ORIGINAL RESEARCH

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Effect of various stocking methods and extra-label PRRS vaccination on average daily gain

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Summary

Purpose: To evaluate the effect of three different methods to stock nurseries (from one source or two, over 24 hours or 5 days, with vaccinated or nonvaccinated pigs) on average daily gain (ADG) in commercial nursery pigs.

Methods: Three commercial nurseries were stocked over 3 consecutive weeks with either: 5-day fill of pigs intranasally (IN) vaccinated against PRRSV from a single source (the "vac-5" group); 5-day fill of pigs from a single source that were unvaccinated (the "nonvac-5" group); and 24-hour fill of nonvaccinated pigs from two sources (the "nonvac-24" group). On day 0, pigs were penned according to entry weight. Eighteen pens of pigs, one pen per room, was weighed on day 0 and weekly thereafter. Thirty six individual pigs were bled weekly and tested for antibodies against PRRSV and assayed for the presence of PRRSV in serum. Virus isolates were characterized by the restriction fragment length polymorphism (RFLP) assay to determine if they were compatible with vaccine or with field virus.

Results: ADG did not differ significantly between the nonvac-24 pigs and vac-5 pigs. However, pigs in both of these nurseries gained significantly faster ($P < .05$) than pigs in the nonvac-5 nursery. Nearly all of the monitored pigs (91 of 98) had seroconverted to PRRSV by the end of the trial, regardless of treatment. Vaccinates had a significantly higher ($P < .0001$) mean ELISA S:P ratio (3.71) than nonvaccinates (1.76) at the end of the trial. Nonvac-24 pigs had a significantly higher ($P < .01$) ELISA S:P ratio than either the vac-5 or the nonvac-5 pigs. On day 0, pigs in the nonvac-5 nursery had a positive ELISA S:P values, while the vac-5 pigs had S:P values of 0.24 and nonvac-24 pigs had S:P values of 0.25. Isolates compatible with vaccine virus or field virus (isolate ATCC VR2332) were found in pigs in all three nurseries. Isolates with RFLP patterns different from vaccine virus or isolate ATCC VR2332 were also found in all three nurseries.

Implications: Vaccinates performed better than nonvaccinates under a 5-day nursery fill system in this system. However, vaccinates under a 5-day nursery fill system did not perform significantly better than nonvaccinates under a 24-hour nursery fill system.

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Porcine reproductive and respiratory syndrome (PRRS) was first reported in the United States in 1987[1,2] and has since become widespread throughout the swine-producing areas of the country.[3] The two main strategies used to limit losses to PRRS virus (PRRSV) infections are changes in management techniques and/or vaccination. One management technique developed to reduce losses from PRRS infections is the McREBEL™ (Management Changes to Reduce Exposure to Bacteria to Eliminate Losses from PRRS) procedure,[4] which was designed to reduce death losses resulting from secondary bacterial infections. McREBEL uses several strategies, including limiting the amount of cross fostering between litters, reducing the handling and injecting of pigs, and discontinuing the practice of feedback to sows and gilts.

Dee and Joo[5] proposed a second management technique to eliminate the virus from the nursery by depopulation and disinfection. By stabilizing sow herd immunity, they observed reduced mortality rates and improved growth rates in the majority of cases.[5] They found that the size of the breeding herd and the annual rate of replacement were important factors in the persistence of nonstable populations — subpopulations — within the herd. Field and laboratory observations point out the importance of controlling the shedding of virus within the breeding herd in a successful nursery control program.[5]

Vaccination is another tool used to reduce losses from PRRS in nurseries. Gorcyca[6] described results of a field trial evaluating the use of a modified-live vaccine (RespPRRS®, NOBL Laboratories, Inc., Sioux Center, Iowa) in nursery pigs. In this study, vaccinated pigs had significantly lower mortality, fewer treatments, and increased weight gains compared to nonvaccinated pigs. According to the label directions, RespPRRS® is to be given as a single intramuscular (IM) injection between the ages of 3 and 18 weeks of age.

Trayer[7] compared the use of two different extra-label vaccination protocols using a modified-live vaccine prior to entry into the nursery and reported increased weight gains and reduced clinical signs. Gillespie[8] and Sanford, et al.,[9] have reported improvements in clinical signs and performance parameters with the use of the same modified-live vaccine in nursery and growing pigs.

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Production systems have an impact on overall nursery health and performance. Dufresne[10] described performance in three production systems:

- single-source three-site,
- commingled three-site using pigs from ≤ five sources matched for health status, and
- commingled multiple site stocked by 7–14 pig sources without being matched for health status.

Based on percent mortality, average daily gain, and medication costs, Dufresne observed the best performance in the single-source three-site system, followed by commingled multiple-site production. Performance in the commingled three-site production lagged behind the other systems in all three parameters even though the nursery was all-in–all-out (AIAO) by room. A possible conclusion to be drawn from this study is that pig flow (AIAO by site) is especially important when commingling piglets from several sources.

PRRSV infections have been studied in relationship to pig flow. Wiseman[11] has suggested that PRRSV could be eliminated by medicated early weaning (MEW) techniques. In this study, three source herds were positive for PRRSV, but no evidence of virus infection was found in nursery pigs. Christianson, et al.,[12] weaned pigs up to 20 days of age free of PRRSV, and concluded that weaning pigs into nurseries isolated from the farm of origin could potentially be used to rear pigs free of PRRSV. However, other studies showed that PRRSV was not eliminated by early weaning. Clark, et al.,[13] observed no weaning age that could guarantee that PRRSV would be eliminated. Effective measures to control PRRSV infection and reduce its effect on the performance of nursery pigs are of vital importance to the swine industry.

The objectives of the present study were to:

- determine whether two different methods of stocking a nursery (5-day fill versus 24-hour fill and single-source versus two-source) could influence the performance of endemically PRRSV infected pigs, and
- evaluate the use of a modified-live PRRS vaccine (RespPRRS®)

on weekly and overall average daily gain (ADG) in the nursery.

Materials and methods

Facilities and populations

The study was carried out on a commercial hog farm that used commingled multiple-site production. The system consisted of nine sow farms, offsite commingled nurseries, and offsite finishing facilities. All sow farms were serologically positive to PRRSV prior to the onset of the trial, although reproductive signs compatible with clinical PRRS had not been noted. All replacements had been vaccinated with a single 2-mL dose of vaccine upon entry into the herd. Three sow farms were new herds, in which all animals in the herd were vaccinated. Six farms contained both vaccinated and nonvaccinated sows.

Each of the nursery sites consisted of two barns with nine rooms each. The standard procedure for stocking the nurseries was to fill a room with pigs weaned from one sow farm over a period of 5 days. Nine sow farms weaned pigs into each nursery, with barrows and gilts weaned into separate rooms. One nursery site was filled each week with weaned pigs with an average weaning age of 17 days. The spread in ages of weaned pigs ranged from 8–21 days of age.

Experimental design

The experiment was designed as a randomized block design with repeated measures. Neonatal pigs were assigned to one of three treatments:

- Vac-5 group: Each room at the nursery received vaccinated (1 mL intranasally [IN] at 7 to 10 days of age) pigs from a single sow farm with a 5-day fill. The extra-label use of vaccine was chosen based on discussions with swine practitioners concerning common industry use. McCaw, et al.,[14] have suggested that IN administration may be beneficial in obtaining a local, as well as systemic, immune response in pseudorabies (Aujeszky's disease) virus, and we speculated that IN administration against PRRSV might evoke a similar immune response. Pigs were vaccinated earlier than 3 weeks in an effort to immunize pigs prior to stocking them in a commingled nursery (manufacturer recommends 3 weeks).
- Nonvac-5 group: Each room at the nursery received nonvaccinated pigs from a single sow farm with a 5-day fill.
- Nonvac-24 group: Each room at the nursery received nonvaccinated pigs from two sow farms with a 24-hour fill. The entire building was filled within 48 hours.

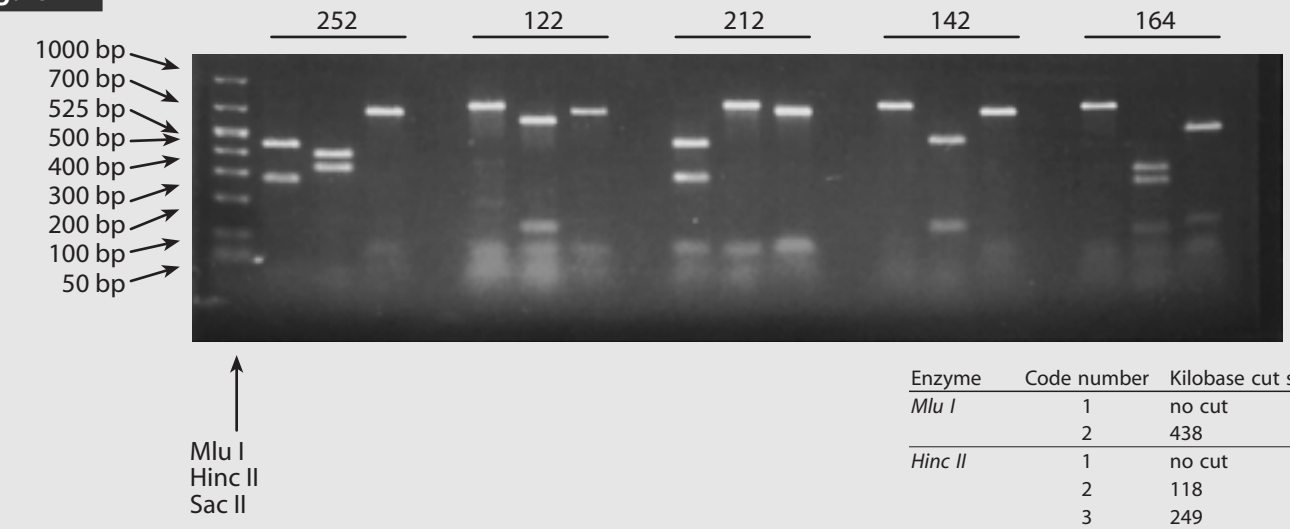
Upon entry into the nurseries, pigs were sorted by entry weight and placed in pens of 22 pigs each. Consistent with the farm's normal procedures, pigs were judged to be of large, medium, or small entry weight and assigned to pens with pigs of equal size. For serological monitoring at each nursery site, two pigs from each of the 18 rooms in the nursery (n = 36) were selected by randomly choosing and ear-tagging one pig from each of two different pens of medium-sized pigs. Serum from these pigs was collected on days 0, 28, and 49.

To monitor growth performance, one pen containing approximately 22 medium entry-weight pigs was randomly selected from each of the 18 rooms in the nursery. All pigs in the selected pen were weighed on a platform scale on day 0, and weekly thereafter for the duration of the trial.

Diagnostic assays

Serum samples were analyzed for antibodies against PRRSV using a commercial ELISA (HerdCheck™PRRS, IDEXX Laboratories, Inc., Westbrook, Maine). In addition, virus isolation was attempted on serum samples as described by Roof[15] using CL2621 cells (Boehringer Ingelheim Animal Health, St. Joseph, Missouri) grown in Eagle's minimum essential media (EMEM) supplemented with 5% fetal bovine serum (JRH Biosciences, Lenexa, Kansas). Cells were standardized to 1×10^6 cells per 1 mL of EMEM and a 500-µL aliquot was distributed into each well of a 24-well plate. The cells were incubated at 37°C with 5% CO_2 for 72 hours. A 200-µL serum sample was then placed in each well. Following a 2-hour incubation at 37°C, an additional 500 µL of

Figure 1



Restriction fragment length polymorphism (RFLP). Differentiation of 5 isolates (252, 122, 212, 142, 164) by visualization of PCR products following restriction enzyme digestion.

Table: PRRSV restriction fragment length polymorphism (RFLP) pattern as determined by site of enzyme cutting of open reading frame (ORF). 5 kilobase pairs. For example, RespPRRS®/2332 virus RFLP pattern is 252.

Enzyme	Code number	Kilobase cut site
Mlu I	1	no cut
	2	438
Hinc II	1	no cut
	2	118
	3	249
	4	118 and 249
	5	390
	6	118 and 390
Sac II	1	no cut
	2	54
	3	585
	4	54 and 585

fresh media was placed in each well. Each plate also included a positive (VR2332-infected) and negative (noninfected) control. Infected 24-well plates were then incubated at 37°C with 5% CO_2 and evaluated daily for 8 consecutive days for cytopathic effects typical of PRRSV. Samples with no noticeable cytopathic effects (CPE) were passed (200 µL) to another plate for confirmation. Samples with CPE were passed (10 µL) to a 96-well plate containing CL2621 cells. Monolayers were fixed after 12 hours and evaluated by indirect IFA using SDOW-17 and SR-10[16] to confirm the presence of PRRSV.

The restriction fragment length polymorphism (RFLP) assay described by Wesley, et al.,[17] was used to evaluate PRRSV isolates recovered from serum in an attempt to differentiate between the modified-live vaccine virus and field isolates. The assay was conducted using cells harvested after CPE were initially observed in the virus isolation procedure to remove infected CL2621 cells. A 500-(L aliquot of cell suspension was centrifuged for 2 minutes at 8000 × g. The supernatant was discarded and the pellet resuspended in 500 (L of Trizol® (Gibco BRL, Gaithersburg, Maryland). The sample was then amplified by reverse transcriptase-nested PCR (RT-nPCR) using a primer specific for PRRSV open reading frame (ORF) 5. The cDNA PCR product was then split into three aliquots and restriction digested with enzymes Mlu 1, Hinc II, and Sac II. The PCR products were visualized (Figure 1) following agarose electrophoresis and classified by RFLP profile.

Statistical analysis

Average daily gain of pens of pigs was analyzed using ANOVA with repeated measures. The pen was the experimental unit for testing the hypothesis that there was no difference in ADG among treatment groups. Individual pig ELISA values were analyzed using the ANOVA procedure.

Results

Weight gains for seven pens in the nonvac-24 nursery were not obtained as the pigs were moved out of the nursery before the final weights and serum samples were taken. Therefore, these data were not used in the analysis of overall weight gain and ELISA values.

Average daily gain

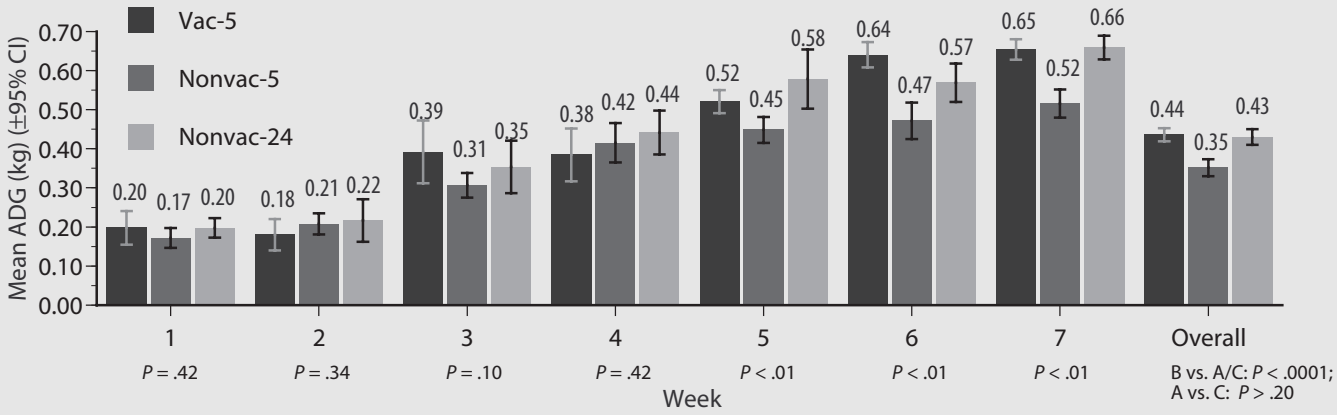
Overall average daily gain was significantly higher in the vac-5 and nonvac-24 nurseries than the nonvac-5 nursery ($P < .0001$) (Figure 2). There was no significant difference in ADG between the vac-5 nursery and the nonvac-24 nursery ($P > .20$). There was no significant difference in weekly ADG among treatments for the first 4 weeks of the trial (Figure 2). Average daily gain in weeks 5, 6, and 7 differed significantly ($P < .01$), with the vac-5 nursery and the nonvac-24 nursery gaining faster than the nonvac-5 nursery.

Serology and virus isolation

On day 0, mean ELISA sample:positive (S:P) values were higher ($P < .05$) in pigs in the nonvac-5 nursery (mean S:P = 0.48) than in pigs in the vac-5 (mean S:P = 0.25) and the nonvac-24 nurseries (mean S:P = 0.25) (Figure 3). By the midpoint of the trial, the vac-5 pigs had significantly higher ($P < .05$) average ELISA values (0.57) than the nonvac-24 pigs (0.17). Vac-5 pigs had significantly higher ($P < .0001$) ELISA S:P ratios at the end of the trial than the nonvaccinated pigs with either stocking method. Average ELISA S:P ratios were 3.71 with a range of 0–7.70 for the vaccinates, while the nonvaccinates had an average ELISA titer of 1.76, with a range of 0.09–3.40.

There were also differences in the proportion of ELISA-positive pigs among groups (Figure 3). The vaccinates entered the nursery approxi-

Figure 2



Average daily gain of vaccinated and nonvaccinated pigs

Vac-5 — vaccinated, 1 source per room, 5-day fill
Nonvac-5 — nonvaccinated, 1 source per room, 5-day fill
Nonvac-24 — nonvaccinated, 2 sources per room, 24-hour fill

mately 7–10 days post vaccination with six of 36 pigs testing positive on the ELISA. By the midpoint of the trial (4 weeks after entry), nearly half (15 of 36) of the pigs tested positive. At the end of the trial, nearly all (33 of 36) pigs tested positive on the ELISA. The nonvac-5 pigs entered the nursery with 16 of 36 pigs testing positive on the ELISA. At the midpoint of the trial, only 11 of the 36 pigs tested positive, while at the end of the trial, all pigs tested were positive. When the nonvac-24 pigs entered the nursery, six of 36 pigs were positive by ELISA. At the midpoint, only three of the 36 were positive, while nearly all (32 of 36) were positive at the end of the trial.

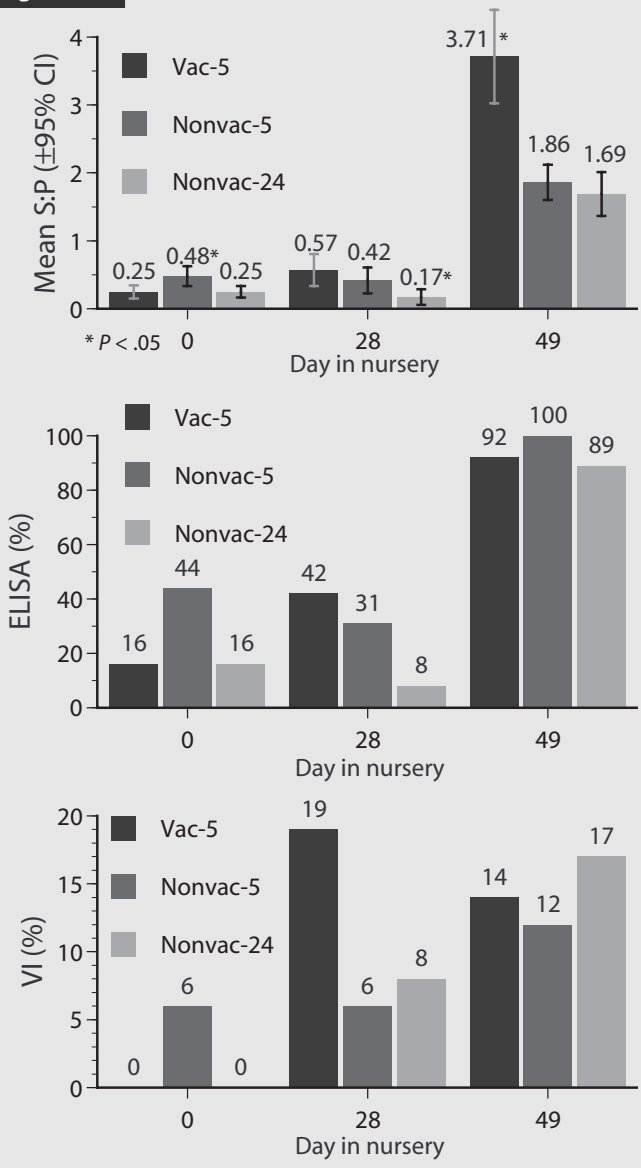
Vaccinated pigs had no detectable viremia on arrival at the nursery, and 11 of 36 pigs become viremic during the trial. In the nonvac-5 nursery, two of 36 pigs were viremic on arrival at the nursery. Five more pigs became viremic during the trial. No viremic pigs were detected on entry into the nonvac-24 nursery, but 10 of the 36 pigs became viremic during the trial.

There were field isolates and isolates compatible on RFLP with RespPRRS®/2332 virus in all three nurseries. Isolates compatible with RespPRRS®/2332 were sometimes identified in pigs from nonvaccinated nurseries, and field isolates were sometimes found in vaccinated pigs. Three isolates were identified by RFLP (212, 122, and 252) from the vaccinated nursery. PRRSV isolates with RFLP profiles of 122 and 212 were found in all three nurseries, while the PRRSV isolate with a RFLP profile of 252, compatible with RespPRRS®/2332 virus, was found in the vac-5 and the nonvac-5 nurseries. Two additional nonvaccine isolates, 142 and 164, were found in the nonvac-24 nursery.

Discussion

Average daily gain was improved in this multisite, commingled nursery in pigs vaccinated against PRRSV in an extra-label usage compared to nonvaccinated pigs in the same type of management system when the nurseries were filled over a 5-day period. Filling the nurseries over 24 hours had an advantage over filling facilities over a period of 5 days,

Figure 3



ELISA and VI results from serum

S:P samples : positives ratio

even though two sources of pigs were mixed in the same room in the nonvac-24 nursery. Pigs in this nursery clearly outperformed the pigs in the nursery that was filled over a 5-day period. Our observations suggest that when nurseries are filled over a longer time (e.g., 5 days), vaccination may be an important tool to be considered. However, reducing the number of days taken to fill the facilities gave nearly identical results in performance without vaccinating the pigs.

The high level of seroconversion in both the vaccinated and nonvaccinated nurseries indicated that nearly all pigs were exposed to PRRSV, either field virus or virus compatible with RespPRRS®/2332. The extremely high ELISA S:P ratios in the vaccinated pigs indicate that a possible anamnestic response had occurred as a result of the vaccine priming the immune response. Significantly lower ELISA values occurred in nonvaccinated pigs. However, the significance of this observation is unclear since nearly all vaccinated and nonvaccinated pigs were serologically positive using the standard threshold S:P ratio of 0.4 at the end of the trial period.

The fact that virus compatible with the vaccine was found in both of the nonvaccinated nurseries leads to speculation as to the source. One possibility is that vaccine virus was transmitted from the dam to her offspring. The dams received all vaccinations prior to breeding, as no pregnant animals are vaccinated in this system. The prolonged period that had elapsed from vaccinating the dam to farrowing, however, makes it unlikely that virus was shed from dam to offspring. There are no documented cases of vaccine virus being shed from dams to offspring. Torrison, et al.,[18] observed evidence of pig-to-pig transmission of vaccine virus. Interestingly, field virus was found in vaccinated pigs, which suggests that vaccination did not prevent infection with field virus.

The results of this study agree with earlier studies by Sanford,[9] Gillespie,[8] and Trayer[7] regarding the effects of PRRSV vaccination on ADG in nursery pigs. There are no documented studies that compare the effects of filling facilities rapidly (i.e., within 24 hours) versus filling them more slowly (i.e., within 5 days). The results of the present study suggest that one must consider whether it is better to keep the number of sources — and probable pathogens - to a minimum and take longer to fill the nursery, or to increase the sources in order to fill a room as quickly as possible. This study shows that, in this system, improvements in performance were achieved by the rapid fill of the room.

The variability of the PRRS status of the sow farm sources may have been a confounding factor in this trial. All of the sow farms were found to be positive by ELISA serology prior to the study. The nonvac-5 nursery was stocked in a week in which the pigs had a higher PRRS mean ELISA value than the vac-5 and nonvac-24 nurseries, which may have influenced the outcome of the trial. However, the mean ELISA values may have been a result of higher maternal antibodies or higher levels of virus exposure prior to weaning.

Another possible confounding factor was the variation in management among nurseries. All nurseries were monitored for health and management techniques as closely as possible throughout the trial. To reduce the possibility of error among nurseries and managers, a trial was designed to study the effect of vaccinating pigs within a single nursery, with nonvaccinated pigs serving as controls in the same airspace (see pages 13–19).

Implications

- Vaccinates performed better than nonvaccinates in a 5-day nursery fill technique in this multisite system, but vaccinates did not perform better than nonvaccinates in a 24-hour fill system.
- Reducing the time to fill a room gave nearly identical results in performance without vaccinating pigs.

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