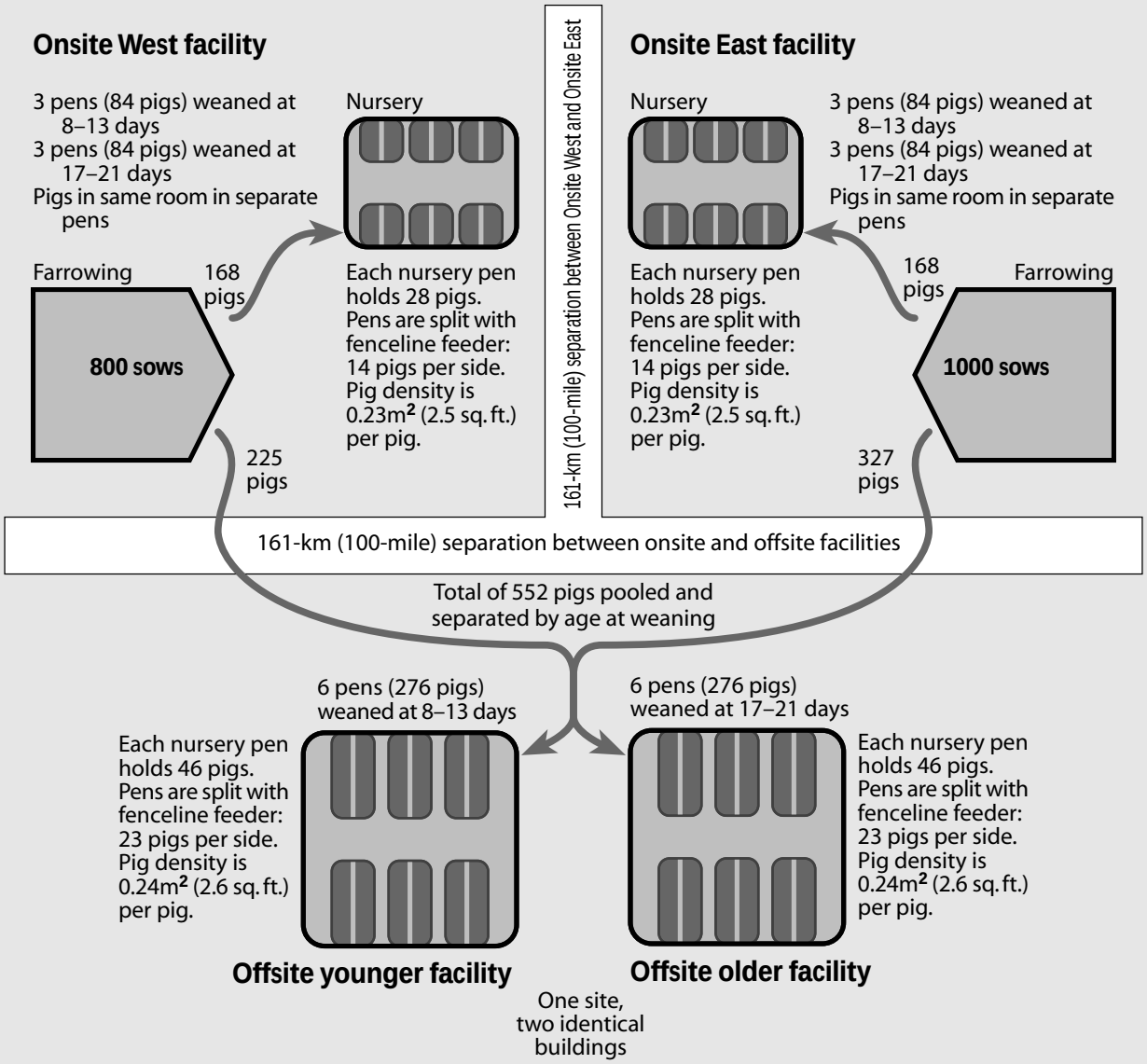
Experimental design

From a 5000-sow production system, managed by an independent management company, we used two farrowing sites. We obtained 495 pigs from a 1000-sow commercial unit that farrows 45 sows per week ("farrowing east") and 393 pigs from an 800-sow commercial unit ("farrowing west"). The east farrowing facility was 161 km (100 miles) away from the west farrowing facility. The 888 pigs were blocked by age so that half were weaned at 17–21 days of age ("older weaning-age group pigs," n = 444) and half were weaned at 8–13 days of age ("younger weaning-age group pigs," n = 444) (Figure 1).

Onsite

Of the 888 pigs included in the study, 336 were moved to facilities adjoining their respective farrowing sites (i.e., "onsite nursery east" and "onsite nursery west"). The onsite pigs were placed in pens according to their weaning age, so that younger weaning-age group pigs were in separate pens from older weaning-age group pigs. Thus, each onsite nursery facility had 84 older weaning-age group pigs and 84 younger weaning-age group pigs for a total of 168 pigs per onsite nursery facility and a grand total of 336 designated to the onsite group. In each nursery room, there were three pens of pigs from the older weaning-age group (32 pigs per pen) and three pens of pigs from the younger weaning-age group. In both nursery sites, pigs were placed in 3.04 m × 2.13 m (10 ft × 7 ft) pens (0.23 m^2 per pig, 2.5 ft^2 per pig) with fenceline feeders.

Figure 1



Experimental pig flow and schematic relationship of sites. Note that only 888 pigs were evaluated from the total farrowed in this production scheme. The facilities were filled with pigs from the farrowing sites, but there were additional pens in each facility not included in the study.

Offsite

Of the 888 pigs in the study, 552 were removed to offsite nursery facilities. Two hundred and seventy-six pigs from the older weaning-age group were placed in an offsite nursery facility ("older offsite nursery") and 276 from the younger weaning-age group were placed in a separate but identical building on the same farm ("younger offsite nursery") located 161 km (100 miles) from the onsite nurseries and 3.22 km (2 miles) from any other pig farms. There were six pens of study pigs in each offsite building with fenceline feeders, with six feeding spaces per feeder. Pens were 3.66 m × 3.05 m (12 ft × 10 ft) to allow for an animal density of 0.24 m^2 (2.6 ft^2) per pig. Six pens were studied in each building; however, all pens were filled with pigs.

Husbandry

Water was provided at all sites via Suivea® porcelain cup waterers.

Pigs in all groups received rations formulated by a major feed manufacturing company (Appendix A). In this study, there were five different rations used and the pigs weaned at the younger age received a different starter ration than the older pigs.

Pigs received no immunizations, but did receive 100 mg of iron at 1 day of age, teeth were clipped, tails were docked, and male pigs were

castrated at 5 days of age. Each nursery room was monitored using a high-low thermometer to determine environmental temperatures and this temperature was recorded once a week. Pigs were received into a room at a temperature of 35°C (95°F), which was reduced 0.6°C (1°F) each day for 7 days. The temperature was reduced by 1.2°C (2°F) at the end of each week for the 6 weeks of the nursery period.

Health monitoring

In an effort to be 95% confident of detecting an infected or serologically positive animal with a suspected prevalence of 40% in a population of 168 or 276 animals, six pigs would have to be tested in each of four rooms for a total of 24 animals.[4] We obtained nasal swabs and serum samples from 24 pigs for culture of suspected bacterial organisms on the first day of the study (day 1) and again on the last day of the study (day 42).

The stools of the pigs were observed and scored at the end of each week. Due to the logistics of this study and lack of adequate cool storage space at the offsite location, dead pigs were not available for autopsy.

Growth monitoring

Feed disappearance and body weight gain were recorded weekly for all pigs. On the farms of origin, Fairbanks dial scales were used to weigh feed and pigs to the nearest pound (2.2 kg). On the offsite farm, a Pride-of-the-Farm digital scale was used to weigh feed and pigs to nearest 0.10 lb (0.05 kg) (this weight was then rounded to the nearest pound).

Statistical analysis

In this study, the pen was the experimental unit. These data were analyzed as a split-plot (by week for 6 weeks) 2×3 factorial in the general linear model procedures of SAS.[3] For performance, the model was blocked for weaning age and included the effects of environment (location) and their interaction. Significant differences between means were determined by a least significant differences (LSD) test. This testing procedure would adjust for unequal pen size. Sample size was predetermined by pen availability according to the production goals of the general manager.

Results

Health monitoring

Death loss remained under 1.5% at all sites.

Serology

At the beginning of the study, the *Mycoplasma hyopneumoniae* antibody titers for the 24 monitored pigs were all < 1, the swine influenza titers were ≤ 1, and the *A. pleuropneumoniae* titers were < 1. These values are considered negative (Oxford Laboratories, Worthington, Minnesota).

At the start of this study, pigs in the onsite east nursery had demonstrated PRRSV titers of 16 or less. A two- to fourfold rise in titer in four of six animals tested from the east onsite nursery for PRRSV was observed at the end of the study 6 weeks later. Results of serology for one pig in the west onsite nursery demonstrated a threefold rise in PRRSV titers over the course of the study. One younger weaning-age group pig demonstrated the same PRRSV titer of 16 at the beginning of the study and 42 days later. For most pigs at the offsite nurseries, PRRSV titers either stayed the same during the course of the study or dropped (Table 1). For two pigs at the older onsite nursery, PRRSV titers increased.

Table 1

Sample pig	TGE Results Start	TGE Results End	PRRS Results Start	PRRS Results End
Offsite younger				
1	32	4	<4	<4
2	16	4	16	<4
3	128	4	<4	<4
4	16	4	<4	<4
5	>512	8	64	<4
6	64	4	16	<4
Offsite older				
7	>512	128	<4	<4
8	32	4	16	16
9	64	4	16	<4
10	32	4	64	<4
11	>512	8	16	<4
12	256	128	64	<4
Onsite East *(younger)*				
13	>512	16	16	64
14	32	16	16	16
15	16	4	16	64
(older)				
16	16	8	<4	<4
17	64	8	<4	16
18	64	8	16	256
Onsite West *(younger)*				
19	256	16	16	16
20	>512	64	16	16
21	16	64	4	<4
(older)				
22	256	64	16	16
23	64	16	<4	16
24	256	64	16	<4

TGEV and PRRSV titer results of 24 sample pigs at day 1 (start) and day 42 (end)

TGEV titers for all monitored pigs decreased significantly ($P < .05$) during the study (Table 1), regardless of weaning age or whether they were on- or offsite.

Nasal swabs

On day 1, all 24 monitored pigs cultured positive to *Streptococcus faecalis* in the nasal passages (bacteriology conducted by Oxford Laboratories, Worthington, Minnesota). At the end of the study 42 days later, pigs from each room cultured positive to *Streptococcus suis* and *Pasteurella multocida* type A and toxigenic type D.

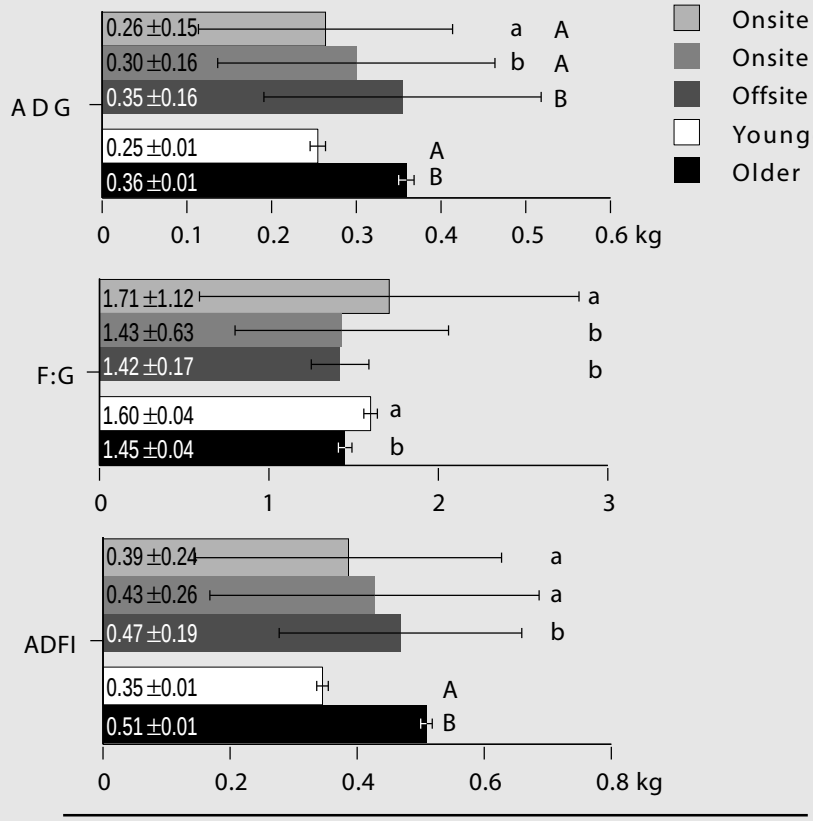
Diarrhea

At the end of the first week of the study, 40% of the west onsite nursery pigs (diagnosed with TGEV) had loose or watery stools. In the following weeks, the stools were observed to be normal at this site as well as on the other onsite nursery. Twenty percent of the pigs located in the older offsite facility had loose stools throughout the study, and all rooms except the younger pigs located at the offsite facility demonstrated an increased incidence of loose stools for the last 2 weeks of the study.

Growth monitoring

The mean starting weight of the older weaning-age group pigs was 4.92 kg (10.83 lb) and the mean starting weight of the younger weaning-age group pigs was 3.33 kg (7.33 lb). The older weaning-age group pigs demonstrated a significantly greater average daily gain (ADG) ($P<.01$) than the younger weaning-age group pigs (Figure 2). This trend was consistent throughout the study. Growth curves of the pigs weighing 4.92 kg (10.83 lb) at weaning consistently exceeded the pigs that weighed 3.33 kg (7.33 lb) at weaning (Figure 3) for both on- and offsite pigs.

Figure 2



Comparison of performance parameters by site and by age group
a,b Differences among sites or age groups are significant, $P<.05$
A,B Differences among sites or age groups are significant, $P<.01$

In this study, ADG was consistently lower in onsite pigs compared to the offsite pigs (Figure 2). There was also a trend for increased ADG in older weaning-age group pigs that were moved to an offsite nursery compared to those in the younger weaning-age group. (Figure 4). Although there was a discernible trend for improved ADG in both weaning age groups moved offsite, it was only significant in the older weaning-age group pigs.

Feed efficiency (F:G) was significantly poorer ($P<.05$) at the west onsite nursery compared to the east onsite nursery than at either of the offsite nursery locations (Figure 2). The feed efficiency of the older weaning-age group pigs was significantly better ($P<.05$) than the younger weaning-age group pigs regardless of whether they were on- or offsite. (Figure 2).

Feed disappearance was significantly greater for older weaning-age group pigs ($P<.01$) compared to younger weaning-age group pigs during the 42 days of this study. Feed disappearance was significantly better ($P<.05$) for the pigs raised offsite (Figure 2) compared to onsite pigs. This trend was demonstrated over the duration of the study.

Discussion

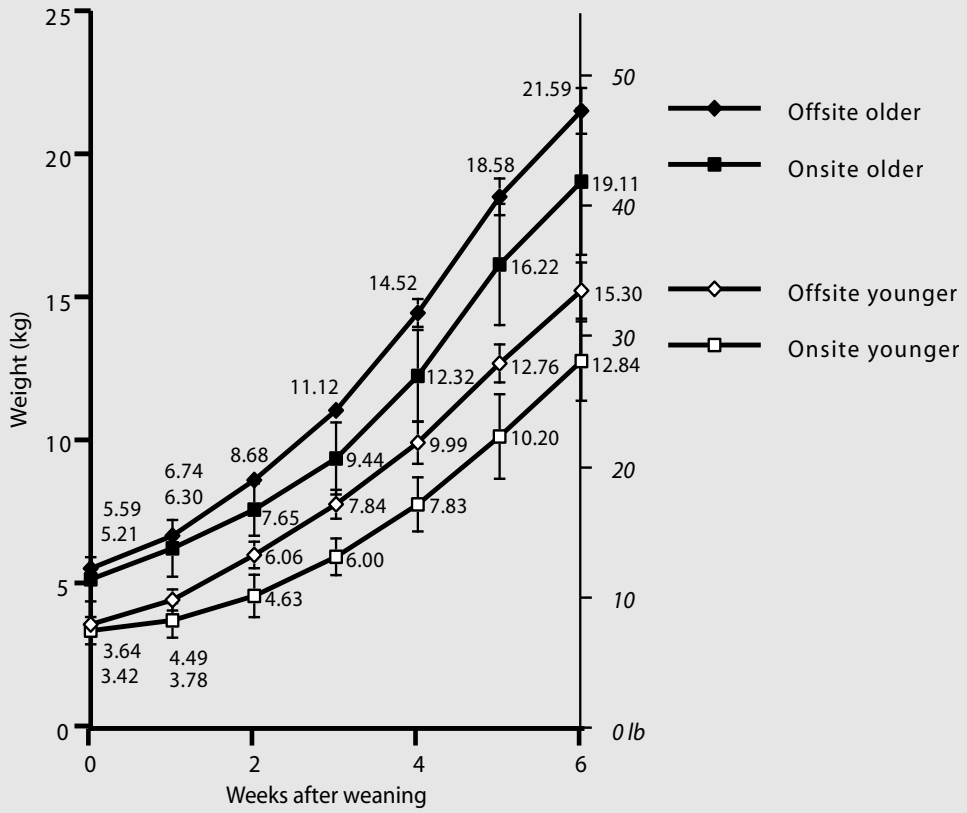
Growth performance

Potential selection biases may have favored the offsite location because standard deviations of starting weights for these pigs were smaller than the other sites (Table 2). However, the differences in starting weights were not statistically significant.

Feed efficiency was extremely poor during the first week of the study at the west onsite nursery. However, this was not a consistent trend. The decreased initial feed efficiency in this onsite nursery was most likely due to a lack of zone heating and excessive temperature manipulation in that nursery during the first week of the study.

For this multi-sow farrowing site production system with nurseries located on- and offsite, it would appear that a 17–21 day weaning age or an average weaning weight of 4.5 kg (10 lb) should be targeted in an effort to achieve the greatest ADG.

Figure 3



Growth curves comparing older and younger weaning age groups and offsite and onsite groups.

Health

Virus

The rate of SN titer decay for TGEV seems to be different for all pigs. Serum neutralization testing is not specific for any one immunoglobulin. Studies of piglet serum following the ingestion of colostrum show that all three classes of immunoglobulin — IgG, IgA, IgM — are absorbed from colostrum, that the pattern of the decline of these antibodies in the serum is almost exponential, and that the half lives of immunoglobulin classes can be determined from the assays of serum concentrations over a period of 2–3 weeks.[5] These findings have been examined more closely using immunoglobulins labeled with Iodine 125 where the mean half lives were determined to be 2.8 days for IgM, 2.7 days for IgA, and 9.1 days for IgG.[6]

The threefold rise in PRRSV titers in the one pig at the west onsite nursery suggests active viral exposure. It is believed that the pigs that remained in the onsite east nursery were exposed to active PRRSV.

The apparent lack of viral activity in the pigs tested at either offsite location does not necessarily suggest that this practice will eliminate all pathogens. The pigs located offsite were also diagnosed with *S. suis* and toxigenic *P. multocida* at the end of the study. Coinfection with these pathogens may result in decreased performance parameters even in pigs moved offsite.

It would appear that moving the pigs to an offsite location will reduce the incidence of viral shedding even when pigs originate from TGEV-positive and PRRSV-positive sources.

Diarrhea

The diarrhea experienced by the older pigs at the offsite facility may be the result of inappropriate nutrient balance for some pigs and may suggest a nutrient balance consistent with the intake of healthy pigs starting at a weight of 3.6 kg (8 lb) and growing to 15.9 kg (35 lb) at the end of 6 weeks.

For an enteric virus such as TGEV, this may be partially explained by recognizing the role of orally ingested antibodies from the milk while the pig is nursing. Orally administered antibodies from both serum and milk have been shown to protect against enteropathogenic serotypes of *Escherichia coli* in experimentally infected gnotobiotic pigs.[7,8,9] All these studies were conducted on piglets at an age when intestinal absorption of immunoglobulins no longer occurred (>3-day-old piglets). Wilson determined that the young pig ingested nearly 3 g of immunoglobulin per day.[10] Wilson also determined that a 7-day-old pig could receive as much immunoglobulin each day orally as it contained in its blood circulation.[10] Since orally ingested milk antibodies

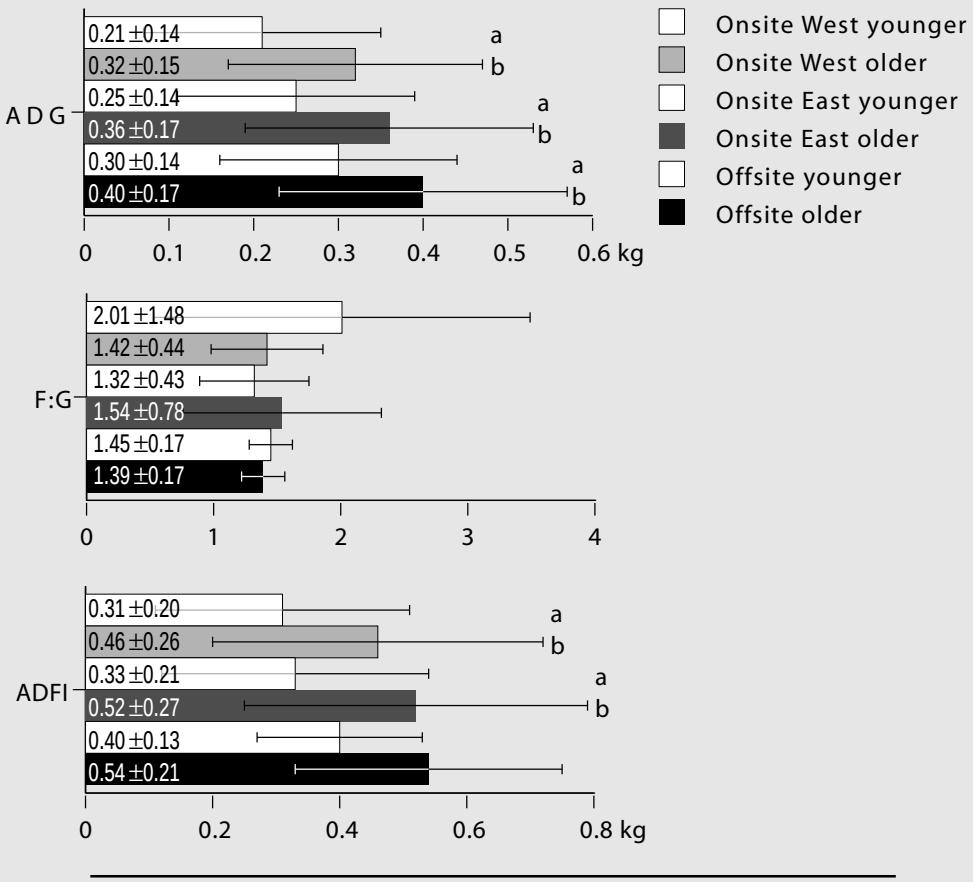
are directed at the site of major infective challenge, in the face of TGEV exposure their local protective function cannot be overemphasized.

If the sow continues to pass protective milk antibodies to her piglets to day 18–21, it may be more advantageous to wean the pigs at 18–21 days of age when enteric virus is present. Circulating blood antibodies from the colostrum would be declining, but a later weaning age would allow a longer exposure to milk antibodies. In this study, it is believed that the pigs blood-tested at the offsite location had received adequate colostral antibody protection, but by 17–21 days of age, two of the tested pigs had titers of 16. These pigs had received adequate milk antibodies to avoid TGEV colonization as the titers continued to drop. When they were moved away from the sow herd, the contact with TGEV was eliminated.

The pig that remained at the onsite west nursery with a TGEV titer of 16 at weaning may have been exposed to active virus as soon as the protective milk antibodies dropped.

The effects of milk antibodies on PRRSV are unknown at this time. It is possible that the effects may be similar to those of TGEV, because the pigs in this study that were moved to an offsite location at weaning demonstrated decreasing titers (except for one pig that stayed the same). At the onsite east nursery, active PRRSV is suspected because rising titers were observed 42 days after weaning.

Figure 4



Comparison of performance parameters by site and age group
a,b Differences within a site or between age groups are significant, $P<.01$

Table 2

Starting and ending weight by site and age at weaning

Site	Age group	Mean starting weight, kg (lb)	Mean ending weight, kg (lb)
Onsite West	younger	3.13 ±1.09 (6.90 ±2.40)	12.43 ±4.59 (27.40 ±10.11)
	older	4.81 ±1.56 (10.60 ±3.43)	16.56 ±6.60* (36.50 ±14.56)
Onsite East	younger	3.45 ±0.50 (7.60 ±1.10)	13.38 ±1.00 (29.50 ±2.21)
	older	4.35 ±1.79 (9.60 ±3.79)	18.05 ±5.92* (39.80 ±13.05)
Offsite	younger	3.63 ±0.31 (8.00 ±0.68)	15.29 ±0.89 (33.70 ±1.97)
	older	5.58 ±0.27 (12.30 ±0.60)	21.55 ±0.73*† (47.50 ±1.61)

* $P<.05$ compared to younger end weight same site
† $P<.06$ compared to onsite West end weight

Implications

- In this study the ADG of the older weaning-age group pigs (weighing 4.92 kg [10.83 lb] at weaning) was 35%–45% higher than the younger weaning-age group pigs (weighing 3.33 kg [7.33 lb] at weaning). It is possible that the industry may need to focus on weaning weights instead of weaning age as long as weaning age is kept below 21 days.
- Site separation of pigs did not eliminate transmission of infectious agents because pigs at all sites cultured positive for *S. suis* and toxigenic *P. multocida*.
- Milk antibodies may prevent viral colonization and reduce the spread of some viruses when pigs are moved away from the sow herd.
- For this study, the established room temperature protocol proved to be acceptable for both weaning weights of pigs.

Appendix A

	Starter	Starter/phase I	Phase II	Phase III	Phase IV
Amount (kg [lb]) of ration fed					
8–13-day wean	1.1 (2.5)	4.54 (10.0)	4.54 (10.0)	4.54 (10.0)	4.54–6.80 (10.0–15.0)
17–21-day wean	0.0 (0.0)	1.8 (4.0)	4.54 (10.0)	4.54 (10.0)	9.07–13.6 (20.0–30.0)
Composition of diet (%)					
Crude protein	21.15	22.92	22.63	21.59	25.03
Crude fat	10.30	6.64	6.09	8.82	6.03
Crude fiber	0.45	2.16	2.53	1.38	2.71
Ash	7.30	6.09	6.04	5.64	6.11
Moisture	7.42	10.27	12.18	10.59	11.79
Available lysine	1.36	1.21	1.11	1.08	1.13
Energy (kcal/kg)					
Gross energy	3910	3590	3470	3740	3480

Diet composition

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