Performance and disease status of pigs grown in a wean-to-finish facility compared to pigs grown in a conventional nursery and grower-finisher facility

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Summary

Health and growth performance were similar whether pigs weaned at 11 to 14 days were raised to market weight in a wean-to-finish facility (999 pigs), or in a grower-finisher facility (998 pigs) located on the same site and managed by the same personnel, after 5 to 7 weeks in an off-site nursery.

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Herd size expansion across the United States pork industry has allowed for specialization by production phase and site. Commonly, sows farrow on one site, and pigs are weaned to a nursery on a second site and moved to a grower-finisher facility on a third site.[1] The concept of multi-site production for the purpose of disease eradication was introduced by Alexander (1980).[2] Presumably, a low level of immune activation is maintained when vertical pathogen transfer between pigs is minimized. [2,3,4]

There is a growing interest in eliminating the nursery phase of production, and moving weaned pigs less than 21 days old into a modern grower-finisher facility where they will stay until they reach market weight. The design of the "wean-to-finish" barn is similar to a total-slat, double-curtain, grower-finisher barn, except that a supplementary heat source is provided for the pigs' first 7 to 14 days in the facility. An infrared heater is suspended over the center alley, or each pen is provided with a 250-watt heat lamp suspended over a mat. Infrared brooders have also been used to provide zone heat, and suspended space heaters may provide additional room heat.

In a study by Connor (1996), 27,939 pigs housed in a wean-to-finish facility gained 0.69 kg (1.51 lb) per day in 167 days, when started at a weight of 4.1 kg (9 lb) and marketed at 114.9 kg (253 lb),[5] with a feed:gain of 2.54. However, there was no control group in this study, and a direct comparison could not be made to more traditional management practices.

In this study, contemporary pigs were placed into two differently managed groups, with 998 pigs raised in a conventional three-site system, and 999 raised in a wean-to-finish system.

Materials and methods

Experimental design

Approximately 2000 barrows from a 2400-sow, farrow-to-wean, breeding stock farm were weaned over a 4-week period beginning on April 1, 1999. Twice a week, 250 pigs were weaned at 11 to 14 days of age, and were assigned to study groups in accordance with the normal production flow of the system. Nine hundred and ninety eight pigs were weaned into a nursery facility on an isolated site (WNF). Two weeks later, 999 pigs were weaned into a total-slat, double-curtain, wean-to-finish facility (WF) 50 miles from the nursery. After 5 weeks (496 pigs) or 7 weeks (495 pigs) in the nursery, the WNF pigs were moved into a grower-finisher facility identical to the wean-to-finish barn and located on the same site. Pen integrity was maintained when the nursery pigs were moved to the grower-finisher site. Pigs were marketed from each barn when 175 to 190 pigs had reached an average weight of 118 kg (260 lb).

Facilities

The nursery was an isolated, 2000-head, four-room Hog Slat® building built over a deep pit. It had been previously occupied by eight groups of pigs between completion of the building in December of 1998, and placement of the WNF pigs in April 1999. Each of the four nursery rooms housed 500 pigs in twenty 1.8 × 3.0 m (6 × 10 ft) pens with plastic-coated wire flooring, providing 0.22 m^2 (2.4 ft^2) per pig with 25 pigs per pen. A propane-fueled space heater was suspended from the ceiling in each room. Room temperature was maintained at 29°C (84°F) for the first 7 days, then dropped by 0.28 C° (0.5F°) per day so that the room temperature was 20.5°C (69°F) after the pigs had been in the nursery for approximately 5 weeks, and 18°C (64°F) after approximately 7 weeks. For the first 3 weeks of the study, staff perceived that environmental ammonia levels in the nursery facility were higher than in the two new barns on the other site. This situation was corrected by making minor adjustments to the nursery ventilation system.

On the grower-finisher site, two identical, 1000-head, total-slat, deep-pit, double-curtain, grower-finisher barns (Hog Slat® turn-key) were located 45 m (50 yards) apart and were managed by the same personnel. The curtains faced east and west because of the prevailing SW winds, and the WF pigs were placed in the west barn,

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limiting air flow from the older WNF group in the east barn. These were the first pigs housed in these buildings.

Each barn contained 40 pens, each 3 × 6 m (10 × 20 ft), with one fence-line feeder between two adjoining pens. With 25 pigs per pen, and accounting for the 0.45 m^2 (5 ft^2) occupied by the feeder, this provided 0.70 m^2 (7.8 ft^2) per pig. The floors were 12.5-cm (5-inch) concrete slats with 2.5-cm (1-inch) slots.

Supplemental heat was provided for the first 7 to 10 days after the 999 WF pigs were weaned into the grower-finisher barn. Two 125-watt heat lamps were suspended over a 1.2 × 1.2 m (4 × 4 ft) black rubber mat located at the front of the pen, 1.8 m (6 ft) from the feeder, providing a heated zone with a sleeping surface temperature between 33.5 and 35°C (92 to 95°F) as determined by a handheld infrared thermometer. Two space heaters suspended from the ceiling heated the building. The thermostat was set at 24°C (75°F) for the first 7 days and dropped by 0.5 F° per day, so that by the end of May, when the pigs had been in the wean-to-finish barn for approximately 5 weeks, room temperature was 20.5°C (69°F).

The nursery, wean-to-finish, and grower-finisher barns provided feed in Hog Slat® fence-line, grower-finisher feeders with six feeder spaces per pen. Water was provided in each facility by swinging water lines, with 1 swing (2 nipples) per pen. Water flow and intake were not measured.

Feed

The WF and WNF pigs received the same rations throughout this study. A segregated early weaning (SEW) diet and a transition diet were replaced by a succession of seven different rations. Feed disappearance was measured daily in all feeders in each facility, using a plumb-bob system designed by the author.[6]

Pig weights

To validate the effects of the two production systems, and gain a better understanding of the weight variability in each pen, all pigs were individually weighed on an electronic digital scale (Tru-Test® SR2000, Auckland, New Zealand). Weights were entered directly into a spreadsheet for analysis.

Pigs in the WF group were weighed at weaning (11 to 14 days of age) and at 34±4, 44±4, 59±4, 81±3, 103± 5, and 119±5 days of age. Pigs in the WNF group were weighed at weaning (11 to 14 days of age) and at 35±3 , 46±5, 60±3, 74±3, 94±3, and 139±3 days of age.

Average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (FE) were calculated for the 20 feeders (40 pens) in each barn. The opportunity to weigh pigs by pen ended when the first group of pigs reached a marketable weight of 118 kg (260 lb) and pen integrity was altered.

Table 1: Exposure Serum Antibody Profiles in pigs weaned at 11 to 14 days and placed in a wean-to-finish facility (WF, 999 pigs) or placed in a nursery (WNF, 998 pigs) and moved to a grower-finisher barn 5 to 7 weeks later.

		Number of Pigs Seropositive at Data Collection Points				
		1	2	3	4	5
Age (days)						
	WF	12	50	85	110	NA
	WNF	12	50	85	110	130
Mycoplasma						
	WF	10/20 (50%)	0/20 (0%)	0/20 (0%)	17/20 (85%)	ND*
	WNF	11/20 (55%)	0/20 (10%)	5/20 (25%)	1/18 (5%)	2/18 (12%)
PRRSV						
	WF	4/20 (20%)	2/20 (10%)	9/20 (45%)	20/20 (100%)	ND*
	WNF	10/20 (50%)	3/20 (15%)	1/20 (5%)	10/18 (50%)	18/18 (100%)
Swine influenza virus						
	WF	0/20 (0%)	1/20 (5%)	1/20 (5%)	0/20 (0%)	ND*
	WNF	3/20 (15%)	0/20 (0%)	0/20 (0%)	4/18 (18%)	0%
Streptococcus suis						
	WF	0/20 (0%)	0/20 (0%)	5/20 (25%)	15/20 (75%)	ND*
	WNF	0/20 (0%)	0/20 (0%)	0/20 (0%)	15/18 (28%)	15/18 (82%)

The test was considered positive for *Mycoplasma* if percent inhibition >50%; for PRRSV if ELISA S:P ratio>0.4; for swine influenza virus if Tween 20 ELISA S:P ratio>0.099; and for *Streptococcus suis* if microagglutination occurred at a dilution >1:8.

* WF pigs were shipped before reaching the last collection point.

Table 2: Number of pigs that died after weaning at 11 to 14 days, in a group of 999 placed in a wean-to-finish facility at weaning (WF), compared to a group of 998 placed in a nursery and moved to a grower-finisher barn 5 to 7 weeks later (WNF).

Age (weeks)	Number of dead WF pigs	Number of dead WNF pigs
2-4	4/999 (0.40%)	4/998 (0.40%)
4-6	4/995 (0.40%)	3/994 (0.30%)
6-8	16/991 (1.60%)	6/991 (0.60%)
8-10	2/975 (0.20%)	4/985 (0.40%)
10-19	46/973 (4.61%)	29/981 (2.91%)
TOTALS	72/999 (7.21%)	46/998 (4.61%)

Health

After the pigs were assigned to pens, one pig per feeder was randomly selected and identified. As litter of origin was unknown after weaning, it is possible that some randomly selected pigs were littermates. Nasal swabs were obtained from these 20 WF and 20 WNF pigs at weaning. Pathogen exposure was monitored at weaning and at approximately 50, 84, 108, and 130 days of age, using repeated serum samples obtained from the same 40 pigs. Sera were submitted to Biovet Laboratories (St. Anthony, Minnesota) for Exposure Serum Antibody Profiles (ESAP), reporting titer changes and percent seropositive for *Actinobacillus pleuropneumoniae* (APP) types 1,5, and 7, *Mycoplasma hyponeumonia*, swine influenza virus (SIV), PRRSV, and *Streptococcus suis*. Tissue samples from pigs that died were submitted to the University of Missouri Veterinary Medical Diagnostic Laboratory.

All pigs showing signs of illness were treated, and medical records were retained. The same protocols for diagnosis and treatment of diarrhea and lameness were used in the WF and WNF pigs.

According to standard practice at the facility, all WF and WNF pigs were treated for 5 days after weaning with neomycin (Neomix 325®, Pharmacia and Upjohn Inc, Kalamazoo, Michigan) in the drinking water at a dose of 5 mg per kg, delivered through a proportioner at the rate of 1 oz per gallon (1:128).

Calculations

Pigs were selected by date of weaning to enter one of the two treatment groups. In each grower-finisher or wean-to-finish barn, and in each of the two nursery rooms, there was one fence-line feeder between two adjoining pens, with 25 pigs on each side of the feeder. The unit for feed efficiency calculations was one feeder and the associated 50 pigs.

The sum of the individual pig weights for each feeder was used to calculate average weight. Feed disappearance was measured daily.[6] Average pig weight and volume of feed consumed were used to calculate average daily gain and feed efficiency for each feeder. Because feed intake was measured daily, the feed consumed by pigs that died between weighing intervals was recorded and included in the ADFI used in the FE calculation.

The age at which pigs were marketed was calculated as a weighted average. For each treatment group, each market weight was multiplied by the number of pigs marketed at that weight. The products were added and the total was divided by the total number of pigs marketed to give the weighted average market age for that group.

Results

Health

For the first 7 to 10 days after weaning, WF pigs piled under the heat lamp after feeding and (or) drinking, suggesting that they were mildly hypothermic. Diarrhea caused by *E coli* was diagnosed in the WNF pigs at 17 days of age, and in the WF pigs at 33 days of age. Proliferative ileitis was diagnosed in the WF pigs at 112 days of age, and in the WNF pigs at 126 days of age. *Lawsonia intracellularis* was identified in intestinal mucosa and intestinal content samples collected at necropsy.

Streptococcus spp. were isolated from all nasal swabs taken at weaning and at necropsy. At necropsy, *Streptococcus suis* was isolated from joints of lame pigs in both groups.

The Exposure Serum Antibody Profile (ESAP) indicated that by 130 days of age, all of the tested pigs in both groups were PRRSV positive (ELISA S:P ratio > 0.4) (Table 1). The number of WF pigs seropositive for *Mycoplasma hyponeumonia* (percent inhibition > 50%) had increased by 108 days of age, but this increase was not observed in the WNF group (Table 1). The percent of pigs seropositive for SIV (Tween 20 ELISA S:P ratio >0.099) was higher for WNF pigs than for WF pigs at weaning and at 108 days of age. After the pigs were 110 days of age, all submitted serum samples from both groups were negative for SIV (H1N1 and H3N2). In the same interval, there was an increase in the number of pigs in both groups positive for Lancefield group D *Streptococcus* (microagglutination at a dilution >1:8). All tested pigs remained negative for APP types 1, 5, and 7 throughout the study (Tween 20 ELISA S:P ratio<0.099).

Over the course of the study, 72 WF pigs died (7.21%) and 46 WNF pigs died (4.61%) (Table 2). Ileitis was the greatest single cause of death in these pigs (4.8% of WF pigs, 2.7% of WNF pigs).

Treatments

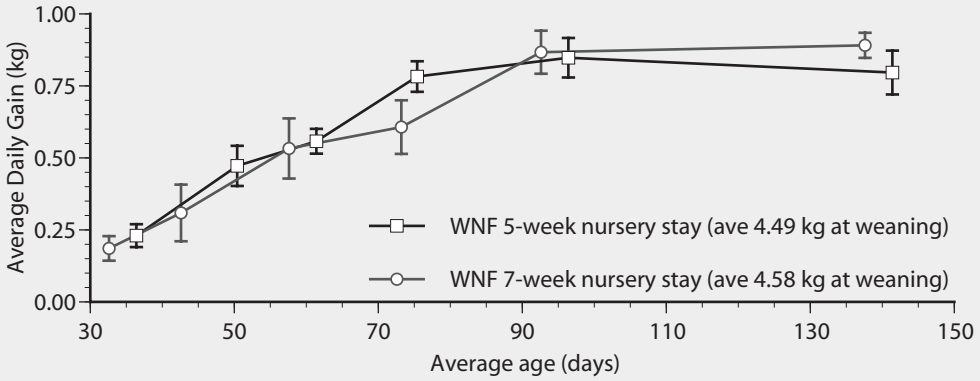
Lame pigs received a single intramuscular dose of benzathine penicillin (150,000 IU) and procaine penicillin (150,000 IU) (Crystiben®; Fort Dodge Animal Health, Overland Park, Kansas). This extra label dose of benzathine penicillin was used because, historically, a lesser dose failed to alleviate clinical signs.

E coli was consistently isolated from pigs with diarrhea. Pigs with diarrhea were treated with ceftiofur sodium (Naxcel®, Pharmacia and Upjohn Inc, Kalamazoo, Michigan), 1 mg per kg BW in a single intramuscular injection.

During their first 4 weeks in the nursery, 228 WNF pigs were individually treated. During their first 4 weeks in the wean-to-finish barn, 171 WF pigs were individually treated. Eight pigs in the WF group and seven pigs in the WNF group died during this interval (Table 2).

All pigs were treated with neomycin (Neomix® 325, Pharmacia and Upjohn Inc, Kalamazoo, Michigan) in the drinking water at weaning. However, the WF pigs

Figure 1: Average daily gain in pigs weaned at 11 to 14 days, housed in a nursery for either 5 or 7 weeks, and moved to a grow-finish facility with pen integrity maintained.



were treated with an additional dose of 5 mg per kg BW of Neomix® 325 (150 g per proportioner) when they were 33 days old because of an increasing incidence of *E coli* diarrhea.

Both groups received medicated feed containing tylosin (Tylan®40, Elanco Animal Health, Indianapolis, Indiana), 100 g per ton (110 mg per kg), for the 3 weeks after proliferative ileitis was diagnosed in the WF pigs at 112 days of age and in the WNF pigs at 126 days of age.

Growth and production

The average weaning weight (at 11 to 14 days of age) was 4.47±0.49 kg (9.91±1.07 lb). There were no apparent differences in ADG or FE between the WNF pigs that stayed in the nursery for 5 weeks and those that stayed in the nursery for 7 weeks (Figure 1). There were no apparent differences in ADG and FE between WNF and WF pigs at any of the 6 data collection points between weaning and marketing of the first pigs from both groups (Table 3).

The WF barn was emptied when the pigs were 192 days of age, and the WNF barn when the pigs were 203 days of age. Pigs were marketed from the WF group (902 pigs) at a weighted average of 182.7 days of age (range 169 to 192 days of age), and from the WNF group (903 pigs) at a weighted average of 183.0 days of age (range 168 to 203 days of age). There were no apparent differences in weighted averages for hot carcass weight (WF 88.8 kg [195.6 lb], WNF 89.3 kg [196.9 lb]), backfat thickness (WF 22.3 mm [0.878 in], WNF 22.5 mm [0.889 in.]) or fat free lean index (WF 48.4, WNF 48.7).

Pigs that weighed less than 109 kg (240 lb) at the end of the study were moved to a low cost facility ("tail ender barn") to be fed for an additional 4 weeks (25 WF pigs and 49 WNF pigs).

Discussion

Pigs were weaned into the conventional nursery as dictated by the flow of animals through the production system. Therefore, when the WNF pigs were moved from the nursery to the grower-finisher barn, they were 14 days older than the WF pigs in the wean-to-finish barn. From a health standpoint, it is ideal to fill an all in, all out (AIAO) barn within a 7-day period. However, many production systems are designed to allow a 4-week age spread on a site and a 2-week age spread in a barn. Therefore, the authors feel that the assignments of production groups were comparable to standard farm operating procedures.

Although growing conditions were as close to identical as possible for the WF and WNF pigs, two standard management practices might have confounded our results. First, because of the constraints of pig flow in the production system, selection of treatment groups might have had an effect on the disease outbreaks that occurred. However, there were no known management or health status changes observed at the farrowing site during this time. Second, environmental ammonia levels were noticeably higher in the nursery than in the two new barns, until minor changes in ventilation in the nursery alleviated this situation 3 weeks post weaning. There was no apparent effect on growth of the WNF pigs compared to the WF pigs in the interval before ventilation in the nursery was improved.

The difference in space per pig in the two systems might have had an effect on pig growth. The WF pigs were provided with 7.8 sq. ft^2 per pig from weaning to marketing. The WNF pigs had 2.5 sq. ft^2 per pig during their 5 to 7 weeks in the nursery, then 7.8 sq. ft^2 per pig in the grower-finisher barn. The same stocking density of 25 pigs per pen (50 pigs per feeder) was maintained at all sites.

Although weaned pigs placed in grower-finisher barns have more pen space, this advantage may be offset by the difficulty in heating the entire pen (beyond the heat mat) to a temperature that will avoid chilling the young pigs. Wean-to-finish barns rely more on zone heating, and room temperatures are generally cooler than in nurseries because of the larger square footage and available air space. This may be a health benefit in that it allows for more air to be exchanged and improves air quality.[7] This benefit may not apply to barns partitioned with plastic sheets to help maintain air temperature close to the pigs.

The WF pigs piled under the heat lamp after feeding or drinking, and may have been mildly hypothermic. It was not possible to obtain rectal temperatures to quantify this observation. We speculate that concrete slats found in a traditional grower-finisher barn, especially the more porous concrete,[8] provide a greater surface area than conventional nursery flooring, allowing for more fecal collection and potential pathogen exposure over time. Pigs stressed by chilling may be more suscep-

Table 3: Production data for pigs weaned at 11 to14 days* and moved to a wean-to-finish facility (WF,999 pigs), or weaned to a nursery (WNF, 998 pigs) and moved to a grower-finisher barn 5 to 7 weeks later.

Parameter	Data Collection Points					
	1	2	3	4	5	6
Number of pigs						
WF	991	986	981	977	951	929
WNF	996	996	982	977	975	953
Age (days + SD)						
WF	35+3	46+5	60+3	74+3	94+3	139+3
WNF	34+4	44+4	59+4	81+3	103+5	119+5
ADG kg+SD (lb+SD)						
WF	0.21+0.05	0.39+0.12	0.55+0.08	0.70+0.12	0.86+0.07	0.84+0.08
	(0.46+0.10)	(0.86+0.26)	(1.20+0.17)	(1.53+0.26)	(1.89+0.16)	(1.86+0.28)
WNF	0.26+0.06	0.42+0.14	0.61+0.13	0.75+0.08	0.82+0.05	0.92+0.10
	(0.58+0.13)	(0.91+0.30)	(1.35+0.29)	(1.66+0.17)	(1.81+0.10)	(2.02+0.22)
FE + SD						
WF	1.68+0.12	1.21+0.77	3.64+0.93	2.14+0.95	2.25+0.45	2.61+0.56
WNF	1.55+0.21	1.83+0.99	2.52+0.49	2.29+0.25	2.80+0.27	2.57+0.28

* Weaning weight for WNF pigs was 4.47 ± 0.49 kg (9.91 ± 1.07 lb), and for WF pigs was 4.34 ± 0.61 kg (10.14 ±1.48 lb).

tible to the increasing pathogen load that builds up in the fecal material on concrete slat flooring, even in a new facility. Brumm and Baysinger (1999) observed scours, diagnosed as gut edema and associated with *E coli,* in wean-to-finish pigs 2 to 3 weeks post weaning, coincident with poor dunging habits.[8] The larger concrete slat surface area in the WF barn may have contributed to the diarrhea that occurred in this group of pigs at 33 days of age.[8] As the same individual recorded daily feed disappearance measurements in both barns, it is possible that the *E coli* that first affected the WNF pigs was transferred to the WF pigs.

An increased incidence of coughing was observed in 10% to 15% of both the WF and WNF pigs at 100 days of age. The ESAP results for this interval showed that in the WF barn, there was an increase in the number of pigs seropositive for *Mycoplasma*, and in the WNF barn, an increase in the number of pigs seropositive for SIV (Table 1). These data suggest that *Mycoplasma* was responsible for the cough in the WF group and SIV (H1N1) was responsible for the cough in the WNF group. Three weeks later, there were no SIV-positive WNF pigs (Table 1).

The increasing prevalence of PRRSV in both groups, and *Mycoplasma* in the WF group, may have predisposed all of the pigs to an increased incidence of ileitis after 110 days of age, and the combination of these two pathogens may also have contributed to the increased death loss observed in both groups after 70 days of age.

On average, the WF pigs were marketed 11 days younger than the WNF pigs, a difference that can be explained by the slight differences observed in ADG over time. There was no apparent difference in the weighted average ages of pigs marketed (182.7 days of age for WF pigs, and 183.0 days of age for WNF pigs). As there were only two experimental units in this study, we were not able to conduct a statistical analysis. We noted that the heavier pigs were distributed throughout the entire WF barn, while the heavier pigs in the WNF group were generally found in pens of older pigs. This distribution may partially account for why the WNF pigs were sold over 35 days, with a 21-day lag between the first large group and the last hogs marketed. In contrast, the WF pigs were sold more evenly over a 24-day period.

There was no difference in ADG between the groups of WNF pigs that were moved to the grower-finisher barn after either 5 or 7 weeks in a conventional nursery (Figure 1). One could even argue that ADG of the conventional group that stayed in the nursery for 7 weeks might have been adversely affected for the short term, but not over the entire period of the study. On the basis of these data, we suggest that it might be possible for production systems designed to include a nursery to use the existing nursery facilities for 5 weeks only, and build additional grower-finisher facilities as required by production expansion. However, the similarity between the WNF groups might also have been partially the result of having a dedicated manager at the nursery site, and maintaining pen integrity when the pigs were moved to the grower-finisher barn.

The wean-to-finish (WF) and grower-finisher (WNF) barns were recently constructed grower-finisher facilities that had never housed animals previous to the study

pigs, and were unlikely to have contained any swine pathogens. The WNF pigs were weaned into a previously populated, continuous-flow nursery building that was stocked AIAO by room, while the WF pigs were weaned directly into one of the new barns. We expected the growth performance of the WNF pigs to be adversely affected by exposure to pathogens during the nursery phase. Therefore, the similarity in growth, health, feed efficiency, health profiles, and death loss patterns for the two groups of pigs was surprising. One possible explanation may be that the warmer environment in the nursery was an advantage for the recently weaned pigs, and maintaining pen integrity when they were moved to the grower-finisher facility minimized the usual stress of re-socialization.

Maintaining pen integrity when moving nursery pigs to grower-finisher facilities is an uncommon practice, but it might result in better feed intake and improved ADG by reducing the amount of fighting associated with re-socialization in the grower-finisher barn. One advantage of the wean-to-finish production system is that pigs do not experience re-socialization, as they are not moved after weaning. Neither the WF or the WNF pigs were re-socialized, which may partially explain why the growth curve and average weights were nearly identical for the two groups. In previous studies, pen integrity was not maintained for grow-to-finish pigs, and the results were different.

Implications

- There was no observed difference in ADF, ADFI, and FE between pigs raised in a wean-to-finish barn, and those weaned to a nursery and moved, after 5 to 7 weeks, with pen integrity maintained, to a grower-finisher barn.
- When pigs more than 12 weeks old were exposed to *Lawsonia intracellularis*, death losses were higher in a wean-to-finish barn than in a conventional management system.
- Clinical signs associated with colibacillosis were observed 5 days post weaning in pigs raised in a conventional nursery for 5 to 7 weeks, and 21 days post weaning in pigs raised in a wean-to-finish facility.
- Concrete slats in the flooring of grower-finisher barns may be too wide to allow fecal material from small pigs to fall through to the pit, resulting in greater fecal contamination of the environment and exposure of young pigs to potential pathogens.
- If pen integrity is maintained when nursery pigs are moved to grower-finisher facilities, re-socialization does not occur, eliminating some of the advantage of a wean-to-finish system.

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