Summary of Reports . . .

3rd Annual Swine Day

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Western Oregon Livestock Association

CONTENTS

Influence of Management on Litter Size

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Performance of all farm livestock is influenced by heredity and environment. Reproduction is only one of the production traits of livestock with which we are concerned in modern agriculture. Although swine reproduce themselves at a much greater rate than other farm livestock, they are quite inefficient in reproduction or litter size.

We will investigate this last statement more carefully. First, it is important to establish the factors that are primarily responsible for litter size.

The first factor is **ovulation rate.** This is the number of ova or eggs released by the ovaries at the time of breeding. This is important because it takes one egg to produce each pig (except in a few rare cases when a single egg separates into two eggs to result in identical twins). Thus, the first limiting factor is the number of eggs produced by the ovaries of the sow. If a sow ovulates only 8 eggs, then 8 pigs is the maximum number that can be produced in the litter.

The second factor is **fertilization rate.** Each egg produced by the sow contains the genetic contribution which she will pass on to her offspring. The other half of the genetic makeup of a pig must come from the boar, and this is carried by the spermatozoan or sperm in the semen. Therefore, the egg and the sperm must be brought together before the formation of the unborn pig can begin. This is done through the process whereby the boar deposits semen in the reproductive tract of the female at breeding time. Sperm move through the female reproductive tract to a point where they come into contact with the egg. They are very small and have a shape somewhat like a very slim tadpole. It takes about 5,000 sperm laid side by side to equal one inch. The egg is much larger and when contact is made, the sperm penetrates the egg which then divides into two cells. These cells stay close together and each of them will redivide again. This process of cell division continues at a rapid rate; and as new cells are formed, there will eventually be a definite form established resembling a pig embryo. Fertilization is said to have occurred when the sperm penetrates the egg and starts the first cell division. Therefore, any egg that does not come into contact with a sperm and is not fertilized will not develop into a pig.

The third factor is **embryo survival.** This includes attachment of the egg to the lining of the sow's uterus and then the growth and development from the time it is fertilized by the sperm until it is born at farrowing time. Soon after the egg is fertilized, it should attach itself to the lining of the uterus where it absorbs nutrients from the blood stream of the dam. This process is very delicate and is easily interfered with and is, therefore, important in the determination of final litter size.

It was stated at the beginning that heredity and environment were the two factors responsible for the performance of all livestock. The heritable por-

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tion of the variation in litter size has been estimated at less than 10%. Thus, environment is responsible for at least 90% of variation in number of pigs per litter. Since environment includes everything to which the animal is exposed, including feeding, disease, shelter, management, and other such factors, it can be concluded that the producer has an opportunity to alter litter size a great deal through his management program.

A brief look at history indicates that litter size in this country has increased markedly during the past 35 years. For example, in 1924 only 5.2 pigs were saved per litter. This was up to 6.0 pigs in 1930; 6.1 pigs in 1940; 6.4 pigs in 1950; and almost 7.2 pigs in 1960. The increase from 5.2 to 7.2 pigs represents an increase of approximately 40% in 35 years. Almost half of this increase has occurred during the past 10 years.

Where are we today and at what point will we reach the optimum so far as litter size in swine is concerned.

Swine are inefficient in reproduction. Ovulation rate was the first limiting factor in establishing litter size. At breeding time a sow will normally produce about 17 eggs. Thus, the maximum average litter size possible at present would be about 17 pigs. Approximately 95% of the eggs produced are contacted and fertilized by sperm from the boar. Thus, about 16.2 pigs begin to grow and develop during the first week after breeding. Records indicate that on an average there are only about 9.4 pigs farrowed alive at term and 7.0 to 7.2 pigs actually saved per litter. Thus, only 40 to 45% of the original 17 eggs produced by the sow at the time of breeding ever reach the market as slaughter pigs.

Many things can be responsible for reducing litter size. The most important factors seem to be those which swine producers can do somethoing about. This would mean that we are not doing as good a job of managing the swine breeding herd as we know how to do.

What are some of the specific management factors that influence litter size?

Daily feed intake

Table 1 illustrates detrimental effects of full feeding on litter size in gilts.

Table 1 indicates that full feeding is beneficial to the production of eggs but that a low percentage of eggs survive and develop into normal pigs during gestation. On the other hand, limited feedings results in fewer eggs at breeding time but a much higher percentage of the eggs survive and develop into normal pigs. Thus, the level of feeding desirable for producing a large number of eggs is not necessarily the same level desired to assure the survival of a greater percentage of embryos.

In an attempt to combine benefits of both full and limited feeding by taking advantage of benefits of full feeding on ovulation rate and benefits of limited feeding on embryo survival,

Table 1. Influence of daily feed intake on reproduction

Level of daily feed intake	Eggs produced	Pigs per litter	Surviving pigs
	no.	*no.*	%
(Wisconsin)			
Full feed	14.6	6.3	43.2
⅔ full feed	11.3	8.0	70.8
(Washington)			
Full feed	15.1	4.7	31.1
⅔ full feed	13.4	7.4	55.2

other studies have been conducted. In these later studies gilts in one group were full fed from 70 days of age through breeding and up to the 25th day of gestation. The second group was limited to only ⅔ of a full feed from 70 days of age to the 25th day of gestation. A third group was on limited feed from 70 days of age to the time of their first heat period which was accurately determined by a daily check with sterile boars. At the time of the first heat these latter gilts were shifted from a limited daily feed allowance to full feed. They remained on full feed until their second heat period which would amount to approximately 3 weeks of full feeding.

All gilts in all three groups were bred at their second heat period. The gilts in the third group that had received a full feed between the first and second heat periods were shifted back to a limited daily feed intake at the time of breeding (bred at second heat). Results of these studies are shown in Table 2.

Group 1 (full feed) produced more eggs than Group 2 (limited feed) but Group 2 had a higher percentage of eggs survive as embryos; therefore, Group 2 had a larger average litter size when slaughtered 25 days after breeding. Group 3 gilts (limited-full-limited) demonstrate that the 3 weeks of full feeding (flushing) between the first and second heat periods resulted in Group 3 gilts producing as many eggs at breeding time as gilts receiving a full feed throughout their life (13.5 vs. 13.6). A greater percentage of the embryos survived to result in a 1.7 pigs larger litter than the full-fed gilts. Not only does limited feeding during the growing period and during gestation tend to increase litter size but also it results in a significant reduction in total costs. It seems quite evident that flushing for a 2- to 3-week period prior to breeding enables a producer to derive the benefits of both full and limited feeding in his breeding gilts.

Table 2. Influence of flushing on reproduction

	Group no. (1) Full feed	(2) Limited feed	(3) Limited-full-limited
No. of eggs	13.6	11.1	13.5
Pigs per litter at 25th day of gestation	7.6	8.8	9.3

These examples of research are from dry lot conditions. Therefore, it is natural to raise the question as to the effects of level of feeding for gilts on pasture. A study was set up to determine the effects, if any.

Three groups of gilts were placed on pasture in each of three years at about 70 pounds in weight. Group 1 was given free access to a self-feeder containing a complete mixed ration. Group 2 received only ⅔ as much feed per day as was consumed by gilts on the self-feeder. Group 3 received only ⅓ as much feed per day as the full-fed gilts were consuming. Results of the three-year study are shown in Table 3.

Not only did each of the two limited-fed groups of gilts farrow more pigs per litter, but they weaned more pigs and more pounds of pigs per gilt than did gilts in the full-fed group. Note the difference of 115 pounds in weight between Group 1 gilts and Group 3 gilts at farrowing time.

Thus, we can safely conclude that breeding gilts should be provided only

Table 3. Effects of feeding level on reproduction in gilts on pasture[1]

	Gilt weight at farrowing	Live pigs farrowed per litter	Average birth weight	Average weaning weight	Total weaning weight
	lbs.	*no.*	*lbs.*	*lbs.*	*lbs.*
Group					
1 (self-fed)	480	7.7	2.93	30.3	224
2 ($\frac{2}{3}$ of G1)	427	8.8	2.75	29.9	257
3 ($\frac{1}{3}$ of G1)	365	9.0	2.73	28.5	245

[1]Self, H. L., *et al.* Journal of Animal Science, Volume 19, 274. 1960.

enough high-quality ration—in dry lot or on pasture—to permit them to grow adequately without becoming fat. Then 10 days or 2 weeks before the breeding season is to begin, gilts should be flushed by increasing the daily feed allowance from 3 to 4 pounds per head up to 5 to 7 pounds per head. Continue the higher level for about 3 weeks which should be the end of the breeding season. Long periods of full feeding should be avoided.

Protein level and protein source

There is no good evidence that increasing the level of crude protein above 15% has any effect except to increase ration costs. In fact, in tests where a 20% crude ration was fed, there appeared to be a slight decrease in reproductive ability in gilts.

Protein source may affect reproductive performance. Tests in Denmark showed a definite increase in litter size when milk was added to the breeding gilt ration.

United States research indicates that protein from an animal source gives some advantage. More recent work with growing-finishing swine indicates that vegetable-origin protein, when properly fortified with other nutrients, gives weight gains equal to those obtained when high quality animal protein is used. It is too early to be certain if it is possible to use only protein of vegetable origin with the breeding herd.

Effect of sexual age

Sexual age refers to the number of heat periods a gilt has experienced, or her physiological age. This is different from calendar age. Two gilts in heat on a given day may both have a calendar age of 8 months, but one gilt could be experiencing her third or fourth heat while the other gilt was in her first. Thus, the gilt that has experienced several heat periods is sexually older than the gilt showing heat for the first time. Sexual age is important in a herd of gilts. Table 4 shows effect of breeding at different sexual ages.

Gilts in all three groups in Table 4 were treated exactly alike except one group was bred the first time they came into heat. Another group was allowed to pass the first heat period and were bred the second time they came into heat; the third group passed at least two heat periods before being bred. Clearly the 2.5 pig advantage for the group allowed to pass two heat

Table 4. Effect of sexual age of gilts on litter size[1]

Heat period bred	1st	2nd	3rd
No. pigs farrowed	6.9	8.0	9.4

[1]Adapted from University of Wisconsin data.

periods is enough to warrant giving this factor serious consideration when selecting breeding herd replacements.

How this can be applied in a practical swine operation varies considerably. Most swine producers can watch their herd closely to see which gilts show their first heat at an early age and then give preference to these gilts when selecting replacements.

As an example, assume that gilts from the 1961 spring pig crop are to farrow in the spring of 1962—when about a year old. This requires breeding soon after they reach 8 months. Gilts that experienced their first heat period at 6 months would be bred on their third or fourth heat period. Gilts that did not show their first heat period until they were 8 months of age or older would be bred on their first heat period. Obviously, gilts showing heat at 6 months of age should produce more pigs at farrowing. They are also more mature physiologically and should do a better job of lactating and caring for litters.

On an average, gilts can be expected to show their first heat between 6½ and 7 months. A few may start at 5½ months. Gilts that go to 9 or 10 months before showing heat should be avoided as replacements.

Time in the heat period to breed

Swine exhibit symptoms of heat at about 21-day intervals, but this may range from 17 to 25 days. The heat period averages 40 to 65 hours. This allows a rather long period during which the female will accept the male.

When, during heat is the best time for mating? An excellent experiment was conducted on this problem in the Union of South Africa. Results are shown in Table 5.

In the Large White breed, most of the sows were out of heat by the forty-eighth hour and did not settle. However, breeding during the first 24 hours of heat maintained good litter size and conception rate. A smaller percentage (64%) of those bred at the thirty-sixth hour of heat settled and the litter size of 11.2 pigs was slightly lower than obtained by breeding earlier.

The Large Black breed had a longer heat period and some settled when bred at the sixtieth hour of heat. Conception rate dropped rather sharply in sows bred as late as the forty-eighth hour of heat although litter size did not drop much in any group of Large Black sows.

Summarizing and generalizing from the data shown in Table 5, mating late on the first day or early on the second

Table 5. Influence of time of mating on litter size in swine

	Large White breed					
Hours in heat	0	12	24	36	48	60
No. of eggs	16.6	16.4	15.4	17.1	----	----
No. of pigs	12.1	13.4	12.3	11.2	----	----
Percent pregnancies to first service	74	92	88	64	28	----
	Large Black breed					
No. of eggs	13.3	13.9	13.3	13.0	13.2	13.5
No. of pigs	9.2	10.9	8.1	9.2	9.6	8.5
Percent pregnancies to first service	79	83	86	81	53	15

day of heat will be most likely to give the best results.

Table 5 also shows another important fact in swine reproduction. Breeds differ markedly in their reproductive levels. For example, the Large White averaged over 16 eggs whereas the Large Black averaged just over 13 eggs per sow. This is a definite breed difference similar to differences that exist among some United States breeds.

Influence of environment at breeding time

Data obtained at Purdue University emphasize another important aspect of management.

Years ago swine sought out mudholes or other places which helped them keep cool and comfortable. As swine are brought into confinement systems, adjustments and allowances must be made. This is demonstrated by data in Table 6.

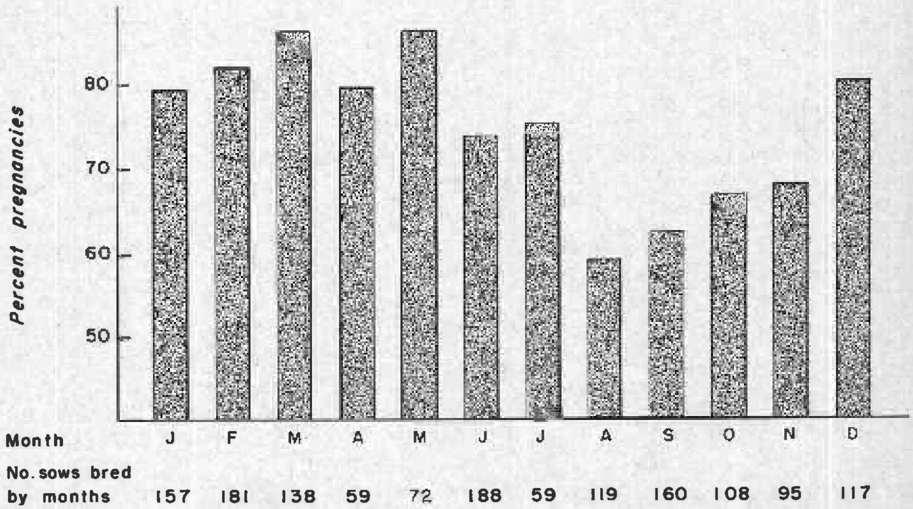
Table 6. Effects of mist-spray on reproductive performance in swine[1]

Boar	Sow	No. of pigs per litter
Uncooled	Uncooled	7.80
Cooled	Uncooled	8.86
Uncooled	Cooled	8.50
Cooled	Cooled	9.55

[1]Purdue Swine Day, 1959.

Confinement arrangements which provided only a dry shade to keep the boar and sow cool resulted in an average litter size of 7.80 pigs. Cooling only the boar by a mist spray

Conception rate by months in Iowa swine nutrition research sow herd, 1954-57.



Average conception rate: 75.6 %

increased litter size to 8.86 pigs. Cooling the sow and not cooling the boar resulted in 8.50 pigs. Cooling both the boar and sow resulted in a 9.55 pig per litter average, almost two more pigs per litter than where neither one was cooled.

The detrimental effect of high summer temperature is further emphasized by the data illustrated in the chart on page 8. Conception rates in August and September over the 4-year period are clearly lower than at any other time of the year. This could mean that hot weather is more detrimental to breeding than the ills, chills, and fever that often plague a sow herd in the fall and winter.

Temperature during gestation may also have a bearing on reproduction. At the Oklahoma station one group of sows was sprinkled during gestation and one group was not. The sprinkled group farrowed 10.9 pigs and sows not sprinkled farrowed 9.2. The sprinkled group weaned 7.76 pigs per litter compared to 5.71 pigs per litter in the unsprinkled group. Benefits from sprinkling during gestation appear greater when temperatures go above 90 to 95 degrees.

Summary

In general, management of the breeding herd can be summarized as follows:

- Select gilts of the correct type from large defect-free litters.
- Grow the gilts out on a ration permitting adequate growth without fatness. This can be done by hand-feeding limited quantities of a high-energy ration or by self-feeding a low-energy ration (a ration high in bulk or fiber).

About 10 days to 2 weeks before the breeding season begins, increase nutrient intake to the equivalent of a full feed and continue until 4 to 5 days after breeding.

Limit feed during the first $\frac{2}{3}$ of gestation to allow a gain of about 1 pound per day. A slight increase in nutrient intake is permissible during the last $\frac{1}{3}$ of the pregnancy period. In no case should drastic changes be made in management and feeding during the last 2 to 3 weeks of gestation.

If the breeding season or the gestation period occurs during hot seasons, arrangements should be made to keep the breeding herd—both males and females—cool and comfortable.

Some Aspects of Runtiness in Baby Pigs

David C. England, Verne M. Chapman

Data on 7,554 pigs in an Indiana study (Vestal, 1938) (1) showed that 18.5% of pigs born weighed 2 pounds or less at birth. Of these, only 37.6% survived to weaning as compared to 76.6% for larger pigs. Range in birth-weight reported was from 1 lb. to 4.75 lbs. Weaning weight of the surviving low birth-weight pigs was only 74% of the weaning weight of all surviving pigs that weighed more than 2 pounds at birth.

The higher death loss among pigs of low birth weight and the slower growth rate of survivors may be caused by (1) innate lack of capacity to ingest an adequate amount of milk and to utilize nutritive materials effectively, (2) such strong competition from larger litter mates for nursing position that starvation results or at best that runt pigs get an inadequate supply of milk to promote rapid growth, or (3) that chilling and activity deplete nutrient reserves of small, newborn pigs to critical levels much more rapidly than with larger newborn pigs.

If the generally reported poor preweaning performance of pigs of low birth weight is due to innate lack of ability to utilize nutrients effectively, management can do little to make them effective performers with the present state of knowledge of metabolism in runty baby pigs. On the other hand, if innate capacity for adequate performance is present and poor performance is due to other causes, management practices can secure effective performance from approximately 20% of pigs that weigh less than 2 pounds at birth.

During the past two farrowing seasons studies have been made in the Oregon State University swine herd to obtain precise information on performance of pigs with low birth weights (*2, 3*). It is a general opinion that the front udder sections of the sow produce more milk than rear sections and that runt pigs end up nursing hind teats. Permanent nursing position of pigs between the ages of 28 and 56 days in 13 litters was observed. A recheck of nursing position indicated that the pigs as a rule nursed the same teat after having become established. Only three deaths occurred in these litters and none were of pigs with low birth weight. Thus, observations include all pigs of low birth weight that were farrowed in these litters (see Tables 1 and 2).

Table 1 shows that within a litter, pigs do not secure permanent nursing positions from the front to the rear of the udder in order of descending birth weights. Pigs with low birth weights are not forced to accept hind teats. Of 10 litters containing pigs with birth weights of 2 pounds or less, in only one litter was the pig with the lowest birth weight nursing one of the two most posteriorly located teats.

Conversely, in 7 of 13 litters in Table 1, the pig with the heaviest birth weight nursed the hind teat. Of the 10 litters containing pigs weighing 2 pounds or less at birth, in 4 litters the

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Table 1. Birth weights of baby pigs and permanent nursing position during the suckling period

Litter number	Birth weight	Udder section nursed*	Litter number	Birth weight	Udder section nursed[1]
	lbs.			*lbs.*	
1	2.00	R3	5	1.80	R1
	2.25	died suddenly 14 days old		2.30	L3
	2.25	R2		2.80	L1
	2.25	R5, L5		2.80	R2
	2.25	L1		2.80	crushed 1 day old
	2.50	R1		3.20	L2
	2.50	R7		3.50	L6
				3.70	R7
2	1.75	L3			
	2.50	L1	6	2.00	R4
	3.75	R2		2.25	L8
	4.00	R7		2.50	R3
				2.50	L5
3	1.75	L3		2.50	L7
	2.00	L2		3.00	R1
	2.25	R1		3.00	L1
	2.25	R2		3.25	R2
	2.25	R4		3.25	L2
	2.25	L4		3.25	R6
	2.25	L7			
			7	2.00	L6
4	1.75	R2		2.25	R2
	2.50	L2		2.25	L3
	2.50	L3		2.50	L5
	2.50	crushed 1 day old		3.00	R6
	2.75	L1		3.25	L2
	2.75	R5			
	3.50	L5			
8	1.80	R1	12	2.25	R2
	2.30	L3		2.25	L2
	2.80	R2		2.50	L4
	2.80	L1		3.00	R1
	3.20	L2		3.00	L1
	3.50	L6		3.00	R5
	3.70	R7		3.00	L6
				4.00	L7
9	1.50	L4			
	1.70	R4	13	2.20	R2
	2.00	L5		2.40	R3
	2.50	R2		2.50	L2
	3.10	L2		2.50	R5
				2.60	R1
10	1.70	R3		2.60	L7
	2.20	R1		2.75	L1
	2.20	R2		3.00	L7
	2.40	L5			
	2.60	L3			
	2.70	L1			
	2.70	L6			

Table 1. *(Continued)* Birth weights of baby pigs and permanent nursing position during the suckling period

Litter number	Birth weight	Udder section nursed*	Litter number	Birth weight	Udder section nursed[1]
	lbs.			*lbs.*	
10	3.30	R4			
	3.40	L2			
11	2.25	L1			
	2.50	L3			
	2.50	R2			
	2.50	L4			
	3.25	R5			
	4.00	R1			
	4.00	R4			
	4.00	L5			

Numbered from the front, R=right side, L=left side.

pig with the lowest birth weight nursed the third teat from the front. In these litters, either 1, 2, or 3 pigs with heavier birth weights nursed at more posteriorly located udder sections. In three of the remaining litters, pigs with lowest birth weights nursed the fourth teat from the front and 1, 3, and 4 pigs respectively nursed at more posteriorly located positions. In the remaining two litters, pigs with the lowest birth weights nursed the front teat in one litter and the second from the front in the other litter with five and three pigs respectively nursing at more posteriorly located positions.

Table 2 shows average birth weights of pigs nursing at each position. It is of interest—but of unknown significance—that in the 13 litters observed, (Table 2), the first and second most anteriorly located udder sections each nursed more pigs than any other positions. Average birth weights of pigs nursing at each of the positions indicates a tendency for pigs of large rather than small birth weight to acquire posterior udder sections as permanent nursing positions. Birth weights of pigs nursing positions 3 and 4 were significantly less ($P < .01$) than birth weights of pigs nursing positions 1 and 2 or positions to the rear of 3 and 4. Birth weights of pigs nursing at any positions other than 3 and 4 were not significantly different from each other.

If the assumption can be accepted that rear udder sections produce less milk than ones farther front, the above data indicate that pigs of low birth weight are not forced to the least productive sections of udders and thus the

Table 2. Average birth weight and weaning weight of pigs nursing at various udder sections as permanent nursing positions

Udder section number[1]	Pigs	Average birth weight	Average weaning weight
	no.	*lbs.*	*lbs.*
R&L1	19	2.69	48
R&L2	22	2.69	44
R&L3	11	2.20	37
R&L4	10	2.40	44
R&L5	12	2.84	43
R&L6,7,8	17	2.96	44

[1]Numbered consecutively from front to rear on each side.

usual high mortality of pigs with low birth weights cannot be attributed to an inadequate milk supply. It is possible that udder sections acquired by pigs of low birth weight are the low producing ones, even though there is lack of complete consistency of nursing position of pigs with low birth weights. Further work is planned to determine whether this is true.

Weaning weights in this study (Table 2) showed that pigs nursing position 3 weighed less at weaning than pigs nursing position 1 ($P < .01$) and positions 6, 7, and 8 ($P < .05$). There were no other significant differences in weaning weight by nursing position. When weaning weights were analyzed on the basis of birth weight without regard to nursing position, weaning weights averaged 45 pounds and 35 pounds respectively for pigs weighing more than 2 pounds at birth and those weighing 2 pounds or less at birth. Weaning weights, however, do not reveal whether differences in preweaning growth are due to differences in milk production by various udder sections or just to birth weights.

Milk intake of artificially reared pigs was measured for each pig at each of five daily feedings for a period of five days (Table 3).

Analysis of data revealed that pigs of heavy birth weight consumed more milk per feeding but that pigs of low birth weight consumed more milk per unit of body weight. Results were sim-

Table 3. Average milk intake per feeding and gains of baby pigs of various birth weight groups when fed five times daily for five days

Birth weight	Pigs	Average intake (ml.) per feeding Day 1	Day 2	Day 3	Day 4	Day 5	Ave. 5-day weight	Ave. total gain
lbs.	*no.*						*lbs.*	*lbs.*
1.2	6	18.8	26.3	33.3	35.8	31.5	1.58	.38
1.4	3	23.3	29.3	40.7	43.0	49.3	1.73	.33
1.5	4	23.8	31.0	36.8	43.8	47.8	1.88	.38
1.6	1	41.0	32.0	34.0	49.0	52.0	1.80	.20
1.8	5	30.0	40.2	48.2	55.2	69.8	2.32	.52
1.9	3	30.0	45.7	55.0	57.3	72.0	2.47	.57
2.0	5	28.0	42.0	52.2	66.0	74.8	2.64	.64
2.1	2	31.5	44.5	62.5	67.0	67.5	2.70	.60
2.2	3	27.3	42.3	50.0	61.3	67.7	2.60	.40
2.3	4	31.2	43.8	52.8	59.2	69.5	2.75	.45
2.4	9	31.7	46.6	53.9	68.8	74.8	2.92	.52
2.5	9	36.1	49.4	59.9	75.3	86.9	3.18	.68
2.6	5	34.6	44.4	56.4	64.0	75.8	3.10	.50
2.7	4	34.7	48.5	65.5	71.5	89.0	3.30	.60
2.8	7	38.7	55.0	61.7	69.6	88.7	3.37	.57
2.9	4	33.2	53.8	62.5	75.5	87.5	3.45	.55
3.0	7	36.1	54.0	70.1	83.0	93.0	3.61	.61
3.1	2	42.5	61.5	72.0	84.0	94.0	3.65	.55
3.2	6	40.7	58.8	68.8	81.0	100.7	4.02	.77
Mean	89	....	....	....	....	....	....	....

ilar for weight gain during the five day period—pigs of heavy birth weight gained more but pigs of low birth weight gained more per unit of body weight. Pigs of large and small birth weights appeared to utilize feed with similar efficiency. Only 1 pig out of 90 involved died during the 5 days. Average weight at 56 days was 31 pounds for pigs with birth weights above 2 pounds and 21 pounds for pigs weighing 2 pounds or less at birth. Thus, under conditions that eliminated much of the competition that usually exists under preweaning conditions, birth weight was closely associated with weaning weight. These data indicate that differences in feed consumption rather than differences in feed utilization are responsible for the association.

The above data also indicate that under good husbandry conditions pigs of low birth weight have innate ability for survival but that growth rate is inferior to that of pigs with heavier birth weight. The data further suggest that ability to compete for food and ability to utilize feed efficiently are more adequate than total capacity and desire to consume feed. This lack of capacity and/or desire may well be critical factors. They would, under unfavorable circumstances, combine with the expected greater heat loss per unit of body size in small pigs to bring about critical depletion of nutrient reserves more rapidly in small pigs. It appears that performance ability of pigs of low birth weight is adequate to justify adaptation of management conditions to improve their chances of survival and subsequent performance.

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A System of Artificially Rearing Pigs in Isolation

VERNE M. CHAPMAN, DAVID C. ENGLAND

Spreading diseases by direct or close contact between animals can be eliminated by preventing noninfected animals from coming in contact with infected stock, equipment, or carriers. Segregating mature animals is a practical impossibility since techniques are not available for positively diagnosing certain disease conditions, such as atrophic rhinitis, virus pneumonia, and TGE, in carrier or sub-clinically infected live animals. A program to eliminate such animals also would call for sacrificing individuals of merit within the herd.

A swine producer or breeder has two alternatives. First, he may sacrifice the entire infected herd and purchase new animals to build a new herd and run the risk of bringing in more disease problems than he originally had. Second, he may separate pigs from their dams at birth and raise them in complete isolation from the rest of the herd. Johnson, Bone, and Oldfield (*1*) reported elimination of atrophic rhinitis from the Oregon State University swine herd through controlled nursing to obtain colostrum. Subsequent rearing was in isolation on artificial diets.

A program of separating pigs from their dams at birth was carried out in the Oregon State swine herd in the spring of 1961. This report describes procedures and methods used in procuring, feeding, and handling the baby pigs and their initial and subsequent performance under artificial conditions.

Two crews were used to minimize indirect contact between "clean" and "unclean" pigs through personnel and equipment. One crew cared for the sows and managed farrowing. A second crew fed and cared for the artificially reared pigs. Members of each crew were careful to restrict their activities to the area in which they were working. Personnel working with the "clean" group did not enter the old hog lots on the regular swine operation, and personnel caring for the regular operation did not enter the immediate area of the artificially reared pigs.

Housing

From birth to between 1 and 2 weeks of age the pigs were kept in groups in large wooden boxes allowing approximately $\frac{1}{2}$ square foot of floor space per pig. These boxes were kept in a laboratory room where temperature was maintained at 65-70°, and heat lamps were used in the boxes to provide supplemental heat, especially for the first 3 or 4 days. The room was kept closed at all times to minimize drafts and an exhaust fan was used for ventilation. Boxes were bedded with an inch of shavings which were replaced daily. As many as 60 pigs were cared for in this facility at one time.

Following the initial period of 1 to 2 weeks in the laboratory room, the pigs were moved to previously used portable pasture houses which had been disinfected and steam cleaned

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since last used. Each house was equipped with a heat lamp until the pigs no longer needed supplemental heat.

At approximately 8 weeks of age the pigs were allowed access to clean pastures.

Procurement of baby pigs

Before farrowing, sows were washed with soap and water and placed in a farrowing crate. They were closely observed for milk letdown and other signs indicating that farrowing was near. Since a baby pig is born relatively free of any infectious disease condition, the quicker he is removed from the immediate area of contamination the less is the probability of picking up infections. In this project pigs were caught at delivery in plastic bags and removed from the swine barn within a few minutes.

Each pig (or pigs if the delivery was fairly rapid) was then taken to the laboratory. Pigs which were missed and touched the pen floor were removed to a separate area in the hog barn during farrowing and later returned to the sow.

Upon arrival at the laboratory, pigs were ear-notched, umbilical cords were disinfected with iodine and glycerine and tied, and needle teeth were clipped. Then the pigs were individually weighed and placed in boxes under a heat lamp. Part of the litter usually was returned to the sow, especially if the number of boars was large. Pigs of all sizes were kept, but heavier birth weight pigs were favored as it was thought that they would perform more satisfactorily. However, almost a third of the pigs kept were 2 pounds or less at birth. These smaller pigs were used to collect data in conjunction with studies on "runtiness" in baby pigs, (*2, 3*).

Feeding

Just as a pig is born relatively free of infectious agents he also is born free of antibodies and lacks the mechanisms of building antibodies to defend himself against disease. This would not be of great concern, if a pig could be isolated without contact with disease producing organisms. However, under our system of isolation rearing, a baby pig comes in contact with many naturally occurring organisms that may cause scouring in pigs lacking antibodies. Fortunately, colostrum milk is rich in antibody material and antibodies are absorbed into the blood stream readily during the first 12-24 hours of life.

Because of the vital role colostrum plays in the development of strong healthy pigs, colostrum was fed the first 24 to 48 hours. A standard milking machine with a special manifold to accommodate 12 teat cups was used to obtain colostrum from the sows. The greatest amount of milk was obtained at the first milking after farrowing. Oxytocin was given in an ear vein to stimulate milk letdown. Yields were as much as a quart or more, which was sufficient to start 4 or 5 pigs. After the first 24-48 hours, depending on availability of colostrum, a commercial sow milk replacer was used. Some colostrum which had been stored frozen for more than 5 months was used successfully. The few pigs which received frozen colostrum grew well but sufficient data are not available for comparison with fresh colostrum. Because of the limited supply of colostrum, initial feedings were made from 12 ounce pop bottles with lamb nipples to avoid wastage. Pigs were allowed full intake at each feeding as long as colostrum was available.

After 5 days of individual feeding at 5-hour intervals, the pigs were either transferred to a specially designed pig nursing can which offered a continuous supply of warm milk or they continued to nurse a bottle which was placed in a rack. This rack held three bottles and greatly reduced the time required for feeding. The pigs were not taught to drink from pans while they were in the laboratory room because of a lack of space in the boxes. After the pigs were moved to the houses outside (at 1-2 weeks of age) they were taught to drink from pans and were fed a dry starter ration free choice.

Strict sanitation procedures were followed. Feeding bottles and nipples were washed and boiled between feedings. Pans and other utensils used for handling milk or milk replacer were washed thoroughly with detergent. Leftover milk replacer or milk was refrigerated.

Performance of artifically reared pigs

This project was carried on for the entire 8-week farrowing period to obtain an adequate sample of the entire herd. Because of this extended farrowing period, some grouping of litters occurred. These groups differed slightly in performance.

The first group consisted of 25 Berkshires from 6 litters. These received the largest amount of colostrum and were kept in the laboratory room for 2 weeks. No deaths or difficulties of any kind occurred. The health of these pigs was excellent. After transfer from the laboratory to outside houses, three of the smallest animals died during two cold nights when the pigs were not fed during the night. Average 56-day weight was 29 pounds. Twenty two pigs of those kept for artificial rearing survived (Table 1).

There was approximately a 2 week period between the first and second group. This allowed time to clean and disinfect the boxes and other equipment before new pigs were brought into the laboratory. As Table 1 shows, vitality and vigor of the pigs in the second group was excellent. In this group of predominantly Yorkshire pigs, 29 of 30 lived for a survival percentage of 96.7. Part of this group was fed with the nursing can device and most of them accepted this method quite readily. There were a few instances of refusal to nurse the device with resultant severe stunting. Because of the increase in the number of sows farrowing, this group was moved to the outside house at a younger age than the first group, but this was not detrimental to their performance.

Table 1. Survival and growth performance of artificially reared pigs

Group	Pigs kept	Survived to 56 days		Average 56 day weight
	no.	*no.*	*%*	*lbs.*
1	25	22	88.0	29.2
2	30	29	96.7	30.4
3	63	33	52.4	21.8
4	33	17	51.5	19.0
5	13	12	92.3	27.6
Total	164	113	68.9	25.6

There were 63 pigs in the third group. All but one of these litters were Berkshire. Pigs of one of the litters were extremely small and averaged less than 1.2 pounds at birth. Six pigs of this litter were raised artificially and five survived until 56 days of age.

Pigs of group 3 were born while pigs of group 2 were still in the laboratory, so it was impossible to clean and disinfect equipment thoroughly before group 3 was brought in. To relieve crowding, some pigs from group 3 were moved to outside houses at 5-8 days of age. Severe scouring developed in these young pigs in outside houses. A number of factors were probably involved as predisposing causes. Weather conditions changed to cold nights at this time and heat lamps were not adequate to prevent chilling. Although no critical levels of colostrum were determined, this group had received less colostrum milk than the preceding groups. Facilities for thoroughly sanitary care of feeding equipment were less adequate than in the laboratory. Forty-eight percent of the pigs in this group died as a result of scouring, and the 56-day weights show the setback suffered by the surviving animals.

Pigs in group 4 were Yorkshires. When these pigs were farrowed many of the preceding group were still in the laboratory. No scouring had occurred in the laboratory and health of animals remaining in the laboratory was good. Equipment was cleaned as much as possible prior to entry of group 4 into the laboratory. Youngest pigs in this group showed evidence of scouring at four days of age and older pigs showed scouring soon after. While causes could not be directly determined the following probably contributed.

¶ Normally, there was no contact between personnel working inside the laboratory and pigs which had been moved outside. This lack of contact was briefly broken just before the scour outbreak in the laboratory.

¶ The pigs were fed a milk replacer mixed with a higher ratio of replacer to water than was recommended by the manufacturer.

¶ Not all pigs in this group received a large amount of colostrum. Postmortem examination revealed some blockage of the caecum which indicates that these pigs received an inadequate amount of colostrum.

¶ Overcrowding and a lack of facilities to isolate sick pigs probably contributed to spread of scouring through all groups. Treatment was extremely difficult. Inability of very young pigs to develop normal protective mechanisms and the lack of knowledge of the cause or of the organisms involved made effective treatment impossible. Antibiotics and acidophilus cultured milk were ineffective. An apple-pectin powder mixed in the milk replacer seemed to be the most effective treatment. The youth of the pigs and their lack of body reserves resulted in rapid emaciation accompanied by a decreased consumption of milk. The most of the 50% mortality in this group occurred during this period. The 19.0 pound average 56 day weight indicates the effect of the scouring on preweaning growth.

Group 5 consisted of a single litter farrowed 3 weeks after the preceding group. Weather conditions were less severe and these pigs were started in a box in one of the small pasture houses. A heat lamp was the only source of heat. These animals responded well to the artificial rearing conditions. Twelve of 13 survived to 56 days of age—with an average 56 day weight of 27.6.

Important procedures

The most important requirement in the success of this type of program is a knowledge of the environmental and nutritional need of the baby pig. Environmental needs are fairly obvious and they are similar to common practices followed by good swine producers in normal rearing of baby pigs. A warm, dry environment free of drafts is essential as the baby pig's nutrient reserves are low and he is not capable of adequately controlling his body temperature. Sanitation is extremely important in controlling and eliminating disease agents which the baby pig cannot easily combat. If a clean herd is to be established there should be a minimum of indirect contact through equipment and personnel. Overcrowding should be avoided as sanitation becomes more difficult and chances of disease problems increase.

Colostrum is essential to give the pigs antibody protection. Four or five feedings appear to be sufficient but more is good insurance. Good commercial sow milk replacers are available and give excellent results. Cleanliness is especially essential with the feeding equipment because milk is an excellent media for bacterial growth. High quality pre-starter rations are generally available and are of real value in supplying nutrients needed by baby pigs.

Application

The advantages to operating a swine enterprise under conditions that exclude infectious disease are obvious. Artificially rearing pigs in isolation, as described in this report, is somewhat costly but not beyond the means of most producers. A group effort may be less expensive in establishing such a program. Establishing a nucleus of "clean" stock from which many producers can draw to establish herds has great potential in controlling infectious diseases.

Further uses and applications of artifiical rearing of pigs are limited only by the ingenuity and resourcefulness of the producers. As specific knowledge of disease mechanisms increases, ample opportunity will exist to improve techniques and economize procedures and increase the usefulness of this program for efficient swine production.

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Hog Prices

M. D. THOMAS

For 50 years or more, prices of butcher hogs in Oregon have been determined primarily by prices in the Midwest plus costs of getting hogs and pork from the Midwest to Oregon markets. This has been true because—

¶ Farmers in Oregon and other nearby states have produced less pork than consumers here have been willing to buy.

¶ Farmers in the Midwest have been willing to produce much more pork than needed to satisfy local wants.

¶ Communication, transporation, and technology have made it possible to move hogs and pork products from the Midwest to Oregon, to other parts of the nation, and to many parts of the world.

When then, makes hog prices in the Midwest?

Before answering this question directly, let us consider prices in general. We all know, but sometimes forget, that prices are made in the minds of men. That is true for hogs, for hats, and for all other goods and services as well. It is true in a free market system. It is also true in a controlled or managed economy.

Men's minds form judgments. These judgments are based on facts, notions, beliefs, and biases. They are subject to human error and to change.

The dominant economic forces influencing men's judgments of hog prices in the Midwest and throughout the country are:

U. S. demand, including—

- Population (physical demand)
- Spendable income (ability to buy)
- Willingness to buy, which reflects needs, wants, tastes, preferences
  Prices of beef, poultry, other meats, other fats
  Quality, availability, convenience, knowledge, promotion
- Exports (world demand for lard especially)

U. S. supply, including—

- Stocks of fresh and canned pork and other meats in coolers
- Current and prospective hog slaughter
- Current and prospective supply of beef, poultry, other meats
- Imports (world supply—canned and cured)

Marketing costs, including—

- Processing
- Distribution
- Other marketing services

These are the principal hog-making forces in this country. Changes in these forces are the main causes of changes in hog prices.

Basically, consumers are the price-makers. The price or value of hogs stems from the extent to which pork products are desired by consumers and

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the extent to which pork products satisfy their wants—the greater the desire and the greater the satisfaction, the higher the price, other things being equal.

At the producer level, hog prices reflect all the knowledge and judgment buyers and sellers have of factors affecting the prices that consumers, retailers, wholesalers, and packers will pay for pork products. These include knowledge of factors affecting marketing costs as well as supply and demand conditions.

Iron Deficiency Anemia in Baby Pigs

J. E. OLDFIELD

Pre-weaning death losses in young pigs, many within the first week of life, pose one of the most important single problems facing swine producers. Studies conducted at the Oregon Agricultural Experiment Station in 1950 showed an average mortality between birth and weaning at 8 weeks of 32% of pigs born, and reference to the agricultural literature indicates losses as high and often higher across the country. There are many reasons for these baby pig losses and the major cause may well vary from one area and specific set of management conditions to another. Over the years, however, considerable evidence has been built up that anemia is a frequently-occurring and important contributor.

History of baby pig anemia

Although anemia of baby pigs may be termed a disease of civilization, in that it has become a problem since adoption of refined swine management techniques, it is not a new disease, having been recognized since the turn of the last century. About 1890 very high mortality was recorded among pigs in the German province of Schleswig-Holstein following transfer of animals to new cement-floored piggeries adjacent to dairy operations (*1*).

Since that time numerous examples have been recorded, usually where pigs have been raised in some form of confinement without access to soil. Affected animals commonly showed difficulty in breathing and a definite pallor about the eyes, nostrils, and mouth. This latter symptom gave rise to the term "anemia" which means, literally, "lack of blood." Many different types of anemia are recognized today including origins in heredity, infectious disease, parasitism, and nutrition. That most commonly encountered in baby pigs is of the nutritional type and is associated with iron deficiency. Scottish workers (*2, 3*) first connected iron deficiency with the baby pig problem, and their work was confirmed quickly at the Wisconsin Agricultural Experiment Station, where it was also learned (*4*) that very small amounts of copper were needed for proper utilization of iron. While this is a point of theoretical interest, it has little importance in supplementation practices, since sufficient copper is almost always available as a contaminant in some form.

One may well wonder why anemia is more of a problem with baby pigs

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than with other classes of young domestic animals. The answer probably lies in two distinct areas—the extremely rapid growth of young pigs which frequently double their birth weights in less than 7 days, and the fact that the baby pig is more dependent upon milk as its early food than young of some other species, and milk is very low in iron. What actually happens, then, is that the baby pig outgrows its iron supply.

Prevention of iron-deficiency anemia

With adequate evidence that iron deficiency was the cause of baby pig anemia, experimentation next turned to means of giving the young animals adequate iron. One of the early methods of supplementation was to place a chunk of sod and soil in litter pens, allowing pigs to obtain their iron more or less naturally from the soil. This method has been fairly effective (*5*) but some objections have been raised against it in recent years because of sanitation. More modern methods have involved treatment of young pigs with solutions of iron salts, either orally or, most recently, by injection. The commonest iron salt, iron sulphate ("copperas") contains some 20% by weight of iron, and has been widely used in saturated solution, either for direct dosing or indirect application by painting on the sows udder. To be effective, either of these treatments must be repeated—a single does is not effective. Daily doses from birth to weaning have been reported satisfactory (*6*). In addition to the inconvenience of daily handling, some criticism of ferrous sulphate's astringent qualities, which may cause constipation, has arisen (*7*). Use of other iron compounds, such as iron pyrophosphate, which are not astrigent, has been suggested (*8*).

In some cases, less than daily dosages of iron have been found satisfactory. Iowa experiments show that twice-weekly doses of an iron-copper paste (40 mg. iron as ferrous sulphate and 2.5 mg. copper as copper sulphate) were effective in preventing anemia (*9*). Specially prepared iron tablets, supplying 292 mg. iron, 21.6 mg. copper, and 2.85 mg. cobalt were given orally at 3 and 10 days of age in New York experiments with a fair degree of success (*10*). One problem noted with tablets was that pigs occasionally coughed them up before they dissolved and thus lost the benefit of the treatments.

Throughout experiments involving iron given by mouth it has been apparent that absorption of iron under these conditions has not been particularly good, meaning that relatively large doses and/or frequent doses have had to be administered. It has been of some significance that injectable preparations of iron have been developed in recent years. The first such compound to enjoy wide usage was an iron-dextran complex developed in England in 1952 (*11*). Intramuscular injection of 100 mg. of iron in this form during the first week of life has been found to be an efficient anemia preventive (*12, 13*).

Injectable iron compounds must be prepared of constituents which will not allow precipitation of ferric hydroxide in the tissues of the pig, since this material will cause muscle damage and possibly result in abscess formation. Some other materials, including a dextrin-ferric oxide complex (*14*) have been prepared and found satisfactory in preliminary trials.

Treatment methods discussed here are successful when superimposed on satisfactory management systems, and the importance of the latter should be emphasized. Several workers have given evidence that the provision of warm, dry, draft-free nests for baby pigs is a most useful adjunct to prophylaxis (*15*). Under natural conditions, the blood condition of young pigs starts to improve shortly after they commence eating significant quantities of dry feed, which is relatively rich in iron as contrasted to milk. This means that modern practices of early weaning are superior to 8-week weaning from an anemia-prevention point of view.

Oregon experiments

Interest in combating baby pig anemia has been evident at the Oregon Agricultural Experiment Station for a number of years. Some of the earliest work reported was on difference in effectiveness of various types of soil when placed in litter pens as an anemia preventive (*16*). Finely divided soils like clay loams seemed more effective than coarser sandy types, possibly because young pigs tended to consume more of the former. Later studies involved estimation of iron requirements and comparison of different methods of iron supplementation.

Since the liver is a major storage organ, iron analyses of livers of baby pigs were carried out to determine the extent of iron reserves (*17*). Results are listed in Table 1.

Table 1. Liver iron storage of baby pigs less than 24 hours after birth

Classification of animals	Body wt.	Liver wt.	Liver iron
	grams	*grams*	*mg.*
Normal, killed for analysis	1,138	24.59	1.30
Born alive, died within 12 hrs.	874	29.66	1.65
Stillborn	1,117	30.26	2.10

Apparently there is no direct relationship between the amount of iron stored in the livers of young pigs and their vitality. This reinforces the opinion that baby pigs are born with fairly adequate iron supplies and that the problem is one of maintaining these supplies through an adequate diet or by other means such as injection.

Further experiments compared different means of administering iron to baby pigs. In work with oral preparations it was learned that a plastic squeeze-bottle was a most convenient tool for dosing young animals. This method allows one man to both hold the animal and administer the dose. Comparative data on responses to oral and injected iron preparations are shown in Table 2.

Table 2. Baby pig response to oral or injected iron

No. of pigs	Treatment	Hemoglobin levels, grams/100 ml.[1] Birth	3 weeks
10	None	10.76	4.86
10	Iron-ammonium citrate, fed[2]	11.00	8.53
10	Iron-dextran, injected[3]	10.55	9.27

[1]Hemoglobin levels are given in grams hemoglobin per 100 ml. of blood. These levels are a good criterion to use in anemia experiments. Generally speaking, a level of over 10 is normal, and below 6 indicates increasing stages of anemia.

[2]Total dose 100 mg. iron, given in 3 doses, 5 days apart.

[3]Total dose 100 mg. iron, given intramuscularly in one injection.

If pigs are to be farrowed and raised to weaning on concrete, some preventive measure against iron-deficiency anemia is a necessity. Provision of clean soil in pens, or oral or intramuscular administration of appropriate iron compounds are all useful treatments.

Experience shows that oral preparations must be given repeatedly, while injections may be effective in a single dose. It is possible that future developments in baby pig starter ration formulas may result in more palatable mixes that pigs will eat at earlier ages. Improvement of rations may offer relief to the anemia situation through normal feeding practice.

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Feed Efficiency and Choice of Market Weight for Swine

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The amount of feed required to produce each pound of gain increases as pigs increase in weight. This increased feed requirement may be due to many factors but major influences are increased maintenance costs and increased fat deposition as weight increases. Inasmuch as the increased fat-to-lean ratio affects not only feed efficiency but also price received per pound, the latter factor is of special significance in considerations of most desirable market weights for swine. This report compares feed efficiencies of pigs during the period of 175 pounds to 200 pounds weight with feed efficiencies during the period of 60 pounds to 175 pounds and examines the economic desirability, from the producer's standpoint, of marketing hogs at the two weights.

Data for this study were collected at the Oregon Swine Evaluation Station of the Umatilla Branch Experiment Station at Hermiston. In most cases the experimental pen of pigs consisted of two boars and two market hogs from the same litter. Most common breeds were included. Rations were balanced barley rations containing approximately 16% crude protein until average weight was 125 pounds and approximately 14% crude protein thereafter to 200 pounds weight. Pigs were weighed every 2 weeks and feed for each 2-week period was recorded. At 200 pounds, boars were probed for backfat thickness and market hogs were slaughtered and carcass measurements and lean-cut yields were obtained. Spring test periods extended from mid-April to late August and fall test periods extended from mid-October to mid-March.

Table 1 records feed efficiency data by pens during each season of testing. As would be expected there is wide variation in changes in feed requirements from the first period to the second period within each experiment and between experiments. However, with test groups from various herds, during different periods and because of differences in fill at weighing, these excessive variations tend to cancel each other. Average differences for the entire group between periods should, therefore, be a relatively reliable indication of the true differences existing in feed efficiency between the two periods under the conditions of each experiment.

Average differences in feed requirement per hundred pounds of gain are 30 pounds, 75 pounds, and 16 pounds for the three experiments. In the first experiment only 2 of 10 pens showed a decreased feed requirement after reaching 175 pounds. In the second experiment, 2 of 21 pens showed a decreased feed requirement after reaching 175 pounds. In the third experi-

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ment, 8 of 18 pens showed a decreased feed requirement after reaching 175 pounds. It appears likely that some environmental change in the last experiment is responsible for the large number of pens showing decreased feed requirements in the last period. Likewise, environmental factors may well have caused excessively increased feed requqirements after 175 pounds weight in the second experiment.

The average feed required per hundred pounds of gain after 175 pounds weight was 372 pounds. Average increase in feed requirements per hundred pounds of gain after 175 pounds weight is 40 pounds. During this stage of growth, feed costs probably constitute at least 90 to 95% of the cost of gains, especially under conditions in which labor for cleaning is kept at a minimum. Thus, if an extra 25 pounds of feed per hundred pounds of gain is allowed to cover labor costs, one can use 4 pounds of feed per pound of gain as the cost of production during the period from 175 pounds to 200 pounds. Overhead in the breeding herd, labor in rearing pigs to feeder age, vaccination, and death loss costs in the preweaning period will remain the same whether market weight is 175 pounds or 200 pounds. Cost of producing the extra 25 pounds weight per pig can be taken as the cost of 100 pounds of feed. Thus, profit to be made at each of the two weights depends primarily on, (1)

Table 1. Feed required per hundred pounds of gain by growing swine during two weight periods

Pen	Experiment 1		Experiment 2		Experiment 3	
	Period 1	Period 2	Period 1	Period 2	Period 1	Period 2
	lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
1	354	379	277	349	356	353
2	348	412	303	379	316	344
3	360	376	304	405	325	446
4	424	323	328	429	380	461
5	323	439	330	340	391	338
6	344	480	290	324	296	340
7	302	334	298	376	300	394
8	311	361	301	379	322	376
9	386	324	258	392	344	297
10	365	390	335	316	374	380
11			319	486	334	359
12			305	382	352	458
13			336	329	368	304
14			276	355	312	279
15			306	373	338	310
16			301	326	367	303
17			300	379	333	307
18			312	429	307	362
19			330	397		
20			296	450		
21			282	365		
Average	352	382	304	379	340	356

Average of all three experiments—Period 1—332 pounds
Average of all three experiments—Period 2—372 pounds

pounds of feed that can be purchased with the price of each pound of live-weight hog (feed:hog ration) and (2) change in price per unit of weight as weight increases from 175 pounds.

On the basis of these experiments, selling at a weight of 200 pounds would be more profitable than selling at 175 pounds any time the price per pound of live hogs would buy more than 4 pounds of feed unless the selling price per pound is lower at 200 pounds than at 175 pounds. When a price difference exists for the two weights, the decrease in price per pound as a result of carrying to the heavier weight should be multiplied by 175 pounds and subtracted from the total value of the added 25 pounds weight. The remainder must be greater than the cost of 100 pounds of feed in order for increased profits to result from selling at 200 pounds as compared to 175 pounds. Feed requirement will differ for each group of pigs and data on each group should be used as the basis for choosing selling weight.

These figures are based on averages of the experiments. The increased feed requirement after 175 pounds weight varied widely among the three experiments. Experiments 1 and 3 were begun in late fall and finished during the period of January to mid-March. Experiment 2 was begun in mid-April and was finished during the months of July and August. Observation of the data for each pen showing improved feed efficiency shows pen 4 in experiment 1 to have been a slow gaining pen until late in the test period. The same is true of pen 10 in experiment 2. Of the 8 pens in experiment 3 showing improved feed efficiency after 175 pounds weight, all except 2 finished after February 9. Of the 7 pens that finished after February 9, only 1 failed to show an increased feed efficiency whereas of the 11 pens that finished during January and the first week of February, only 2 showed increased efficiency at the heavier weight. It thus appears that weather conditions were responsible for the improved feed efficiency at heavier weights in most of the pens in experiment 3 that showed such improvement since the ration formula remained the same.

From these data, it is possible to draw the following conclusions.

¶ Assuming no favorable change in environmental conditions after 175 pounds weight is reached, feed requirement per pound of gain will continue to increase as weight increases.

¶ Favorable changes in environment may largely or completely offset the normally expected increase in feed requirement as weight increases.

¶ The feed requirement of a group of slow starting feeders may improve at heavier weights under good conditions if fast growth occurs at the heavier weight.

¶ Marketing at heavier as compared to lighter weight must take into account both feed requirements and relative price per pound at the two weights.

¶ Choice of most desirable market weight can be more intelligently made when growth rate and feed efficiency data are available.

These data do not include information on carcass composition. Meat-type hogs would be expected to have more desirable carcasses at either weight than would fat hogs. Selling price per pound would be expected to decrease more sharply for fat hogs than for meat-type hogs as weight increases.

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Miscellanous Paper 117

September 1961

Agricultural Experiment Station

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Corvallis