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A STUDY OF MORTALITY AMONG YOUNG PIGS

The Influence of Wheat-germ Meal on the
Reproduction and Suckling of Pigs



SUMMARY AND CONCLUSIONS

1. A group of 18 sows fed wheat-germ meal, which is rich in vitamins B and E, in addition to a ration of yellow corn, alfalfa-leaf meal, tankage, and steamed bone meal, farrowed 165 living pigs and weaned 98 (59.3 per cent). A group of 17 sows receiving the basal ration (without wheat-germ meal) farrowed 148 living pigs and weaned 83 (56.1 per cent). This shows a slight advantage for the feeding of 10 per cent wheat-germ meal in the ration, but the difference is not large enough to be significant.

2. No sow receiving wheat-germ meal was considered a poor milker, while four of those not receiving this supplement were poor milkers. This indicates that the addition of wheat-germ meal apparently improves the ability of sows to secrete milk.

3. The very good milking sows, receiving no wheat-germ meal, raised seven pigs per litter, while the poor milking sows raised 2.25 pigs. In the group receiving the wheat-germ meal the very good milking sows raised 7.57 pigs per litter, and the fair milking sows raised 3.8 pigs. This shows a very definite relation between the ability of a sow to secrete milk and the number of pigs she is able to raise.

4. As the sows and pigs were kept on clean concrete floors, it was necessary to supply iron to the pigs to prevent anemia during the suckling period. The application of iron sulphate to the udder was found to be a practical method of administering the iron.

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A STUDY OF MORTALITY AMONG YOUNG PIGS¹

The Influence of Wheat-germ Meal on the Reproduction and Suckling of Pigs

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INTRODUCTION

The handling of live stock under intensive conditions has brought large losses among young animals. The production of swine is no exception. Data show that 35 per cent or more of the pigs farrowed are lost during the nursing period. These deaths occur in spite of efforts to improve the sanitary and nutritional conditions surrounding farrowing. It would seem, therefore, that there must be some obscure factors which work against the successful rearing of pigs.

From 1921 to 1927, while studying the effect of vitamins A and C on the growth and reproduction in swine as reported in Technical Bulletin No. 23 (8) of the Kansas Agricultural Experiment Station, a very high mortality occurred among the suckling young pigs. Large losses were observed, also, among the college herd sows, and swine producers throughout the state complained of similar losses. Some sows lost their entire litters, while others saved only one or two out of nine or ten strong pigs. The pigs that died seemed to become weaker each day. In fact, they seemed to "fade away." Those that survived often developed normally. Many others, however, were just "runts." The cause of this mortality was not determined.

Attention was called to the high mortality in rat litters from the work of Evans and Burr (4), who said, "A deficiency in lactation results in the death of most of the young, and the weaning of survivors with poor weight." This description seems not unlike the condition found in swine. Evans and Burr (4) and Sure (9) (10) were able to improve lactation among the rats and reduce the mortality by including in the diet of the mother a sufficient amount of vitamin B. They found that the amount of vitamin B necessary for suckling young rats was much greater than was necessary for well-being at other times. This suggested that the high death rate of young pigs might be due in part to an insufficiency of vitamin B in the feed of the sows.

The investigations herein reported were conducted to determine if the death rate of young pigs could be lowered by increasing the

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amount of vitamin B in the ration of pregnant and lactating sows. Wheat-germ meal, which has been shown by many investigators to be an excellent source of vitamin B, was used to increase the amount of this vitamin in the ration. The use of this meal also increased the amount of vitamin E in the feed.

METHODS EMPLOYED IN THE EXPERIMENTS

The study of wheat-germ meal in the ration of swine was begun the winter of 1927-'28. During this year and each of the three succeeding years one experiment of two lots of five pigs each was conducted. The first year gilts were used in conducting Experiment I, comprising lots 1 and 2. The second year the gilts of the preceding year were carried on as sows. These constituted Experiment II, lots 3 and 4. The experiments the two following years were with gilts and were known as Experiment III, comprising lots 5 and 6, and Experiment IV, lots 7 and 8.

The gilts used in the experiments were bred and raised in the college herd. They were all pure-bred Duroc Jerseys and closely related. All gilts were either half or full sisters, being sired by the same boar. When full sisters were in the experimental group, they were divided as equally as possible in each lot. The individuals in the experiment each year were kept in the same quarters and under the same conditions. When gilts were used they were selected from the farrow of the preceding spring and put on experimental feed at about eight months of age, when they were well developed and weighed about 235 pounds. The gilts in Experiment I were bred to one boar and the gilts in Experiments II, III and IV were bred to another boar. While on experiment the gilts were housed in a well-lighted and well-ventilated barn, and provided with individual feeding stalls, which were paved with concrete and were 8 by 8 feet in dimension. These pens, with a feed alley on one side, extended the length of the barn, which stands in an east and west direction. Each pen had an outside area to the south about 8 feet square paved with concrete.

Since the houses in which they were penned preceding and during gestation had no facilities for farrowing, such as pig rails, the gilts were driven to another well-equipped barn for farrowing. After farrowing, the sows and their litters were allowed to remain in the farrowing quarters about three weeks, then returned to their pre-farrowing pen and kept there until the pigs were weaned.

A study of the ability of each sow to secrete milk was made in each experiment. This was determined by taking on different days several weights of the pigs before being put in to nurse, and again after nursing. The increase in weight of the pigs represented the amount of milk secured by them and gave an indication of the amount of milk secreted by the sow. For purposes of comparison all sows whose pigs gained less than 100 grams in weight while nursing, after being kept away from their dam four hours, were considered poor milkers. Those whose pigs gained around 150

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grams were considered fair milkers, and those whose pigs gained 200 to 225 grams, good milkers; while those whose pigs gained over 250 grams were considered very good milkers. Of course, the number of pigs nursing the sow would influence the amount of milk secured, and in classifying the sows this was taken into consideration.

The individuals in each experiment, 10 in number, divided into two lots of five each, were fed as follows:

- Lot I received: Basal ration—
 - 75 per cent ground yellow corn
 - 10 per cent alfalfa-leaf meal
 - 10 per cent tankage (60 per cent protein)
 - 5 per cent steamed bone meal

- Lot II received:
 - 65 per cent ground yellow corn
 - 10 per cent wheat-germ meal
 - 10 per cent alfalfa-leaf meal
 - 10 per cent tankage (60 per cent protein)
 - 5 per cent steamed bone meal

Each gilt had salt before her at all times and received 10 c.c. of cod-liver oil per day on alternate weeks.

The rations were thoroughly mixed and fed dry. The feed for each gilt was weighed. The amount was changed from time to time, but each received the amount of feed she would clean up, morning and evening. The individuals in each lot received approximately the same amount of feed daily. The average daily amount of feed consumed by each is shown in Table I.

TABLE I.—FEEDING SCHEDULE OF THE GILTS, SHOWING AVERAGE DAILY RATION.

PERIOD EXPERIMENTALLY FED.	Average age of gilt.	Average weight.	Average daily feed.
	<i>Months.</i>	<i>Pounds.</i>	<i>Pounds.</i>
1st 30 days.....	9	235	6.0
2d 30 days (a).....	10	265	7.0
3d 30 days.....	11	295	8.0
4th 30 days.....	12	320	7.5
5th 30 days.....	13	370	8.5
6th 30 days (b).....	14	410	9.0
7th 30 days (c).....	15	480	9.5
8th 30 days (c).....	16	420	9.5 to 12.0

(a) Bred in this period.
 (b) Farrowed in this period.
 (c) Nursing litters in this period.

Water was available at all times. The feeding and watering was done in iron troughs. The ration of lots 2, 4, 6, and 8 differs from lots 1, 3, 5, and 7 only in that wheat-germ meal replaced 10 per cent of the ground yellow corn. Ten per cent of wheat-germ meal was considered sufficient to increase the amount of vitamins in the ration because yellow corn and alfalfa hay are both good sources of vitamin B.

Arrangements were made with the Washburn Crosby Milling Company, of Kansas City, Mo., to supply fresh wheat-germ meal every four weeks. In this way the feeding of rancid meal was avoided.

EXPERIMENT I

These gilts were of March farrow and averaged in weight 215 pounds, (Fig. 1.) They were housed and started on feed November 4, 1927. Breeding was begun December 21 and by January 25, 1928, all were bred. April 6, 1928, the first two gilts were removed to the farrowing house; the others were removed a short time later; and by May 18, 1928, all gilts had farrowed.

Table II shows the farrowing record in this experiment.

TABLE II.—FARROWING RECORD, EXPERIMENT I.

Sow No.	Number of pigs farrowed.....	Number of pigs farrowed alive.....	Number of pigs farrowed dead.....	Number strong.....	Number weak.....	Died from all causes.....	Died before 10 days of age.....	Died 10 to 20 days of age.....	Died after 20 days of age.....	Number of pigs raised.....	Milling qualities of sow (a).....
Lot 1—Sows Fed Basal Ration											
30.....	8	8	0	8	0	3	1	1	1	5	p
8.....	8	7	1	7	0	4	4	0	0	4	p
26.....	9	9	0	9	0	5	5	0	0	4	p
11.....	14	13	1	11	2	13	13	0	0	1	p
1.....	12	11	1	9	2	10	9	0	1	2	p
Total,	51	48	3	44	4	35	32	1	2	16	
Lot 2—Sows Fed Ration Containing Wheat-germ Meal											
3.....	9	9	0	9	0	2	1	0	1	7	vg
28.....	4	4	0	4	0	0	0	0	0	4	f
55.....	11	11	0	10	1	3	3	0	0	8	vg
42.....	9	9	0	8	1	8	1	1	5	2	vg
29.....	13	13	0	13	0	7	3	5	0	5	vg
Total,	46	46	0	44	2	20	8	6	6	26	

(a) Very good, vg; good, g; fair, f; poor, p.
Per cent of pigs weaned: Lot 1, 33.3; lot 2, 56.5.

From Table II it is observed that the sows fed wheat-germ meal raised 56.5 per cent of their pigs, making a mortality of 43.5 per cent, while those receiving no wheat-germ meal raised only 33.3

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per cent, making a mortality of 66.7 per cent. A better farrow was made, also, in regard to strength of pigs and number of pigs farrowed dead among the sows fed wheat-germ meal, although more pigs died after 10 days' time among these sows than among those receiving no wheat-germ meal.

The table also shows that the milking qualities of the sows fed wheat-germ meal were better than those not receiving wheat-germ

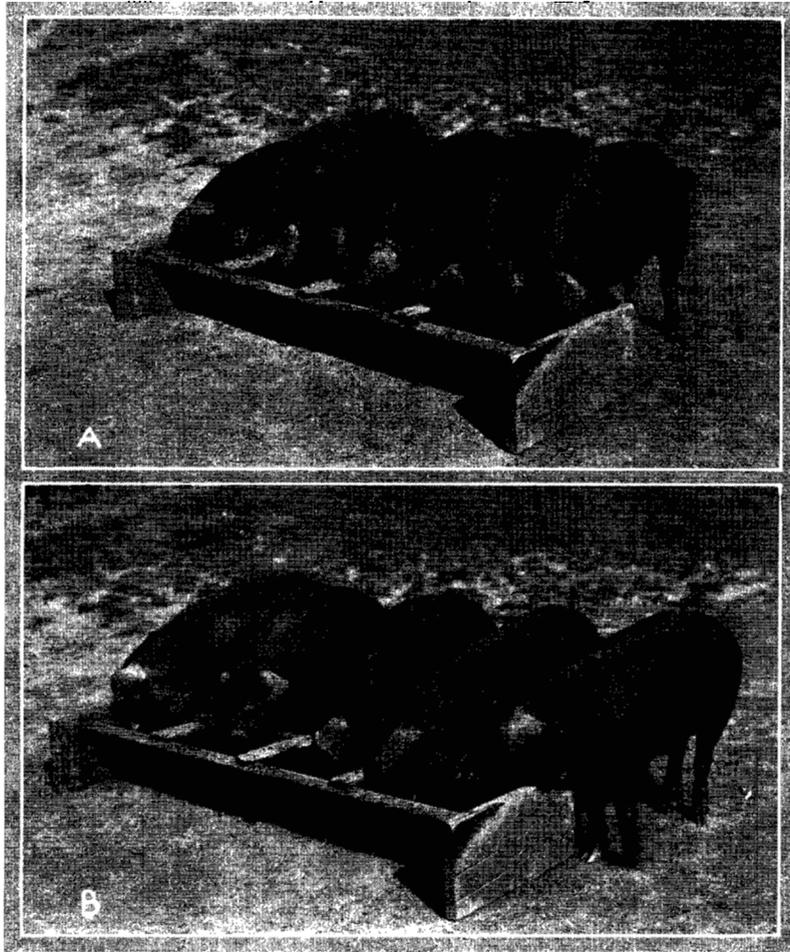


FIG. 1.—(A) Lot 1, Experiment I. Duroc Jersey gilts at start of experiment. These gilts received the basal ration of 75 per cent yellow corn, 10 per cent tankage, 10 per cent alfalfa meal, and 5 per cent steamed bone meal. Three of these gilts with two substitutions comprised lot 2, Experiment II, the following year and received the ration containing wheat-germ meal.

(B) Lot 2, Experiment I. Duroc Jersey gilts at start of experiment. These gilts received 10 per cent wheat-germ meal, 65 per cent yellow corn, 10 per cent tankage, 10 per cent alfalfa meal, and 5 per cent steamed bone meal. These gilts comprised lot 1, Experiment II, the following year and received no wheat-germ meal.

meal. Three sows of lot 2 were very good milkers and no sow was considered a poor milker, whereas three poor milkers, and two good milkers were the ratings for the sows in lot 1.

During this farrow the sanitation measures were pursued that were in general use with the sows of the college breeding herd. This included a thorough cleaning of the farrowing quarters prior to confining the sows. The pigs, after birth, were kept away from the sows and were permitted to nurse at regular intervals for five days. In spite of this a considerable number of pigs died. (Fig. 2.) Post-mortem examinations by the Department of Pathology of the Division of Veterinary Medicine of the college showed an intes-



FIG. 2.—Litter of sow No. 29, lot 2, Experiment I, farrowed May 18, 1928. The ration of this sow included wheat-germ meal. Her 13 pigs, averaging 2.9 pounds at birth, were all strong pigs, yet the sow raised only five of them. The others died within 15 days.

tinal infection among most of the pigs which indicated a problem of sanitation as well as nutrition, and suggested that more rigorous sanitation measures should be employed. However, since the sows fed wheat-germ meal in the experiment raised 23.2 per cent more pigs than those fed no wheat-germ meal, it might be stated, although not definitely concluded, that the pigs farrowed in Experiment I from sows fed wheat-germ meal must have had more resistance to the causes that brought on mortality than those not receiving the meal.

EXPERIMENT II

Since the sows fed wheat-germ meal in Experiment I raised 23.2 per cent more pigs than those not fed the meal, it was decided to reverse the sows in the lots for the second experiment because it was thought a chance selection might have caused the favorable results in the litters of the sows fed wheat-germ meal. It was also thought that the sows fed no wheat-germ meal might be carriers of the factors that were causing the mortality.

Consequently, in the winter of 1928-'29, the sows fed wheat-germ meal the previous year were fed no wheat-germ meal and were known as lot 3, and those fed no wheat-germ meal the previous year were fed the wheat-germ meal and were known as lot 4. Since infection the previous year was so marked, it was decided to pursue more rigorous methods of sanitation and give the pigs additional care. It was necessary to replace two of the sows in lot 3. This was done by substituting a full-sister gilt and a half-sister gilt of those removed.

These sows (fig. 1) averaged 370 pounds in weight and the substitute gilts averaged 195 pounds. They were housed and started



FIG. 3.—Litter of sow 11, lot 4, Experiment II, farrowed April 13, 1929. The ration of this sow included wheat-germ meal. Her 13 pigs averaged 2.58 pounds at birth. She raised 11 of the 13. This sow the previous year received no wheat-germ meal, farrowed 13 living pigs, and raised only one, the others dying within four days' time.

on feed September 17, 1928. Breeding was begun December 20, and by January 26, 1929, all were bred. April 5, 1929, the first three sows were removed to the farrowing house, and by May 7, 1929, all sows had farrowed. Three sows failed to settle this year. The reason for this is unknown. They were thought to be pregnant until well along in gestation, for at no time did they show œstrum.

Following the decision to use better methods of sanitation the sows were washed when removed to the farrowing house and the udder and feet were sprayed with a 5 per cent solution of creolin dip. This tended to eliminate any infections the sows might have carried with them from the old quarters. The pens into which the sows were put to farrow and the outside feeding way were scrubbed with boiling lye water five days before receiving the sows, and three days later were sprayed with a strong solution of creolin dip. It was hoped in this way to eliminate infections at farrowing. An attendant was on hand day and night, and as soon as the pigs were

farrowed they were removed and when all had been farrowed they were permitted to nurse at three- to four-hour intervals until five days old. They were then returned to their mother. In this way deaths due to overlaying and mechanical injury could be more accurately noted. After farrowing the quarters of each sow were carefully cleaned and disinfected and a general disinfecting was made each day about the house.

Table III shows the farrowing record in this experiment.

TABLE III.—FARROWING RECORD, EXPERIMENT II.

Sow No.	Number of pigs farrowed	Number of pigs farrowed alive	Number of pigs farrowed dead	Number strong	Number weak	Died from all causes	Died before 10 days of age	Died 10 to 20 days of age	Died after 20 days of age	Number of pigs raised	Milking qualities of sow (a)
Lot 3—Sows Fed Basal Ration											
74(b)	15	15	0	5	10	7	6	0	1	8	vg
79(b)	9	9	0	9	0	1	0	0	1	8	vg
3	5	5	0	5	0	1	0	0	1	4	g
55	Not set tled.										
42	Not set tled.										
Total	29	29	0	19	10	9	6	0	3	20	
Lot 4—Sows Fed Ration Containing Wheat-germ Meal											
30	10	10	0	9	1	2	1	0	1	8	vg
11	13	13	0	12	1	2	1	1	0	11	vg
1	6	6	0	6	0	0	0	0	0	6	vg
28	11	11	0	5	6	5	1	4	0	6	g
8	Not set tled.										
Total	40	40	0	32	8	9	3	5	1	31	

(a) Very good, vg; good, g; fair, f; poor, p.
 (b) A substitution.
 Per cent of pigs weaned: Lot 3, 68.9; lot 4, 77.5.

The results of Experiment II show no appreciable difference in the mortality of the two lots, considering the numbers involved. But the total number of deaths were very much reduced from those of the preceding year. The four sows farrowing in lot 4, the group fed wheat-germ meal, raised 77.5 per cent of their pigs, thus making a mortality of 22.5 per cent; while the group fed the basal ration, lot 3, raised 68.9 per cent, making a mortality of 31.1 per cent. The record shows, however, that a better farrow was made in regard to strong and weak pigs farrowed, among the sows fed wheat-germ meal, also that more pigs died after 10 days among these sows than among those receiving no wheat-germ meal.

By comparing Table II and Table III it is seen that the sows in lot I, Table II, that received no wheat-germ meal in Experiment I, improved in their milking qualities when fed wheat-germ meal in

Experiment II, as shown in Table III, lot 4. The tables show, also, that the only sow farrowing in lot 3, Experiment II, that was in lot 2 in Experiment I, decreased somewhat in her milking qualities when a change was made in her ration.

Post-mortem examinations again showed much intestinal infection in spite of the rigorous methods of sanitation employed and the care of the pigs by an attendant. The elimination of all dirt from the farrowing pens in carrying out the sanitation measures made it possible for the pigs to develop anemia. Accordingly, samples of blood were taken from the ears of the pigs and the hemoglobin was determined by the acid-hematin method, using a standard prepared according to Cohen and Smith (1).

The results of the first hemoglobin determination on six litters of pigs, averaging in age from 20 to 30 days, shows a low hemoglobin content in nearly all pigs. This suggested the presence of pig anemia. The average was 4.89 grams of hemoglobin per 100 c.c. of blood. The pigs were immediately given access to a box of sterile soil containing iron oxide and copper sulphate, because studies by Doyle, Mathews, and Whiting (2) (3) had shown that some factor in outside conditions affected pig anemia, and also because the studies of Hart, Elvehjem, Steenbock, and coworkers (6) had shown that the favorable effect of the out-of-doors in preventing pig anemia lay in the fact that the pig rooted in the soil, thereby getting substances which supplement the milk of the sow.

The average hemoglobin content of the pigs after having access to the box of soil for a week was brought up to 5.35 grams. Three weeks later it was 9.1 grams. Thereafter each litter in this experiment was provided with soil a short time after farrowing.

Totaling the results of Experiments I and II, it is observed that the number of pigs raised from the sows fed wheat germ, lots 2 and 4, averaged 67 per cent and the number raised from those receiving no wheat-germ meal, lots 1 and 3, averaged only 51.1 per cent, and again it might be stated, although not definitely concluded, that the wheat-germ meal reduced the death rate in young pigs.

EXPERIMENT III

Since the gilts fed wheat-germ meal in Experiment I had made a better farrow than the sows fed the same way in Experiment II, it was decided to select an entirely new group of gilts for Experiment III, because it was thought that gilts might be responding to the influence of the wheat-germ meal better than the sows. Lots 5 and 6 comprised this experiment.

The gilts selected were similar in type and breeding to those used in Experiment I. (Fig. 1.) They were of March farrow and averaged in weight 210 pounds. They were housed and started on feed September 20, 1929. Breeding was begun December 17, and by February 15, 1930, all were bred. April 6, 1930, the first sow was removed to the farrowing house and by June 13 all sows had farrowed.

The same care in sanitation and handling the sows and pigs was observed in this experiment as in the previous one.

Table IV shows the farrowing record of these gilts.

TABLE IV.—FARROWING RECORD, EXPERIMENT III.

Sow No.	Number of pigs farrowed.....	Number of pigs farrowed alive.....	Number of pigs farrowed dead.....	Number strong.....	Number weak.....	Died from all causes.....	Died before 10 days of age.....	Died 10 to 20 days of age.....	Died after 20 days of age.....	Number of pigs raised.....	Milking qualities of sow (a).....
Lot 5—Sows Fed Basal Ration											
69.....	5	5	0	5	0	0	0	0	0	5	g
21.....	9	9	0	8	1	2	2	0	0	7	vg
30.....	9	9	0	8	1	2	2	0	0	7	vg
53.....	8	7	1	6	1	2	1	0	0	5	f
68.....	9	8	1	7	1	2	2	0	0	6	vg
Total,	40	38	2	34	4	8	7	1	0	30	
Lot 6—Sows Fed Ration Containing Wheat-germ Meal											
61.....	10	10	0	6	4	2	1	1	0	8	vg
70.....	13	12	1	10	2	7	2	4	1	5	f
71.....	9	9	0	8	1	3	2	1	0	6	r
29.....	13	13	0	11	2	7	5	1	1	3	r
7.....	4	4	0	4	0	2	4	0	1	2	r
Total,	49	48	1	39	9	21	14	7	3	24	

(a) Very good, vg; good, g; fair, f; poor, p.
Per cent weaned: Lot 5, 78.9; lot 6, 50.

From Table IV it may be seen that the sows not receiving wheat-germ meal, lot 5, raised 78.9 per cent of their pigs, making a mortality of 21.1 per cent; while those receiving wheat-germ meal, lot 6, raised only 50 per cent, thus making a mortality of 50 per cent. A better farrow was made, also, in most other respects by the sows receiving no wheat-germ meal. The table also shows that the milking qualities of the sows receiving no wheat-germ meal was very much better than those receiving the wheat-germ meal.

In these respects the results are a reversal of the preceding two experiments in which it was found that the feeding of wheat-germ meal produced better results.

The post-mortem examinations again showed much intestinal infection, in spite of the rigorous methods of sanitation employed and the care of the pigs by an attendant.

THE HEMOGLOBIN CONTENT OF THE BLOOD AS RELATED TO PIG ANEMIA

Warned by the happenings of the previous year in regard to pig anemia, it was thought best in the spring of 1930 when the sows in Experiment III were farrowing, to check up on the hemoglobin content of the blood of each litter.

The first litter farrowed showed a hemoglobin content of 6.57 grams per 100 c.c. of blood at 10 days of age. As this was considered low it was decided to supplement the sow's milk with iron and copper salts since Hart, Elvehjem, Steenbock, and coworkers (7) had found this a satisfactory method to prevent pig anemia. Accordingly, a solution of copper and iron was given to the pigs three times each day by applying it to the udder of the sow by means of a brush. The method was that used by Hamilton, Hunt, Mitchell, and Carroll (5). The solution was made up as follows:

- 500 C.C. water
- 19.04 grams $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
- 125.80 grams $\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$
- 500 grams Karo corn syrup

Fourteen days after applying the solution, the hemoglobin content was 11.68 grams per 100 c.c., and 11 days later it was up to 13.71 grams per 100 c.c. blood.

A second litter showed a hemoglobin content of 7.6 grams per 100 c.c. at 10 days of age. The copper solution was applied at this time and the pigs at 24 days of age showed a hemoglobin content of 9.81 grams, and at 48 days it had increased to 10.87 grams per 100 c.c. of blood.

Since the pigs of the first and second litters showed a low hemoglobin count at 10 days of age, it was thought advisable to test the blood of the pigs of a number of sows when they were one day old, again at five and 10 days, and when the hemoglobin count was low, to apply the iron and copper solution. Table V gives the results of this analysis.

From Table V it is observed that the hemoglobin content dropped during the first 10 days when the pigs received no supplement, but as soon as the pigs received the iron supplement the hemoglobin began to increase.

TABLE V.—THE AVERAGE HEMOGLOBIN CONTENT OF THE BLOOD FROM SIX LITTERS OF PIGS AT DIFFERENT AGES.

Sow No.	Number of pigs in litter.	Days of age.			
		1	5	10	40
Average grams of hemoglobin per 100 c. c. of blood per pig.					
61.....	10	14.53	12.48	(a) 7.92	10.76
30.....	9	15.02	10.02	(a) 7.92	10.08
53.....	7	15.17	13.42	(a) 8.59	12.63
68.....	7	16.85	12.93	(a) 11.71	13.26
70.....	12	13.63	12.28	(a) 8.40	11.82
71.....	9	16.33	12.63	(a) 9.42	12.10

(a) Solution of iron sulphate and copper sulphate applied to the udder.

Since it was evident from the treatment of the pigs in the foregoing litters that the hemoglobin content could be increased in pigs after it had decreased, it was decided to attempt to maintain the normal hemoglobin content at farrowing time by applying the solution immediately after farrowing.

Table VI shows the effect of this treatment with two litters.

TABLE VI.—HEMOGLOBIN CONTENT OF THE BLOOD OF TWO LITTERS OF PIGS WHOSE DAMS HAD THE COPPER AND IRON SOLUTION APPLIED TO THEIR UDDERS IMMEDIATELY AFTER FARROWING.

Sow No.	Number of pigs in litter.	Days of age.			
		Day of birth.	5	10	40
		Average grams of hemoglobin per 100 c. c. of blood per pig.			
29.....	13	(a) 15.43	12.39	10.42	11.35
27.....	8	(a) 15.68	13.39	12.96	12.70

(a) Solution of iron sulphate and copper sulphate applied to the udder.

It is seen from Table VI that applying the copper and iron solution immediately after birth did not keep the concentration so high at the end of 40 days as it was at birth, but there was a more gradual and smaller decline than where the pig had no treatment.

From these results it is apparent that a solution of iron and copper salts painted on the udder of the sow has the tendency to supply the necessary substances which hold up the hemoglobin content of the blood and thus ameliorate the anemic condition in the pigs.

EXPERIMENT IV

Since the farrow of the gilts in Experiment III was the reverse of the two preceding farrows, another experiment was begun with gilts the following year, and lots 7 and 8 were fed. These gilts were similar in type and breeding to those in the former experiments (fig. 1) and were housed and started on feed October 30, 1930. Breeding was begun December 21, and by January 10, 1931, all were bred. April 8, 1931, the first two sows were removed to the farrowing quarters and by May 1 all sows had farrowed. One gilt in each lot failed to settle this year. The cause was undetermined. They were thought to be pregnant, until well along in gestation, for at no time did they show œstrum.

The same care in sanitation and handling the sows and pigs was observed in this experiment, as in the previous ones.

Table VII shows the farrowing record of these gilts.

From Table VII it is seen that this farrow shows very little difference in the mortality of the two lots. The lot fed the basal ration, lot 7, raised 51.5 per cent of their pigs, making a mortality of 48.5 per cent, and the lot fed wheat-germ meal, lot 8, raised 54.8

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TABLE VII.—FARROWING RECORD, EXPERIMENT IV.

Sow No.	Number of pigs farrowed	Number of pigs farrowed alive	Number of pigs farrowed dead	Number strong	Number weak	Died from all causes	Died before 10 days of age	Died 10 to 20 days of age	Died after 20 days of age	Number of pigs raised	Milking qualities of sow (a)
Lot 7—Sows Fed Basal Ration											
39.....	11	8	3	8	0	5	5	0	0	6	vg
30.....	13	11	2	8	3	12	11	1	0	1	p
34.....	11	9	2	6	3	6	6	0	0	5	f
48.....	6	5	1	5	0	1	1	0	0	5	g
20.....	Not settled.										
Total,	41	33	8	27	6	24	23	1	0	17	
Lot 8—Sows Fed Ration Containing Wheat-germ Meal											
32.....	11	9	2	8	1	10	7	3	0	1	g
16.....	8	7	1	7	0	3	3	0	0	5	f
50.....	10	10	0	8	2	3	3	0	0	7	g
27.....	5	5	0	4	1	1	1	0	0	4	g
25.....	Not settled.										
Total,	34	31	3	27	4	17	14	3	0	17	

(a) Very good, vg; good, g; fair, f; poor, p.
Per cent weaned: Lot 7, 51.5; lot 8, 54.8.

per cent, thus making a mortality of 45.2 per cent. Fewer pigs were farrowed dead and fewer weak, however, in the lot fed wheat germ; also a smaller number died from all causes and before 10 days' time. A comparison of the milking qualities of the sows of the two lots shows considerable similarity.

Realizing that anemia would likely overtake the young pigs unless they were safeguarded, the udders of the sows were painted twice daily, beginning at the time the pigs were a week old. A water solution of iron sulphate was used this year. The treatment seemed to be effective, for fewer pigs were lost, after 10 days of age in this experiment than in either of the previous experiments, and autopsy of the pigs failed to show any evidence of pig anemia.

Again, as in the previous experiments, post-mortem examinations of the dead pigs showed much intestinal infection. Attempts to isolate the specific organisms responsible for the deaths were of no avail.

GENERAL DISCUSSION

In the conduct of the four experiments herein reported, problems were encountered which brought about interesting speculations and an answer to one question generally raised another. But considering the fact that the four experiments involved the farrow of 35 sows and the observation of 330 young pigs, from which the figures in Table VIII are compiled, it is thought that some of these figures are important enough to justify having additional attention directed to them.

TABLE VIII.—SUMMARY OF FARROWING RECORDS OF THE FOUR EXPERIMENTS.

Experiment No.	Total No.	Number of sows	Number of pigs farrowed	Number of pigs farrowed alive	Number of pigs farrowed dead	Number strong	Number weak	Died from all causes	Died before 10 days of age	Died 10 to 20 days of age	Died after 20 days of age	Number of pigs raised	Per cent of pigs raised
Sows Fed Basal Ration													
I	1	5	51	48	3	44	4	35	32	1	2	16	33.3
II	3	3	29	29	0	19	10	9	7	0	3	20	68.9
III	5	5	40	38	2	34	4	8	4	1	0	30	75.0
IV	7	4	41	33	8	27	6	24	23	1	0	17	51.5
Total		17	161	148	13	124	24	76	68	3	5	83	56.1
Sows Fed Ration Containing Wheat-germ Meal													
I	2	5	46	46	0	44	2	20	8	6	6	26	56.5
II	4	4	40	40	0	32	8	9	3	5	1	31	77.5
III	6	5	49	48	1	39	9	21	14	7	3	24	50.0
IV	8	4	34	31	3	27	4	17	14	3	0	17	54.8
Total		18	169	165	4	142	23	67	39	21	10	98	59.3

PER CENT OF PIGS RAISED

The first two experiments showed less mortality among the sows fed wheat-germ meal. The third experiment, however, brought a reversal of this, and the fourth experiment showed no significant difference. From this variation one might expect that when the results of the farrow of the four experiments were averaged it would be found that no great difference existed. Such is the case. An average of the pigs raised in the four experiments shows that there is 8.2 per cent difference between the two lots of sows. Those receiving wheat-germ meal raised 59.3 per cent of their pigs, and those not receiving wheat-germ meal raised only 56.1 per cent. This is not significant, yet it shows an indication in favor of the feeding of wheat-germ meal.

If an average is made of the three experiments in which only gilts were farrowed, again no significant difference is found in the per cent of pigs raised. Yet the feeding of wheat-germ meal apparently had a tendency to increase the per cent of pigs raised, since the gilts not fed wheat-germ meal raised 52.9 per cent of their pigs, while those receiving the wheat-germ meal raised 57.6 per cent. This is a difference of 4.7 per cent.

A further indication that wheat-germ meal may have been effective in the ration may be found in Table IX. Here it is seen that the average number of pigs raised per litter in the group fed wheat-germ meal was 5.44, while the group not receiving wheat-germ meal averaged only 4.88 pigs. This is a difference of 0.56 of a pig per litter.

From these data it seems that the feeding of wheat-germ meal

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has a tendency to influence the number of pigs raised in relation to the number farrowed alive, and also to the average number raised per litter.

CONDITION OF THE PIGS FARROWED

An average of the four experiments shows that the sows receiving the wheat-germ meal farrowed 5.7 per cent fewer dead pigs and 3 per cent more strong pigs than the sows that received no wheat germ. When, however, the number of pigs that died after 10 days is considered, it is seen that 13 per cent more of the pigs died among those receiving wheat-germ meal than among those not receiving the meal.

TABLE IX.—SUMMARY OF MILKING QUALITIES OF THE SOWS AND THE RELATION OF THESE QUALITIES TO MORTALITY OF THE PIGS.

EXPERIMENT No.	Lot No.	Number of sows.	Milking qualities of sows.			
			Poor.	Fair.	Good.	Very good.
Sows Fed Basal Ration						
I.....	1	5	3	0	2	0
II.....	3	3	0	0	1	2
III.....	5	5	0	1	1	3
IV.....	7	4	1	1	1	1
Total.....		17	4	2	5	5
Average number of pigs raised per litter.....		4.88	2.25	5	4.6	7
Per cent mortality.....		43.9	81	37.5	28.2	27.6
Sows Fed Ration Containing Wheat-germ Meal						
I.....	2	5	0	1	1	3
II.....	4	4	0	0	1	3
III.....	6	5	0	3	1	1
IV.....	8	4	0	1	3	0
Total.....		18	0	5	6	7
Average number of pigs raised per litter.....		5.44	0	3.8	4.33	7.57
Per cent mortality.....		40.7	0	52.5	51.0	26.4

MILKING QUALITIES OF THE SOWS

In Table IX is found a summary of the milking qualities of the sows in the four experiments.

Table IX shows that when all the sows are considered, those receiving wheat-germ meal averaged better in milking ability than those receiving no wheat-germ meal. The number of good and very good milkers was about the same in each group, but no sow receiving wheat-germ meal was considered a poor milker, while four sows not receiving wheat-germ meal were of this classification. Further

evidence that wheat-germ meal may have an influence on the milking qualities was pointed out in the discussion of Experiment II, where it was shown that the sows receiving no wheat-germ meal in Experiment I improved in their milking qualities when fed wheat-germ meal in Experiment II, and further that the only sow in Experiment I that had received the wheat-germ meal decreased in her milking qualities in Experiment II when deprived of the wheat-germ meal.

It would seem, therefore, from these data that wheat-germ meal in the ration of nursing sows has a tendency to improve their milking qualities.

RELATION OF MILKING QUALITY TO MORTALITY

One of the most interesting points brought out in these experiments is the relation of the milking qualities of the sows to the number of pigs raised per litter, and to the per cent of mortality during the suckling period. The data presented in Table IX show that the size of the litter raised by the sows in both groups is influenced by the ability of the sow to secrete milk. This relation is evident, for in the lot fed the basal ration the very good milkers raised seven pigs to the litter, whereas the poor milkers raised only 2.25 pigs. In the lot fed wheat-germ meal the number of pigs raised by the very good milkers was 7.57, whereas the fair milkers raised only 3.8 pigs. This follows the expectation for such a condition, but it is particularly interesting in view of the fact that evidence has been presented previously that seems to indicate an influence of the feeding of the wheat-germ meal on the milking qualities of the sows. If this influence is conceded, then this evidence added to the fact that the better-milking sow raises the larger litter, will permit the question to be raised as to whether or not some of the factors that produce the poor-milking qualities in the sows are not also responsible for mortality among suckling pigs.

In this connection attention is called to the fact that the only experiment in which the sows receiving the basal ration (lot 5) raised more pigs than the sows receiving the wheat-germ meal (lot 6), was the only experiment in which the sows fed the basal ration showed a superiority in milking qualities. This would indicate that there are other factors than wheat-germ meal in a ration responsible for the low death rate. At any rate, from the data herein presented it is clear that there is a relation between the mortality of the pigs and the ability of sows to secrete milk.

AUTOPSY FINDINGS

Because of the uniformity of the post-mortem pictures of the majority of dead pigs from each experiment, it is felt that a collective description of the post-mortem appearance will be adequate and will avoid a necessary duplication should a description be given for each of the four experiments.

During the progress of Experiment I, autopsies failed to show any

evidence of pig anemia; while during Experiments II and III, pig anemia was demonstrated on autopsy in a relatively few instances. (During Experiment II, 2.9 per cent, and during Experiment III, 1.2 per cent.) Progress in Experiment IV was identical to that in Experiment I, in that no instances of pig anemia were shown on post-mortem examinations. These findings were quite significant and more or less in line with the hemoglobin estimations, which were not extremely low in any instance, and also show quite clearly that the death loss must have been due to other causes than pig anemia.

The usual post-mortem picture of a dead pig was more or less typical and is as follows: Marked emaciation, dry wrinkled skin, no visible discharges or changes in any of the natural openings except the rectum, perianal tissues, and tail which showed quite an erythema due to "scalding" from an irritative diarrheal discharge. Internal examination almost invariably revealed a marked enteritis which in some instances was hemorrhagic but which characteristically was mucopurulent, or catarrhal in nature. The stomach usually revealed a slight inflammation, but quite characteristically small ulcerations throughout the glandular part were seen. The entire alimentary tract was usually quite empty. Occasionally a pig was seen in which pneumonia was found. In some of these the pneumonia was thought to be metastatic and derived from the migration of infection from the intestine; while in a few others exposure to climatic conditions may have been a factor.

During the four experiments, 17 pigs were farrowed dead, and this group of pigs universally exhibited the same lesions as described above except for the erythema or "scalding" around the rectum and tail. Also, these pigs showed the expected atelectatic lung characteristic of animals that have not breathed.

With but few exceptions the lesions named constitute the ones characteristic of the pigs that died. Occasionally lesions characteristic of suffocation and sometimes hemorrhages from ruptured organs, along with fractured ribs, were found. These were the result of accidents and should not be confused with the true loss of the pigs.

Bacteriological examinations were made without securing any definite etiological factor. Organisms of the colon and intermediate colon groups were isolated, but failed to reproduce the disease following their injection into pigs. Stomach and intestinal contents of dead pigs when fed to normal pigs failed to produce any diseased condition.

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