Performance Differences between Natural-Ventilated and Tunnel-Ventilated Finishing Facilities

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Summary and Implications

Based on farm-level data from 744,500 head of pigs finished in confinement, the performance of pigs housed in tunnel-ventilation facilities was shown to be superior to that of pigs housed in natural-ventilation facilities, as measured by both daily feed consumption and feed conversion. This, in turn, resulted in higher average daily gain, a lower cull rate, and a lower feed cost per cwt of gain. The lower cost of gain, together with the reduced number of cull hogs and the extra 9.4 lb of market weight sold, are significant economic advantages that resulted in an estimated higher net return of $5.61 per pig for each group fed in tunnel housing.

Introduction

The data used for this study were obtained from contract finishing operations independently owned by 143 farm families in the upper Midwest. The time frame covered 24 months of production, between September 1, 1996, and August 30, 1998. The measurements were actual production close-outs, by lot, using “all-in, all-out” technology. The feeder pigs originated through a systematized three-site approach. Weaning occurred at about 17 days of age, at which time the pigs were sent to nurseries for 6.5 weeks, then delivered to the finishing facilities. A common genetic pool and identical nutrition programs were used for all buildings, eliminating these variables as sources of variation in performance.

Materials and Methods

The first facilities were built in 1991, and were naturally ventilated. All the natural houses have 6,750 sq ft of floor space, with 7.5 sq ft allowed for each of the 900 pig spaces. Each house is equipped with two evenly divided pig rooms, with an 8-ft control room in the center. The side walls are 2 ft x 6 ft stud walls, covered on the inside with 3-ft hog panel fencing, with insulated curtains on the north side wall and noninsulated curtains on the south side wall. During colder seasons fresh air is brought in by minimum ventilation fans. Each room has two 24-in. variable speed fans, placed in the end wall of the room, that are driven by temperature sensors placed in the middle of the room air space, approximately 4 ft above the floor. When the minimum ventilation fans are unable to control room temperature beyond the desired level, both side wall curtains automatically drop 4 in., hold for at least 6 min, then drop another 4 in. During periods of minimum ventilation (colder seasons) fresh air is drawn in by the fans through punched soffits in the north and south eaves, into the insulated attic, and down through ten evenly spaced two-sided, weighted inlet louvers. Maximum ventilation in natural housing depends on how much wind driven air can be sent through a building with 5-ft openings on the south and north walls.

The tunnel buildings have essentially the same floor plan as the natural housing. The main variation is the ability to mechanically control air speed across the pig area. The ventilation system is composed of a bank of fans on the end of the facility, all driven by a static pressure/temperature sensitive controller. Three 48-in. fans, one 36-in. fan and one 24-in. fan are placed in the end wall, all operated on a staged, variable speed basis. A second 24-in. fan is placed in the north wall about two-thirds of the distance down the building, away from the fan bank. The combination of the two 24-in. fans provides the very minimum amount of fresh air to the building under the most extreme cold temperatures.

Another important difference in the tunnel-ventilated design is that the north wall is solid and insulated. The south wall is still a curtain, but does not move up and down based on static pressure/temperature. The curtain is there only to provide a safety factor during power outages, prior to the startup of a generator. This curtain runs the entire length of the south wall, and is equipped with two tunnel curtains on both sides of the center alley that automatically drop when the fresh air inlets alone are not enough to keep the room temperature from rising above the desired level. Again, much like the natural ventilation, each drop of the curtain is staged, which allows the sensing of temperature adjustments before the curtains open further. The tunnel curtains begin to drop automatically when the second 48-in. fan comes on. Under minimum ventilation, both systems are designed to move 7 ft^3 per minute (cfm) of air per pig.

Maximum ventilation in the tunnel buildings is achieved by moving air across the pigs at 4 miles per hour, or 300 cfm per pig. In both designs comfort of the pigs is further enhanced with a water mister system. However, the air conditioning effect in the tunnel buildings is more effective than in the natural buildings, due to the difference of windy conditions versus quiet air-speed conditions. The net effective temperature to the pig is 82°F in tunnel housing, but in natural housing can reach 100°F on quiet, hot days. For most of Iowa, though, swine ventilation systems are challenged more by cold conditions than hot conditions. This is because the ideal temperature for most pigs during feedlot phase is near 70°F.

Results and Discussion

Data were obtained from 432 groups of pigs finished in natural housing and 364 groups finished in tunnel housing. These represented 167natural facilities and 210 tunnel facilities located on 143 farms in eight states. A total of 744,500 pigs was finished.

The stocking rates averaged 924 head per house for the natural systems and 916 head per house for the tunnel systems. Pigs were transported with one load in and five loads out. The marketing loads were generally timed at 105 days on feed for the first load (mostly barrows), two loads at around 120 days, and two loads at around 135 days.

The performance measures compared included average daily feed consumption, adjusted feed conversion, cull rate, death loss rate, and cost of gain. Cost of gain is the combination of feed cost, health costs (water, injectables and feed medications) and transportation costs in and out. The mean values and tests of significance for the key values for each system are summarized in Table 1.

For both types of housing, diets were changed when a fixed quantity of feed was consumed, regardless of how long it took. Thus, the total pounds of feed consumed per pig was nearly identical for each system. The pigs fed in the naturally-ventilated facilities took slightly longer to consume the standard quantity of feed, 132.3 days versus 130.0 days. Though small, this difference was consistent, and was statistically significant at the 1% level.

Given that the pigs housed in the tunnel facilities ate the same amount of feed in fewer days, on average, it is logical to conclude that they exhibited a higher average daily feed consumption. The mean advantage was 0.09 lb of feed consumed per day per pig, which was statistically significant.

The average beginning weights of 43.5 lb for pigs in natural ventilation and 44.6 lb for pigs in tunnel ventilation were not significantly different. However, ending weights were 250.8 lb for tunnel system pigs and 241.3 lb for natural system pigs, a significant difference of 9.5 lb per head. This is despite the fact that the pig days on feed were over 2 days longer for the pigs in natural ventilation. The difference between the beginning and ending weights, or total pounds of gain, was 8.4 lb per pig, which was also statistically significant.

The pigs in tunnel-ventilated housing consumed essentially the same quantity of feed but gained more weight, on average. Thus, they converted feed into gain more efficiently. There was a statistically significant advantage of 0.16 fewer pounds of feed per pound of gain for the tunnel-ventilation facilities.

Average daily gain (ADG) depends mathematically on daily feed consumption and the rate of feed conversion. Not surprisingly, the difference in ADG, equal to 0.09 lb per day, was also significant at the 1% level.

A cull pig was defined as any pig that had not achieved a slaughter weight of at least 220 lb by completion of the feeding period. This did not include pigs lost to death loss. The cull rate was calculated as the number of cull pigs in a lot divided by the original number placed on feed. The tunnel housing had a cull rate of 3.22 versus 4.90% for the natural housing, a difference of over 15 pigs per group. Logically, the lower culling rate is closely related to the higher average daily gain and ending weight.

The death loss rate was computed as the number of deaths divided by the original number of pigs started in the house. Death loss averaged 3.25% for tunnel housing and 3.56% for natural housing, a difference of nearly three head per lot. This difference was not statistically significant at the 1% level, but it was significant at the 5% level. This difference may have been related to the more constant temperatures in the tunnel-ventilated houses.

It was hypothesized that differences in performance by pigs in tunnel-ventilated and naturally-ventilated houses might be more extreme during some months of the year than others, because temperature and wind patterns vary by season. To test this, lots were divided according to the month they were closed out, that is, when the last pigs were sold. Because the average number of days on feed was about 130, performance values were achieved during the close-out month and the preceding 4 months, approximately.

Figure 1 shows average daily feed consumption for each type of facility for each close-out month between September 1996 and August 1998. Note that for both systems daily feed consumption was lowest for lots closed out in September, October, and November for both years. These hogs were started on feed during May, June, July, and August, the hottest months of the year. There was no significant difference in performance between the two systems during these months.

However, the pigs in the tunnel facilities consumed significantly more feed per day for lots closed out in February, March, May, and August 1997 and January 1998. For the most part these pigs were on feed during the fall and spring months, when winds and temperatures are more changeable. The higher performance levels achieved in the tunnel buildings are consistent with the theory that this type of ventilation system can adjust more quickly to changes in the weather, and maintain a more consistent internal environment.

Figure 2 shows average feed conversion rates for lots closed out during the 2-year time period. There were more months in which the tunnel system had a significant advantage in feed conversion (less feed required per pound of gain) than for feed consumption. In fact, during the period of June 1997 through May 1998 there was a statistically significant advantage in all but three close-out months. Again, the greatest differences were for pigs that were on feed during spring and fall months.

Figure 3 shows the combined effects of feed consumption and conversion, as measured by average daily gain. Again, significant differences were observed for lots closed out in winter and summer months, i.e., those on feed during the spring and fall. Where differences were significant, the tunnel houses always had the advantage.

The final part of the analysis compared the estimated total income and variable costs per lot for each type of building. Results are summarized in Table 2. The average stocking rate for naturally-ventilated buildings was slightly higher than for tunnel buildings (924 head per group versus 916 head per group). However, the higher cull rates and death loss resulted in fewer head sold at market weight, 846 head versus 857.

Information on the market price received for the close-out lots was incomplete, because not all the hogs fed were owned by the contractor. However, there is no reason to believe that the selling price for the pigs that reached market weight would be affected by the type of ventilation used. Therefore, a selling price of $.51 per pound, the average received during this time period for the lots for which information is available, was used for both types of housing. A standard price of $80 per head was used to value cull hogs (those not reaching 220 lb). The total revenue received per lot was estimated to be > $4,000 higher for the tunnel-ventilation houses than for the natural-ventilation houses, due to the higher number of pigs sold at market weight.

The cost of feeder pigs going into the buildings was estimated at $1.20 per pound for both types of buildings, based on the average for the (incomplete) records available. However, because the average weight of the pigs going into the tunnel houses was slightly higher (44.6 lb compared with 43.5 lb), the tunnel housing pigs had a slightly higher cost per head. Only slight differences were observed in costs for health and transportation, as noted earlier.

Due to the larger numbers of fans present in the tunnel-ventilated houses, it could be expected that these buildings would consume more electricity. Because utility costs were paid by the building owners rather than the contractor, no consistent record of electrical consumption or expense is available. However, records were kept by two similar farms in the same county, one with two tunnel-ventilated buildings and one with two naturally-ventilated buildings, for a full year. Electricity was supplied by the same source, and was used only to operate the buildings and the accompanying wells. The tunnel houses consumed more electricity, but the natural houses used more propane. The combined cost of electricity and propane was not significantly different for the two types of houses.

The variable costs per group were estimated to be $96,919 for the natural houses and $96,116 for the tunnel houses. The tunnel houses had slightly higher feeder pig costs, but lower feed costs. The return over variable costs was estimated to be $10,816 for each group finished in the natural facilities versus $15,861 in the tunnel facilities. The economic advantage to the tunnel technology was $5,045 per group, or approximately $5.61 per pig finished.

No estimates were made for facility ownership costs, labor or management. Estimated construction costs for the two types of systems were essentially equal, so no significant difference in ownership costs was expected. Likewise, labor and management costs were not included in the estimates. Actual labor hours expended by the operator were not recorded. However, because both ventilation systems are controlled electronically, there is no reason to believe that a significant difference in labor requirements exists.

Acknowledgement

We gratefully acknowledge the cooperation of Farmland Industries, Inc. for making available the data upon which this study is based.

Table 1. Comparison of means (per pig).

Variable	Mean, natural	Mean, tunnel	Difference
Total feed consumed, lb	569.3	570.7	-1.4
Days on feed, days	132.3	130.0	2.3a
Daily feed consumption, lb/day	4.31	4.40	-0.09a
Beginning weight, lb	43.5	44.6	-1.1
Ending weight lb	241.3	250.8	-9.5a
Total gain, lb	197.8	206.2	-8.4a
Average daily gain, lb	1.49	1.58	-0.09a
Feed conversion, lb feed/lb gain	2.92	2.76	0.16a
Cull rate, %	4.90	3.22	1.68a
Death loss rate, %	3.56	3.25	0.31
Feed cost, $ per cwt	$24.16	$22.53	$1.63a
Health cost, $ per cwt	$1.24	$1.25	$-.01
Transportation cost, $ per cwt	$2.80	$2.74	$.06

a, P<.01.

Table 2. Estimated income and variable costs per group.

	Natural ventilation	Tunnel ventilation
Income:		
Stocking rate per turn (head)	924	916
Death loss (%)	3.56%	3.25%
Cull rate (%)	4.90%	3.22%
Head sold at market weight	846	857
Average selling weight (lb)	241.3	250.8
Revenue from market pigs @ $.51 per lb	$104,111	$109,617
Head of cull pigs sold	45.3	29.5
Revenue from cull pigs @ $80 per head	$3,624	$2,360
Total revenue	$107,735	$111,977
Variable costs:		
Feeder pig cost ($53.62 and $52.20)	48,233	49,116
Feed ($46.41 and $47.73 per head)	$44,103	$42,512
Health ($1.25 and $1.24 per head)	1,146	1,145
Transportation ($2.74 and $2.80 per head)	2,587	2,510
Utilities ($.91 and $.92 per head, estimated)	850	833
Total variable costs	$96,919	$96,116
Return over variable costs:		
Per group	$10,816	$15,861
Per head	$11.71	$17.32
Advantage per group		$5,045
Advantage per pig		$5.61

Figure 1. Daily Feed Consumption

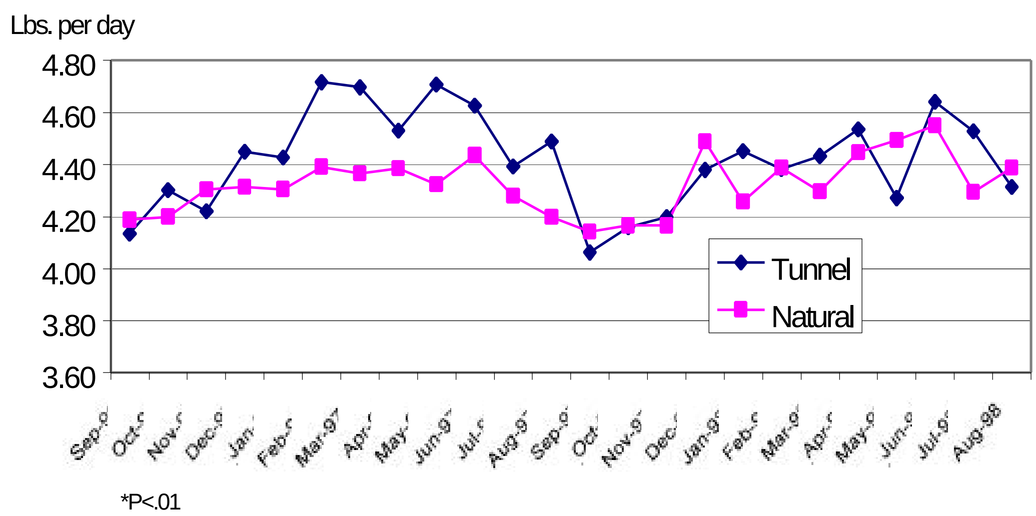


Figure 2. Average Feed Conversion

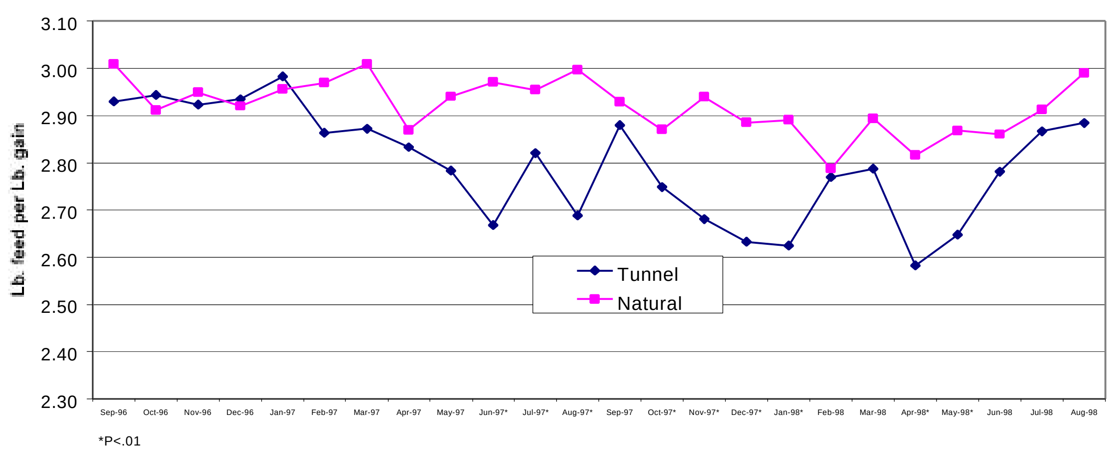
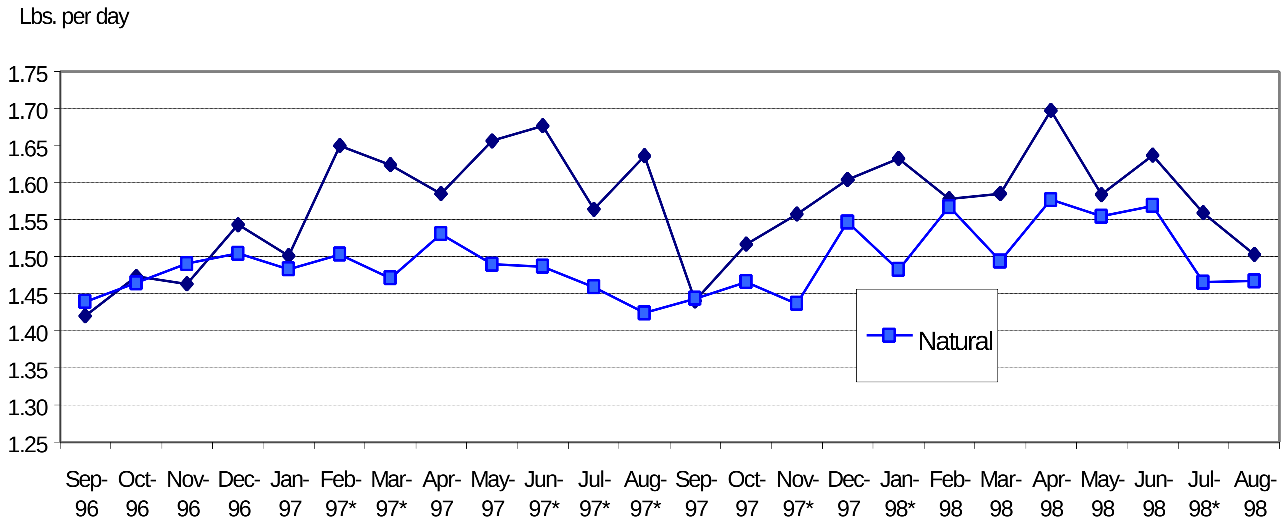


Figure 3. Average Daily Gain



*P<.01