

FEEDING EXPERIMENTS WITH COTTONSEED-MEAL.

by

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Never before in the history of our country has either the demand for pork been so great or were there so many hogs raised as at the present time. Corn is and always will be "King of the feed yard". Swine cannot subsist upon dry fodder as do the ruminants, and as corn is the most abundant and convenient grain to feed, it has, in the past, been almost the only grain fed to hogs. With the advance of Agricultural Science, the study of feeds for live stock has radically changed the feeding methods in the great stock producing regions. The necessity of foods richer in protein than corn, to form with corn a balanced ration, has increased the demand for the various mill by-products beyond the supply.

Not only is the balanced ration more economical but more healthful. In the past each great corn year has been followed by wide spread ravages of hog cholera. The losses of a single season amounting to millions of dollars and for several seasons paralyzing swine raising in the affected regions. It was a noticeable fact that a hog fed on mill-feeds or that had free access to abundant alfalfa or clover pasture, not only fed better but was more resistant to disease than the exclusively corn-fed hog. Though clover and alfalfa is the cheapest of feeds in their season, some other protein feed must be provided for the winter months. Shorts, bran and ground linseed oil-cake have been used with corn extensively and profitably to produce a better balanced ration. However, the increasing demand for these feeds has raised their price almost beyond the feeders reach.

Within the last few years the increased use of cotton-seed oil in the arts and trades has placed ^{on} the market at a very reasonable price, an unlimited supply of cotton-seed cake or meal. Cottonseed-meal is the richest in proteids of any feed upon the market or that can be raised upon the farm. More than that the constituents are in a very easily digestible form. These factors would place cottonseed-meal at the head of the list of stock feeds, were it not that past experience in feeding it to cattle and swine, seem to indicate that there is some principle in the meal, or else decomposition product formed during the process of digestion, that is detrimental to the animal. Recent extended experiments have proved that cattle may be fed without injury, small amounts of cottonseed-meal indefinitely, and that large amounts may be fed for ninety or one hundred days without serious results and with rapid and profitable gains in weight. The proof of this is that each year at the southern ^{mills} oil, large numbers of cattle are fattened on cottonseed-meal, besides the increasing amount of cottonseed-meal being fed in the corn growing states.

With swine, however, the story has been different. Early experiments in feeding cottonseed-meal to pigs, show a very large percentage of fatalities; so great, in fact, that the experimenters reported that the cottonseed-meal acted as a poison when fed to swine and hence could not profitably be used as a feed even though it did produce quick and cheap gains in weight in the surviving animals. The following is from a bulletin of the North Dakota Experiment Station published in 1901: "Cottonseed-meal cannot be profitably fed to hogs, but is generally positively injurious, and when persisted in, most frequently results in the death of the animals". This seems to express the opinion of most stockmen and many experiment station writers upon

the subject.

Just what causes death in the animals fed upon cottonseed-meal is a mooted question. There are but few premonitory signs of death, the animals dying very quickly after they are first noticed to be sick. The symptoms are paralysis of the limbs or may be an apparent stiffness, a weakened heart action and labored breathing. Dr. Dinwiddie, of the Arkansas Experiment Station has investigated the pathological symptoms of cottonseed poisoning more than any other man. He says, "In all our cases immediate cause of death was obviously asphyxia, due to pressure on the lungs by the dropsical effusions into the pleural cavities. In its final manifestations the disease was an acute dropsey of the pleural and pericardial sacs." Asphyxia seems to be the most prominent symptom. Dr. Dinwiddie found no inflammation of the stomach or intestines upon post mortem examination. Other Stations, including our own, have found intense inflammation of the small intestines of hogs dying as a result of cottonseed-meal poisoning. In 1881, the German chemist, Bohm, in analyzing cottonseed-meal found chlorine, an alkaloid base. In 1882, Weger and Rittenhausen found chlorine and betaine in cottonseed-meal. Since then Maxwell, of the Department of Agriculture, has verified this analysis. Other chemists, notably the analysis made by the Texas Experiment Station, have been unable to detect chlorine in cottonseed-meal. Betiane seems to be present always, but it is not considered poisonous. Chlorine has a physiological action similar to the active poison, neurine, but it is not so active. Brieger found it necessary to give 0.5 grammes of chlorine to a rabbit weighing one kilogram to produce fatal results. This was ten times the fatal dose of neurine. Neurine, chlorine

and muscarine, all of which belong to the same group of ptomains, have a paralyzing effect upon the extremities of the animals; then respiration is stopped while "the rate of heart beat gradually decreases till finally stoppage in diastole takes place." The symptoms of chlorine poisoning resembles somewhat the symptoms of hogs dying from hogs eating cottonseed-meal. Yet if susceptibility is proportionate to the size of the animals it would take forty to fifty grammes of chlorine to be a fatal dose for a two hundred pound pig. This would represent about one hundred pounds of cottonseed-meal. Dr. Wiley, of the Department of Agriculture thinks chlorine may be formed from betaine by oxidation and that it may be thus formed during the process of digestion. This theory would seem to be substantiated by the fact that the fatalities are greater among pigs following cattle, fed cottonseed-meal, than where the meal is fed directly to the pigs.

The high price of pork during the past five or six years has stimulated swine growing in the South. This has renewed the attempt to discover some means of feeding cottonseed-meal to swine with safety.

Several Southern Experiment Stations have had excellent success feeding cottonseed-meal to pigs. Prof. Burtis of the Oklahoma Experiment Station, has probably done the most to discover under what conditions and in what quantities cottonseed-meal may be fed to swine safely and with profit. In the winter of 1900-1901, the Oklahoma Experiment Station fed four lots of four weanling pigs each. The pigs averaged about forty-five pounds at the beginning of the experiment. They were put in small dry lots with good shelter, and had fresh water, salt, charcoal and ashes before them at all times.

During the first half of the experiment they had all the grain they could clean up between feeds. The second half were fed lightly and always greedy for their feed. All the feed was fed mixed with water making a thick slop. Lot I received corn meal alone; Lot II received one-third corn meal, two-thirds middlings; Lot III received one-fifth cottonseed-meal, four-fifths corn meal; Lot IV received one-fifth cottonseed-meal, four-fifths corn meal for four weeks then corn meal alone for two weeks, returning again to cottonseed-meal and corn meal for four weeks and so on. Three pigs died - two in Lot III and one in Lot IV, all the others kept healthy and made good gains. Lot I made a daily average gain per pig of .50 pounds; Lot II 1.04 pounds; Lot III 1.01 pounds and Lot IV .99 pounds. The greater gain of the lots receiving a nitrogenous ration, over those getting corn alone, is quite marked. The following table gives the gains, amount of grain eaten and cost of gain per pig for each lot, for the first eighty-four days of the experiment:

January 11 to April 5. eighty-four days. Average per pig.	Lot I. corn meal alone.	Lot II. 1/3 corn meal 2/3 middlings.	Lot III. 1/5 cotton seed-meal 4/5 corn meal.	Lot IV. 1/5 cotton seed-meal 4/5 corn- alternate.
Weight April 5.	pounds 88.50	pounds 133.75	pounds 131.50	pounds 126.50
Gain, pounds	42.25	88.00	85.00	82.16
Daily gain	.50	1.04	1.01	.99
Grain eaten	236.75	323.00	285.80	301.15
Grain eaten per day	2.81	3.84	3.72	3.53
Grain required for One pound gain.	5.60	3.67	3.27	3.66
Cost of grain for One pound gain.	2.99	2.85	1.95	2.18

In Lot I two of the pigs were in a very scrawney condition. Lot III shows up the best of any as to grain required to produce one pound of gain and the cost of one pound of gain. The experiment was continued to May 17 without any change in feeds except that Lot I received one-fifth cottonseed-meal and four-fifths corn meal for four weeks, then corn alone for two weeks. Alternating same as Lot IV. The following table gives the results:

April 5 to May 17 Forty-two days. Average per pig.	Lot I. 1/5 cotton seed-meal 4/5 corn alternating.	Lot II. 1/3 corn meal 2/3 middlings	Lot III. 1/5 cotton seed-meal 4/5 corn meal	Lot IV. 1/5 cottonseed meal, 4/5 corn meal alternating with corn.
Weight May 17	pounds 124.50	pounds 191.25	pounds 181.50	pounds 178.33
Gain, pounds	38.50	57.50	50.50	54.83
Daily gain	.92	1.37	1.19	1.36
Grain eaten	131.50	215.50	197.00	191.60
Grain eaten per day	3.13	5.13	4.69	4.56
Grain required for one pound gain.	3.42	3.74	3.94	3.49
Cost of grain for one pound gain.	1.95	2.91	2.47	2.08

Summary for 126 days, per pig.

Lot No.	Weight May 17.	Gain in 126 days	Daily gain.	Grain eaten.	Grain eaten per pound gain.	Cost of gain.	Cost of grain per pound grain only
	pounds	pounds	pounds	pounds	pounds	dollars	cents
Lot I	124.5	78.3	.62	386	4.70	2.04	2.61
Lot II	199.3	145.5	1.15	539	3.70	4.18	2.87
Lot III	181.5	135.0	1.07	483	3.57	3.03	2.24
Lot IV	177.7	133.7	1.06	493	3.68	2.93	2.14

If the dead pigs were not taken into account, the summary shows that the lots receiving cottonseed-meal made the best and cheapest gains. In commenting upon this experiment, Professor Burtis says, "It must be borne in mind that the pigs were under unfavorable circumstances. ***** If these pigs had had a wheat pasture to run on, been given a light grain ration for sixty to ninety days, then put on a full feed of grain, the grains would have probably cost one-third less." It is the opinion of Burtis, based upon preliminary work in this line at his Station, "that had Lots III and IV been running on green pasture and fed a light grain ration for the first half of the experiment, that no pigs would have died."

At the same Station, twenty-two thrifty shoats were put in a large paddock, March 22, 1901, and fed a ration of one-fifth cottonseed-meal and four-fifths Kafir-corn meal for fourteen days, then Kafir-corn meal alone for seven days, and so on. This experiment was to test the alternating method of feeding cotton seed-meal. After sixty-seven days the experiment closed without losing a pig and all making fair gains. Another experiment was carried on at the same time with sixteen scrawney, runtied pigs that were about one year old and weighed seventy-nine pounds per head. Commencing April 12, these pigs were hurdled on wheat pasture and fed a light grain ration of one-fifth cottonseed-meal and four-fifths Kafir-corn meal. During the first twenty-six days the pigs made a daily average gain of .96 pounds per head. May 8 they were shut up in a lot and fed the same grain. After twenty-one days they showed no bad effects from eating cottonseed-meal and had made a daily gain per pig of 1.71 pounds, requiring but 3.07 pounds of grain for one pound of gain. In other experiments hogs

were fed for ninety-four consecutive days on a ration containing one-fifth cottonseed-meal with only good results. In summing up his experiments, Professor Burtis advised using the alternate method of feeding, i.e., feed cottonseed-meal as part of the ration for two or three weeks, then omit it for a week or two and so on, also "endeavor to let the pigs have range and green pasture at the same time." Other Stations have carried on similar experiments with varied results. Dr. Dinwiddie, in his bulletin upon feeding cottonseed-meal to swine, at the Arkansas Experiment Station, says, "The harmful effect of over feeding with cottonseed-meal, are manifested in all species of animals so far tested. Hogs exhibit no great excess of susceptibility over cattle when fed in doses proportionate to their weight." This bulletin showed that the best results were obtained when some bulky feed, as chopped cowpeas hay was mixed with the grain. This applies only to winter feeding when no green feed is available. Without exception the writers on the subject advise using cottonseed-meal in small quantities not over one-fifth the ration or even less. Even though the balance of the ration is corn or Kafir, one-fifth cottonseed-meal will provide plenty of proteids for any class of swine.

Previous to the winter of 1903-1904 no experiments with cottonseed-meal had been carried out at this Station for several years, and to answer more satisfactorily numerous inquiries from farmers of the State wishing advise relative to feeding cottonseed-meal to swine, Professor O. Erf, and G. C. Wheeler planned an experiment to determine the relative value of different grains fed with cottonseed-meal, also to determine if possible whether certain mixtures were less fatal than others. Since green feed was not available at this time of year, it was determined to try the effect of keeping the system of the pigs in a condition resembling

that of pigs on green pasture by the use of mild laxatives, as raw linseed oil and linseed-oil meal; also to note the effects of cottonseed-meal upon the body temperature, whether or not it caused a feverish condition of the system as some writers claimed it would. The writer conducted the experiment, doing the feeding and keeping daily notes upon the experiment, from which the following data was taken: November 11, 1903, twelve pigs as nearly alike in size, condition and form as possible, were selected from a bunch of forty. They were about seven months old and in good condition, having been on alfalfa pasture all fall. Six of the pigs were pure blood Duroc-Jersey, six one-half Duroc-Jersey and Berkshire. They were divided into six lots, a Duroc-Jersey and a grade in each lot. The lots were small but had fair shelter, when the weather became severe they were removed to lots having tight houses in them. Salt and ashes were kept before them all of the time, and good water provided for them to drink. At first the amount of cottonseed-meal was but a small part of the ration (2%) the amount being gradually increased until November 20, when the ration was one-fifth cottonseed-meal. The average weight of the pigs when shut up was 157 pounds, and they were weighed each Monday throughout the experiment, which commenced Monday November 23, 1903, with all the pigs thrifty and greedy. Rations of lots:

- I. Corn chop, 75%; oil meal, 5%; cottonseed-meal 20%.
- II. " " 80%; 1/5 pint raw linseed oil daily; cottonseed-meal 20%
- III. Barley, ground, 80%; cottonseed-meal, 20%.
- IV. Corn chop, 80%; Cottonseed-meal, 20%.
- V. Kafir-meal, 80%; Cottonseed-meal, 20%.
- VI. Shorts, 80%; Cottonseed-meal, 20%.

The feed for each lot was thoroughly mixed and they were fed

twice a day all they would clean up in an hour. after feeding. The feed was made into a thick slop with water, cold days the water was warmed to prevent the feed freezing before it was eaten. Daily notes were taken as to the condition of the pigs, how much grain they ate and how much if any was left in the trough, also the condition of the feces was noted. The following table gives the total weight per pig each week, with total gain per lot:

Lot	Pig No.	date 11-23	date 11-30	date 12-7	date 12-14	date 12-21	date 12-28	date 1-4	date 1-11	date 1-18
I.	157	171	185	182	189	203	210	215	230	230
	129	189	200	208	211	230	240	245	256	257
II.	162	157	168	175	175	196	200	205	217	221
	128	181	195	202	208	223	247	243	260	275
III.	126	196	205	212	212	230	235	235	237	240
	127	151	161	170	176	185	193	195	204	206
IV.	155	174	193	193	205	215	221	232	240	250
	120	175	190	195	196	215	227	232	240	250
V.	159	188	203	210	215	230	241	248	260	275
	124	159	171	180	183	200	205	210	210	215
VI.	153	189	200	209	211	225	241	241	240	255
	109	175	183	194	194	210	221	226	245	257

Lot	Pig No.	date 1-25	date 2-2	gain per pig	gain per lot
I.	157	236	241	71#	149#
	129	262	267	78	
II.	162	241	240	83	187
	128	280	285	104	
III.	126	245	250	54	119
	127	211	216	65	
IV.	155	252	255	81	163
	120	254	257	82	
V.	159	278	280	96	159
	124	221	226	67	
VI.	153	260	262	73	163
	109	260	265	90	

The experiment closed February 2, when the pigs were sold as fat hogs. Lot III made the least gains and were not in as good condition when sold as the other lots. They were all in very fair condition however. The ground barley hulls made a bulky feed that was

not relished and it was easy to over feed this lot. The Kafir-corn in the first half of the experiment, with Lot V, was old seed and very musty and dirty, the pigs would not eat it in any quantity, but later new seed was obtained and the pigs ate better. The other lots were greedy at all times, except Lot IV which was off feed for three or four days only. Those in the lots receiving shorts and cottonseed-meal were a surprise. They ate more pounds of grain than any other lot and their ration was more bulky and as is evident was a pasty, sticky slop that was hard to eat. Each lot ate on an average about twelve pounds of grain per day. The following table gives the amount of grain consumed by each lot during the ten weeks of the experiment and the total cost of the feed and the cost per hundred pounds of gain:

Lot	Total grain pounds	C-seed meal pounds	Corn chop pounds	Kafir-meal pounds	Barley pounds	Shorts pounds	Oil meal #	Linseed oil quarts	Total cost \$	Cost per 100# gain \$
I.	910	181	686				45		6.85	4.76
II.	912	181	730					8	7.85	4.20
III.	887	177			610				8.50	7.14
IV.	912	182	730						6.25	3.80
V.	875	175		700					6.07	3.81
VI.	920	184				736			6.75	4.20

There was but little difference in the amount of grain consumed by each lot but the difference in price made the total cost vary considerably. The price of the feed per hundred pounds is as follows: corn chop, \$0.53; Kafir-chop, \$0.53; barley, \$1.00; shorts, \$0.85; oil meal, \$1.75; cottonseed-meal, \$1.35; raw linseed oil, \$0.20 per quart. Lots IV and V receiving corn and Kafir-corn with cottonseed-

meal made much the cheaper gains. Barley is too expensive a feed to fatten hogs with, at present prices of other grains.

The temperatures of the pigs were taken at four different periods in the experiment, to determine, as was stated, whether or not cottonseed-meal produced a feverish condition of the system. November 22 the temperature of five pigs that were being fattened on corn were taken as a comparison with the experiment lots. They were: 103.4° F, 103.2° F, 103.8° F, 105.1° F and 103.8° F, respectively. These temperatures are the same as those of the experiment pigs taken the same day. On January 4, 1904, the temperatures of several hogs in the same lot as the first, were taken, but the list was lost. They coincided with those of the experiment lots taken the same day. The table below gives the temperature of each of the experiment pigs on the assigned dates.

Lot	Pig No.	November 22	December 7	December 21	January 4
I.	157	103.8° F	104.5° F	103.4° F	103.6° F
	129	103.8	103.9	103.5	103.9
II.	162	103.7	103.7	104.2	103.3
	128	103.0	103.6	102.7	102.4
III.	126	104.3	103.7	102.8	103.0
	127	103.9	103.9	102.7	103.4
IV.	155	103.2	103.4	103.9	103.5
	120	103.3	103.0	103.4	103.2
V.	159	103.8	103.2	103.8	102.6
	124	103.0	103.3	103.2	103.2
VI.	153	104.0	103.2	103.1	102.9
	109	103.7	103.0	103.9	103.5

The normal temperature of a hog is 102° to 104° F. The table and the temperatures of the other hogs show that the temperature of the experiment pigs was normal.

Taken as a whole the experiment was a success. These pigs

were only seven months old when the experiment began and were in excellent condition, considerably fatter than the ordinary stock hogs, yet they made an average of eight pounds per head per week throughout the experiment which was carried on in mid winter. Not a pig was sick or off feed for more than a day or two. The gains would indicate that nothing could be gained by using high priced feed with cottonseed meal as lots II, IV and VI. Whether the oil had any effect in producing the gains of lot II, is a question. Evidently the oil meal was just that much high protein wasted on lot I. As the temperatures indicate their systems were normal, no temperature being far from the normal, 102° to 104° F. During the first half of the experiment, the feces of lot I and II were more moist and had a more oily appearance than that of the other lots but later there did not seem to be much difference, even though the oil fed to lot II was doubled. The feces of all lots were more fluid than that of hogs being fattened on corn and shorts. This was probably due in part, at least, to the sloppy nature of the feed of the experiment pigs. The cottonseed-meal used in this experiment was part of a lot bought of a local dealer in May 1903, and had been kept in the dry all summer. It was not musty nor were there any lumps in it. A sample of the meal was analyzed by Professor Shaw of the Experiment Station, and was found below the average in oil and a little high in protein. The following table is Professor Shaw's analysis:

	Protein	Fat.	Nitrogen-free extract.	Water.	Ash.	Fibre
	per cent	per cent	per cent	per cent	per cent	per cent
Cottonseed-meal used in expt.	48.21	9.23	26.59	5.79	6.13	4.05
Cottonseed-meal Wolf's standard	43.60	16.40	19.70	8.90	7.20	5.76

Professor Shaw has also made an analysis for chlorine and betaine. Each of these ptomaines were present in small amounts. The exact percentage of each has not been determined at present, as the analysis is not yet completed.

In this experiment there was a waste of protein feed. The nutritive ratios of the rations ranged from 1:3.2 to 1:5.4. The nutritive ratios for a fattening hog, given in Wolf's standard, is 1:6.4. Thus it would appear that a smaller amount of cottonseed-meal could have been used and the same gains resulted and there would have been a lessened danger of losing the pigs from over feeding of cottonseed-meal.

The highly nitrogenous ration is needed, not so much for fattening animals, as for growing and breeding stock. It would seem that if cottonseed-meal can be used safely as a feed for this class of stock, its value, at present prices, will be unlimited to swine growers. For early pigs the sows are bred to farrow about March 1. No sow can produce a large litter of strong pigs if she has been fed only on corn and water during the winter months. Protein is necessary to the formation of body tissue. If the mother is not provided with sufficient protein in her food, her unborn young must suffer from lack of nourishment. Then again after the pigs are farrowed they must have an abundance of milk if they are to make a satisfactory growth. To maintain a large milk flow, rich proteid feeds are necessary. Some feeders try to avoid buying protein feeds by having their sows farrow after clover pasture is available, yet I think most farmers will agree that it is the early pigs, provided they can be carried through to grass, in a thrifty condition, that bring the greatest profits to the feeder because they get full benefit of the summer pasturage and are fattened

for market before cold weather. Also by this method two litters of pigs are raised each year by the same sows. To successfully raise pigs the sows must have a nitrogenous ration from breeding time until the pigs are weaned, especially for the six weeks before farrowing time until the pigs are weaned. Cottonseed-meal is the cheapest protein feed on the market and to test its effect upon brood sows and their unborn pigs, Dr. Dinwiddie of the Arkansas Experiment Station, fed a sow of common stock, for eighty days previous to farrowing, upon a ration containing one part cottonseed-meal and three parts bran. The sow improved in condition upon the feed and later farrowed three large healthy pigs with no still births. There were no bad results from the cottonseed-meal unless the small size of the litter is attributable to that cause which is hardly probable. The writer started an experiment with two bred sows, February 5, 1904. Both sows had raised one or more litters before. One sow was a pure bred Duroc-Jersey, bred to a Tamworth male, the other a pure bred Poland-China bred to a Poland-China male. The first lot of feed mixed for these sows contained 10 per cent cottonseed-meal, the rest equal parts corn and bran. The amount of cottonseed-meal was increased until March 12, one-fifth of the ration was cottonseed-meal. The sows did well. On April 7, the Duroc-Jersey farrowed seven strong thrifty pigs and one still birth. These pigs were not weighed but averaged not less than three pounds. May 2 the Poland-China sow farrowed seven live pigs, no still births. These pigs were weighed within an hour after birth. They weighed as follows: 2-5/8 pounds, 3-7/8 pounds, 3-6/8, 3-4/8, 3 and 3-4/8. Averaging 3-3/8 pounds. This is considerably about the average of new born pigs given by Professor Henry, which is about

2.5 pounds. The Poland-China sow killed one of her pigs the second day by lying upon it. All the others are still living. April 23 the amount of cottonseed-meal was increased to one-fourth of the ration for the Duroc-Jersey sow, the other still getting one-fifth cottonseed-meal as before. At this time, May 25, the pigs are doing well, considering the fact that the sows get nothing but grain and water and are kept in small pens. The older litter are large enough to eat considerable quantities of feed from the trough when the sow is fed. No bad effects from eating the cottonseed-meal can be seen in either the sows or the pigs. In fact the pigs are doing as well as those whose dams are getting shorts and milk.

This experiment would seem to prove, in one case at least, that cottonseed-meal may be fed to breeding and growing swine with safety. The rations fed in both these experiments were narrower than the standards require, hence less cottonseed-meal could be used and still have a balanced ration. We believe that as the farmers begin to pay more attention to balancing the rations for their stock, small amounts of cottonseed-meal, one-eighth to one-fifth of the ration, will be a valuable feed to go with corn or Kafir-corn. Clover and alfalfa pasture with the milk produced on the farm may provide the protein part of the ration, through the summer months for the brood sow and their growing pigs, but before the grass comes in the spring something else must be provided. Shorts and bran are available but at higher prices each year. We believe it is only a matter of time until cottonseed-meal will be an important feed in the regions adjacent to the cotton oil mills of Oklahoma, Texas and Arkansas.