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THE INFLUENCE OF FARROWING SYSTEM AND MANAGEMENT ON THE ECONOMICS OF PIG PRODUCTION TO WEANING

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This research was conducted on a commercial pig farm (approximately 10,000 pigs produced annually) in Missouri owned and operated by Mr. Gerald Sandidge. L. L. Pembrook, Research Assistant in Animal Husbandry, assisted in the daily collection of the research data.

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INTRODUCTION

Comparative information on the efficiency of pork production in various types of confinement and outdoor systems is limited. This research was undertaken to evaluate the performance, economics, environment and management of farrowing sows in two different enclosed confinement buildings vs. individual outdoor farrowing houses.

Sprouse *et al.* [1] found that a solid concrete floored building where the sows were removed from the crates daily for group feeding was the least economical farrowing system during the spring farrowing season when compared with either a building with partial slats where the sows were fed in the stalls to reduce labor costs, or the individual outdoor farrowing houses which required the lowest investment cost and provided the most flexibility. McFate *et al.* [2] reported that the daily labor required in a solid concrete floored building where the sows were fed in groups daily was twice that required in a building with total slats and automated feeding in the farrowing crates.

Jones *et al.* [3] and Daniel *et al.* [4] found that more pigs were lost from being laid on by the sow in farrowing pens and individual houses than in the other units that contained farrowing crates, although total production costs and the average number of pigs raised per litter to three weeks of age were similar for all types of experimental farrowing units studied. Robertson *et al.* [5] reported that the farrowing stall system of management reduced baby pig mortality measured both at three and eight weeks compared to the conventional pen system.

The dynamic trend in swine production has been toward specialization with increased volume of production using various types of confinement facilities to reduce labor costs. Concurrent increases in the cost of building materials and equipment with marked increases in the cost of electrical energy have and will continue to plague the pig producer with completely enclosed confinement buildings.

MATERIALS AND METHODS

Farrowing facilities

The three farrowing systems studied are described as follows:

Facility 1.—An enclosed, insulated building (49x7m), remodeled to contain 58 wood farrowing crates (2.13 x 1.52 m) placed on concrete slats (10.2 cm slat with 0.95 cm slot) elevated 0.6 m over an above-floor pit. Two wide slats (24 cm) in the pig area of each crate contained pipe for hot water heating. Electric heat lamps provided supplemental heat in cold weather. Zone cooling was available for the sows in hot weather.

The building was divided in half with an office and utility room in the center. Each end had two rows of elevated farrowing crates facing the center alley, and a ventilation fan with an Air Moving and Condition Association (AMCA) rating of 68.7 m^3/min at 0.254 cm static pressure.

Feed was augered to individual self-feeders from an outside bin. Each crate contained an automatic water cup. Wheat bran was used as bedding for the first week post partum. A portable ramp was used in the alleys along the sidewalls to get the sows in and out of the crates.

Facility 2—An enclosed insulated building (55 x 11 m) with 62 wood farrowing stalls (2.13 x 1.52 m) in two rows on a solid concrete floor sloping towards pens (1.52 x 1.52 m) behind the stalls. Each pen contained aluminum slats (8.9 cm slat with 2.54 cm slot) that extended 0.3 m into the farrowing stall. The stalls faced a center alley with an alley behind the pens on each sidewall.

The sows and litters were kept in the stalls until five days post partum. At that time, the rear of the stall was opened and one side rotated to the side of the pen to create a "free stall" with access to the pen. Hot water pipes in the floor and electric heat lampls provided heat for the baby pigs. Zone cooling was available for the sows. Wheat bran was used for bedding the first week past partum.

The pits on each side connected to form an oxidation ditch with a paddle wheel powered by a 5 HP electric motor. The pit liquid level of 0.4m was maintained with an overflow to an outside lagoon. Four variable speed fans with minimum AMCA rating of 28.3 m^3/min and maximum of 132.0 m^3/min, at 0.254 cm static pressure were located on the north side wall. An adjustable slot inlet along the eaves of the south wall provided fresh air. The sows were hand fed to appetite daily. The sows were hand watered in the crates until allowed into the pen which contained an automatic watering cup.

Facility 3—(*Individual outdoor houses*) Thirty-four individual portable wood houses (1.83 x 2.13m) located side by side facing south. Each house had a wood floor and guard rails. Each houses had a hinged roof and a door in front. Each house had a slotted (approximately 14 cm oak slat with 3.8 cm slot) platform (2.5 x 2.1m) in front with automatic waterers and self feeder. The slats had worn to increase the slot opening from about 2.5 cm to 3.8 cm after four years use. The platform was shaded and foggers were used on the platform during hot weather.

The houses and platforms were moved twice a year to remove the solid waste underneath. The liquid drained toward a nearby lagoon. Two 7.6-cm diameter

holes located near the top of the rear wall provided ventilation, but during hot weather the roofs were partially opened to allow more air movement. Straw was used for bedding.

Animals and Management

Crossbred sow litters (145) farrowed in July were used in the study. Gilt litters were not included. The sows were bred in dirt lots and fed once daily on a concrete slab. They received about two kg of a 16 percent protein corn-oats-soybean meal diet, fortified to meet National Research Council [6] recommendations, for vitamins and minerals. The sows were washed and allotted to the farrowing facilities about 10 days before farrowing.

Needle teeth of pigs were clipped within 16 hours after farrowing. Tail docking, castrating, and administering injectible iron was done between two and five days of age. The sows received the same diet during lactation as they received during gestation. Those in Facilities 1 and 3 were self-fed and those in Facility 2 were fed about 4.6 kg daily. The sow diet was prepared in a continuous flow automatic electric hammer mill and stored in bulk tanks at Facilities 1 and 2. Sow diet was delivered to individual self feeders at the outdoor facilities from an auger wagon. The piglets in all the facilities were offered an 18 percent crude protein diet containing 165 mg each of oxytetracycline and neomycin sulfate per kg, starting at one week of age. The pigs were weaned in all the facilities at an average age of 35 days.

Data collected

Litter weights were obtained at birth and at 35 days of age. Causes of piglet deaths were recorded. Sow and piglet feed consumption were measured to weaning. Labor records were kept on the basis of time required to complete all tasks performed for each facility. Temperature and relative humidity were recorded continuously inside each enclosed facility about 1 m above the floor level. Similar measurements were taken outside. Air samples[1] were taken weekly in the two enclosed buildings at the same representative location 0.3 m above floor level to determine relative ammonia, carbon dioxide, and hydrogen sulfide gas concentrations. Total variable and fixed costs were obtained for the three farrowing systems.

RESULTS

Environment

The average high and low temperatures (°C), were more uniform for the insulated, enclosed Facilities 1 (29.4, 23.9) and 2 (28.3, 20.6) compared to the outdoors (31.7, 18.3) from early July to mid-August. The average high and low relative humidity (%) for Facility 2 (65 and 47%) was higher compared with

[1]Precision Gas Detector (Bendix Fastec), National Environmental Instruments, Inc., Warwick, R. I. USA.

Facility 1 (59 and 43%) and outdoors (65 and 32%) which may be attributed to the oxidation ditch operated in Facility 2. The high temperatures in the outdoor houses were a detriment to performance although the hinged roofs were propped open, on hot days to increase ventilation while still shading the house.

The air samples collected indicated that the average ammonia level in Facility 2 (3.3 ppm) was about half the level in Facility 1 (6.5 ppm), which may be attributed in part to the continuous operation of the oxidation ditch. Carbon dioxide levels (0.2%) were the same in both facilities while hydrogen sulfide was not detected in either facility. The levels of these gases are well below the threshold limit values for man and animals [7] and the desired levels of ammonia and hydrogen sulfide for swine [8].

Piglet performance

The variation that existed in number of pigs born alive per litter in the three facilities (Table 1) was considered to be independent of facility type. However, death losses to weaning at 35 days of age were markedly influenced by facility type and management system which also influenced litter weight at weaning.

Pig losses in Facility 3 (individual houses) were 27.5 percent compared with 12.6 percent in Facility 1 and 15.2 percent in Facility 2. The sows laid under the foggers on the slotted wood platforms in front of the individual houses in hot weather. The piglets slipped and had difficulty moving on the wet slats. In some cases the piglets caught their legs in slots that had widened due to wear. Thus, a high percentage (20.3%) of the total loss in Facility 3 was due sows crushing piglets lying on the platforms. A narrower and more uniform slot opening of about 2 cm may have reduced the incidence of legs being caught between slats. Doors on opposite ends of the individual houses would also have provided greater summer ventilation and animal comfort. Thus, by eliminating the fogging, which was a major contribution to the problem of crushing, the slippery condition on the slats would have been greatly reduced.

All three groups averaged about one-half stillborn pig per litter. The incidence of spraddle legs was very low. Losses due to runts, starvation and other causes such as diseases increased with litter size and averaged 0.55 to 0.80 pig per litter.

Sprouse *et al.* [1] found that the mortality per litter in individual outdoor farrowing houses was similar to that obtained in two confinement farrowing systems (9 to 11%) during the spring farrowing season, which was more ideal for outdoor production systems compared with the summer season in out study. Baker *et al.* [9] also reported that the performance of pigs farrowed in A-frame type houses was directly related to the seasonal environment. Either spring or fall provided more desirable climatic conditions compared with the heat of summer and cold of winter. Thus, our study was conducted at an undesirable time of the year in regard to obtaining maximum performance in individual houses. Robertson *et al.* [5] reported that pig mortality was greater in the conventional pen system compared with the farrowing stall. Jones *et al.* [3] and Daniel *et al.* [4] reported more deaths due to crushing in the farrowing pens and individual outdoor houses than in the other systems they evaluated.

TABLE 1
Litter performance in three farrowing facilities

Item	Farrowing facility 1[a]	2[b]	3[c]
Number of sow litters	51	62	32
Number of pigs per litter born alive	9.67	10.74	10.09
Number of pigs weaned per litter at 35 days	8.45	9.10	7.32
Litter birth weight, kg	14.08	16.82	14.37
Litter weaning weight at 35 days, kg.	73.62	74.61	56.15
Number of deaths per litter to weaning attributed to:			
Crushing	0.61	0.74	2.05
Spraddle legs	0.06	0.09	0.12
Runts, starvation, all other causes	0.55	0.80	0.60

[a]An enclosed, insulated building with 58 farrowing crates elevated 0.6 m over an above floor pit on concrete slats.

[b]An enclosed, insulated building with a farrowing stall and slotted floor pen arrangement having a capacity of 62 sows.

[c]Individual outdoor farrowing houses (34) with shaded and slotted platforms in front.

Labor

The daily labor required per sow and litter in Facility 1 was about 76 percent of that required in Facility 2 and 71 percent of that required in Facility 3 (Table 2). The lower labor required for Facility 1 can be attributed to automatic filling of the self feeders with less time spent for watering and checking compared to Facilities 2 and 3. McFate *et al.* [2] reported that the daily labor was reduced 50 percent when a solid concrete floored building, where the sows were fed in groups daily, was remodeled to provide total slats with automated feeding in the farrowing crates.

The results of this study (Table 2) differ from those obtained by Sprouse *et al.* [1] during the spring farrowing season where the daily labor required per sow unit for an individual outdoor farrowing system was considerably less than that required for two different systems of confinement farrowing. However, the results of this study are in agreement with the report by Jones *et al.* [3] which indicated that the individual farrowing houses required considerably more labor per sow and litter than the other experimental farrowing units during the spring and fall farrowing seasons, although the data in this study were obtained during the more adverse summer farrowing season. The discrepancies obtained between these studies may be attributed to the concept that swine enterprises vary in their individual characteristics, primarily by the way in which the biological processes (management) are combined and manipulated by individual managers [10].

Labor for cleaning and preparation between farrowings was similar for Facilities 1 and 3 and slightly greater for Facility 2 (Table 2). The individual houses and platforms were moved and cleaned only twice annually compared to the cleanup after each farrowing for Facilities 1 and 2.

TABLE 2
Itemized labor distribution for three farrowing facilities

Item	Farrowing facility[a] 1	2	3
Daily labor required[b] per sow and litter	*Time in minutes*		
Feeding time	0.00	0.50	0.75
Water time	0.00	0.25	0.00
Cleaning time	0.75	0.70	0.50[d]
Checking time	1.00	1.00	1.40
Miscellaneous time	0.50	0.50	0.50
Total time per day	2.25	2.95	3.15
Cleaning and preparation time between farrowings per sow and litter	30.00	40.00	32.00
Castrating, injectible iron shots, and tail docking time per litter	8.00	9.00	10.00

[a]See Table 1 for a brief description of the farrowing facilities.

[b]Daily labor required for 45 days (10 days prefarrowing and 35 days postfarrowing). The self-feeders for the sows were filled automatically in Facility 1 and twice weekly with an auger wagon in Facility 3. The sows in Facility 2 were hand-fed daily. Automatic waterers were used in Facilities 1 and 3, and in Facility 2 after five days postpartum. The sows in Facility 2 were watered manually until five days postpartum. The individual houses (Facility 3) were cleaned once a week. Checking time includes caring for new litters, spreading bedding, routine observations and clipping needle teeth. Miscellaneous time includes adjusting heat lamps and building and equipment maintenance in Facilities 1 and 2; and opening and closing the hinged roofs and removing pigs caught in the slats in Facility 3. The individual houses and platforms were moved twice a year for cleaning and manure removal. Facilities 1 and 2 were cleaned between each farrowing group.

Economics

Facility 3 had the highest total variable cost per sow and litter and per 45 kg of live pig produced (Table 3) followed by Facilities 2 and 1, respectively, even though zone cooling increased the electrical cost in Facilities 1 and 2. The higher cost per sow and litter for Facility 3 may be attributed to the greater sow feed and daily labor cost even though less creep feed was consumed. Hand-feeding the sows in Facility 2 reduced the feed cost compared to self feeding the sows in Facilities 1 and 3. The higher cost per 45 kg of live pig produced in Facility 3 is also associated with fewer pigs weaned per litter as previously discussed. The cost per kg of live pig produced was calculated on the basis of total litter weight gain plus or minus sow weight gain or loss, respectively, from farrowing to weaning. Utilizing the appropriate physical and management adjustments discussed above to minimize baby pig losses and to increase the kg of live pig produced per litter in our experiment, the individual houses would become more productive and economical.

TABLE 3
Variable cost comparison for three farrowing facilities

Cost per sow and litter	Farrowing facility[1] 1	2	3
Total daily labor cost for 45 days	$ 5.06	$.6.64	$ 7.09
Castrating, injectible iron shots and tail docking	1.00	1.05	1.10
Bedding	1.00	1.25	1.00
Electricity	5.00	6.13	0.00
Cleaning between farrowings	1.50	2.00	2.00
Feed cost per sow	35.42	32.20	41.86
Creep feed per litter	1.76	2.08	0.80
Total variable cost	50.74	51.35	53.85
Total variable cost to produce 45.0 kg of live pig	36.68	40.62	43.87

[1]Daily labor time from Table 2 at $3.00 per hour x 45 days. An injectable iron cost of $0.05 per pig plus the labor cost for castration, tail docking and giving the injectible iron. A bedding cost of $5.60 per 45 kg of wheat bran and $1.00 per bale of straw. An electricity cost of $.022 per kilowatt. Cleaning between farrowings for Facility 3 includes labor plus a cost for the use of a manure spreader. A sow feed cost of $154.28 per metric ton including processing and hauling. A creep feed cost of $176.00 per metric ton. The total litter weight plus or minus sow weight gain or loss, respectively, was used to calculate kg of live pig produced from farrowing to weaning.

The total investment in each farrowing facility (Table 4) indicates that Facility 2 had the highest investment cost per individual farrowing unit or stall ($885.48) followed by Facilities 1 ($774.14) and 3 ($494.12). The annual fixed costs for the facilities were calculated based on the costs for land, permanent or portable buildings and equipment. The permanent buildings were depreciated over 15 years and equipment and individual houses were depreciated seven years. The loan interest for permanent and portable buildings and equipment was based on 8 percent over a 10-year depreciation period which results in an average loan interest rate of 4 percent. Facility 2 had the highest fixed cost per sow and litter ($22.52) followed by Facility 1 ($19.40) and Facility 3 ($16.23) based on six farrowings per year in each facility.

DISCUSSION

Even though the climatic conditions were unfavorable and the physical condition and management of the individual outdoor houses were less than optimum with regard to reducing baby pig losses due to crushing, the total cost per 45.0 kg of live pig produced in those facilities ($57.70) was less than that obtained for Facility 2 ($58.44). That was due to the high investment cost of Facility 2 which could not be justified in terms of the total labor cost for that facility. The labor cost was similar to the individual outdoor units but considerably greater than that for Facility 1 which was the most profitable system

in this study (total live pig production cost of $50.70 per 45.0 kg). The investment cost for Facility 1 was offset in part by a reduction in labor while maintaining a high level of production. This type of facility offers additional protection from the environment for both the pigs and the people working in the facility in adverse climatic conditions either hot or cold. This study supports the conclusion [11] that the detailed design characteristics of a particular type of facility may have a greater effect on the cost per kg of live pig produced than differences in types of well designed facilities. The optimum farrowing system will depend on labor, capital, management and size economics.

TABLE 4
Actual investment and fixed cost computation for three farrowing facilities[1]

Item	Total investment cost	Annual interest (%)	Annual fixed cost	Fixed cost per sow and litter
	Farrowing facility 1			
Land, 0.40 ha	$ 800	8.00	$ 64.00	$ 0.18
Permanent building	34,180	13.67	4672.41	13.43
Equipment	9,920	20.30	2013.76	5.79
Total	44,900		6750.17	19.40
	Farrowing facility 2			
Land, 0.40 ha	800	8.00	$ 64.00	$ 0.17
Pernament Building	40,230	13.67	5499.44	14.78
Equipment	13,870	20.30	2815.61	7.57
Total	54,900		8378.05	22.52
	Farrowing facility 3			
Land, 0.40 ha	$ 800	8.00	$ 64.00	$ 0.31
Individual houses, platforms & shades	14,000	20.30	2842.00	13.93
Equipment	2,000	20.30	406.00	1.99
Total	16,800		3312.00	16.23

[1]Annual interest for each category of investment is calculated as follows:

	Land	*Building (15 years)*	*Individual houses and equipment (7 years)*
Depreciation (%)	—	6.67	14.3
Loan Interest (%)	7.0	4.0	4.0
Repairs, taxes, ins. (%)	1.0	3.0	2.0
Total	8.0	13.67	20.3

The fixed cost per sow and litter is based on six farrowing per year with 348, 372, and 204 litters annually in Facilities 1, 2, and 3, respectively. Equipment cost for Facilities 1 and 2 includes farrowing crates, air conditioning, heaters, wiring, use of bulk truck, tractor and trailer. Facility 3 includes individual outdoor units (34) with an equipment cost for self feeders, waterers and the use of a tractor, trailer, and auger wagon.

SUMMARY

This study was conducted during the summer of 1975 to evaluate the performance, economics, environment and management of 145 litters farrowed in three different facilities:

1. Building with farrowing crates on total slats with automatic feeding
2. Building with stalls on solid concrete and a slatted pen behind the stalls with hand feeding
3. Individual outdoor houses with slatted wood platforms in front with self feeders.

Mortality from birth to 35-day weaning was 13 percent in Facility 1, 14 percent in Facility 2 and 27 percent in Facility 3. The high mortality in Facility 3 resulted from crushing due to the physical condition and management within the facility during the summer season. Variation in daytime temperature and humidity was less in Facilities 1 and 2 than outdoors. The daily labor required per sow and litter for Facility 1 was 76 percent of that required for Facility 2 and 71 percent of that regained for Facility 3.

Facility 1 was the most profitable system in this study based on the total cost (variable plus fixed) per 45 kg of live pig produced. The total cost per 45 kg of live pig produced in facility 3 was less than that required for Facility 2. The individual houses are a practical alternative for pig producers in a moderate climate with limited capital and a need for flexibility. A well designed confinement building offers a long-run economic advantage of increasing the number of pigs handled without increasing labor. At the same time it provides protection from adverse climatic conditions for both the pigs and the producer.

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