THE OPTIMUM PROTEIN LEVEL FOR PIGS OF VARIOUS WEIGHTS

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PREFACE

Protein feeds are necessary to maintain and build body tissue. Because of this requirement, swine producers are constantly confronted with the problem of providing adequate amounts and proper kinds of protein for the proper nutrition of the animal. Hogs grow more rapidly in relation to their weight than other farm animals, consequently, their feed requirements change rapidly. In a comparatively short time there is a change from the high protein requirement of growth to a lower protein requirement during the fattening period after growth has been attained.

From the standpoint of nutrition the period from weaning to one hundred pounds in live weight is a very critical one. Under farm conditions the weanling pig is frequently taken from an excellent source of protein, the sow's milk, and placed on a ration not only lower in quantity of protein but poorer in quality as well. As a result there follows a period of six to eight weeks when the pigs make slow and uneconomical gains. It is in this period that we are particularly concerned, although a study was made of the complete period from weaning until a market weight of 225 pounds was attained.

Protein rich feeds, particularly those containing protein of high quality are nearly always higher in price than energy feeds. This fact gives practical importance to the level of protein necessary to produce maximum gains and economy. The present emergency reemphasizes the need for more efficient pork production as well as optimum relationship between the percentage of protein concentrates and gains.

The literature on protein supplements and supplemental mixtures is voluminous. The most of it, however, deals with comparing various

supplements for pigs weighing from 100 to 230 pounds. The percentage of protein in the ration that will best meet the requirements of growing and fattening pigs, particularly those under the weight of 100 pounds, has not been as thoroughly investigated as its practical importance warrants.

It is possible that younger pigs do not receive enough protein for maximum growth, and that older pigs in some cases are receiving more than necessary. In many cases swine feeders do not realize that the protein requirement of a pig changes greatly with the increased weight of the pig. Thus, they are not feeding the optimum amount of protein at all times.

If from this study we can establish the optimum protein level of pigs at various weights and make such material available to swine producers, then we should have attained a great step toward the goal of maximum return from each dollar invested in a swine feeding enterprise.

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REVIEW OF LITERATURE

Carrol and Burroughs (1) studied the protein requirement of a ration to produce maximum efficiency as judged by rate and economy of gain. In their study they compared rations of 22 percent protein against rations containing 18 and 14 percent for pigs weighing 50 to 75 pounds. For pigs weighing 75 to 100 pounds they used 19, 15 and 11 percent protein. For pigs weighing 100 to 150 pounds they compared 16, 12 and 8 percent protein rations. From 150 to 200 they compared 14, 10 and 8 percent rations.

For pigs weighing 50 to 75 pounds, the lot getting a 22 percent protein ration made progressively faster gains than either of the lots getting the 18 or 14 percent protein ration. From the standpoint of economy the high protein level also held a good advantage.

In the second period or series of pigs weighing from 75 to 100 pounds, rations containing 19, 15 and 11 percent protein were compared. The gains made on the 19 and 15 percent protein ration were approximately the same. Gains made on rations of 11 percent crude protein were distinctly lower. The total feed required to produce 100 pounds of gain was in favor of the group receiving the medium protein level.

As the pigs put on the next 50 pounds gain (from 100 to 150 pounds) the percentage of protein in the ration appeared to be decreased too severely from percentages used in the previous interval. The gains as well as the economy of gains were progressively benefited when the protein content was advanced from 8 to 12 and then to 16 percent.

In the last period from the time the pigs weighed 150 pounds until they reached market weight at 200 pounds, the percentages of protein fed were 14, 10, 8 respectively. The gains and feed consumption during

this period favored the higher percentage of protein.

Complete results of experiment are given in Table 1.

Table 1. Comparison of twelve lots of growing fattening pigs fed at four weight levels to determine protein requirements.

	Rations of Pigs Weighing											
	50 to 75 Pounds			75 to 100 Pounds			100 to 150 Pounds			150 to 200 Pounds		
	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6	Lot 7	Lot 8	Lot 9	Lot 10	Lot 11	Lot 12
Approximate Percentage of Protein Fed	22	18	14	19	15	11	16	12	8	14	10	8
Number of Pigs Started	21	20	21	20	18	20	18	19	17	15	15	16
Number of Pigs Finished	19	20	19	20	18	18	17	18	12	15	13	14
	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.
Average Initial Weight	50	49	50	76	75	75	101	103	100	152	151	150
Average Final Weight	75	75	75	102	102	99	149	149	139	201	195	196
Average Daily Gain	.83	.77	.67	1.05	1.06	.79	1.23	1.05	.86	1.62	1.20	1.01
Average Daily Feed	3.40	3.16	3.14	4.50	4.26	4.10	5.12	5.29	5.17	6.56	5.94	5.84
Feed for 100# Gain	415	426	499	443	422	560	435	531	580	421	536	606

Carroll and Burroughs (2) have completed some work on nitrogen metabolism. In this study an 18 percent protein ration was compared to one containing 22 percent crude protein. Another series compared rations of 20 and 24 percent crude protein, still another studying rations of 22 and 26 percent protein. Each pair of rations was designated to furnish the same quantity of energy, ash, and organic mutrients per pound.

In all the eight groups of pigs studied, the daily nitrogen balance increased an average of 26.3 percent when the protein content was raised from 18 to 22 percent. When the protein content was raised from 20 to 24 percent the rate of nitrogen retention increased 20.7 percent; and finally when the protein level was raised from 22 to 26 percent the nitrogen retention increased only 12.9 percent. However, in this latter comparison with the two heavier groups weighing around 100 pounds, the increase in nitrogen retention amounted to only 2.8 percent and 2.5 percent. Thus conclusions were for pigs of this weight that a ration of 22 percent crude protein or 18 percent digestible protein is nearly, if not quite, adequate. For the younger pigs of lighter weight, clearly more than 22 percent protein is needed for maximum growth. However, it appears probable that the protein content of a ration needed for maximum growth is greater for pigs closely confined as were those in this experiment than for pigs given the free run of a good-sized feed lot because in the latter case more feed energy for muscular activity, but no more feed protein, is required.

Crampton (3) in studying protein requirement of weanling pigs found that with pigs from weaning to 100 pounds in weight within a given level of daily feed consumption increasing the percentage of protein in the ration may be expected to result in increased gains. But also increased

gains will result from increased food intake at a given level of protein intake. Thus protein requirement determined by any method is inseparably linked with average daily food consumption and due allowances for various levels of total food intake must be made in any workable feeding standard.

For example, Morrison gives the requirement of a 75 pound pig as 3.4 dry matter and 0.31 pounds of digestible protein. These are approximately equivalent to 3.75 pounds of feed and 0.40 pounds of total crude protein. Intakes of this level should result in a daily gain of about 1 pound. If less feed is eaten, however, but with the same daily protein intake, less rapid gains must be expected unless the percentage protein of the diet is raised enough to result actually in a greater consumption of protein per day. This is illustrated in Table 2 where it is seen, for example, that to obtain the same daily gain on a diet eaten at 3.50 pounds per day as would be obtained were 4.00 pounds of feed eaten requires that the protein percentage of the ration be raised some 8 units.

Table 2. Average daily gains (in pounds) of pigs from weaning to a final weight of 100 pounds, according to daily feed intake and the pounds of protein it contained.

Pounds Daily Protein Eaten	Average Daily Feed Eaten		
	3.00 Lbs.	3.50 Lbs.	4.00 Lbs.
.30	.77	.89	1.01
.50	.91	1.03	1.15
.70	1.06	1.18	1.30
.90	1.20	1.32	1.44

Table 3. Average daily gain (in pounds) of pigs from weaning to a final weight of 100 pounds of feed intake and the percent of protein.

Percent Protein in Ration	Average Daily Feed Eaten		
	3.00 Lbs.	3.50 Lbs.	4.00 Lbs.
15	.87	1.06	1.25
17	.92	1.11	1.30
19	.96	1.15	1.34
21	1.01	1.19	1.38
23	1.05	1.24	1.43

Keith and Miller (5) checked the protein level for pigs of various weights by feeding them rations of corn supplemented with low protein tankage, soybean oil meal and alfalfa meal. They compared a 10 percent protein ration against one containing 15 percent crude protein for pigs of 130 pounds initial weight.

Pigs fed the 15 percent ration made on the average 32 percent greater gain in weight and required 37 percent less feed for each 100 pound gain than the pigs fed the 10 percent protein ration. The individual average daily gains of the pigs fed the 15 percent protein ration ranged from .20 to .58 pound or from 14 to 114 percent more than their paired mates fed the 10 percent ration. They also required from 12 to 53 percent less feed per 100 pound gain. Pigs consuming 15 percent protein ration required 326 pounds of feed for each 100 pound gain, while the pigs on the 10 percent protein ration required 447 pounds of feed for each 100 pound gain.

A second trial was conducted studying protein levels of 15, 20 and 25 percent protein levels. The average initial weight of the pigs given the 15 percent ration was 82 pounds. Their average daily gain was 1.55

pounds to a final weight of 202 pounds. Feed required per 100 pound gain was 276 pounds.

The average initial weight of pigs receiving the 20 percent ration was 85 pounds and were carried to a final weight of 205 pounds. The average daily gain of this group was identical to the group receiving 15 percent protein, being 1.55 pounds and requiring 276 pounds of feed per 100 pounds of gain.

The group receiving 25 percent protein ration had an initial weight of 86 pounds and a final weight of 193 pounds. Their average daily gain was 1.38 pounds and required 314 pounds of feed per 100 pounds of gain. Of this same group of pigs, the most economical ration for weight of between 82 and 128 pounds, approximately, were studied. Here the pigs fed the 20 percent ration made more rapid gains on less feed and in less time than pigs fed either the 15 or 25 percent protein ration. Summary of results are shown in Table 4.

Table 4

No. of Pigs	Percent of Protein in Ration	Days in Period	Initial Weight	Final Weight	Average Daily Gain	Feed Required for Each 100 Pounds Gain
13	15	35	82	128	1.34	269
13	20	31	85	128	1.38	252
13	25	33	86	127	1.28	284

The optimum percentage of protein required in a ration for pigs from 125 to 200 pounds was studied. Results are shown in the following table.

Table 5

Number of Pigs	Percent of Protein	Days in Period	Initial Weight	Final Weight	Average Daily Gain	Feed Required per 100 Pound Gain
7	15	39	128	196	1.76	268
7	20	46	128	207	1.73	265
7	25	45	127	193	1.49	316

A comparison was also made of gains in live weight of three groups of pigs fed 12, 17 and 22 percent protein rations respectively. Weights, gains and economy of gains of pigs between the average initial weight of 38 and the final weight of 75 pounds being fed 12, 17 and 22 percent protein ration are shown in Table 6.

Table 6

Number of Pigs	Percent of Protein	Days in Period	Initial Weight	Final Weight	Average Daily Gain	Feed Required per 100 Pound Gain
9	12	76	40	74	.45	375
12	17	72	38	75	.50	301
12	22	70	41	74	.51	289

Pigs fed the 22 percent ration made .06 pound greater average daily gain, 13 percent more in 6 days or similar gains in 8 percent less time than pigs fed the 12 percent protein ration. They required 23 percent less feed than pigs fed the 12 percent protein ration.

The pigs fed the 17 percent protein ration made .05 pound greater average daily gain, 11 percent more in 4 days or similar gains in 5 percent less time than the pigs fed the 12 percent protein ration. They required 19 percent less feed for each 100 pounds of gain than the pigs fed the 12 percent ration.

Pigs fed the 22 percent ration made .01 pound greater average daily gain and required 4 percent less feed than the pigs fed the 17 percent protein ration.

Results obtained from pigs weighing 73 pounds and being carried to a weight of 131 pounds with rations of a 12, 17 and 22 percent protein level were studied and are given in Table 7.

Table 7. Weights, gains, and economy of gains of the pigs between the average initial weight of 73 pounds and the average final weight of 131 pounds being fed the 12, 17 and 22 percent protein rations.

Number of Pigs	Protein Content of Ration	Days in Period	Initial Weight	Final Weight	Average Daily Gain	Feed for Each 100 Pound Gain
9	12	54	73	128	1.02	310
12	17	45	75	131	1.27	245
11	22	48	75	128	1.13	259

Pigs fed the 17 percent protein ration made .25 pound or 21 percent greater average daily gain and required 21 percent less feed for each 100 pounds of gain than the pigs fed the 12 percent ration. The pigs fed the 17 percent ration made more economical gains than the pigs fed the 22 percent protein ration, and the pigs fed the 22 percent protein ration made more economical gains than the pigs fed the 12 percent protein ration.

The same investigators also ran a trial with three groups of pigs with an initial weight of approximately 32 pounds and a final weight of approximately 80 pounds using 17, 22 and 27 percent protein levels. They found the most economical protein level for pigs from weaning to the average weight of 70 pounds to be the rations containing 22 percent protein.

Robison (6) in a preliminary trial studied the effects of high protein on pigs. Using four 70-pound pigs he fed them 13 weeks on a 42

percent protein ration. Unless an exceptionally laxative condition is considered harmful no ill effects were observed. He later ran another trial using pigs with an initial weight ranging from 60 to 71 pounds and an average age of 66 days in comparing the effects of protein levels of 17.3, 25.6, 34.2 and 51.0.

In this trial Robison reports that scouring was prevalent and persisted among the pigs fed the 26 percent or more of protein. Each increase in protein increased the severity of the scouring. So far as was observed the scouring had no serious detrimental effect on the pigs.

With each increase above 26 percent of protein there was a decrease in the average rapidity of gains and gains produced per unit of feed. The 51 percent protein ration, however, was much more effective than the 9 percent protein ration. The latter made a less unfavorable showing as the pigs became heavier but there was no period in which the pigs on it did not require an excessive amount of feed per unit of gain or in which they gained at a normal rate.

To approximately 90 pounds in weight, the 26 and 34 percent protein rations were more effective than the smaller or larger amounts. Between the weights of approximately 90 to 125 pounds the 17 percent was as effective as the 26 and 34 percent protein rations. Above 125 pounds the rations containing 14 and 17 percent of protein produced more rapid gains per unit of feed than those containing more protein.

Pigs fed the larger amounts of protein shrank more in transit and dressed out less than those fed somewhat smaller amounts. Feeding of high amounts of protein did not produce carcasses carrying much more than a normal amount of lean. The lot that received no protein concentrate resulted in excessive fatness rather than normal growth.

Pigs fed the 51 percent protein ration were examined upon slaughter for any harmful effects. The kidneys, livers and spleens were approximately 48, 23 and 24 percent larger respectively than those pigs of similar weight fed more nearly normal rations. Although the kidneys, livers and spleens were enlarged, they did not appear abnormal.

Ferrin (4) studied three lots of pigs fed varying amounts of protein concentrates. Lot 1 received 0.20 of a pound per pig daily of equal parts dry rendered tankage and soybean oil meal. Lot 2 received 0.40 pound per pig daily, and Lot 3 was self-fed the protein supplement. All lots were self-fed corn and had free access to rape pasture.

The average gain of the pigs in the three lots varied in direct proportion to the amounts of the protein mixture fed. Lot 1, with an average initial weight of 51 pounds and an average final weight of 160 pounds, made the lowest and least economical gains for the 91 day feeding period.

Lot 2, with an average initial weight of 49 pounds and a final weight of 167 pounds, were not only more economical in their gains than Lot 1, but gained 1.30 pounds per day for the entire period as compared to 1.20 for Lot 1.

Pigs in Lot 3 started with an initial weight of 47 pounds and finished at an average weight of 186 pounds. This lot was self-fed the supplement and consumed on an average 0.75 pound per head daily. Lot 3 was the most efficient lot of the trial, gaining 16.25 percent more than Lot 1, and requiring 19.34 percent less feed. They gained 11.37 percent faster than Lot 2, and required 13.44 percent less feed per 100 pound of gain in live weight.

Woodman, Evans and Turpitt (7) studied the influence of high protein intake on protein and mineral metabolism. They found that an unusually

heavy replacement of cereal by protein rich food in diets of large white bacon pigs had only the slightest effect on the rate of live weight increase between weaning and slaughter. The diet containing an abnormally high percentage of protein rich feed gave rise to carcasses neither leaner nor fatter than those arising from a diet containing a medium amount. From the standpoint of both growth and fattening, the high protein diet was scarcely to be distinguished from medium protein diet. It was found further that the gilts in the experiment produced somewhat leaner carcasses than barrows from the same litter, a find that pointed to a somewhat more efficient retention of food nitrogen by the gilts. Since the factors which determine the leanness of bacon carcasses are of considerable economic importance, it was decided to investigate further by the more precise technique of metabolism trials, the utilization of food protein by bacon pigs at different stages of growth from weaning to slaughter.

In conducting the metabolism trials the investigators compared a medium protein level with what they considered a high protein level. Both groups had an equal percentage of white fish meal, but the high protein level group had an addition of 12 percent of soybean meal which replaced an equal weight of barley in the ration. Their conclusions of the experiment were as follows:

(1) The young pigs after weaning were able to digest their food with as high an efficiency as was displayed in the latter stages of growth. The extra protein in the high protein rations had little or no effect on the extent to which the food was digested.

(2) No evidence was secured at any stage of the trial suggesting the presence of protein in the urine of the pigs subsisting on the high protein diet.

(3) The gilts showed consistently higher rate of nitrogen retention than barrows of the same litter. This behavior was manifested even when the protein supply in the gilts ration was lower than that in the ration of the hog with which it was compared. This more efficient utilization of food protein by the gilts is held to explain the tendency of gilts to give somewhat leaner carcasses than barrows.

(4) Nitrogen retention from high protein diet was no higher than from the normal protein diet, a finding suggesting that the amount of protein in the normal ration is sufficient to meet the demands for the quick growth required by modern standards of bacon production, a very large proportion of the extra protein in the high protein ration could be accounted for by extra urea eliminated in the urine of the pigs on these rations. This finding affords a scientific basis for explaining why an increase of the protein supply beyond the levels ordinarily fed in practice leads to no gain in respect to carcass leanness.

(5) The daily retention of nitrogen by the bacon pig remains very much the same throughout the whole period of growth from weaning to slaughter at 200 pounds live weight.

EXPERIMENTAL

Object

The object of this experiment was to determine the optimum percentage of protein a ration should contain for maximum efficiency and economy of gains for pigs of various weights. We were particularly interested in the optimum protein level from weaning to 100 pounds live weight but a study of the complete period of weaning to market weight was made.

Experimental Animals

Pigs used in the experiment were all of purebred breeding selected from the 1942 spring pig crop of the College herd. The breeds represented included Duroc, Poland China, Chester White, Hampshire and Berkshire.

Housing, Yards and Equipment

This experiment was conducted in the experimental unit of the swine farm, Oklahoma Agricultural and Mechanical College. The building is a shed type brick construction, open to the south and is uniformly divided into pens joining paved lots.

Each pig was provided with an identical individual feeder built in a small holding pen. The pigs were admitted three times each day and could free themselves after they completed feeding. Self-waterers are available in each lot.

Feeds and Method of Feeding

The rations fed consisted of coarsely ground No. 2 yellow corn and varying amounts of the following supplemental mixture: 30 parts of dry rendered tankage, 20 parts of sardine meal, and 25 parts of cottonseed meal. Dehydrated alfalfa leaf meal made up 5 percent of the ration in all cases. Powdered limestone and steamed bone meal were added to all

rations where it was necessary in order to maintain a maximum of 0.5 percent calcium and 0.3 percent phosphorus. An effort was also made to keep the calcium-phosphorus ration between 1:1 and 2:1.

A sufficient quantity of each of the feeds were obtained, sampled, analyzed, and the ration computed and mixed at the beginning of each trial. An analyses was also run on each mixed ration intermittently during the feeding trial. The chemical analysis on the feeds included protein, fat, fiber, nitrogen free extract, calcium, phosphorus and carotene content in the case of alfalfa leaf meal.

Table 8

Chemical Analyses of Feeds

Sample	H_2O	Ash	Protein	Fat	Fiber	N.F.E.	Ca.	Phos.	Carotene
Corn	14.39	1.39	10.00	3.59	1.39	69.24	.03	.279	--
Alfalfa Leaf Meal	9.41	9.93	24.32	5.22	16.08	35.04	1.22	.415	190*
Cotton Seed Meal	6.78	7.22	40.90	7.34	8.62	29.14	.182	1.365	--
Tankage	5.85	9.87	60.22	18.86	1.49	3.71	4.00	2.967	--
Sardine Meal	7.49	17.48	63.94	3.07	.33	7.69	5.43	3.183	--
Bone Meal	2.72	79.37	7.09	4.02	1.30	5.5	30.08	13.794	--
Carbotex	.15	99.17	--	--	--	0.68	39.15	.013	--

*Parts per million

Chemical Analyses of Protein Concentrate

H_2O	Ash	Protein	Fat	Fiber	N.F.E.	Ca.	Phos.
6.89	10.52	54.31	10.32	4.93	13.03	2.39	1.954

Table 9

Rations Used in This Experiment

	Ration I	Ration II	Ration III	Ration IV	Ration V	Ration VI	Ration VII
Approximate Percent of Crude Protein	27	24	21	18	15	12	9
Corn	351	380	420	465	498	535	560
Protein Concentrate	219	190	150	105	66	28	-
Alfalfa Leaf Meal	30	30	30	30	30	30	30
Carbotex	-	-	-	-	6	7	10
Total	600	600	600	600	600	600	600

Protein Supplement Concentrate

Tankage	60 Parts
Sardine Meal	40 Parts
Cottonseed Meal	50 Parts
Total	150 Parts

Experimental Procedure

Pigs were selected at weaning (56 days of age) on the basis of sex, breed, weight and apparent thrift. They were then grouped into trios by carefully considering similarities in breeding, weight, thrift and potential feeding ability. Each pig was assigned a series of protein levels and was changed from one level to another in accordance with his weight as is shown in the following table.

Table 10

Feeding schedule of protein levels from weaning to market weight

	Crude Protein in Ration		
	High Protein	Medium Protein	Low Protein
Weaning to 50 Pounds	27	24	21
50 to 80 Pounds	24	21	18
80 to 120 Pounds	21	18	15
120 to 165 Pounds	18	15	12
165 to 225 Pounds	15	12	9

Protein levels in the above table were determined after carefully reviewing the results from similar experimental work at other experiment stations.

A complete record of feed consumption and gain in live weight was recorded throughout the trial. Pigs were weighed every 14 days and were changed from one protein level to another as nearly on schedule as possible. In many cases it was necessary to weigh certain pigs and change their protein level between the regular weigh periods.

Experimental Results

Table I

Rate and Economy of Gains of Pigs
from Weaning to 50 Pounds of Weight

	High Protein Group A	Medium Protein Group B	Low Protein Group C
Percentage of Protein in Ration	27	24	21
Number of Pigs	10	10	10
Average Initial Weight	33.97	34.87	35.35
Average Final Weight	52.55	51.15	51.0
*Average No. of Days in Period	19	19	22
Average Gain Per Pig in Period	18.58	16.28	15.65
Average Daily Gain	0.97	0.84	0.71
Average Daily Feed Consumption	1.89	1.82	1.77
Feed Required per 100# Gain			
Corn	116.59	137.27	172.07
Protein Concentrate	72.74	68.65	61.45
Alfalfa Leaf Meal	9.96	10.84	12.29
Total Feed Required per 100# Gain	199.30	216.75	245.81
Feed Cost per 100# Gain	$ 7.02	$ 7.12	$ 7.20

*Rounded to Nearest Day

In the first trial, rations containing 27, 24 and 21 percent crude protein respectively were studied. Pigs used in this trial were weanling pigs with an initial weight of approximately 34 pounds and were fed to a final weight of approximately 50 pounds.

The pigs on ration A that received the 27 percent protein ration made progressively faster and more economical gains than either the group receiving the 24 or 21 percent protein ration. The pigs that received

ration A gained .97 pound per day during this period as compared to .71 pound per day or 36.6 percent faster than the low level group that received ration C. The high level group was also 23.3 percent more economical in feed required to produce 100 pounds of gain in live weight. The additional 11.23 pounds of protein consumed by the high level group for each 100 pounds of gain saved 55.48 pounds of corn in comparison to the requirement for the low protein group.

Pigs receiving the 24 percent protein ration also gained appreciably faster than those receiving the 21 percent protein ration. They gained 13.4 faster and were 18.3 percent more economical in feed required to produce 100 pounds of gain in live weight. The medium protein level group required 216.75 pounds of feed for each 100 pounds of gain compared to 245.81 for the low level group. From the standpoint of feed saved, the extra 7.20 pounds of protein concentrate consumed by group B saved 35.80 pounds of corn as compared to the feed required per 100 pounds of gain of the low protein level group.

Table II

Rate and Economy of Gains
of Pigs 50 to 80 pounds of Weight

	High Protein Group A	Medium Protein Group B	Low Protein Group C
Percentage of Protein in Ration	24	21	18
Number of Pigs	11	11	11
Average Initial Weight	52.36	50.54	50.64
Average Final Weight	80.73	80.73	80.82
*Average No. of Days in Period	26	31	27
Average Gain per Pig in Period	28.37	30.19	30.28
Average Daily Gain	1.09	0.96	1.13
Average Daily Feed Consumption	2.48	2.81	3.12
Feed Required per 100# Gain			
Corn	144.06	208.02	214.84
Protein Concentrate	72.05	74.28	48.5
Alfalfa Leaf Meal	11.37	14.85	13.85
Total Feed Required per 100# Gain	227.48	297.15	277.19
Feed Cost per 100# Gain	$ 7.47	$ 8.71	$ 7.04

*Rounded to Nearest Day

In the second part of this experiment the same pigs with an initial weight of approximately 50 pounds and a final weight of 80 pounds were studied. Rations fed contained approximately 24, 21 and 18 percent crude protein. Group A, the lot receiving the 24 percent protein ration, and Group C, fed the 18 percent protein ration, made similar gains. Group C held the advantage in this series by gaining 3.7 percent faster than Group A, but required 21.8 percent more feed for each 100 pounds of gain

in live weight. Group C gained 17.7 percent faster than Group B and was also 7.2 percent more economical in their gain in respect to feed consumed.

The group receiving the high protein level was the most efficient in utilization of feed and also held an advantage over Group B in average daily gain of .13 pound per day.

Table III

Rate and Economy of Gains
of Pigs 80 to 120 Pounds of Weight

	High Protein Group A	Medium Protein Group B	Low Protein Group C
Percentage of Protein in Ration	21	18	15
Number of Pigs	11	11	11
Average Initial Weight	80.73	80.73	80.82
Average Final Weight	123	124	125
*Average Number of Days in Period	29	31	37
Average Gain per Pig in Period	42.27	43.27	44.18
Average Daily Gain	1.47	1.38	1.19
Average Daily Feed Consumption	4.55	4.56	4.45
Feed Required per 100# Gain			
Corn	206.72	271.65	309.85
Protein Concentrate	73.82	61.33	41.06
Alfalfa Leaf Meal	14.76	17.52	18.66
Carbotex	—	—	3.73
Total Feed Required per 100# Gain	295.30	350.50	373.30
Feed Cost per 100# Gain	$ 8.65	$ 8.91	$ 8.21

*Rounded to Nearest Day

The optimum protein level for pigs between the weights of 80 to 120 pounds was studied in the third part of this investigation. Groups A, B and C, respectively, received rations containing 21, 18 and 15 percent crude protein.

Group A had an average initial weight of 80.73 pounds and a final weight of 123 pounds. The average daily gain for the group was 1.47 pounds per day and they required 295.30 pounds of feed for each 100 pounds of gain.

Group B, with an average initial weight of 80.73 pounds and a final weight of 124 pounds, gained 1.38 pounds per day and required 350.50 pounds of feed per 100 pound gains.

Group C received the 15 percent protein ration and gained 1.19 pounds per day. They required 373.30 pounds of feed for each 100 pounds of gain in live weight. This group had an average initial weight of 80.82 pounds and a final weight of 125 pounds.

In this test Group A was 26.4 percent more economical in the feed required for each pound of gain and made 23.5 percent greater daily gain than Group C. Group B gained 15.9 percent faster and required 6.5 percent less feed for each 100 pounds of gain than Group C.

From weaning up to 120 pounds the high protein level group had an average daily gain of 1.21 pounds per day as compared to 1.09 for Group B and 1.04 pounds per day for Group C. Group A was also 22.6 percent more economical than Group C, and 22.4 percent more economical than Group B in the amount of feed required per pound of gain.

Table IV

Rate and Economy of Gains
of Pigs 120 to 165 Pounds of Weight

	High Protein Group A	Medium Protein Group B	Low Protein Group C
Percentage of Protein in Ration	18	15	12
Number of Pigs	11	11	11
Average Initial Weight	123	124	125
Average Final Weight	163.55	165.9	167.45
*Average No. of Days in Period	29	31	31
Average Gain per Pig in Period	40.55	41.90	42.45
Average Daily Gain	1.39	1.34	1.35
Average Daily Feed Consumption	5.15	5.78	5.94
Feed Required per 100# Gain			
Corn	289.08	367.85	392.92
Protein Concentrate	65.27	48.74	20.54
Alfalfa Leaf Meal	18.65	22.15	22.06
Carbotex	--	4.43	5.11
Total Feed Required per 100# Gain	373.00	443.17	440.65
Feed Cost per 100# Gain	$ 9.49	$ 9.75	$ 8.24

*Rounded to Nearest Day

In the test of pigs from 120 to 165 pounds of weight the crude protein in the rations was lowered to approximately 18, 15 and 12 percent for Groups A, B and C, respectively.

Group A again made the greatest daily gain, also the most economical from the standpoint of feed consumed. During the period they made an average daily gain of 1.30 pounds per day and required 373.0 pounds of feed for each 100 pounds of gain in live weight. Group B made an average daily gain

of 1.34 pounds per day and required 443.17 pounds of feed for each 100 pounds of gain, while Group C gained on an average of 1.35 pounds per day and required 440.65 pounds of feed per 100 pounds of gain.

Group A during this period was 18.7 percent more efficient in utilization of feed than Group B, and 18.1 percent more efficient than Group C. Although the difference in average daily gain was not significant, Group A gained 2.9 percent faster than Group C and 3.6 percent faster than Group B.

During the entire period from weaning to 165 pounds, Group A gained 1.26 pounds per day or 8.6 percent faster than Group C, which gained 1.13 pounds per day. The high protein level group was also 22.4 percent more economical in feed required per 100 pounds of gain.

Group B had gained on an average of 1.16 pounds per day which was three hundredths of a pound per day greater than Group C, but consumed 8.4 percent less feed to attain the weight of 165 pounds.

Table V

Rate and Economy of Gains
of Pigs 165 to 225 Pounds of Weight

	High Protein Group A	Medium Protein Group B	Low Protein Group C
Percentage of Protein in Ration	15	12	9
Number of Pigs	11	11	11
Average Initial Weight	163.55	165.9	167.45
Average Final Weight	225.18	225.2	222.18
*Average No. of Days in Period	44	41	43
Average Gain per Pig in Period	61.63	59.30	54.73
Average Daily Gain	1.39	1.44	1.26
Average Daily Feed Consumption	6.83	7.04	5.84
Feed Required per 100# Gain			
Corn	403.47	437.14	436.93
Protein Concentrate	53.47	22.86	--
Alfalfa Leaf Meal	24.30	24.52	23.40
Carbotex	4.68	5.68	7.77
Total Feed Required per 100# Gain	486.10	490.20	468.10
Feed Cost per 100# Gain	$ 10.69	$ 9.17	$ 7.62

*Rounded to Nearest Day

In the final part of this experiment of studying optimum protein level for pigs of various weights, rations containing approximately 15, 12 and 9 percent crude protein were studied, using pigs with an average initial weight of approximately 165 pounds and a final weight of approximately 225 pounds.

Group A which received the 15 percent ration had an average initial weight of 163.5 pounds and was carried to a final weight of 225 pounds.

The average daily gain for this group was 1.39 pounds and required 486.10 pounds of feed per 100 pounds of gain. Group B, with an average initial weight of 165.9 pounds and a final weight of 225 pounds, gained 1.44 pounds per day and required 490.20 pounds of feed for each 100 pounds of gain in live weight. Group C, which received the 9 percent protein ration, gained 1.26 pounds per day and required 468.10 pounds of feed for each 100 pounds of gain. Group C had an initial weight of 167.4 pounds and was carried to a final weight of 222.10 pounds.

The medium level group that received the 12 percent protein ration made the greatest daily gain, gaining 14.2 percent faster than Group C and 3.9 percent faster than Group A. Group C, which received the 9 percent protein ration, was 3.8 percent more economical in the amount of feed required per pound of gain than Group A, and 4.7 percent more economical than Group B.

For the entire period from weaning to a final weight of 225 pounds, Group A made the greatest daily gain, gaining 1.30 per day as compared to 1.23 pounds for Group B and 1.16 pounds for Group C. Group A was also the most efficient in feed utilization, requiring 361.6 pounds of feed for each 100 pounds of gain, which was 9.8 percent more efficient than the low level group and 5.2 percent more efficient than the medium protein level group. Group B required 379.1 pounds of feed per 100 pounds of gain, and Group C required 396.6 for each 100 pounds of gain.

Table 16

Rate and Economy of Gains of Pigs
from Weaning to 225 Pounds of Weight

	Group	Percent of Protein in Ration	Average Daily Gain	Economy of Gain	Average Total Gain in Period Per Pig	Average Daily Feed Consumed
Weaning to 50 Pounds	A	27	0.97	199.30	18.58	1.89
	B	24	0.84	216.75	16.28	1.82
	C	21	0.71	245.81	15.65	1.77
50 - 80 Pounds	A	24	1.09	227.48	28.37	2.48
	B	21	0.96	297.15	30.19	2.81
	C	18	1.13	277.19	30.28	3.12
Weaning to 80 Pounds	A	--	1.04	230.70	46.95	2.18
	B	--	.91	270.70	46.47	2.41
	C	--	.94	269.19	45.93	2.48
80 - 120 Pounds	A	21	1.47	295.3	42.27	4.55
	B	18	1.38	350.5	43.27	4.56
	C	15	1.19	373.3	44.18	4.45
Weaning to 120 Pounds	A	--	1.21	261.9	89.22	2.98
	B	--	1.09	312.7	87.74	3.24
	C	--	1.04	321.1	90.11	3.29
120 - 165 Pounds	A	18	1.39	373.0	40.55	5.15
	B	15	1.34	443.2	41.90	5.78
	C	12	1.35	440.6	42.45	5.94
Weaning to 165 Pounds	A	--	1.26	296.98	129.77	3.47
	B	--	1.16	347.70	131.64	3.69
	C	--	1.13	377.20	132.56	4.03
165 - 225 Pounds	A	15	1.39	486.10	61.63	6.83
	B	12	1.44	490.20	59.30	7.04
	C	9	1.26	468.10	54.73	5.84
Weaning to 225 Pounds	A	--	1.30	361.60	191.40	4.20
	B	--	1.23	379.10	190.94	4.55
	C	--	1.16	396.60	187.19	4.48

DISCUSSION

In this experiment of high protein versus medium and low protein rations for pigs from weaning to a market weight of 225 pounds, no ill effects were detected from either the high, medium or low protein rations. The group of pigs that received the high level protein ration made faster gains during most of the trial, but were apparently no more thrifty than either of the other groups.

During the time this experiment was conducted, the ratio between the cost of protein concentrate and grain was rather wide. This accounts for the fact that in some of the weight series Group A was considerably more efficient in their gains, but feed cost per 100 pounds of gain often was as much or exceeded those of Group C. When the price of energy feeds and protein concentrate are more nearly equal in price per pound the additional concentrate fed the high level group saved enough grain to justify feeding of high protein rations. The feed prices used in computing the cost of gains for this trial show that a pound of protein concentrate costs slightly more than four times the cost of a pound of corn which is a greater spread than normally exists.

From the results obtained from one trial, the optimum protein level cannot be definitely determined.

SUMMARY

1. From the results of this trial the optimum protein level for pigs from weaning to 50 pounds appeared to be at least 27 percent. Higher levels of protein rations were not tried.

2. From 50 to 80 pounds, the group receiving the 18 percent ration made the greatest daily gains, but required approximately 50 pounds more feed for each 100 pounds gain in live weight than did the group receiving the 24 percent protein ration.

3. The high level group that received a 27 percent protein ration up to 50 pounds and a 24 percent ration from 50 to 80 pounds gained progressively faster and required approximately 40 pounds less feed for each 100 pounds of gain than either the medium or low level group whose requirements were almost identical to a weight of 80 pounds.

4. In the weight series of 80 to 120 pounds, it appears as though the protein level of the rations were lowered too fast as the group that received the 15 percent ration made slower and more expensive gain than either Group A or B, which received 21 and 18 percent rations. For pigs of this weight the 21 percent ration was the most economical in feed required per 100 pounds of gain and also made the greatest average daily gain.

5. From 120 to 165 pounds rations of approximately 18, 15, 12 percent crude protein were used, and there was no appreciable difference in average daily gains, but the 18 percent ration produced a pound of gain with 18.1 percent less feed than was obtained from the 12 percent ration and 18.7 percent less feed than the 15 percent ration.

6. In the final weight series, 165 to 225 pounds, the 12 percent ration appeared to be nearly the optimum for maximum gains for pigs of

this weight.

7. For the entire period of weaning to a weight of 225 pounds, the group that received the high level of protein were most efficient in utilization of feeds and also gained approximately 6 percent faster than did the medium level group, and 12 percent faster than the low level group.

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