SUBSTITUTES FOR CORN IN RATIONS FOR FATTENING SWINE

OHIO

Agricultural Experiment Station

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BULLETIN 268

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BULLETIN

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NUMBER 268 JANUARY, 1914

SUBSTITUTES FOR CORN IN RATIONS FOR FATTENING SWINE

GEO. R. EASTWOOD

INTRODUCTION

The extensive development of the swine industry in the corn belt is intimately associated with the abundant production of corn. No grain is more efficient and, under usual market conditions, more economical for use in pork production than is corn, providing it is properly supplemented and intelligently supplied. Bulletins 209, 213 and 242 of this Station (available upon request) give the results of a number of experiments in which corn in various amounts and combinations was used. Corn has been and will probably continue to be the basis of most rations used in corn-belt pork production. However, in sections outside of the corn-belt, or even in the corn-belt, corn may at times be so high in price that the use of other feeds instead of it may increase the profits from swine.

There are a number of commercial and home grown feeds that may be fed to swine in place of corn. Profits are too often reduced rather than increased by the use of some of these feeds. A knowledge of the relative efficiency of these feeds and of corn will assist materially in the selection of feeds for this use. In order to secure data on this subject this Station has conducted experiments in which a limited number of these feeds have been compared with corn. The results of this work to date, including experiments in which corn has been completely replaced by oats, hominy feed, wheat, wheat middlings and rye, and partially replaced by oats and by green feed, in rations for fattening swine, are given herein.

PIGS USED

The pigs used in the experiments reported in this bulletin were pure bred Duroc-Jerseys, from closely related dams. In selecting pigs for these experiments the pigs in the different lots in an experiment were selected so as to be as similar as possible in age, weight, sex, breeding, thrift and in regard to treatment received previous to the beginning of the experiment.

WEIGHING

Individual weights of all pigs on experiment were taken early in the afternoon at the beginning of the experiment, and once each week at the same hour throughout the experiment. All experiments began with the evening feed of the first day and closed with the morning feed of the last day of the experiment.

FEEDING

All lots received their daily feed in two equal parts at regular hours morning and evening. All rations were mixed dry, all parts being by weight. Just before feeding, sufficient water was added to the feed to form a thick slop, warm water being used in cold weather. All lots were fed all they would clean up without waste. Water was freely supplied.

FEEDS USED

All the feeds used in these experiments were ground. The corn was of good quality, ground in such quantities as would be fed up in a reasonably short time. The wheat, oats and rye were sound, dry and of good quality. The middlings used were known on the market as "white middlings," and were of good quality. The hominy feed[1] used was sold under a guarantee to contain 9 to 11 percent protein; 7 to 9 percent fat; and 7 to 8 percent fiber. The tankage used was digester tankage guaranteed to contain 60 percent protein; 8 percent fat; 6 percent phosphates, and not over 3 percent crude fiber.

The composition of the feeds was determined by the Department of Chemistry, with results as shown in Table I.

TABLE I. Percentage composition of feeds used

	Water	Ash	Fiber	Protein (N. X 6.25)	N-Free extract	Fat
Corn, Experiment I and II	11.82	1.35	2.07	9.56	71.78	3.42
Oats, Experiment I and II	12.39	3.09	11.37	11.15	57.94	4.06
Hominy feed, Experiment III and IV.	9.61	2.98	5.68	10.78	63.37	7.58
Corn, Experiment V	11.02	1.40	2.50	9.50	74.03	1.55
Wheat, Experiment V	11.50	2.13	2.69	13.06	69.82	.80
Wheat middlings, Experiment V.	11.55	2.13	3.39	15.62	65.37	1.94
Rye, Experiment VI.	11.56	1.91	2.40	12.56	69.83	1.74
Tankage (Average of four samples)	6.75	16.92	3.70	61.79	.81	10.04

[1] "Hominy feed consists of the germ, bran and a part of the starchy portion of the corn kernel." (1914 Report of the Ohio State Board of Agriculture.)

Table II shows the comparative fineness of corn, oats and hominy feed, as determined by sifting five-pound samples.

TABLE II. Comparative fineness of ground corn, hominy feed and ground oats used

Size of mesh (Openings per sq. in.)	Percent of feed that passed through sieves with meshes of various sizes		
	Hominy feed	Corn	Oats
36	100	96.875	82.500
64	100	93.750	46.250
144	97	61.250	16.250
256	95	31.250	11.875
576	91	13.125	10.000

COMPARISON OF CORN AND OATS

EXPERIMENT I

Ten late spring pigs about three months old and averaging in weight about fifty pounds at the beginning of the experiment were selected and divided into two lots of five pigs each and fed as follows:

Lot 1, Corn, 9 parts; tankage, 1 part.
Lot 2, Oats, 9 parts; tankage, 1 part.

Each lot was confined in a 7-foot by 8-foot pen in the hog barn, having no access to outside runs during the experiment. The results of the experiment are shown in Table III.

TABLE III. EXPERIMENT I: 5 pigs in each lot; test lasted 126 days, August 27, to December 31, 1912

Lot	Ration	Initial weight lbs.	Final weight lbs.	Total gain lbs.	Average daily gain per pig lbs.	Total feed consumed lbs.	Average daily feed consumed per pig lbs.	Feed consumed per 100 lbs. gain lbs.
1	Corn, 9; tankage, 1	267.5	806[1]	640.0	1.52	2676	6.37	418.0
2	Oats, 9; tankage, 1	265.5	784[2]	570.5	1.09	2828	5.39	495.7

[1]Two pigs taken out September 17, weight 101.5.
[2]One pig taken out September 17, weight 52 pounds.

At the beginning of the experiment Lot 2 did not relish their feed as well as did Lot 1. Later, after they had become accustomed to their new ration, they were as regular in their daily feed consumption as was lot 1, although they did not consume as much feed. The pigs fed the oats and tankage ration consumed on an average 5.39 pounds daily of a ration carrying 10.6 percent of crude fiber, while the pigs fed the corn and tankage ration consumed on an average 6.37 pounds of a ration carrying only 2.23 percent crude fiber. It seems probable that the comparatively high percentage of crude fiber in the oats ration made it impossible for the pigs receiving this ration to consume a sufficient quantity of digestible nutrients

to make gains as rapidly as they might, had these nutrients been supplied in a ration carrying a lower percentage of crude fiber. At the close of the experiment the average weight of the pigs fed corn and tankage was 268.7 pounds, while that for the pigs fed oats and tankage was 196 pounds, a difference of 72.7 pounds, and this difference seemed to be due largely to the larger amount of fat carried by the pigs fed corn and tankage. The cuts on pages 154 and 155 show that the pig which received oats and tankage made about as much growth in the way of general devlopment of bone and muscles as did the pig which received corn and tankage, which would indicate that one ration was not particularly superior to the other in meeting the requirements for growth of pigs this size, but that the pig which received oats and tankage had comparatively little material left for the production of fat after maintenance and growth had been provided for.

At the close of this experiment two pigs, each representing as nearly as possible the average of its lot, were retained and continued on the experimental rations until January 22, 1913, when they were slaughtered with the results shown in Table IV.

TABLE IV. EXPERIMENT I. Gain and yield of dressed carcass by representative pigs

Ration	Initial weight August 27, 1912 lbs.	Final weight January 23, 1913 lbs.	Total gain in 148 days lbs.	Average daily gain per pig lbs.	Dressed weight January 23, 1913 lbs.	Yield in dressed carcass percent
Corn, 9; tankage, 1	54.5	276	221.5	1.50	223 5	81%
Oats, 9; tankage, 1.....	62.5	212	149.5	1.01	161 0	76%

It will be noted in Table IV that the pig which received corn and tankage made gains approximately 50 percent more rapidly and yielded 5 percent more of its live weight in dressed carcass than did the pig which received oats and tankage.

EXPERIMENT II

The pigs used in this experiment were selected from a number of spring pigs that had been used in a feeding experiment on rape pasture during the summer and were smooth, growthy pigs averaging in weight about 150 pounds at the beginning of the experiment. They were divided into four lots of five pigs each and fed the following rations:

Lot 1, Corn, 9 parts; tankage, 1 part.
Lot 2, Corn, 6 parts; oats, 3 parts; tankage, 1 part.
Lot 3, Corn, 3 parts; oats, 6 parts; tankage, 1 part.
Lot 4, Oats, 9 parts; tankage, 1 part.

Each lot was confined in a 20-foot by 52-foot outside pen, having for shelter an "A" type hog house with 64 square feet of floor space. All lots were given a week's feeding prior to the taking of the initial weights, in which to become accustomed to the new rations. The results of the experiment are shown in Table V.

TABLE V. EXPERIMENT II. 5 pigs in each lot; test lasted 84 days, October 10, 1912, to January 2, 1913

Lot	Rations	Initial weight lbs.	Final weight lbs.	Total gain lbs.	Average daily gain per pig lbs.	Total feed consumed lbs.	Average daily feed consumed per pig lbs.	Feed consumed per 100 lbs. gain lbs.
1	Corn, 9; tankage, 1.. . .	768.0	1501.5	733.5	1.75	3157.0	7.52	430.4
2	Corn, 6; oats, 3; tankage, 1.	758.0	1418.5	660.5	1.57	3025.5	7.20	458.1
3	Corn, 3; oats, 6; tankage, 1.	740.5	1368.0	627.5	1.49	2969.5	7.07	473.2
4	Oats, 9; tankage, 1..	726.5	1142.5	416.0	.99	2476.0	5.66	571.2

In this experiment the substitution of oats for corn, either totally or in part, resulted in a higher feed requirement for a given gain and in a slower rate of gain. The pigs which received corn and tankage made the most rapid gains and required the smallest amount of feed per hundred pounds of gain, while those which received oats and tankage made the slowest gain and required the largest amount of feed per hundred pounds of gain of any lot. Lot 2, which received a ration of 60 percent corn and 30 percent oats, made more satisfactory gains than did Lot 3, which received a ration of 30 percent corn and 60 percent oats. In this experiment the pigs fed corn and tankage made gains approximately 75 percent faster and required 140.8 pounds less feed per hundred pounds of gain than did those fed oats and tankage. It should be remembered in this connection that a part of this increased feed requirement per unit of gain was made up of an expensive commercial feed rather than altogether of oats. The results secured here with Lots 1 and 2 show a slightly greater difference, but are similar to those secured in Experiment I.

The results of these experiments indicate that if an economical substitution of oats for corn is to be made in rations for fattening swine, corn must be relatively high in price. The cost per hundredweight of gain as produced by the different lots in this experiment, under various market prices for corn and oats, is shown in Table VI. At the following prices per bushel for corn and oats, the cost of gains as produced in this experiment would have been the same whether produced on corn and tankage or oats and tankage: Oats, 20 cents; corn 51.5 cents. Oats, 24 cents; corn, 60.8 cents. Oats, 32 cents; corn, 79.4 cents. Oats, 40 cents; corn, 97.9 cents per

bushel. By comparing mixtures of corn, oats and tankage with corn and tankage, it will be seen that gains could be produced at equal cost on these rations under less widely differing prices for corn and oats, the difference depending upon the relative proportions of corn and oats in the ration.

TABLE VI. EXPERIMENT II: Influence of cost of feed and combinations of feeds upon cost of gains.

Prices per bushel for corn and oats; tankage charged at $50 per ton		Lot 1 Corn, 9; tankage, 1	Lot 2 Corn, 6; oats, 3; tankage, 1	Lot 3 Corn, 3; oats 6; tankage, 1	Lot 4 Oats, 9; tankage, 1
Corn	Oats	Cost per 100 pounds gain			
42c	20c	$3.98	$4.07	$4.02	$4.64
56c	20c	4.95	4.75	4.38	4.64
70c	20c	5.92	5.44	4.73	4.64
42c	24c	3.98	4.24	4.38	5.28
56c	24c	4.95	4.92	4.73	5.28
70c	24c	5.92	5.61	5.09	5.28
42c	32c	3.98	4.58	5.09	6.57
56c	32c	4.95	5.27	5.44	6.57
70c	32c	5.92	5.96	5.80	6.57
42c	40c	3.98	4.92	5.80	7.85
56c	40c	4.95	5.61	6.15	7.85
70c	40c	5.92	6.30	6.51	7.85

The figures in Table VII show the profit on gain in live weight of one hog at 6½ cents per pound, with tankage at $50 per ton and with varying prices for corn and oats. It will be noted that the relative prices of corn and oats at which oats could be profitably substituted either partially or completely for corn, are such as seldom exist.

The figures in Tables VI and VII are also of interest in showing something of the influence of varying market prices of feeds on profits from pork production and the importance of a careful consideration of both market prices and efficiency of feeds in the selection of rations.

TABLE VII. EXPERIMENT II: Profit on gain in live weight of one hog at $6.50 per hundredweight under varying market prices for corn and oats.

Prices per bushel for corn and oats; tankage charged at $50 per ton		Lot 1 Corn, 9; tankage, 1	Lot 2 Corn, 6; oats, 3; tankage, 1	Lot 3 Corn, 3; oats, 6; tankage, 1	Lot 4 Oats, 9; tankage, 1
Corn	Oats				
42c	20c	$3.70	$3.21	$3.11	$1.55
56c	20c	2.28	2.31	2.66	1.55
70c	20c	.86	1.40	2.22	1.55
42c	24c	3.70	2.99	2.66	1.02
56c	24c	2.28	2.09	2.22	1.02
70c	24c	.86	1 18	1.77	1.02
42c	32c	3.70	2.54	1.77	—.06
56c	32c	2.28	1.63	1.33	—.06
70c	32c	.86	.71	.88	—.06
42c	40c	3.70	2.09	.88	—1.12
56c	40c	2.28	1.18	.44	—1.12
70c	40c	.86	.26	—.61	—1.12

In this experiment as in Experiment I, one pig representing as nearly as possible the average of the lot was retained in each of Lots 1 and 4, fed corn and tankage, and oats and tankage, respectively, and continued on their experimental rations until January 22, 1913, when they were slaughtered with the results shown in Table VIII.

TABLE VIII. EXPERIMENT II: Gain and yield of dressed carcass by representative pigs from Lots 1 and 4.

Rations	Initial weight Oct. 3, 1912 lbs.	Final weight Jan. 22, 1913 lbs.	Total gain in 111 days lbs.	Average daily gain lbs.	Dressed weight Jan. 23, 1913 lbs.	Yield in dressed carcass percent
Corn, 9; tankage, 1	144.5	325	180 5	1 63	261	80.3
Oats, 9; tankage, 1.....	130.5	238	107.5	.97	181	76.1

While there was no measure taken of the lean meat in the carcasses of these pigs, yet apparently there was no great difference between the carcasses in this respect. On the other hand the much larger amount of fat in the carcass of the corn and tankage fed pig show one respect in which these rations differ.

The results secured with mixtures of corn and oats suggest that whenever prices will permit, oats might well be used as a part of the ration during the early part of the fattening period, the oats in the ration being gradually decreased until the last 4 or 5 weeks of feeding, when they should usually be omitted entirely from the ration on account of their bulkiness, which stands in the way of a large consumption of feed and rapid gains.

In selecting oats for use in rations for fattening swine the quality or weight per bushel of the oats should be taken into consideration, as they vary considerably in this particular with different seasons. An average of 20 varieties of oats grown on the Station farm at Wooster shows a variation in weight per bushel from 23.56 pounds to 32.97 pounds.[1] A much wider variation than this exists in oats grown in the south as compared with oats grown in the north or northwest, where a weight of 40 pounds per bushel is not uncommon. The oats used during the first three weeks of this experiment tested 31 pounds per bushel, and those during the remainder of the experiment 28 pounds per bushel. It would seem obvious that heavier or lighter oats would have a correspondingly higher or lower feeding value for swine than that indicated by the results of this experiment.

[1]Bulletin 257, Ohio Agricultural Experiment Station.

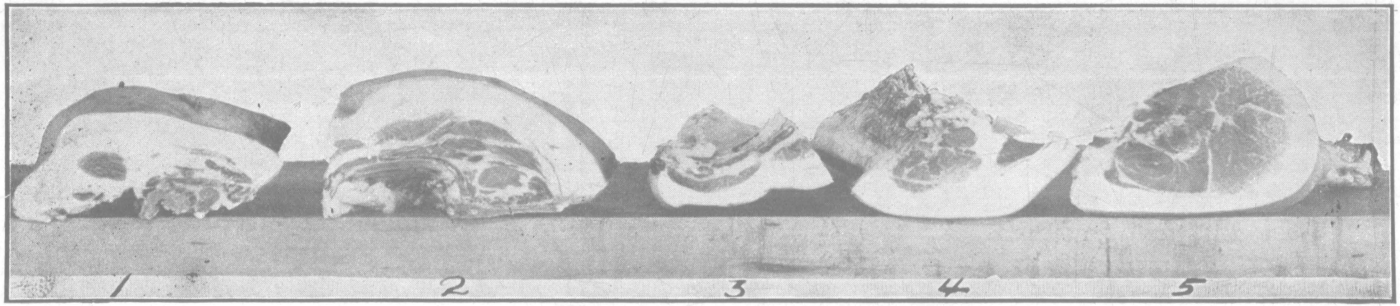

Fig. 1. Experiment I. From pig fed oats, 9 parts; tankage, 1 part; 148 days. (Aug. 27, 1912, to Jan. 22, 1913.)

Cuts—1. Head.	2. Rough shoulder.	3. Side.	4. Loin.	5. Ham.	Dressed weight of pig,
Weight— 9 lbs.	15 lbs.	13 lbs.	18.75 lbs.	11.5 lbs.	161 lbs.

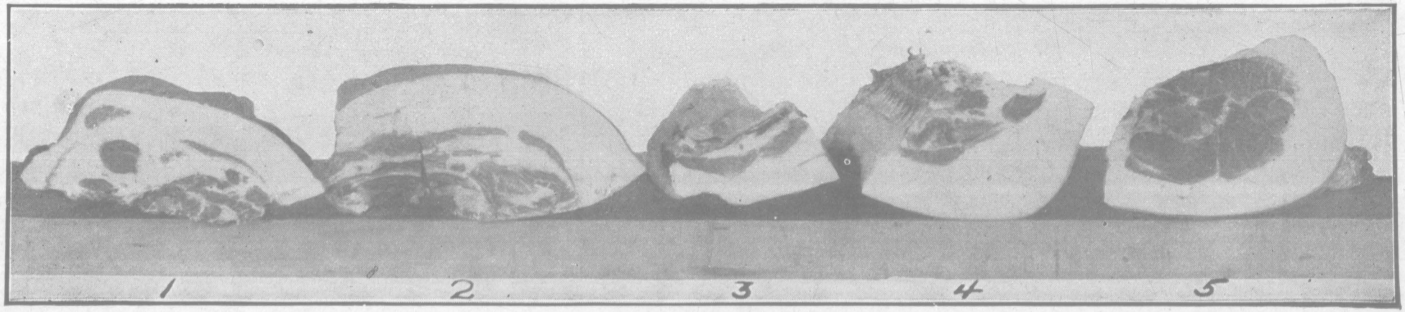

Fig. 2. Experiment I. From pig fed corn, 9 parts; tankage, 1 part, 148 days. (Aug. 27, 1912, to Jan. 22, 1913.)

Cuts—1. Head.	2. Rough shoulder.	3. Side.	4. Loin.	5. Ham.	Dressed weight of pig,
Weight—10.75 lbs.	20.25 lbs.	20.25 lbs.	28.5 lbs.	13.5 lbs.	223.5 lbs.

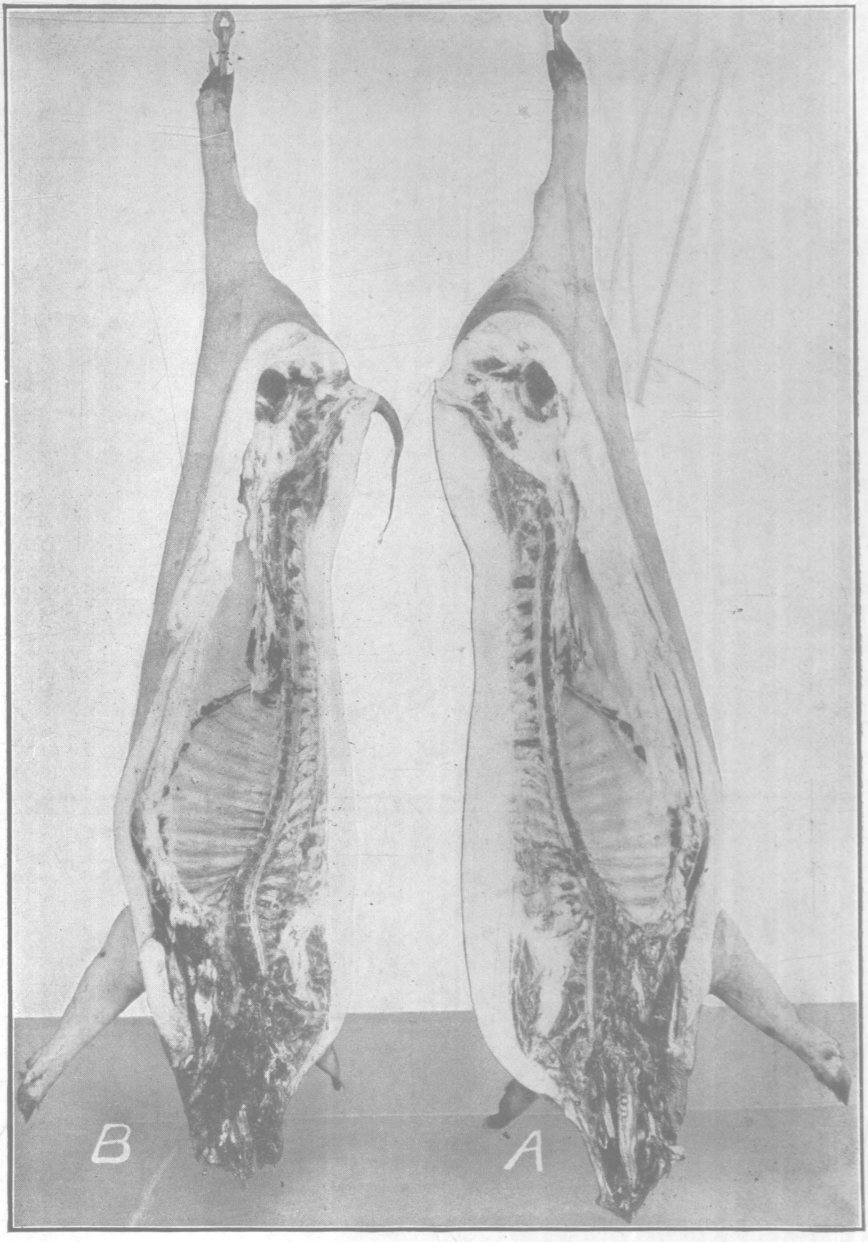

Fig. 3. Experiment II. (A) Fed corn, 9 parts; tankage, 1 part. (B) Fed oats, 9 parts; tankage, 1 part. (111 days, Oct. 3, 1912, to Jan. 22, 1913.)
(A) Av. daily gain, 1.63 lbs. Dressed weight, 261 lbs.
(B) Av. daily gain, .97 lbs. Dressed weight, 181 lbs.
(See Table VIII).

COMPARISON OF CORN AND HOMINY FEED

EXPERIMENT III

The sixteen pigs used in this experiment were late spring pigs that had been pastured in rape pasture during the summer, and averaged in weight 82.5 pounds at the beginning of the experiment. They were divided into four as nearly equal lots as possible with four pigs in each lot and were fed as follows:

Lots 1 and 3, Ground corn, 9 parts; tankage, 1 part.

Lots 2 and 4, Hominy feed, 9 parts; tankage, 1 part.

The lots were continued on these rations until November 21, 1912, (9 weeks), when the rations were reversed so that the lots that had been receiving corn and tankage received hominy feed and tankage, and vice versa. The results of the experiment are shown in Table IX.

TABLE IX. EXPERIMENT III: 4 pigs in each lot; test lasted 105 days, September 19, 1912, to January 2, 1913.

Lot	Rations	Initial weight lbs.	Final weight lbs.	Total gain lbs.	Average daily gain per pig lbs.	Total feed consumed lbs.	Average feed consumed daily per pig lbs.	Feed consumed per 100 lbs. gain lbs.
	Part I: Lasted 63 days—September 19 to November 21, 1912.							
1	Corn, 9; tankage, 1..	375.0	600	225.0	.89	1,021	4.05	453.8
2	Hominy feed, 9; tankage, 1[1]	372.5	596	298.5	1.52	1,157	5.87	387.6
3	Corn, 9; tankage, 1.... ..	363.5	658	294.5	1.17	1,208	4.79	410.2
4	Hominy feed, 9; tankage, 1	372.0	719	347.0	1.38	1,338	5.31	385.6
	Part II: Lasted 42 days—November 21 to January 2, 1913.							
1	Hominy feed, 9; tankage, 1	600	820.5	220.5	1.31	852.0	5.07	386.4
2	Corn, 9; tankage, 1	596	838.0	242.0	1.92	1,118 0	8.87	462 0
3	Hominy feed, 9; tankage, 1	658	889.5	231.5	1.38	916.5	5.46	395.9
4	Corn, 9; tankage, 1.....	719	1,014.5	295.5	1.76	1,418.0	8.44	479.9

[1]One pig taken out September 27, 1912. Weight 75 pounds.

It will be noted in Part I of the table that the pigs which received hominy feed and tankage ate more feed and made more rapid gains than did those fed corn and tankage, and also that Lot 1 made relatively small and Lot 2 relatively large gains compared with the gains made by Lots 3 and 4. The gains made by Lot 1 were not very satisfactory on account of the low rate of gain and the high feed requirement for a given gain. The rapid gains made by Lot 2 were evidently due, in part at least, to the fact that one pig in Lot 2 became unthrifty, and was taken out of the lot shortly after the experiment began, leaving 3 pigs in this lot that proved to be better individuals than the average pigs of the other lots. The results secured with Lots 1 and 2, however, are the same in character, except for greater differences, as those secured with Lots 3 and 4, which behaved very uniformly throughout the experiment.

Part II of the table shows the results of the last 6 weeks of the experiment when the rations were reversed. The change in rations at the end of the ninth week was made in a single feed. The change from hominy feed to corn did not have any noticeable effect on the amount of feed consumed. On the other hand the change from corn to hominy feed resulted in a smaller feed consumption, Lot 1 requiring over two weeks before they took a daily ration equal in weight to the one they were taking just before the rations were changed. This difference in amount of feed consumed seems to be due, in part at least, to the fact that hominy feed has more bulk, that is, greater volume per unit of weight, than has ground corn, rather than to any difference in palatability. Samples of the ground corn and hominy feed used, measured and weighed in a grain tester, showed a weight of 45 pounds per bushel for the ground corn and 32 pounds per bushel for the hominy feed.

It will be noted in Table II, that a little over 13 percent of the ground corn and 91 percent of the hominy feed sifted, passed through a sieve with 576 meshes to the square inch. That this difference had an influence upon the efficiency of the feeds is altogether possible; however, sufficient data to establish the existence of this influence are lacking at present.

In Part I of this experiment, Lots 2 and 4, which received hominy feed and tankage, made more rapid gains and required less feed for a given gain than did Lots 1 and 3, which received corn and tankage. During Part II of the experiment, Lots 2 and 4, then receiving corn and tankage, continued to make more rapid gains but showed a marked increase in feed required for a given gain, while Lots 1 and 3, then receiving hominy feed and tankage, showed a decrease in feed required for a given gain.

A brief summary of feed consumed and gains produced in this experiment shows that 4,765 pounds of the corn and tankage ration produced 1,057 pounds of gain, while 4,263.5 pounds of the hominy feed and tankage ration produced 1,097.5 pounds of gain, or that the substitution of hominy feed for corn resulted in the production of almost the same gain on approximately 14 percent less feed.

EXPERIMENT IV

In order to secure additional data concerning the relative efficiency of corn and hominy feed, Experiment IV was planned. In this experiment 16 fall pigs were divided into 4 lots of 4 pigs each, the pigs in Lots 1 and 2 averaging in weight about 67 pounds, and

those in Lots 3 and 4 averaging about 55 pounds, at the beginning of the experiment. Each lot was confined in a 7-foot by 8-foot pen in the hog barn, having no access to outside runs, and fed as follows:

Lot 1, Ground corn, 9 parts; tankage, 1 part.
Lot 2, Hominy feed, 9 parts; tankage, 1 part.
Lot 3, Ground corn, 9 parts; tankage, 1 part.
Lot 4, Hominy feed, 9 parts; tankage, 1 part.

These lots were fed as indicated above for a period of 10 weeks. At the close of this 10-week period the rations were reversed so that the pigs that had been receiving corn and tankage received hominy and tankage and vice versa. The results of the experiment are shown in Table X.

TABLE X. EXPERIMENT IV: Test lasted 126 days, January 21 to May 27, 1913.

Lot	Rations	Initial weight lbs.	Final weight lbs.	Total gain lbs.	Average daily gain per pig lbs.	Total feed consumed lbs.	Average feed consumed daily per pig lbs.	Feed consumed per 100 lbs. gain lbs.
Part I: 4 pigs in each lot; lasted 70 days, January 21 to April 1, 1913.								
1	Corn, 9; tankage, 1.....	267.5	572.5	305.0	1.09	1,254.75	4.48	411.4
2	Hominy, 9; tankage, 1[1] ...	266.5	424.0	261.0	.98	1,008.75	3.78	386.5
3	Corn, 9; tankage, 1[2].....	221.5	349.0	194.5	.75	879.75	3.40	452.3
4	Hominy, 9; tankage, 1[3]..	221.0	367.5	220.5	.85	885.50	3.42	401.6
Part II: 3 pigs in each lot; lasted 56 days, April 1 to May 27, 1913.								
1	Hominy, 9; tankage,1 ..	398.0	673.0	275.0	1.64	1,114.75	6.64	405.4
2	Corn, 9; tankage, 1.....	424.0	724.5	300.5	1.79	1,214.25	7.23	404.1
3	Hominy, 9; tankage, 1 ..	349.0	568.5	219.5	1.31	884.75	5.27	403.1
4	Corn, 9; tankage, 1.....	367.5	605.0	237.5	1.41	1,014.50	6.04	427.2

[1]One pig taken out of Lot 2, March 19, 1913. Weight 103.5 pounds.
[2]One pig taken out of Lot 3, March 11, 1913. Weight 67 pounds.
[3]One pig taken out of Lot 4, March 11, 1913. Weight 74 pounds.

Unfortunately the results secured in this experiment are not as conclusive as they might have been, owing to some of the pigs going off feed and having to be removed from the experiment. The results, however, are of interest, and duplicate in a general way the results secured in Experiment III. It will be noted in Part I that when corn was replaced by hominy feed the rate of gain was practically the same, with a marked decrease in feed required for a given gain.

During Part II of the experiment, when the rations were reversed, Lots 1 and 3 made cheaper gains and Lots 2 and 4 more expensive gains than during the first part of the experiment. During this part of the experiment there was also a marked change in the amount of feed required per 100 pounds of gain by Lots 3 and 4. Lot 3 showed a decrease and Lot 4 an increase in feed required per hundred pounds of gain as compared with the amount of feed consumed per hundred pounds of gain by these lots during Part I of the experiment.

The results of this experiment as well as those of Experiment III indicated a higher feeding value for hominy feed than for ground corn and show that, when prices will permit, hominy feed may be substituted for corn with excellent results. The data at hand seem insufficient to establish relative values for corn and hominy feed, yet it is believed that the approximate difference in favor of hominy feed secured in Experiment III is not far wrong. Additional work along this line, however, is needed and will be continued in the future.

COMPARISON OF CORN, WHEAT AND MIDDLINGS

EXPERIMENT V

In order to secure data concerning the relative value of corn, wheat and middlings for fattening swine, twenty spring pigs averaging in weight about 110 pounds at the beginning of the experiment were divided into four lots of five pigs each and fed as follows:

Lot 1, Ground corn, 9 parts; tankage, 1 part.
Lot 2, Ground wheat, 9 parts; tankage, 1 part.
Lot 3, Middlings, 9 parts; tankage, 1 part.
Lot 4, Middlings alone.

Each lot was confined to a 10-foot by 12-foot pen in the hog barn with a 10-foot by 40-foot outside run.

In studying the results of this experiment it should be kept in mind that the results secured here indicate the relative value of corn, wheat and middlings when fed as in this experiment and not when fed as a single feed.

The results of the experiment are shown in Table XI.

TABLE XI. EXPERIMENT V: 5 pigs in each lot; test lasted 91 days, September 1 to November 30, 1912.

Lot	Rations	Initial weight lbs.	Final weight lbs.	Total gain lbs.	Average daily gain per pig lbs.	Total feed consumed lbs.	Average daily feed consumed per pig lbs.	Feed consumed per 100 lbs. gain lbs.
1	Corn, 9; tankage, 1.....	511.5	1,224.5	713	1.57	2,613.0	5.74	366.5
2	Wheat, 9; tankage, 1.....	587.0	1,310.0	723	1.59	2,771.0	6.09	383.3
3	Middlings, 9; tankage, 1..	557.0	1,249.0	692	1.52	2,577.0	5.66	372.4
4	Middlings alone.....	568.5	1 225.5	657	1.44	2,398.5	5.27	365.1

All lots made good gains at a very low feed requirement. There was little difference in the rate of gain by the different lots; the greatest difference being between Lots 2 and 4. Lot 2 made the most rapid gain, and Lot 4 showed the smallest feed requirement for a given gain. Except for the very small difference in favor of Lot 2, the rate of gain was practically the same for Lots 1, 2 and 3. Neither was there a large difference in amounts of feed consumed by these

lots, a result that indicates that there was no great difference in either palatability or efficiency of the rations. Owing to the small differences in efficiency, a choice of the rations fed Lots 1, 2 and 3, would be largely a matter of choosing the ration of which a given amount could be secured at least cost. In most instances this would likely be the ration of corn and tankage. However, conditions may arise under which the substitution of wheat or middlings for corn would result in greater economy.

It is not usual for the milling value of good, sound wheat to be so low as to permit it to be used economically for feeding purposes. However, wheat that has been damaged in a way that materially lessens its value for milling purposes without rendering it unwholesome may often be fed with greater profit than would be secured if the wheat were marketed.

Table XII, showing the cost per 100 pounds of gain in live weight from the different rations and under varying market prices for corn, wheat and middlings, with tankage at $50 per ton, affords an interesting comparison of the rations used.

TABLE XII. EXPERIMENT V: Cost of 100 pounds of gain under varying market prices for feed. Tankage $50 per ton.

Price of corn per bushel	Corn, 9; tankage, 1	Price of wheat per bushel	Wheat, 9; tankage, 1	Price of middlings per ton	Middlings, 9; tankage, 1	Middlings alone
$.42	$3.39	$.450	$3.55	$15.00	$3.44	$2.74
.49	3.80	.525	3.98	17.50	3.86	3.19
.56	4.21	.600	4.41	20.00	4.28	3.65
.63	4.63	.675	4.84	22.50	4.70	4.11
.70	5.04	.750	5.27	25.00	5.12	4.56
.77	5.45	.825	5.70	27.50	5.54	5.02
.84	5.86	.900	6.13	30.00	5.96	5.48

It will be noted in this table that the small difference in cost of gains under various equal prices per pound for corn, wheat and middlings was slightly in favor of the corn and tankage ration when these feeds were supplemented by tankage, and that less expensive gains were produced on middlings alone than on middlings and tankage. It should be remembered here that the pigs used were well grown pigs at the beginning of the experiment and unsatisfactory results that are sometimes met with when younger pigs are fed middlings alone or middlings and corn through a long period were not encountered.

COMPARISON OF CORN AND RYE

EXPERIMENT VI

In an experiment in which a one-fourth acre plot of rye was hogged down a somewhat indirect comparison of corn and rye was secured.

Six pigs averaging in weight 44 pounds were put on one-quarter acre of rye on July 14, 1911, to hog down the rye. At the same time these pigs were turned on the rye, similar pigs were started on a ration of corn, 9 parts and tankage, 1 part in dry lot. The pigs on rye were fed two-tenths of a pound of tankage daily per pig, an amount about equal to that consumed by the pigs in dry lot.

These six pigs were kept on the rye until September 1. After August 21 they received, in addition to the rye they secured from the plot, a light grain ration. During the 49 days that these pigs were on the rye, they made an average daily gain of .51 pound per pig, requiring, on the basis of an estimate by different parties that the rye would yield at the rate of 30 bushels per acre, 372.1 pounds of feed per hundredweight of gain. It should be remembered that these figures are based on an estimate and not an actual weight, and for this reason are of rather minor importance so far as a definite comparison is concerned. Furthermore, the rye plot had been seeded to clover in the spring and although no satisfactory stand was secured, yet the pigs ate what clover was present, which doubtless influenced both rate and economy of gains. During this same period, July 14 to September 1, the pigs in dry lot made an average daily gain of .46 pound per pig, requiring 448.3 pounds of feed per hundred pounds of gain.

On September 1, the pigs that were on the rye plot were placed in the barn under conditions the same as for those that had been kept in the barn from the beginning of the experiment, and fed a ration of ground rye, 9 parts; tankage, 1 part, with the results shown in Table XIII.

TABLE XIII. EXPERIMENT VI: Test lasting 112 days, September 1 to December 22, 1911.

Lot	No. pigs in lot	Rations	Initial weight lbs.	Final weight lbs.	Total gain lbs.	Average daily gain per pig lbs.	Total feed consumed lbs.	Average daily feed consumed per pig lbs.	Feed consumed per 100 lbs. gain lbs.
1	4	Corn, 9; trnkage, 1, in dry lot...	286.0	776.0	490	1.09	1,957.25	4.37	399.4
2	6	Rye, 9; tankage, 1, in dry lot.....	412.5	935.5	615	1.00	2,712.00	4.40	441.0

The rate of gain by these two lots was practically the same, with the corn fed pigs, however, requiring approximately 9 percent less feed per hundredweight of gain. It should be remembered that previous to September 1 these two lots of pigs were subjected

to widely different treatment, the one lot being kept in the barn and fed while the other was forced to gather feed in the plot field. However, the results secured here indicate that ground rye has a feeding value somewhat less than that of ground corn.

It is not a common or frequent occurrence that rye may be purchased on the market at a price that would make it an economical substitute for corn. The fact that rye has a lower feeding value, or, at best, not a higher feeding value, and yields less grain per acre than corn, stands in the way of an extensive utilization of rye in economical pork production. Rye used as a cover crop may frequently be further utilized as late fall and early spring pasture and, under circumstances that would make harvesting and thrashing it inconvenient, may be allowed to mature and be hogged down, with good results.

GREEN FEEDS

Green feeds have an important place in pork production both as a substitute and a supplement for corn. A complete substitution of green feeds for corn would not be expected to produce rapid gains on account of the bulky nature of the green feed, yet the use of green feeds in connection with grain often lessens the cost of gains and makes possible larger profits than are generally secured in dry lot feeding.

The following table from Bulletin 209, of this Station, shows the results of an experiment in which light and heavy grain rations were compared on blue grass and white clover pasture.

TABLE XIV. Light vs. heavy grain rations on pasture. Five hogs in each lot. Experiment lasting 55 days, July 5 to August 28, 1907.

Rations	Initial weight lbs.	Final weight lbs.	Gain lbs.	Average daily gain per pig lbs.	Grain consumed lbs.	Grain consumed per 100 lbs gain lbs.
Ground corn...	719.5	1,103.5	384.0	1.396	1,795.0	467.4
Ground corn (⅔ full feed)...	675.0	982.5	307.5	1.118	1,189.2	386.7

In this experiment pigs fed twice daily all the ground corn they would clean up without waste made slightly more rapid gains but required 80.7 pounds more feed per 100 pounds of gain than did pigs fed two-thirds as much ground corn. The pigs receiving the light grain ration made a more extensive use of green feed than did those receiving the heavy grain ration.

The following table shows the result of an experiment in which light and heavy grain rations on rape pasture were compared with a heavy grain ration in dry lot.

TABLE XV. Feeding swine on rape pasture. Test lasting 77 days, July 18 to October 3, 1912.

Lot	No. pigs in each lot	Rations	Initial weight lbs.	Final weight lbs.	Total gain lbs.	Average daily gain per pig lbs.	Concentrates consumed per 100 lbs. gain lbs.	Concentrates replaced per 100 lbs. gain by pasture lbs.
1	5	Corn, 9; tankage, 1; full feed in dry lot	367 5	613 5	346 0	.90	384.7	....
2	8[1]	Corn, full feed, on rape pasture	411.0	1,134.5	745 5	1.21	325.4	59.3
3	6	Corn, 75% full feed, on rape pasture	318 0	809.5	491.5	1 06	278.1	106.6
4	8[2]	Corn, 9; tankage, 1; full feed, on rape pasture	407 0	1 193.0	887 0	1.47	316.6	68.1
5	8[3]	Corn, 9; tankage, 1; 75% full feed, on rape pasture	312 5	870 0	554.0	1 20	294 0	90.7

[1]Pig weighing 80 pounds replaced by one weighing 58 pounds, July 26.
[2]Pig taken out September 20, weight 101 pounds.
[3]Pig weighing 73.5 pounds, replaced by one weighing 77 pounds, August 22.

The pigs used in this experiment were young, growing pigs about 16 weeks old and averaging in weight about 50 pounds each at the beginning of the experiment.

It will be noted that pigs fed a full feed on pasture made gains more rapidly and on 15 to 17 percent less grain per 100 pounds of gain than did those which received a full feed in dry lot, and that pigs securing three-fourths of a full feed on pasture made gains more rapidly and required 23 to 27 percent less grain per 100 pounds of gain than did those which received a full feed in dry lot, and made gains slightly less rapidly and required from 22 to 47 pounds less grain per 100 pounds of gain than did those which received a full feed on pasture.

In this experiment a ration of corn alone on pasture proved more efficient than a ration of corn and tankage in dry lot but slightly less efficient than a ration of corn and tankage on pasture.

The results of these experiments, as well as those of experiments reported in Bulletin 242 of this Station, indicate that, by feeding a light grain ration on pasture, gains may be produced at a much smaller expenditure for grain, though less rapidly, than by feeding a heavy grain ration on pasture, and also that the use of green feeds in connection with corn greatly diminishes the need for nitrogenous concentrates that exists in dry lot feeding.

To what extent corn should be replaced by green feed will depend somewhat on local conditions. If corn is scarce or very high in price, a light grain ration, although resulting in less rapid gains, might prove more profitable than a heavy grain ration. On the other hand, if pasture is scarce, the use of a rather heavy grain ration would likely prove more profitable in making the pasture last longer and thereby take the place of a larger amount of nitrogenous concentrates, which are relatively more expensive than corn.

SUMMARY

Various feeds may be used as substitutes for corn. Which ones to use, and when to use them, will depend very largely upon the supply of feeds and market prices for them.

Oats have proved less valuable, per unit of weight, than shelled corn. The results of the one experiment conducted to secure data relative to mixtures of corn and tankage; corn, oats and tankage; and of oats and tankage, indicate that a combination of corn, oats and tankage is more efficient than is a ration made up of oats and tankage, but not so efficient as a ration made up of corn and tankage. The larger the proportion of corn in the corn, oats and tankage combination, the greater is the efficiency.

Hominy feed and tankage yielded somewhat better results than did corn and tankage. The results of investigations to date indicate that hominy feed has a feeding value for swine about 10 to 15 percent greater than that of an equal weight of ground corn.

Wheat and tankage did not prove more efficient than did corn and tankage. Marketable wheat should not be used as a feed for swine, unless its market value is as low per pound as that of corn.

For pigs weighing about 110 pounds, rations of corn and tankage, wheat and tankage, and middlings and tankage, proved almost equal in efficiency; all three producing slightly more rapid but less economical gains than one of middlings alone, when all four rations were charged at the same price per pound. (Table XI).

The relative yield and feeding value of rye, as compared with that of corn, generally limit the economical substitution of rye for corn to the hogging down of rye under circumstances that render it inconvenient to harvest and thresh the rye.