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ROBERT M. FINLEY, NOEL DEVISCH AND ROBERT RETZLAFF*

In 1974 the hog enterprise in Missouri, producing some 8 percent of the national output, was ranked third in the country. Hogs are produced in every county with the northern half of Missouri primarily engaged in the production of market hogs and the southern half recognized as the production region of quality feeder pigs.

Two basic structural changes have occurred in the hog industry. First, the size of the herds has increased in the past and keeps increasing. Secondly, the production technique has become more intensive. For example, multiple farrowings continue to replace "spring farrowing" and confinement systems are becoming more widespread. Technological progress and the cyclical price pattern have been major factors precipitating these structural changes.

More intensive and larger scale production require large amounts of capital investment. The hog industry, however, is subject to limited long run profits and entails considerable risk and uncertainty both in the production process and on the market. Long run decision making in this sector needs all possible information that can be made available.

Very often, producers are interested in the relationship between production system, the size of the enterprise and the average production cost. This will be the subject of the present study. More specifically, the economies of size in hog production will be examined for conventional production systems and confinement systems and for a farrowing intensity of two, four, and six farrowings per year.[1]

Procedure and Methodology

Budgeting is used as the principle research technique. Costs were synthesized from data obtained from farmers, specialists in agricultural engineering and animal science, other cost studies, as well as from supply catalogs issued by hog equipment manufacturers and building contractors. The study was originally based on 1970 data and later updated with 1974 prices.

Selection of the capacity sizes was determined by considering the smallest number of hogs that might likely be produced, the number of hogs that is typically produced, and a capacity level that can be achieved by expanding enterprises. Table 1 summarizes the size of the enterprises in terms of the

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[1]Technical terms used are defined in Appendix A.

Table 1

Number of Sows on the Farm and Number of Pigs Weaned and Market Hogs Produced per Year, for Six Selected Capacities, Three Farrowing Intensities and Two Litter Sizes[1]

Capacity Level	Two Farrowings Per Year					Four Farrowings Per Year					Six Farrowings Per Year				
	# Sows	# Pigs		# Mkt. Hogs		# Sows	# Pigs		# Mkt. Hogs		# Sows	# Pigs		# Mkt. Hogs	
Litter Size		8.5	7.0	8.5	7.0		8.5	7.0	8.5	7.0		8.5	7.0	8.5	7.0
1	8	136	112	134	110	16	272	224	268	221	24	408	336	403	332
2	30	510	420	504	415	60	1020	840	1008	830	90	1530	1260	1512	1245
3	60	1020	840	1008	830	120	2040	1680	2016	1680	180	3060	2520	3024	2490
4	100	1700	1400	1680	1382	200	3400	2800	3360	2766	300	5100	4200	5040	4149
5	150	2550	2100	2520	2074	300	5100	4200	5040	4149	450	7650	6300	7560	6223
6	200	3400	2800	3360	2766	400	6800	5600	6720	5533	600	10200	8400	10080	8300

[1]The mortality rate in the growing and finishing period is estimated at 1.2 percent.

number of sows, the annual output of feeder pigs, and the yearly production of market hogs. Six capacity levels were considered, representing respectively 8, 30, 60, 100, 150, and 200 farrowing stalls and the required growing and finishing accommodation in a breeding-finishing operation. This is presented for three farrowing intensities and two litter sizes. The farrowing levels chosen per year were two farrowings or one group of sows farrowed twice; four farrowings or two groups of sows farrowed twice; and six farrowings or three groups of sows farrowed twice. The litter sizes were arbitrarily selected at respectively 7.0 and 8.5 pigs weaned per litter.

For these different sizes, intensities and performance levels, budgets have been computed in order to measure average production cost both for a conventional production system and for a complete confinement system. Comparisons between the two systems were made and the impact of size and farrowing intensity on the cost structure was examined. A detailed account of the assumptions on which the budgeting is based is given in Appendix B.

Analysis by Capacity

For the six capacity levels, a comparison of production costs was made for the three different farrowing intensities and a litter size of 7.0 and 8.5 pigs, respectively. This analysis was carried out for both the conventional and confinement systems. As the capacity levels increased, changes were made in the production practices and techniques. In some cases, minor changes had also to be made when the farrowing intensity increased. A detailed account of the operational differences between capacity levels and/or farrowing intensities is given in Table 2. These operational differences had their impact on the labor requirements as did the capacity and the performance level. The total labor requirements are calculated in hours per market hog and summarized in Table 3.

The cost of production was calculated on a per cwt. basis and grouped into variable costs, fixed costs, and total costs per cwt. All results are presented in Table 4. A discussion of the results for a performance level of 7.0 pigs per litter at weaning stage, will be the subject of this section.

Capacity 1

Capacity 1 consists of one, two, and three sets of eight sows, respectively, each farrowed twice. This capacity level may be considered as the smallest possible level of commerical production. With only eight sows on the farm, production costs exceed $41 per cwt., mainly because of the high labor costs involved. Labor costs are particularly high for the conventional system, due to the method of manure handling. While the difference in costs between the conventional and the confinement system is negligible when only farrowed twice, the confinement system turns out to be less expensive than the conventional system for four or six farrowings per year. This can be explained by the fact that the decrease in labor costs more than offsets the increase in fixed costs as the changes from conventional to confinement. One notices from Figure 1a that considerable economies occur if the facilities

Physical Operation Techniques for the Conventional and Confinement Systems at Different Capacities and Farrowing Intensities

Capacity	Farrowing Level	Conventional System	Confinement System
1	2, 4	Processing and delivery of feed by commercial company; self feeders	Processing and delivery of feed by commercial company; automatic feeding system
	6	Portable grinder mixer	Grinder mixer
	2, 4, 6	Conventional farrowing; corner of pen isolated from sow	Farrowing crates
		Manure handled as solids and spread on field	Lagoon for manure disposal
2	2, 4, 6	Stationary automatic hammer mill Auger wagon	Stationary automatic hammer mill Automatic auger feeding system
		Manure handled as Capacity 1	Lagoon and farrowing pit, pumped commercially
		Farrowing system as Capacity 1	Farrowing crates
3	2, 4, 6	Mill and processing center Auger wagon	Mill and processing center Automatic feeding
		Manure handling as Capacity 1	Manure handling as Capacity 2 except: tank wagon for liquid manure removal (for farrowing levels 4 and 6)
		Farrowing system as Capacity 1	Farrowing system as Capacity 1
4	2, 4, 6	Mill and processing center Automatic feeding for finishing	Mill and processing center Automatic feeding
		Manure handling as Capacity 1 except lagoon for growing-finishing	Manure handling as Capacity 3
		Farrowing system as Capacity 3	Farrowing system as Capacity 3
5 and 6	2, 4, 6	Stationary mill Automatic feeding for the whole enterprise	Stationary mill Feeding system as Capacity 4
		Manure handling as Capacity 4	Manure handling as Capacity 4
		Farrowing system as Capacity 4	Farrowing system as Capacity 4

Table 3

Hours of Labor per Market Hog for Conventional (CV) and Confinement (CF) Systems, 2-4-6 Farrowings, Capacities 1-6 and Litter Size of 8.5 Pigs and 7.0 Pigs

Farrowing Systems	Capacity 1	Capacity 2	Capacity 3	Capacity 4	Capacity 5	Capacity 6
	Hours Per Hog	Hours Per Hog	Hours Per Hog	Hours Per Hog	Hours Per Hog	Hours Per Hog
2 Farrow CV, 8.5 pigs/litter	1.89	1.48	1.38	1.08	.82	.83
2 Farrow CF, 8.5 pigs/litter	1.51	1.32	1.00	1.05	.79	.83
4 Farrow CV, 8.5 pigs/litter	1.53	1.21	1.24	1.06	.86	.88
4 Farrow CF, 8.5 pigs/litter	1.16	.95	.94	1.01	.77	.88
6 Farrow CV, 8.5 pigs/litter	1.52	1.11	1.23	1.11	.76	.83
6 Farrow CF, 8.5 pigs/litter	1.22	.94	.95	.95	.73	.81
2 Farrow CV, 7.0 pigs/litter	2.22	1.76	1.64	1.28	.96	.98
2 Farrow CF, 7.0 pigs/litter	1.76	1.56	1.18	1.25	.94	.97
4 Farrow CV, 7.0 pigs/litter	1.83	1.44	1.45	1.25	1.02	1.03
4 Farrow CF, 7.0 pigs/litter	1.37	1.12	1.10	1.19	.91	.96
6 Farrow CV, 7.0 pigs/litter	1.74	1.32	1.47	1.31	.89	.97
6 Farrow CF, 7.0 pigs/litter	1.38	1.11	1.12	1.15	.85	.95

Table 4

Budgeting Results for Both the Conventional and Confinement Systems, at Six Capacity Levels, Three Farrowing Intensities and Two Litter Sizes

	Two Farrowings Per Year				Four Farrowings Per Year				Six Farrowings Per Year			
System	Conventional		Confinement		Conventional		Confinement		Conventional		Confinement	
Pigs Weaned Per Litter	8.5	7.0	8.5	7.0	8.5	7.0	8.5	7.0	8.5	7.0	8.5	7.0
Capacity 1												
Number of Sows	8	8	8	8	16	16	16	16	24	24	24	24
Number of Hogs Sold	134	110	134	110	268	221	268	221	403	332	403	332
Variable Cost Per Cwt.	33.02	35.44	32.81	35.17	32.74	33.40	32.21	32.73	31.20	32.27	30.74	31.71
Fixed Cost Per Cwt.	5.01	6.11	5.38	6.56	3.70	4.49	3.81	4.61	3.48	4.22	3.64	4.41
Total Cost Per Cwt.	38.03	41.55	38.20	41.72	36.44	37.89	36.02	37.35	34.68	36.49	34.38	36.12
Capacity 2												
Number of Sows	30	30	30	30	60	60	60	60	90	90	90	90
Number of Hogs Sold	504	415	504	415	1008	830	1008	830	1512	1245	1512	1245
Variable Cost Per Cwt.	31.30	33.29	31.17	33.12	29.99	31.69	29.81	31.48	29.71	31.38	29.51	31.14
Fixed Cost Per Cwt.	4.53	5.50	4.94	6.00	3.47	4.21	3.74	4.55	3.24	3.95	3.43	4.19
Total Cost Per Cwt.	35.83	38.79	36.11	39.12	33.46	35.90	33.56	36.03	32.95	35.33	32.94	35.32
Capacity 3												
Number of Sows	60	60	60	60	120	120	120	120	180	180	180	180
Number of Hogs Sold	1008	830	1008	830	2016	1680	2016	1680	3024	2490	3024	2490
Variable Cost Per Cwt.	30.71	32.77	30.23	32.19	29.97	31.65	29.63	31.19	29.78	31.47	29.30	30.88
Fixed Cost Per Cwt.	4.25	5.16	5.11	6.21	3.39	4.07	3.95	4.74	3.14	3.82	3.59	4.35
Total Cost Per Cwt.	34.96	37.93	35.34	38.40	33.36	35.72	33.58	35.93	32.92	35.28	32.89	35.24
Capacity 4												
Number of Sows	100	100	100	100	200	200	200	200	300	300	300	300
Number of Hogs Sold	1680	1383	1680	1383	3360	2766	3360	2766	5040	4150	5040	4150
Variable Cost Per Cwt.	30.05	31.81	30.27	32.09	29.62	31.24	29.80	31.46	29.48	31.14	29.30	31.00
Fixed Cost Per Cwt.	4.68	5.69	5.29	6.43	3.64	4.43	3.96	4.82	3.30	4.00	3.59	4.37
Total Cost Per Cwt.	34.73	37.51	35.56	38.52	33.26	35.67	33.76	36.28	32.78	35.14	32.89	35.37
Capacity 5												
Number of Sows	150	150	150	150	300	300	300	300	450	450	450	450
Number of Hogs Sold	2520	2074	2520	2074	5040	4150	5040	4150	7560	6224	7560	6224
Variable Cost Per Cwt.	29.21	30.84	29.44	31.14	28.94	30.51	29.13	30.67	28.66	30.08	28.76	30.22
Fixed Cost Per Cwt.	4.66	5.66	5.35	6.51	3.52	4.35	3.89	4.72	3.27	3.97	3.59	4.36
Total Cost Per Cwt.	33.87	36.49	34.79	37.65	32.46	34.86	33.03	35.40	31.93	34.05	32.25	34.58
Capacity 6												
Number of Sows	200	200	200	200	400	400	400	400	600	600	600	600
Number of Hogs Sold	3360	2766	3360	2766	6720	5533	6720	5533	10080	8300	10080	8300
Variable Cost Per Cwt.	29.34	31.01	29.64	31.30	29.17	30.64	29.41	30.95	28.78	30.25	28.95	30.45
Fixed Cost Per Cwt.	4.57	5.56	5.27	6.40	3.63	4.34	3.96	4.80	3.25	3.95	3.59	4.36
Total Cost Per Cwt.	33.92	36.57	34.91	37.70	32.80	34.98	33.37	35.75	32.03	34.19	32.55	34.82

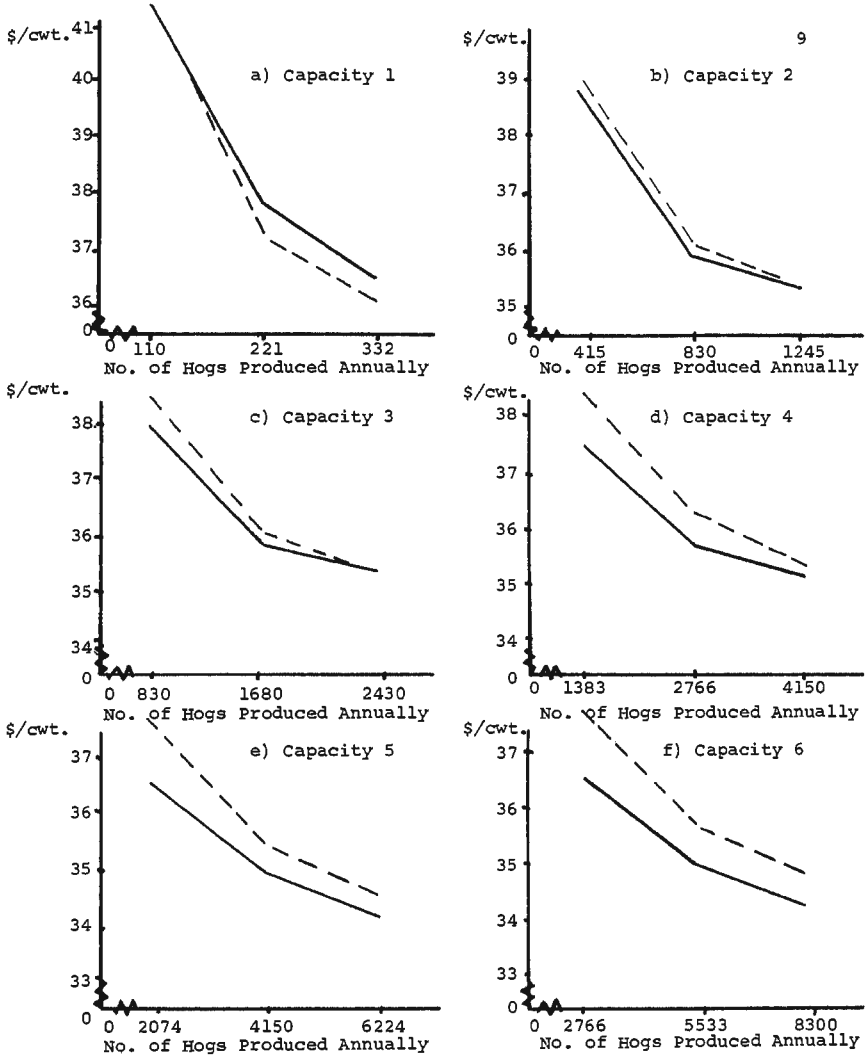

Figure 1. Cost Per Cwt. in Function of the Number of Hogs Produced, at Six Capacity Levels, for Conventional (———) and Confinement (– – –) Systems

are more intensively utilized. Given the higher fixed costs in the confinement system, cost decreases in this system will exceed those of the conventional system. Even for this last system, production costs decrease by $5 per cwt. as the farrowing intensity increases from two to six farrowings per year.

As can be seen from Figure 1, most of the cost reduction occurs when farrowing intensity doubles from two farrowings per year. This allows more optimal use of both the farrowing and finishing facilities. It has indeed been assumed that by doubling the farrowing intensity, no increase in farrowing facilities is needed and only a 20 percent increase in finishing capacity is required. Weaners can stay in the farrowing buildings until the finishing building is cleared from the previous batch. A 20 percent increase in finishing capacity is, however, justified by the imperfections in timing that occur in every production system. No such gain in efficiency can be obtained when the farrowing intensity is tripled. In this case the finishing capacity has to be doubled, while the farrowing capacity has to be enlarged by 20 percent, again to allow for timing imperfections. This results in a further cost decrease per unit, but not to the same extent as in the previous case. The importance of these cost savings is represented in Figure 1 for all capacity levels.

Capacity 2

Capacity 2 contains one, two, and three sets of 30 sows, respectively, each farrowed twice a year. As can be noted from Table 2, operational changes occurred in the feeding system as compared to capacity 1; commercial feed processing or portable grinder are replaced by a stationary automatic hammer mill and auger wagon. A decline in labor costs and more efficient use of the facilities reduce average production costs from about $39 per cwt. at two farrowings per year to some $35.3 per cwt. at six farrowings. Comparing the confinement and conventional systems, one observes that the higher fixed costs in the confinement system are almost exactly offset by the higher labor costs in the conventional system; this can be verified in Figure 1b and Table 4.

Capacity 3

Doubling the previous capacity does not lead to major operational changes in the conventional system. In the confinement system the only important difference is found in the purchase of a liquid manure spreader. If only farrowed twice, fixed costs in the confined system exceed those of the conventional system by more than $1 per cwt. As more intensive use is made of the facilities by increasing the farrowing intensity, this difference is reduced to $.50 per cwt. which is almost equal to the higher labor costs found in the conventional system (Figure 1c and Table 4).

Capacity 4

Capacity 4 consists of one, two, and three sets of 100 sows, respectively, each set farrowed twice. Compared with capacity 3, the conventional system has been changed considerably: automatic feeding systems have been added as well as a lagoon for the growing-finishing. This brings the conventional system closer to the confinement system, compared to previous capacity

level. Labor requirements for the conventional system exceed those of the confinement system by less than 10 percent. Fixed costs are lower, however, in the conventional system, due in part to the costs for ventilation equipment in the confinement system. Total costs will be higher in the confinement system; however, the difference decreases with higher production intensity (Figure 1d).

Capacity 5

Capacity 5 consists of one, two, and three sets of 150 sows, each set farrowed twice. The basic change in operation as compared to the previous capacities consists of the addition of an automatic feeding system to the farrowing house for both systems.

For all previous capacities the feeders were manually filled. At this level, all housing (farrowing, growing, and finishing) buildings have automatic waterers and the automatic feeding system. Labor in the conventional system remains slightly higher when compared to the confinement system because the manure is manually washed or shoved into the lagoon. Fixed costs are higher in the confinement system again mainly reflecting the added investment in ventilation equipment. Fixed costs fell on average more than $2 per cwt. as the farrowing intensity changed from two to six farrowings per year.

Capacity 6

Capacity six, the largest capacity under consideration, consisted of one, two, and, three sets of 200 sows, respectively, each set farrowed twice a year. The physical operation was identical to capacity 5 except for the larger size. As can be noticed from Table 4 and Figure 1f the confinement production cost per cwt. exceeds the cost in conventional production system, ranging from $1.10 at two farrowings to $.60 at six farrowings per year. Average cost drops more than $2.50 when farrowing intensity is increased from two to six. Labor costs are almost identical between the two systems. The lowest possible production cost is slightly more than $34 per cwt. (Table 4); this is obtained for six farrowings per year in the conventional system.

Conclusion

Comparing the six capacities in Figure 1, some common features are noted:

1) Production costs fall considerably with increased farrowing intensity; the largest difference is obtained with a change from two to four farrowings per year.

2) The cost reduction obtained by increasing the farrowing level becomes smaller as the capacity increases.

3) The cost reduction is more important for the confinement system than for the conventional system due to the higher level of fixed costs in the former system.

4) Given that an equal performance level exists between both systems, the conventional system becomes relatively more attractive the larger the capacity of the enterprises. This point will become more obvious when the budgets are analyzed by farrowing intensity.

Analysis by Farrowing Intensity

The number of market hogs produced can be increased by intensifying the farrowing level for a given breeding capacity or by increasing the breeding herd and capacity for a given farrowing level. This last option will be the subject of this section.

Changing capacity levels is clearly a long run concept: additional buildings, more equipment, and an increased breeding herd are needed. Furthermore, as the capacity increases changes were made in system as was discussed in the previous section and summarized in Table 3. As we move on from one capacity to the next, the tacit assumption is made that the costs of changing from one system to another are zero.

Two Farrowings Per Year

In the two farrowings system the following capacities are compared: 8, 30, 60, 100, 150, and 200 sows. The budgeted results can be found in Table 4 and are also presented in Figure 2a. Note the fixed costs per cwt. for both systems remain fairly constant for the different capacity levels (Table 4). This is the result of two counteracting forces: firstly farrowing intensity tends to decrease investment costs per unit with increasing capacity; secondly as the size increases, it becomes more attractive to substitute some capital for labor by means of more mechanized feeding and manure handling techniques. The total results of this substitution and size effects remain close to zero.

However, both size and substitution effect have a considerable impact on the labor requirements so that variable costs decrease substantially as the enterprise is expanded up to 150 sows. In these budgets no further economies are apparent from capacity 5 on. Higher costs for sanitation and small increases in veterinary costs together with slightly increased labor requirements offset the decrease in fixed costs.

Production costs in the confinement system exceed those of the conventional system considerably since the two farrowing system makes inefficient use of the expensive facilities, both for the farrowing stalls and the growing-finishing buildings.

Four Farrowings Per Year

The four farrowing system utilized the same farrowing facilities as used in the two farrowing system. However, 20 percent extra facilities were needed in the growing and finishing phase to handle the additional two farrowings.

As was the case in the two farrowing system, fixed costs remain fairly constant over the capacity range under consideration (see Table 4). Variable costs decreased almost $3 per cwt. between the smallest and largest capacity in the conventional system but less than $2 per cwt. for the confinement system. Since more efficient use is made of the facilities, the difference in production cost between conventional and confinement system is reduced to $.75 per cwt. at the largest capacity. At this capacity level and a performance level of 7.0 pigs per litter at weaning stage, hogs can be produced at $35 per cwt. If the same number of hogs produced are compared both in the two farrowing system and the four farrowing system (2766 hogs) the four farrowing system produces at more than $1 per cwt.

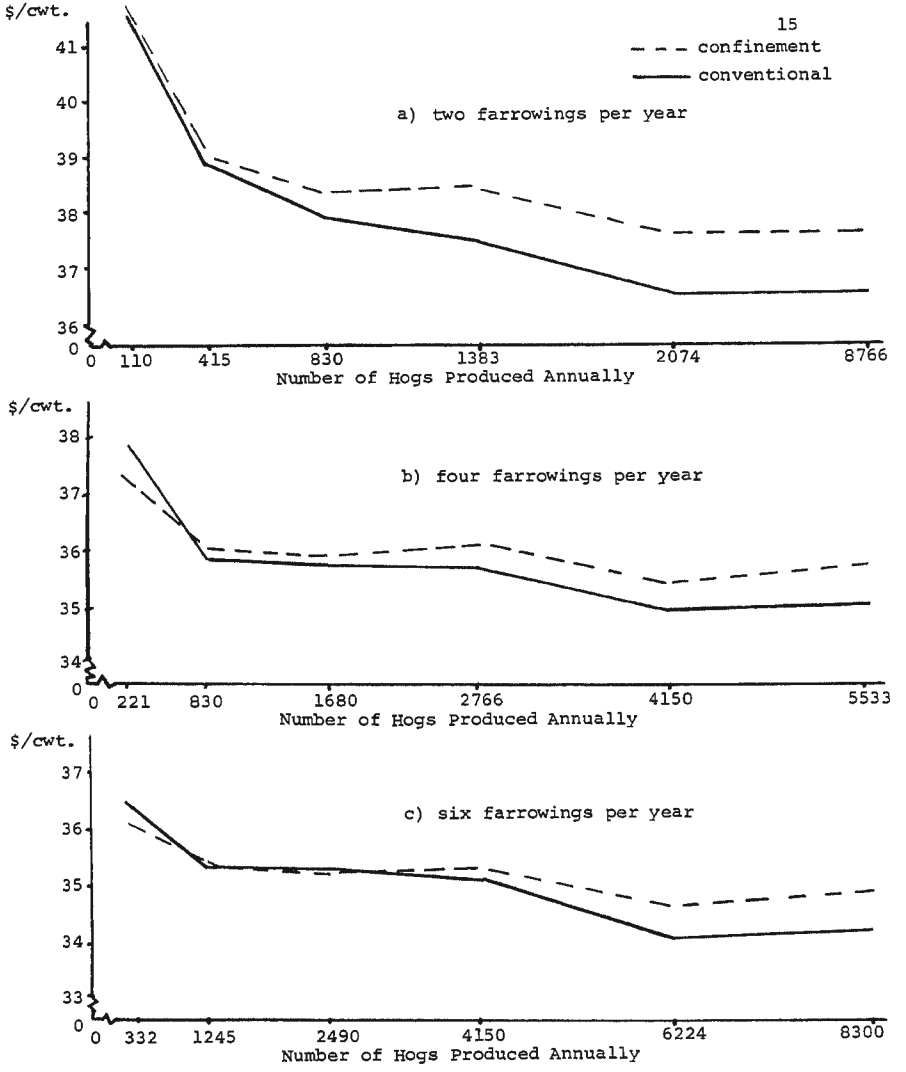

Figure 2. Cost Per Cwt. of the Number of Hogs Produced, at Three Farrowing Levels, for Conventional (——) and Confinement (- - -) Systems

Six Farrowings Per Year

Capacities 1 through 6 represent three sets of sows of respectively 8, 30, 100, 150, and 200 sows. This results in the production of a number of hogs ranging from 352 up to 8300. The six farrowing system uses 20 percent extra farrowing facilities mainly to take care of the imperfect timing of the operating and twice the growing and finishing capacity of the two farrowing systems.

This production system makes optimal use of the facilities and will consequently result in the lowest production cost (Figure 2c). Average fixed costs fluctuate slightly around $4 per cwt. for the conventional system and $4.35 for the confinement system (Table 4). Variable costs decreased with some $2 per cwt. in the conventional system, but by only $1.15 for the confinement system.

Conclusion

A comparison of the impact of the capacity level for the three farrowing intensities can lead us to the following conclusion:

1) Considerable economies of size are obtained up to a breeding capacity of 150 farrowing stalls. Beyond that level, extra care required for sanitation and handling additional hogs seem to offset any decrease in fixed costs.

2) The cost reduction obtained by increasing the capacity becomes smaller, the higher the farrowing intensity.

3) Economies of size are more important for the conventional system than for the confinement system. Some of this difference may be due to the assumptions in operational differences as capacities increase (Table 2).

4) At large capacities, the conventional system seems to be a more efficient method of production.

Analysis by Performance Level

A third way of increasing the total production of market hogs may be found in an increased number of hogs per litter. In this section a comparison is made between a litter size of 7.0 and a litter size of 8.5 pigs at weaning stage. The budgets are based on the assumption that this increased performance does *not* require an increase in facilities both for the farrowing and for the growing-finishing stage. Increase in labor cost and other variable cost associated with the higher litter size is taken into account.

As can be seen from Figure 3 the performance level has a considerable impact on the production costs. The increase of the litter size with 1.5 results in a cost decrease ranging from $3.5 per cwt. to $2.2 depending on the farrowing intensity and capacity.

Whatever the farrowing intensity, small enterprises with a high performance level may produce at lower cost than large enterprises with average performances. For instance, a production unit with two sets of 30 sows obtaining 8.5 pigs per litter and thus producing 1008 hogs per year produces at lower cost than a larger unit with 3 sets of 200 sows obtaining only a litter size of 7.0 pigs.

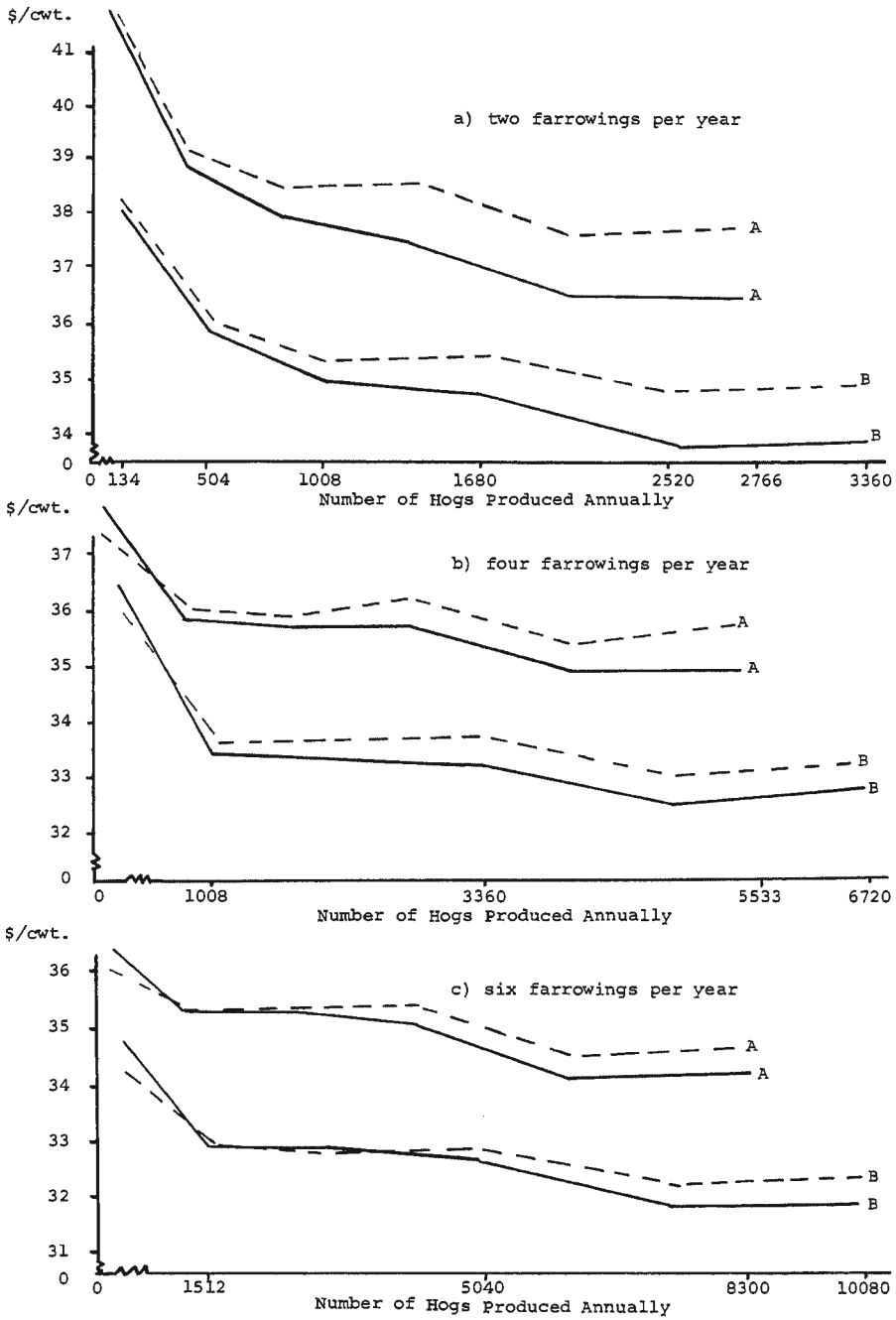

Figure 3. Cost Per Cwt. of the Number o Hogs Produced, at Three Farrowing Levels, a Litter Size of 7.0 (A) and 8.5 (B), for Conventional (——) and Confinement (---) Systems

Performance levels are closely associated with the quality of management; this is an input variable which is the most difficult to modify. The sensitivity of the cost function to performance level may be one of the reasons why in the real world such a wide range of capacities and production techniques is found.

Interaction Between Farrowing Intensity and Capacity Level

As mentioned before, the number of market hogs produced can be increased by increasing the capacity level, the farrowing intensity, the performance level or a combination of them. Since it is extremely difficult to change the management level that determines the performance, we only concentrate on the alternative capacity level and farrowing intensity. In Figure 4 and Figure 5 the three farrowing intensities are superimposed on each other respectively for the conventional system and for the confinement system and a performance level of 7 pigs per litter.

One notices from the graphs that while there is a considerable difference in cost between the two farrowing levels on the one hand and the four and six farrowing levels on the other hand, the difference between four and six farrowings is minor. This indicates that about the same cost reduction may be obtained by increasing the capacity of the operation as by increasing the farrowing intensity from four to six. As an example, one can produce 4150 hogs per year by having 2 sets of 150 sows or by having 3 sets of 100 sows. Both production systems result in about the same costs. A similar type of substitution is not possible between two and four farrowings per year and their relevant capacities since the gains obtained by increasing the farrowing intensity far outweigh those of capacity increases.

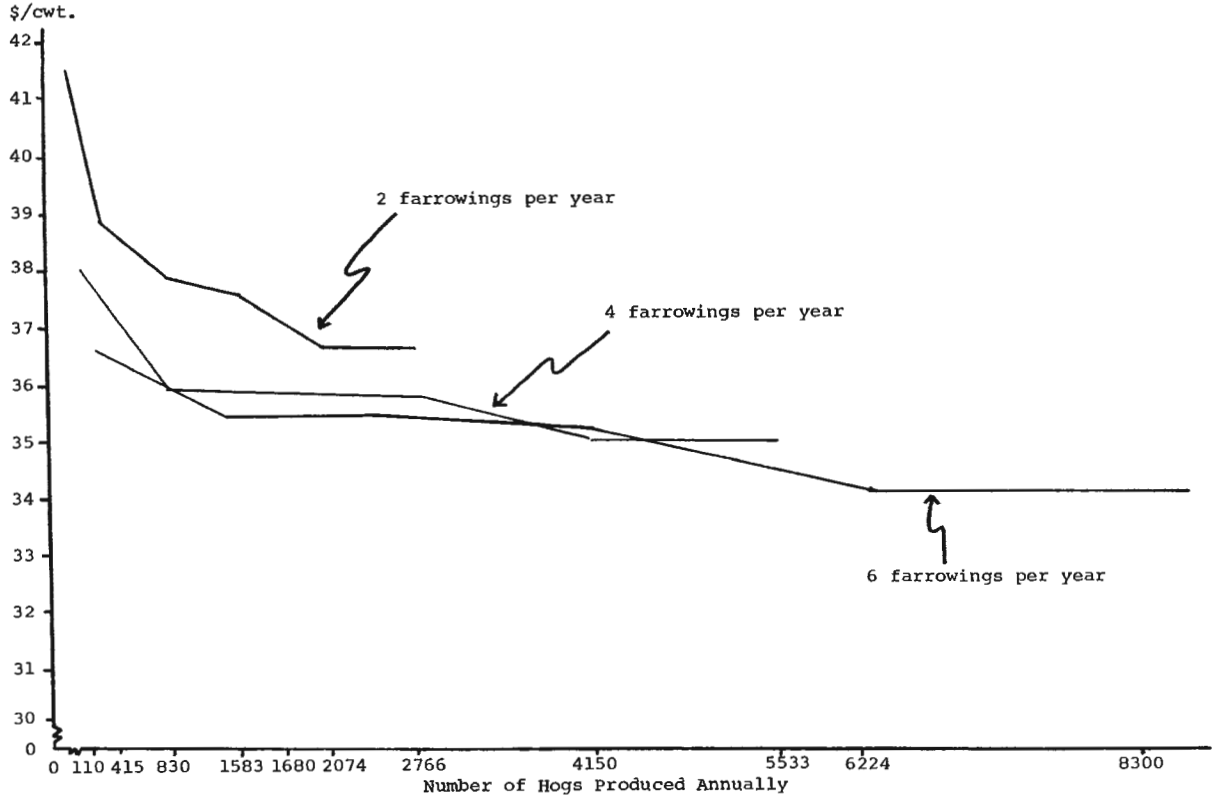

Figure 4. Cost Per Cwt. of the Number of Hogs Produced and Farrowing Intensity for the Conventional System (Performance Level of 7 Pigs Per Litter)

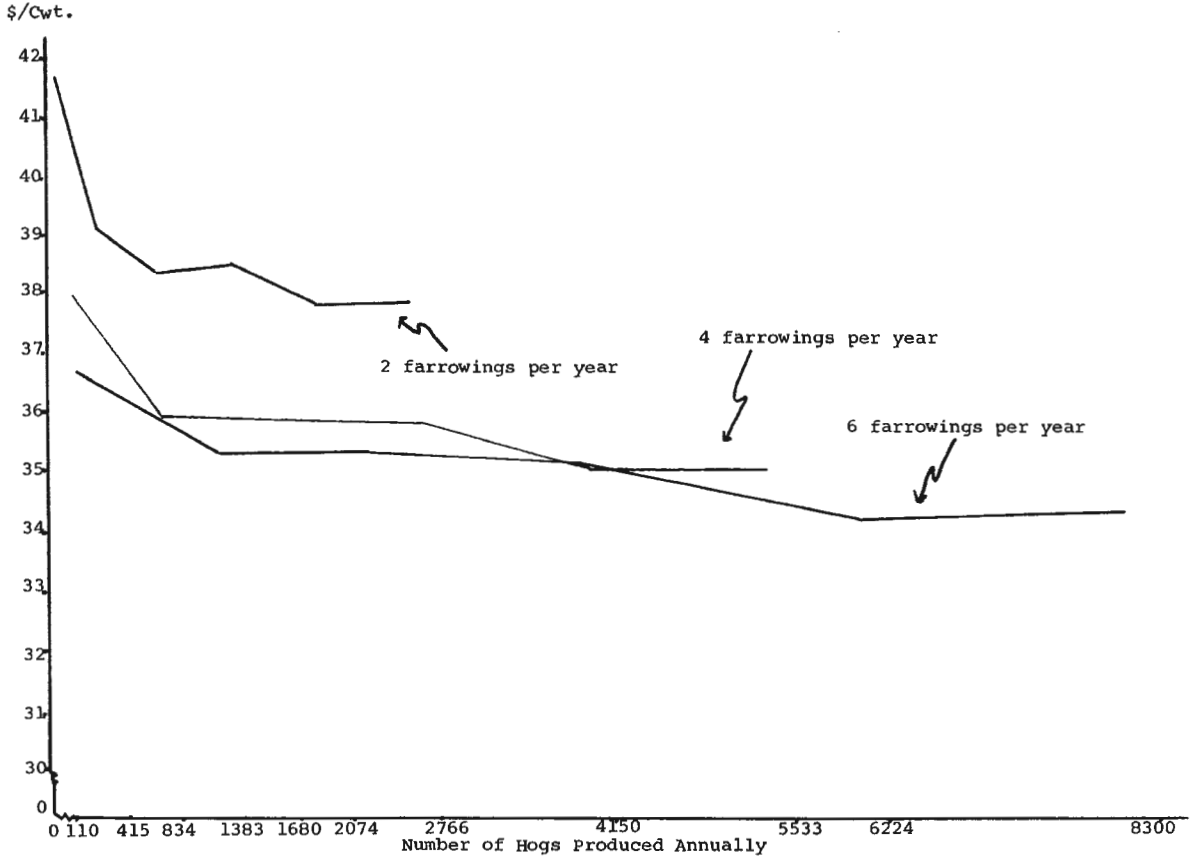

Figure 5. Cost Per Cwt. of the Number of Hogs Produced and Farrowing Intensity for the Confinement System (Performance Level of 7 Pigs Per Litter)

Appendix A

Definition of the Technical Terms Used in This Paper

Economies of size. Economies of size occur when the average production cost decreases with increasing output. Economic theory suggests that as output increases, average costs will first decline, due to a more efficient combination of input factors, will reach a minimum for an "optimal output" and from there on increase, due to some limited resource such as management. This last stage is called "diseconomies of size." The concept "economies of size" is broader than "economies of scale" in the sense that in the first notion, input factors do not have to expand in constant proportions and prices are not assumed to stay constant as is the case in the second concept.

Conventional system. The conventional system is a production method using buildings that are open on one side, have a solid concrete floor, a concrete feeding area, automatic feeders and waterers; a lagoon may or may not be adjacent to the feeding floor. The system requires bedding as the temperature is not controlled.

Confinement system. In the confinement systems, the buildings are completely enclosed and are environmentally controlled; they have completely or partially slotted floors, automatic feeders and waterers, and require no bedding.

Capacity. Capacity is defined as the minimum physical facilities needed to farrow a specified number of sows or gilts at one time, and the facilities required to grow and finish the feeder pigs obtained from those farrowings, given a specified farrowing intensity.

Multiple farrowing. Multiple farrowing is the farrowing of two or more sets of sows twice a year. The greater the number of farrowings, the more intensive the use of the facilities. The farrowing of three groups of sows, twice a year is considered to be the most intensive system.

Farrowing period. The farrowing period is the time period one week prior to the actual farrowing until the pigs are weaned, at about six weeks of age.

Growing period. The growing period is the period from weaning to the time when the pigs reach 100 pounds.

Finishing period. The finishing period is the time period needed for the pigs to grow from 100 pounds to their final market weight of 200 pounds.

Fixed resources. The fixed resources include land, buildings, fences, equipment, the breeding stock, and family labor.

Variable resources. The variable resources include feed, bedding, fuel and oil, electricity, small equipment, and hired labor.

Fixed costs. Fixed costs are those costs that occur at all levels of output, even if no production occurs. They include insurance on buildings and equipment, real estate taxes, land charges or rent, interest on fixed capital, depreciation, and a remuneration for the operator's labor.

Variable costs. Variable costs vary with the level of output and include feed costs, insurance on livestock, wages for hired labor, fuel, oil and electricity costs, machinery maintenance, interest on hogs, and death loss.

Appendix B

The Budgeting Assumptions

1. Basic Assumptions.
   a) All pigs were fed the same ration regardless of the production system. The rations were based on the nutritional requirements as recommended by the National Research Council Committee. They were adapted from information obtained from Dr. T.L. Veum, Animal Husbandry Department, UMC.
   b) It was assumed that there were no differences in feed efficiency between conventional and confinement systems.
   c) Comparable sets of facilities (particularly regarding building dimensions) for a given capacity level were utilized in the production of hogs for the conventional and confinement systems.
   d) Both inputs and outputs were assumed to be homogeneous for all systems.
   e) No volume discounts on purchases were considered.
2. Cost Coefficient Assumptions.
   a) Buildings were assumed to last 15 years and have no salvage value; straight line depreciation was used. The conventional system's floors were solid concrete. The confinement system building floors were partially or completely slated concrete floor.
   b) Repairs on buildings were calculated at 2 percent of the initial cost per year.
   c) Equipment was assumed to last 10 years with a 20 percent of the initial cost considered salvage value. The only exception was the ventilation equipment which is assumed to last 15 years and has a 20 percent salvage value.
   d) Repairs on equipment per year calculated at 5 percent of the new price.
   e) Insurance on buildings, equipment and breeding stock per year was calculated at .05 percent of the purchase price.
   f) Eight acres of land per 1000 hogs were assumed necessary for a building site, lagoon, drainage area, and for manure spreading. The land was valued at $600 per acre and a 6.7 percent charge for interest was assumed. Taxes per acre were assumed at $6.00 per acre.
   g) Bedding was calculated at $.84 per sow per farrowing.
   h) Labor coefficient was built on the basis of secondary sources of data—primarily though not exclusively, from research conducted by other universities. Labor was charged at $5 per hour.

i) Total death losses were assumed to be 1.2 percent of the total number of pigs weaned at either the 8.5 litter size or the 7.0 litter size for all capacity levels and all farrowing intensity levels.

j) Costs for the water system were based on the assumption that one well, pump and pump house was necessary for each 3000 hogs. The well was depreciated out over 15 years with no salvage while the pump lasted 10 years.

k) Storage cost for corn and soybean oil meal were based on $.10 per bushel for corn and $5 per ton of soybean oil meal.

l) Fences constructed of steel panels and gates in the buildings and of woven wire and posts for drylots were assumed to last 15 years with no salvage value. A 2 percent charge was allowed for repairs.

m) Lagoon costs were calculated on the basis of 15 cubic yards per pig times the given capacity of the building. A cubic yard of ground cost $.40 to $.45 to remove.

n) Breeding stock costs were calculated as follows: boar at $600 with $150 salvage and three years of useful life; and gilts at $220 with $120 salvage and two years of useful life.

o) Interest on fixed and variable captial was calculated at 8.9 percent per year.

3. Management Assumptions.

a) Sows were rebred one week after weaning with weaning occurring at six weeks of age.

b) For the gestating sow, 15 square feet was the minimum space allowed for shelter.

c) Boar (s) were kept by themselves when not in use. Each boar requires 15 to 20 square feet of floor space plus sufficient pasture for exercise. The boar's maximum use per year was 20 matings in a given breeding period with no more than 60 matings per year.

d) Sows were farrowed in farrowing crates in the confinement system. The conventional system used a pen 4½′x12′x3′ with a corner isolated from the sow for the young pigs.

e) The growing phase begins at weaning and ends when the pig reaches 100 pounds. The pens in the growing building pens were large enough to hold 20-25 pigs with 3-4 square feet of floor space allowed per pig. Equipment requirements were 1 water space per 25 pigs and 1 feeder space per 4 pigs.

f) The finishing phase begins at 100 pounds and ends at 220 pounds. The waterer and feed equipment requirements were the same as in the growing phase. Finishing pens were 16′x10′ in dimension and allowed 8 square feet per pig.

g) The approximate amount of manure produced daily per one hundred pounds of hogs was figured at ⅛ cubic foot, 1.0 gallon, or 7.5 pounds. Solid manure to be handled efficiently requires a manure loader, spreader, and proper slope and design of pens and gates. Manure in the conventional system is usually handled as a solid with the exception of capacities 4, 5, and 6 where the manure was washed into an adjacent lagoon.

In the confinement system the liquid manure system was used. This system requires slotted floors, lagoon or storage pit, and equipment that will stir, pump, haul, and spread the liquid on nearby fields.

h) Feed costs were assumed to be identical for both the conventional and confinement systems. The feed cost for a market hog (220 pounds) totaled $44.57; feed costs for a sow reached $150.11 per year and for a boar $130.20 per year. All feed costs were calculated at December 1974 prices.