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DEPARTMENT OF ANIMAL HUSBANDRY

**SUPPLEMENTS TO CORN FOR  
FATTENING HOGS.**

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## SUPPLEMENTS TO CORN FOR FATTENING HOGS.

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Fifteen lots of six-months-old pigs, usually five in each lot, were fed, most of them for ninety days, in a comparison of wheat middlings, linseed oilmeal, cottonseed meal, gluten meal, gluten feed and germ oilmeal used as supplements to corn meal in dry lot feeding during the months of December, January, February and March, 1904-5. Two more lots were fed a year later, during November, December and January, 1905-6, in a comparison of ear corn and corn meal, both being fed with linseed oilcake. The following is a summary of the results:

1. The rations of linseed oilmeal and corn meal in proportion of 1 to 5 were eaten in larger quantity than any other feeds tested, and made more pork, with smaller expenditure of feed than any other ration involved. Estimating the cost of linseed oilmeal at \$30 per ton, corn at 30 cents per bushel, grinding at 10 cents per hundredweight, and wheat middlings at \$18 per ton the cost of pork made from the oilmeal rations averaged 11.3 per cent less than from the rations of corn meal and wheat middlings. The average cost per 100 pounds with the oilmeal rations was \$3.23, and with the middlings rations, \$3.60 or a difference of 37 cents per 100 pounds of pork in favor of the oilmeal rations. In order to make pork from corn meal and wheat middlings as cheaply as from the above mentioned ration of corn meal and linseed oilmeal the middlings would have to be bought at prices ranging from \$14.70 to \$15 per ton in the various lots. Middlings are usually more expensive, and linseed oilmeal is usually less so than as here figured.

With corn at 25 cents per bushel it would be an even

thing so far as cost of gain is concerned whether one would feed it alone or with oilmeal at \$30 per ton as in lot 15; with corn at 29 cents per bushel there would be no saving or loss from the feeding of middlings with corn as in lot 14, allowing in each case ten pounds of pork per bushel of corn fed alone.

2. The rations of corn meal and wheat middlings, half and half, required from 13 to 14 per cent more grain to produce a given weight of pork than the ration of corn meal and oilmeal in proportion of 5 to 1, and made from 19 to 27 per cent less pork in a given time.

3. The rations of corn meal and wheat middlings in proportion of 2 to 1 required 16 to 23 per cent more grain in the production of pork than corn and oilmeal, in the proportion of 5 to 1, and made from 22 to 32 per cent less pork in a given time.

4. Corn meal and fermented cottonseed meal fed in the proportion of 8 to 1 killed three out of fifteen hogs at the end of 51 days feeding. The gains up to that time had been moderate in extent and cost. The hogs did not relish this feed. A change to the corn and linseed oilmeal ration induced much greater consumption of grain, increased the gains in weight 39 per cent and reduced the grain requirement per pound of increase to the extent of 13.1 per cent.

5. An attempt was made to cheapen the corn meal and linseed oilmeal ration by a substitution of gluten meal, gluten feed and germ oilmeal in three rations respectively for half of the linseed oilmeal in the standard 5 to 1 ration. In each case the amount of food eaten and the rate of increase were lowered by the substitution, and the amount of grain requisite to the production of a pound of pork was increased. The ration containing gluten feed was eaten in greater quantity and was used with better effect than the rations containing gluten meal or germ oilmeal. The ration containing gluten meal was eaten in the smallest quantity and returned the least pork for the feed consumed.



6. Corn meal five parts and oilcake (pea size) one part, fed dry and mixed, produced gains in weight with nine per cent less grain than did ear corn and oilcake fed separately, both dry. The gain in the corn meal lot was 28.6 per cent greater than in the ear corn lot. The hogs receiving ear corn would not eat more than one-sixth as much oilcake as corn (the cob figured out) when both were allowed ad libitum.

7. The pork produced in these experiments cost more than that made in the previous trials reported in Bulletin 65 because of the severe winter weather prevailing and because the hogs used had been raised on grain feed with very little use of pasture.

The table summarizing these results and the discussion of their practical bearing are on pages 13-19.

#### DETAILS OF THE EXPERIMENT.

This series of feeding experiments is in large measure a continuation of the work reported in Bulletin 65 of this Station and hence is supplementary to it.

These tests were for the purpose of comparing wheat middlings, linseed oilmeal, cottonseed meal, gluten meal, gluten feed and germ oilmeal, in various proportions and combinations, as supplements to corn meal for dry-lot fattening of hogs, and to compare ear corn with corn meal, both being fed with linseed oilcake. The hogs fed in these tests were grown together on the Experiment Station farm and received the same treatment from birth. Each lot was subjected to the usual preliminary feeding of from four to six weeks in the quarters used for the experiments.

The general method of operation was identical with that described in Bulletin 65; that is, the pigs were fed twice daily, as much as they would clean up of ground grain mixed with just enough water so that the slop would pour handily. Lots 16 and 17, however, received their grain dry.

The cottonseed meal was fermented at living room temperature for twenty-four hours previous to feeding, sour milk having been used as a starter. It was hoped that the fermentation might render the meal less toxic than this feed is reputed to be. The meal used was obtained fresh from the factory. The ration containing it was mixed with more water than was used with the others. It was made into a rather thin swill instead of a thick one as with the other rations in order to conform to the directions of some of those who recommend this feed for hogs.

The pigs used, sixty-nine in number, were mostly grade Poland-Chinas of good quality and were raised on the Experiment Station farm. The hogs in lots 16 and 17 were pure-bred Duroc Jerseys and Berkshires.

At the beginning of the experiments the hogs were neither fat nor thin, just, in good growing condition. All were pigs of the preceding summer, and were about six months of age. During the experiment and including the preliminary feeding period they were confined in small pens having granitoid floors, a shed protecting them from the snow but not from wind or cold.

The weather during most of the time of these tests, that is the winter of 1904-5, was unusually severe for this region. The pigs suffered much discomfort for lack of better shelter, and these results compared with those obtained by the same methods in spring and fall show very conclusively that cold slop feeding is not the best method for severe winter weather. A comparison of feeding results obtained by this method during different seasons of the year is to be found on page 19.

## CHEMICAL COMPOSITION OF FEEDS. \*

TABLE I.

Foodstuffs.	Water %	Protein, (N. X 6. 25.) %	Carbo- hydrates, (N-free extract). %	Crude fiber %	Ether extract %	Ash. %
Corn meal	12.85	8.44	73.31	1.25	2.85	1.30
Wheat middlings	9.28	15.00	63.07	4.40	4.30	3.95
Linseed oilmeal	8.94	34.50	39.77	7.65	3.90	5.24
Gluten meal	8.10	32.62	53.28	2.25	2.30	1.45
Germ oilmeal	9.95	23.62	46.83	8.30	8.85	2.45
Gluten feed	8.78	24.19	55.63	7.85	1.80	1.75
Cottonseed meal	7.70	37.13	25.85	8.12	14.75	6.45

\*Analyses by Dr. Paul Schweitzer.

An inspection of Table I, page 7, in which the chemical composition of foods used is exhibited, indicates that the corn meal was very low in protein and in oil.

The wheat middlings was a first-class lot in every way.

The linseed oilmeal was bought for old-process meal, but the analysis indicates that the new process was used in its manufacture.

The gluten feed, gluten meal, and germ oilmeal were obtained from the Glucose Sugar Refining Company of Chicago, and fairly represent the products sold under these names.

It will be noted that the wheat middlings contained twice as much protein and three times as much ash as the corn meal, and that the linseed oilmeal was still very much richer than the middlings in these two kinds of nutriment.

The protein and ash content constitute a measure of the value of the foodstuffs for the production of muscle and bone. The sugar refinery products were all very low in ash content. They do not differ greatly as to per cent of starch contained. The gluten meal is richest in protein but poorest in ash. The germ oilmeal and gluten feed are about equally rich in protein, but the former is much the richest in ash and oil. Among foodstuffs generally the germ oilmeal ranks very high in oil content.

The gluten feed analyzes higher in ash and in fiber than gluten meal because of the fact that the latter contains much more of the corn bran.

The cottonseed meal is richer in ash and in protein than any of the other feeds but is very poor in starch.

#### COEFFICIENTS OF DIGESTIBILITY OF FEEDS.

TABLE II.

Foodstuffs.	Number of trials.	Dry matter.	Protein (N. X. 6.25). %	Crude fiber. %	Nitrogen- free extract. %	Ether extract. %	Authority.
Corn meal	4	92.0	86.0	40.0	95.0	76.0	Wolf.
Wheat middlings	2	76.5	76.2	48.2	86.2	94.5	Minn. Station.*
Linseed oilmeal	2	77.5	86.0	12.0	85.0	80.0	Minn. Station.
Gluten meal	4	92.0	86.0	40.0	95.0	76.0	Assumed same as corn
Germ oilmeal	4	92.0	86.0	40.0	95.0	76.0	Assumed same as corn
Gluten feed	4	92.0	86.0	40.0	95.0	76.0	Assumed same as corn
Cottonseed meal	6	76.0	88.0	32.0	64.0	93.0	Mass. Exp. Sta.**

\*Computed by the author from data in Bull. 26, page 25, Minn. Sta.

\*\*With ruminants.

The coefficients of digestibility of the feeds used are assumed to be as in Table II, page 8. In the absence of more satisfactory data these must serve as the basis of our computations.

POUNDS OF DIGESTIBLE NUTRIENTS IN ONE HUNDRED POUNDS OF EACH OF THE RATIONS FED.

TABLE III.

Lot No.	Rations.	Protein	Carbo- hydrates	Ether extract	Total
1	Cornmeal, wheat middlings; half and half.	9.34	63.31	3.11	75.76
2	Corn meal, two parts; wheat middlings, one part.	8.65	65.59	2.79	77.03
3	Corn meal, five parts; linseed oilmeal, one part.	10.99	64.24	2.32	77.55
4	Corn meal, ten parts; linseed oilmeal, one part; germ oilmeal, one part.	10.22	65.32	2.62	78.16
5	Corn meal, ten parts; linseed oilmeal, one part; gluten meal, one part.	11.02	65.64	2.20	78.86
6	Corn meal, ten parts; linseed oilmeal, one part; gluten feed, one part.	10.25	66.00	2.17	78.42
7	Corn meal, eight parts; cottonseed meal, one part.	10.07	64.27	3.44	77.78
8	Corn meal, eight parts; cottonseed meal, one part.	10.07	64.27	3.44	77.78
9	Corn meal, eight parts; cottonseed meal, one part.	10.07	64.27	3.44	77.78
10	Corn meal, five parts; linseed oilmeal, one part.	10.99	64.24	2.32	77.55
11	Corn meal, five parts; linseed oilmeal, one part.	10.99	64.24	2.32	77.55

Table III—*Continued.*

12	Corn meal, five parts; linseed oilmeal, one part.	10.99	64.24	2.32	77.55
13	Corn meal, wheat middlings, half and half.	9.34	63.31	3.11	75.76
14	Corn meal, two parts; wheat middlings, one part.	8.65	65.59	2.79	77.03
15	Corn meal, five parts; linseed oilmeal, one part.	10.99	64.24	2.32	77.55

In Table III, page 9, we have an exposition of the digestibility of the rations as compounded. In a general way it may be said that a little more than three-fourths of any of these grain rations is digestible nutriment. Such slight differences in digestibility as there are between these rations are not of great importance. The two rations of lowest digestibility were fed to lots 1, 2, 13 and 14 and were composed of corn meal and wheat middlings. Of these the ration of corn meal and wheat middlings, half an half, was the less digestible of the two, but as may be seen by inspection of Table IV page 13, was the more efficient. It is true that the digestibility of a ration is a matter of prime importance, especially in hog feeding, but among such rations as these, composed as they are of grain alone, the digestibility is so high in every case that the slight differences between them are overcome by other more important considerations. Still these slight differences in digestibility are not without influence in the determination of the net outcome.

## DIGESTIBLE NUTRIENTS AND GAIN IN WEIGHT.

Table IV, page 13, exhibits the fact that in general the economy of gain in weight is closely dependent upon (1) the amount of food consumed as influenced by palatability, mechanical condition, etc. (2) the nutritive ratio of nutrients, and (3) the more intimate chemical nature of the foodstuffs involved.

In general the hog that consumes the most food makes the largest gains in weight at the least expense in nutriment though some rations are so palatable that hogs will overeat of them and thus increase the grain requirement per pound of gain. Hogs eat more corn and linseed oil-meal if allowed to do so than they can use with maximum profit.

It is likewise true that the rations containing protein in larger proportion to non-proteid nutrients were more efficient than others composed of the same foodstuffs in such proportion that the proteid content was lowered. This is evidenced by a comparison of ration 1 with 2 and 13 with 14, all rations of corn meal and wheat middlings. The rations of corn and middlings, half and half, were more efficient than those containing twice as much corn as middlings.

The remarkably favorable showing made by lots 3 and 15 fed on corn five parts and linseed meal one part, indicates that the nutrients obtained by the hog from this ration are in an especially efficient combination.

Conversely it is evident that the more intimate chemical characteristics of cottonseed meal, even when not causing the death of hogs, are not favorable to most economical pork production. This was noticeable when lots 7, 8 and 9 receiving corn and cottonseed meal, after the death of one pig in each lot, were changed to corn and linseed oil-meal as in rations 10, 11 and 12. The digestible nutriment required per pound of increase was reduced 13 per cent by

the change. True, the second ration was slightly richer in protein and was eaten in greater quantity. Cottonseed meal fed as a supplement to corn produces gains in weight more economically while the pigs live than some other grain feeds which never cause sickness among hogs.

It is worthy of note that of the three corn products, gluten feed, gluten meal and germ oilmeal, the first mentioned seems to be more useful than the others when fed with corn and linseed oilmeal. None of them, however, in this combination are as useful as linseed oilmeal by itself.

Gluten meal is richer than gluten feed, differing from it only in lacking the corn bran with which it is ground to make the latter, but it does not seem to be as useful a supplement to corn and oilmeal. The ration containing it was not so well relished and was not so efficient. It is possible that the usual recommendation that gluten meal be soaked before feeding to hogs, would if followed have rendered it more valuable in comparison with gluten feed than it was in this experiment where it was fed immediately after wetting.



FEED AND GAINS IN WEIGHT.

TABLE IV.

Lot No.	Rations.	No. of pigs	Date of feeding.	Days on feed.	Average initial weight. Lbs.	Average final weight. Lbs.	Daily grain per head. Lbs.	Daily gain per head. Lbs.	Grain per cwt. gain. Lbs.	Digestible nutriment per pound of gain. Lbs.	Nutritive ratio of rations.
1	Corn meal, wheat middlings; half and half.	5	Dec. 12—Mar. 12	90	95.6	189.4	5.233	1.042	502.1	380.3	1:7.5
2	Corn meal, two parts; wheat middlings, one part.	5	Dec. 12—Mar. 12	90	91.0	178.4	5.032	.971	518.2	399.2	1:8.3
3	Corn meal, five parts; linseed oilmeal, one part.	5	Dec. 12—Mar. 12	90	93.1	232.3	6.366	1.430	445.3	345.2	1:6.3
4	Corn meal, ten parts; linseed oilmeal, 1 part; germ oilmeal, 1 part.	5	Dec. 12—Mar. 12	90	92.6	195.8	5.463	1.174	476.4	372.3	1:7
5	Corn meal, ten parts; linseed oilmeal, 1 part; gluten meal, 1 part.	5	Dec. 12—Mar. 12	90	93.8	197.6	5.578	1.153	483.7	381.4	1:6.4
6	Corn meal, ten parts; linseed oilmeal, 1 part; gluten feed, 1 part.	5	Dec. 12—Mar. 12	90	92.6	212.8	5.922	1.312	451.5	354.0	1:6.7
7	Corn meal, eight parts; cottonseed meal, one part.	5	Dec. 12—Feb. 1	51	88.0	129.1	4.394	.806	545.3	425.1	1:7.2
8	Corn meal, eight parts; cottonseed meal, one part.	5	Dec. 12—Feb. 1	51	87.4	140.4	5.033	1.039	484.3	377.6	1:7.2

Table IV—Continued.

Lot No.	Rations.	No of pigs	Date of feeding.	Days on feed.	Average initial weight. Lbs.	Average final weight. Lbs.	Daily grain per head. Lbs.	Daily gain per head. Lbs.	Gain per cwt. grain. Lbs.	Digestible nutriment per pound of gain. Lbs.	Nutritive ratio of rations.
9	Corn meal, eight parts; cottonseed meal, one part.	5	Dec. 12—Feb. 1	51	91.4	145.1	4.852	1.052	460.8	355.5	1:7.2
10	Corn meal, five parts; linseed oilmeal, one part.	4	Feb. 2—Mar. 12	38	131.4	183.0	5.684	1.359	418.4	324.3	1:6.3
11	Corn meal, five parts; linseed oilmeal, one part.	4	Feb. 2—Mar. 12	38	153.6	206.5	6.007	1.391	431.7	334.6	1:6.3
12	Corn meal, five parts; linseed oilmeal, one part.	4	Feb. 2—Mar. 12	38	157.0	205.2	5.647	1.269	444.9	344.9	1:6.3
13	Corn meal, wheat middlings, half and half.	5	Feb. 11—Mar. 28	45	156.0	220.4	6.282	1.436	437.6	331.4	1:7.5
14	Corn meal, two parts; wheat middlings, one part.	5	Feb. 11—Mar. 28	45	154.6	217.	6.587	1.337	475.0	364.8	1:8.3
15	Corn meal, five parts; linseed oilmeal, one part.	4	Feb. 11—Mar. 28	29	160.5	212.	6.840	1.776	385.2	298.6	1:6.3
16	Corn meal, five parts; linseed oilcake, one part.	4	Nov. 16—Jan. 16	61	216.	295.	7.809	1.291	604.8		
17	*Ear corn, six parts; linseed oilcake, one part.	4	Nov. 16—Jan. 16	61	210.	271.	6.68	1.004	665.		

\*Cob figured out; corn shelled 16.4 % cob.

## PRACTICAL CONSIDERATION OF RESULTS.

These young hogs, averaging about 90 pounds in weight when the experiment began were fed in most cases for 90 days. As compared with former feeding trials at this station the gains in weight were expensive in the case of lots 1-12 (see Table IV, pages 13-14), because of severe weather and lack of comfortable quarters, but lots 13-15 which were fed after spring had come made pork much more economically. Gains made by lots 16 and 17 were also expensive because the hogs has been raised on grain feed and weighed over two hundred pounds when the experiment began.

Lots 1, 2 and 3 compare two rations of corn and wheat middlings with a third of corn and linseed oilmeal. To reinforce the data secured from these lots the test was repeated with the same rations in lots 13, 14 and 15. In both cases the ration of corn and wheat middlings, half and half, produced larger and cheaper gains than the same feeds given in proportion of two of corn to one of middlings. In both cases the corn and linseed oilmeal lot greatly excelled either of the wheat middling rations both as to the amount and economy of gain. Lot 1, receiving corn and middlings, half and half, ate more food than lot 2, receiving corn and middlings, two to one, but this was regarded at the time as being due to the individuality of the pigs in lot 2. They did not prove to be especially good feeders. In the repetition of the test in lots 13 and 14 we found that the ration of corn, two parts and wheat middlings one part was the more palatable. This we believe usually to be the case.

The oilmeal ration was so much more palatable than the middling rations that much more of it was eaten daily. The pigs receiving this feed, always ate heartily and consistently even during the coldest weather and evinced a fondness for their food that was not noticeable in any other case.

In lots 4, 5 and 6 where half of the linseed oilmeal of ration 3 was replaced by the corn products, gluten meal, gluten feed and germ oilmeal, the rate and economy of gain were in each case reduced by the substitution. The pigs ate most of the ration containing the gluten feed, and this lot excelled both the others as regards amount and economy of gain. The lot receiving germ oilmeal ranked second in regard to amount of food eaten while the gluten meal lot ate the least food.

Lots 7, 8 and 9 were fed on a mixture of eight parts of corn and one part of fermented cottonseed meal. They ate a moderate amount of food and made fair gains at an expenditure of food not greatly above the average.

These lots at first refused the feed and after rooting it from the trough left it untouched. In three days time they had come to their feed in fair shape, but after nine days they began again to lose appetite for it. They became dainty about eating; would do fairly well for a few days, but then would eat much less until hunger overcame their objections. They never ate heartily of this feed for many days in succession. After 51 days' feeding one pig died very suddenly in each of these three lots with the usual symptoms of cottonseed meal poisoning.

Considering that this settled the question of the profitability of this method of preparing and feeding cottonseed meal the rations in these lots were changed to corn, five parts and linseed oilmeal, one part. The pigs took to the new ration in good shape, ate much more feed than they had previously eaten and made much larger gains at a decided decrease in nutriment required.

It will be noted that lots 7, 8 and 9, receiving corn and cottonseed meal, differed considerably in the economy with which they produced increase in weight, and also that after they had been changed to corn meal and linseed oilmeal and had become lots 10, 11 and 12 respectively, the greatest improvement in the efficiency with which they used the food

provided was in the lot which had done the least well on the cottonseed ration. It is also true, that the cottonseed lot which handled its ration in the best shape showed the least improvement by the change to corn and linseed oilmeal.

With corn at 30 cents per bushel, grinding at 10 cents per hundred-weight and linseed oilmeal at \$30.00 per ton, it cost with lot 3 receiving corn and oilmeal \$3.47 per hundredweight to make pork, this high cost being due to the exposure to which the hogs were subjected, and to the severe weather. In lot 15 the cost of 100 pounds of pork with the same feeds at the same price was \$3.00. In order to make pork from corn and wheat middlings at the same expense as from corn and linseed oilmeal at the above prices, the middlings would have to be bought at \$14.90, \$14.80, \$14.70 and \$15.00 per ton respectively on the basis of the results obtained from the feeding of lots 1, 2, 13 and 14. It is very rarely possible to buy middlings so cheaply as above indicated and not often that we must pay as much as \$30.00 per ton for linseed oilmeal.

We must also consider the fact of the greater rapidity of the gains produced by the linseed oilmeal ration. With both rapidity and economy of production in its favor it would seem that this were the better feed with which to supplement corn for fattening hogs, at least under the conditions obtaining during this experiment.

As for the corn products, gluten meal, gluten feed and germ oilmeal our experience with them does not commend them especially to us as supplements to corn for hogs, and cottonseed meal as here fed is certainly not in the same class as to usefulness with other foodstuffs which are known not to be dangerous.

It is also worthy of note that the low protein content of wheat middlings, requiring as it does that it be fed in large proportion with corn in case it is used to supplement

the latter feed, is a point of great importance in this connection. The feeding of corn and wheat middlings, half and half, as is necessary for most economical results with this supplement, occasions a cash outlay and an amount of hauling of feed from town that is quite out of the question in a great many local situations.

The results of the feeding of lots 16 and 17 furnish a basis for comparing ear corn with corn meal, both being fed dry with linseed oilcake, in pea size. The same kind of corn was used in each case. The corn meal lot ate much more feed, gained one-third of a pound per day more than did the ear corn lot and with an expenditure of 9 per cent less grain. An attempt was made to feed the oilcake and corn in the proportion of one to five in each case but the ear corn lot would not eat so much oilmeal. They ate six times as much corn as oilmeal. It seems to be advisable to mix the feeds in this ration rather than give them separately. It was noticeable in this test that the pigs much preferred the larger fragments of oilcake to the finely ground portion. The very expensive gains made by these two lots of hogs is due to the fact that they weighed over two-hundred pounds when they went on feed and had received grain from birth. Profit would have required that these hogs be sent to market at the time they were going onto their experimental ration. There was no appreciable waste of grain at the trough in either case.

## INFLUENCE OF SEASON UPON COST OF GAIN.

TABLE V.

Rations.	Grain per cwt. gain. Lbs.				Ave. daily gain. Lbs.			
	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Corn meal, five parts; linseed oilmeal, one part.	376.6	476.3	383.7	445.3	1.483	1.478	1.624	1.430
Corn meal, two parts; wheat middlings, one part.	427.8	566.8		518.2	1.244	1.223		.971
Corn meal, twenty parts; linseed oilmeal, one part.	430.3	528.6			1.160	1.358		
Corn meal, four parts; wheat middlings, one part.	460.4	604.4			1.183	1.113		
Corn meal, ten parts; linseed oilmeal, one part; gluten feed, one part.			410.	451.5			1.574	1.312

These figures indicate that extreme heat of summer and extreme cold of winter act alike to the extent that they both occasion large energy expenditure on the part of the animal, in one case to keep warm, in the other to keep cool; and in either case occasion a great reduction in the profit from feeding in the dry lot when compared with results obtained in spring and fall. These results, however, do not apply to the feeding of hogs on pasture.