

The effect of all-in-all-out growing-finishing on the health of pigs

Alan B. Scheidt, DVM, MS; Tilford R. Cline, PhD; L. Kirk Clark, DVM, PhD; Vern B. Mayrose, PhD; William G. Van Alstine, DVM, PhD; Mark A. Diekman, PhD; and Wayne L. Singleton, PhD

Summary: This study compares all-in-all-out (AIAO) production with continuous-flow (CF) production during the growing-finishing phase. Thirty-three randomly selected pigs were moved into a room designated as the AIAO facility at approximately 17–20 kg (37–44 lb) body weight. These pigs may have been infected with *Mycoplasma hyopneumoniae* and *Pasteurella multocida* but were not exhibiting clinical signs of pneumonia at this age. They remained in that facility until they attained 101–120 kg (222–264 lb) body weight and were slaughtered. Thirty-three randomly selected pigs were at the same time moved into a room (identical to the AIAO room) that was designated as the CF room. Nine of these 33 pigs were from the same cohort as the AIAO pigs. The other 24 pigs were older, ranging between 3–5 months of age, and were from the same farm but came from the CF finishing unit. These older CF pigs were presumed to be naturally infected with *Mycoplasma hyopneumoniae* and *Pasteurella multocida*. Necropsy, examination of lungs at slaughter, bacterial isolations, serologic tests, and fluorescent antibody tests indicated that the younger pigs in the CF room had been infected with *M. hyopneumoniae* and *P. multocida*. Pigs and feed consumed were weighed and recorded monthly. Antimicrobials were not added to rations during this study. Pigs were examined at least once each week for coughing and clinical signs of other maladies. Six replicates of both AIAO and CF groups were completed during a 2-year period. At slaughter, individual pig lungs were examined for lesions of pneumonia. Additionally, 10 lungs from pigs (designated as sentinel pigs) per treatment group were tested by indirect-immunofluorescent assay (IFA) for *Mycoplasma hyopneumoniae*, and cultured for *Pasteurella multocida* and other bacterial pathogens, and examined for macroscopic and microscopic lesions.

Lung lesions were less prevalent and severe in AIAO pigs (mean severity score 3%) than in CF pigs (mean severity score 15%). Five CF pigs died, while no AIAO pigs died. AIAO pigs were not observed coughing at any of the weekly examinations, whereas CF pigs were observed coughing at all weekly examinations. Forty-three percent of CF pigs displayed clinical signs of other maladies, compared to 7% of AIAO pigs. Of the sentinel pigs, one AIAO pig was positive by IFA for *Mycoplasma hyopneumoniae*, whereas eight CF pigs were positive by IFA for *Mycoplasma hyopneumoniae* and *Pasteurella multocida*.

All-in-all-out (AIAO) production of pigs during the growing-finishing phase is well established as a means for reducing certain diseases and improving growth performance, including improvements in average daily gain (ADG), feed intake and feed conversion, pig mortalities, number of pigs culled, and lesions of pneumonia and atrophic rhinitis detected at slaughter.^{1–6} Historically, producers have used AIAO production in both the farrowing and nursery facilities to control disease and allow them to be thoroughly cleaned between groups of pigs. An added advantage is that pigs in one farrowing group are approximately the same age, making it easier to maintain optimum temperature and ventilation within the building. Competent breeding management and defined scheduling goals are necessary to achieve AIAO during the growing-finishing phase. Many factors affect whether an AIAO management strategy will prove beneficial, including:

- the liveweight range the packer will accept,
- the biological variability in pig growth,
- the differences in pig weights at the beginning,
- gender variation in pig growth,
- the presence of diseases that adversely affect pig growth,
- the production schedule, and
- the capacity and design of the growing-finishing facilities.

Genetics, nutrition, and management must be optimum for success. Attempting to measure the benefit:cost ratio is difficult because most previous research has been done in privately owned herds in which many significant, confounding variables cannot be controlled. In this study, we controlled environment, management, nutrition, and genetics to assess the effect of AIAO production on pigs that grew between 17–120 kg (37–264 lb) from a herd affected by mycoplasmal and pasteurella pneumonia.

ABS: Senior Technical Services Veterinarian, 205 Clarendon Crescent, Raleigh, North Carolina, 27610. LKC: Department of Veterinary Clinical Sciences. WVA: Department of Veterinary Pathobiology. TRC, VBM, MAD, WLS: Department of Animal Sciences, Purdue University, West Lafayette, Indiana 47907.

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Materials and methods

Facilities

This study was carried out in the Research Unit within the Animal Sciences Swine Center at Purdue University. Pigs (50% barrows and 50% gilts) were randomly allocated by weight, litter, and sex to one of two rooms. Each room was equipped with separate ventilation and a beneath-the-flooring flush manure-disposal system. Three pigs were housed in one pen, 1.8 meters × 1.2 meters, with a total of 11 pens per room.

Continuous-flow room

Initially, we moved 24, 3- to 5-month-old pigs from a continuous flow growing-finishing building with a history of mycoplasma and pasteurella pneumonia into a cleaned and disinfected room, which was designated a continuous-flow growing-finishing room. Nine 2-month-old pigs from an AIAO nursery were also moved into this room. We anticipated that the older pigs would transmit *M. hyopneumoniae* and *P. multocida* to the younger pigs. As pigs reached market weight and were removed, we moved other pigs weighing about 18 kg (40 lb) from the AIAO nursery into the room to maintain a constant population of 33 pigs in the replicate. The staggered age and weight of CF pigs is a natural model for transmitting *Mycoplasma hyopneumoniae* and *Pasteurella multocida* from older, infected pigs to younger, susceptible pigs. Once the study began, the CF room was never devoid of pigs. Six staggered replicates, each consisting of 33 pigs, were evaluated during this study.

All-in-all-out room

Thirty-three 2-month-old pigs were moved from the AIAO nursery into the second cleaned and disinfected room, which was designated the AIAO growing-finishing room. Six replicates of this study, each starting with 33 pigs, were performed. During each replicate, the group of AIAO pigs occupying the room were all sold to slaughter on the same day when they reached 101–120 kg (222–264 lb) of weight, and the next replicate was moved into the cleaned and disinfected room after a downtime of 7 days.

Nutrition

One nipple watering device and a two-hole ad libitum feeder was in each pen. A 15% crude protein, corn-soybean-meal ground ration, fortified with vitamins and minerals according to National Research Council guidelines, was fed throughout the study.⁷ The formulation was designed for barrows weighing 20–60 kg (44–132 lb). Antimicrobials were not added to feed at any time during the study. Individual pigs were weighed at monthly intervals. Feed was weighed into each feeder at monthly intervals. Average daily weight gain and days-to-105-kg (230 lb) were calculated on individual pigs. Total feed consumed and feed conversion were computed by pens. Means for feed parameters were compared using a Chi-square test.

Disease monitoring

Pigs were examined at least once per week for clinical signs, including coughing. An observer stood in the aisle and listened for coughing during a 10-minute period once each week, and re-

corded the ear tag number of the pig that was observed to cough. At approximately 101–120 kg (222–264 lb), pigs were slaughtered and individual lungs of all the pigs in both groups from all six replicates were identified and examined for macroscopic lesions typical of mycoplasma and pasteurella pneumonia. Lesions were sketched onto a lung diagram and a computer digitizer (Osteoplan™, Zeiss, New York, New York), was used to calculate the area within the two-dimensional diagram to determine the percentage of the surface area affected.

Ten pigs from each group (AIAO and CF) from one replicate were randomly designated as sentinel pigs. The lungs from these sentinel pigs were submitted to the Animal Disease Diagnostic Laboratory at Purdue University for macroscopic and microscopic lesion examination, were tested by indirect-immunofluorescence assay (IFA) for *Mycoplasma hyopneumoniae*, and underwent microbiologic examination.⁸

Pigs that died during the study (five CF pigs) were recorded and necropsied. Their lungs were examined for macroscopic lesions, and the digitizer was used to determine the surface area of the lung affected. Subsequently, lung tissue samples were examined by a veterinary pathologist at the Animal Disease Diagnostic Laboratory for microscopic lesions and by the microbiology laboratory using an indirect immunofluorescence (IFA) test for *Mycoplasma hyopneumoniae* and culturing for aerobic bacteria.

Results

Lung lesions

Lung lesions detected at slaughter were 54% less prevalent in pigs produced AIAO (a 95% prevalence for CF pigs and a 41% prevalence for AIAO pigs). The severity score or mean percent of lung affected was 80% less among AIAO pigs than CF pigs (15% for CF pigs and 3% for AIAO pigs, $P < 0.05$) (Figure 1). Macroscopic lesions of bronchopneumonia were observed in four of 10 AIAO and 10 of 10 CF sentinel pigs' lungs (Figure 1). Pigs with macroscopic lesions also had microscopic lesions consistent with mycoplasmal and bacterial pneumonia.

IFA and culture

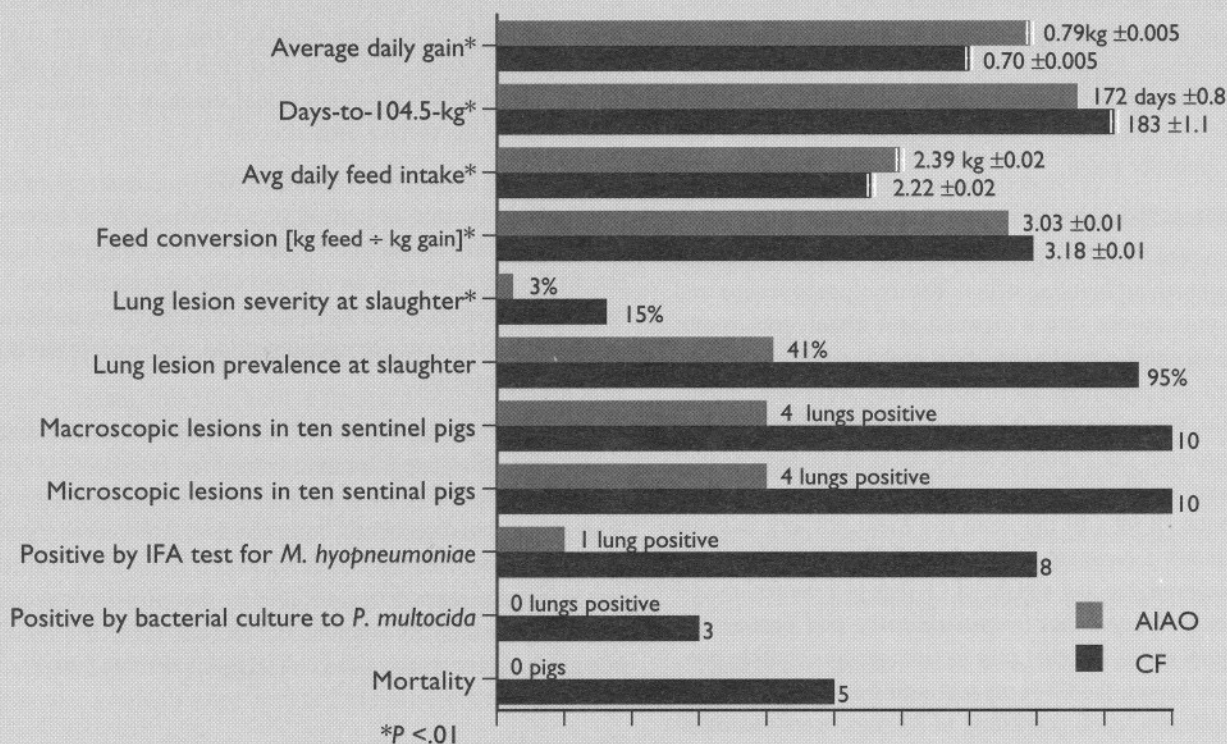
One of 10 AIAO pigs and eight of 10 CF pigs were positive by IFA for *Mycoplasma hyopneumoniae* (Figure 1). All 10 lungs from AIAO pigs were negative for bacterial cultures, whereas three of 10 lungs from CF pigs were positive for *Pasteurella multocida*. Other lungs from CF pigs yielded *Streptococcus suis* type II and *Pasteurella haemolytica* on cultural examination.

Five CF pigs died (Figure 1) during the study. All five were positive for macroscopic lesions and four were positive for microscopic lesions consistent with mycoplasma and pasteurella pneumonia. One was positive by IFA for *Mycoplasma hyopneumoniae*, and three were culturally positive for *Pasteurella multocida*.

Clinical signs

Continuous-flow pigs were heard coughing during all six replicates, whereas coughing was not heard among AIAO pigs. During

Comparison of health and growth performance between AIAO- and CF-reared pigs.



the 2-year study, 85 of 198 CF pigs (43%) exhibited the following clinical signs:

- dyspnea or labored breathing (28),
- gaunt with rough hair (48),
- lameness (four), and
- diarrhea (five).

Fourteen of 198 AIAO pigs (7%) exhibited the following clinical signs:

- gaunt with rough hair (four),
- lameness (eight), and
- ear laceration (two).

Growth

Average daily gain was improved in AIAO pigs (0.79 kg, 1.74 lb) compared to CF pigs (0.70 kg, 1.54 lb) ($P < 0.01$). Days-to-105 kg (230 lb) was also improved from 183 days in the CF pigs to 172 days in the AIAO pigs ($P < 0.01$) (Figure 1).¹⁰ Feed parameters were improved, including average daily feed intake (2.39 kg [5.26 lb] for AIAO pigs versus 2.22 kg [4.84 lb] for CF pigs, $P < 0.01$) and feed conversion (3.03 kg feed per kg gain for AIAO pigs versus 3.18 kg feed per kg gain for CF pigs, $P < 0.01$) (Figure 1).¹⁰

Discussion

Previous studies, which have reported improvements in the growth and health of pigs raised in AIAO production during the growing-finishing phases, may have been confounded by environment, management, or nutrition since they were performed in different commercial herds. In the present study, confounding variables were controlled, and health, growth, and feed parameters all improved.

Using data based upon the biological improvements reported in this study, we estimated the net positive return to be gained from switching from CF to AIAO production, using three different economic models (all of which are based on remodeling existing swine facilities to convert them to AIAO growing-finishing units).¹¹ These models suggest that switching from a CF system to an AIAO system will net a positive return ranging from \$1 to \$5 per pig produced (the exact result of the estimate depends upon which of three models one uses). The highest returns from switching to AIAO are gained if the reduced number of days to 105 kg (230 lb) is fully exploited. Additional kg of pork must be raised in the AIAO system to balance out the extra costs. Producers must either produce more pigs, which may be difficult without an increase in the number of farrowings, or sell the same number of pigs at a higher weight, risking a discount by the packer, particularly if they are too fat.

The decision to switch to AIAO production during the growing-finishing phase of production remains valid by a wide range of values for economic variables such as interest rates, labor costs, corn prices, and pig prices.¹¹

Balancing additional capital and labor expenditures is the most economical way to convert to AIAO production. Producers planning to convert facilities to AIAO should realize that AIAO production requires more intensive breeding management, a more intensive farrowing schedule, and a marketing strategy that includes a plan to sell slow-growing pigs to an alternative market. Producers that build new facilities will probably be able to gain more of the potential economic advantage of AIAO (i.e., \$5 per pig).¹¹

Pneumonia has a major impact on growth performance of pigs and on profitability due to the adverse impact on growth and feed parameters.⁵ Due to the ubiquitous nature of *Mycoplasma hyopneumoniae* and *Pasteurella multocida*, swine pneumonia presents a challenge to producers. It is difficult to eradicate pneumonia without actively intervening by depopulating and repopulating or by using segregated early weaning. Even then, the risk for reinfection may be high.

Management of pneumonia has involved antimicrobial therapy by feed, water, or injection. Vaccines are available for mycoplasmal pneumonia to enhance the pigs' immunity prior to the onset of infection and clinical signs. Modifying facilities or building new ones that allow AIAO production is another management tool to reduce the economic effect of pneumonia on a system. The results in this study show that a significant reduction in pneumonia was associated with a significant improvement in growth performance and a positive benefit:cost ratio for remodeling facilities to switch to AIAO.

Studies vary as to the significance of pneumonia on the growth of pigs.¹² This may be due in part to the complex nature of pneumonia in commercial herds and the lack of methods to accurately and uniformly measure the economic losses associated with the disease. Within commercial herds, environmental stressors vary and concurrent clinical diseases occur. The cumulative economic effect of these factors on a swine herd's productivity is unknown; however, it is not uncommon for increased pig mortalities, retarded growth performance, diminished feed utilization, and increased antimicrobial costs to result from them. Added environmental stressors—including season, temperature fluctuations, dust, and pigs of varying ages in the same airspace—contribute to increased disease prevalence and a more costly economic effect.¹³ Morrison et al.¹⁴ developed a computer-aided guide to the prevalence of pneumonia in pig herds in an attempt to assess the economic significance within herds. One risk factor is AIAO production during all phases of production.

All-in—all-out animal flow during the growing-finishing phase of production offers profit potential to producers who choose to adapt this technology. Owners of new facilities may realize more

of the profit potential than remodeled older ones depending upon the costs and labor involved. The benefit:cost of moving pigs from multiple sow farms or nurseries where the health status of the source herd is unknown has not been determined. Healthy pigs from sow farms mixed with pigs carrying *Mycoplasma* spp. and *Pasteurella* spp or other microorganisms will become infected even though the pigs may be in an AIAO facility. The only exception may be in medicated early weaning or segregated early weaning when the pigs are weaned from the sow at an age earlier than most commercial herds.

Implications

- AIAO production can improve the feed efficiency, weight gain, days-to-230-lb, and respiratory health of pigs compared to CF production.
- A \$1–\$5 savings per pig produced may be realized when using AIAO growing-finishing in remodeled facilities.
- A higher savings may be achievable when building new facilities and using AIAO during the growing-finishing phase.

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