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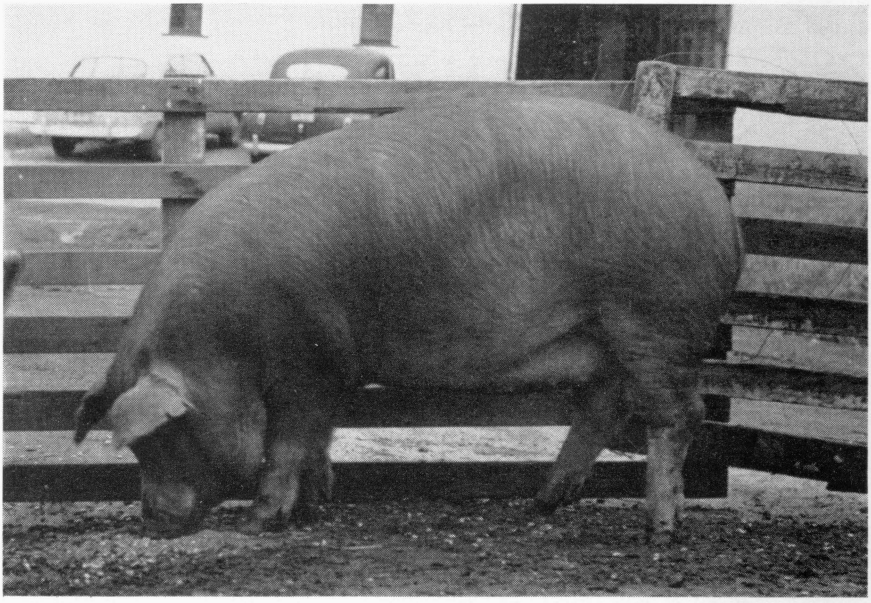

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THE USE OF AN ANTIBIOTIC IN RATIONS FOR PIGS

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INTRODUCTION

Since April, 1949, when Stokstadt and Jukes (53, 36) announced that a crude preparation of Streptomyces aureofaciens culture material possessed growth promoting properties that were not attributable to the vitamin B_{12} it contained and presumably were due to the very small residue of antibiotic it contained there has been a great deal of interest in the use of antibiotic supplements in rations for pigs.

Antibiotics are substances produced by a number of molds, bacteria or microorganisms which are antagonistic to or inhibit the growth of other microorganisms. Penicillin which was the first known antibiotic was discovered by Sir. Alexander Fleming in 1929. It was first used to combat an infection in man in 1941. So rapid was the discovery and development of antibiotics thereafter that 140 different antibiotics were listed in Baron's "Handbook of Antibiotics" which was published late in 1950.

Only a relatively few of the many antibiotics discovered are useful in controlling infections in man and animals. Among the antibiotics that have been used experimentally in rations for pigs are chlortetracycline, oxytetracycline, penicillin, bacitracin, streptomycin, chloramphenicol, neomycin and subtilin. Chlortetracycline is manufactured by the Fine Chemicals Division of the American Cyanamid Company and is sold under the trade name of Aureomycin. Oxytetracycline is manufactured by Charles Pfizer and Company, Inc., and is sold under the trade name of Terramycin.

Each antibiotic is produced by a different microorganism. Furthermore, the types of microorganisms inhibited by a particular antibiotic are specific. Penicillin inhibits the growth of spirochetes, of Gram-positive and of a few Gram-negative bacteria. Streptomycin is effective

[1]Secured the slaughter test data reported in Section 4.

only against Gram-negative bacteria. Chloramphenicol, aureomycin and terramycin inhibit the growth of a wide variety of microorganisms and so are spoken of as having a wide spectral range.

The amounts of antibiotic used in animal feeding are much smaller than the therapeutic amounts used in combatting acute infections. Although antibiotics in crystalline form are sometimes used for the purpose of securing experimental data with the exception of procaine penicillin, the antibiotic products that are available for use in feeds are commonly the residues or are products that are derived from the residues from the production of antibiotics for therapeutic purposes. In this form they are usually less expensive per gram of antibiotic than are the drug grades.

A number of experiments in which rations without and with an antibiotic or an antibiotic supplement in them are compared are herein reported.

Table 1 gives the prices that were used in calculating the feed cost per 100 pounds of gain for the various groups in the different experiments.

Irradiated yeast was used at the rate of 0.01 of a percent of the total feed as a source of vitamin D in all of the rations in the dry lot experiments.

SECTION 1

Dry Lot Experiments With Standard Protein, Soybean Oil Meal Rations

EXPERIMENT 1

In a dry lot experiment that was started November 29, 1949, to study the effect of adding a vitamin B_{12} supplement to a ration of corn, dried distillers' grain solubles, soybean oil meal, ground alfalfa, irradiated yeast and minerals for pigs carried from shortly after weaning until they reached a given market weight, two vitamin B_{12} or, as they were then designated, APF concentrates were fed. The pigs receiving the one gained 1.57 pounds daily and required 368 pounds of feed per 100 pounds of gain. Those receiving the other gained 1.70 pounds daily and required 351 pounds of feed per 100 pounds of gain.

In the production of the first of these supplements, fullers' earth was used as the adsorbate of vitamin B_{12}. It contained 12.5 mg. of B_{12} to the pound. It was fed at the rate of 0.1 of a percent and thus supplied 1.25 mg. of B_{12} per 100 pounds of feed.

The second B_{12} supplement used was produced by merely drying the mash left from the production of aureomycin and adding a diluent. It contained 1.8 mg. of B_{12} and 1.7 gm. of aureomycin per pound. It

TABLE 1.—Prices Used

Item	Price
Shelled corn	2.5 ¢ a lb.
Dried distillers' grain solubles	4.5 ¢ a lb.
Fish meal, 60% protein	7.5 ¢ a lb.
Meat scraps, 55% protein	6.5 ¢ a lb.
Soybean oil meal, 44% protein	5.0 ¢ a lb.
Ground alfalfa	2.5 ¢ a lb.
Irradiated yeast	40.00¢ a lb.
Grinding corn	0.15¢ a lb.
Iodized salt	1.7 ¢ a lb.
Pulverized limestone	1.0 ¢ a lb.
Special steamed bone meal	4.5 ¢ a lb.
Ferrous sulfate	5.0 ¢ a lb.
Cobaltous chloride, $CoCl_2 . 6H_2O$	178.0 ¢ a lb.
Pasture	2.0 ¢ a day
B_{12} supplement No. 1, 12.5 mg. per lb.	54.17¢ a lb.
B_{12} supplement No. 2, 10.0 mg. per lb	42.00¢ a lb.
B vitamins concentrate*	47.50¢ a lb.
Aurofac, 1.8 mg. of B_{12} and 1.8 gm. aureomycin per lb.	34.00¢ a lb.
Aurofac 2A, 3.6 gm. aureomycin per lb.	48.00¢ a lb.
Bi-con TM 5, 5.0 gm. of terramycin per lb.	65.50¢ a lb.
Baciferm, 10.0 gm. of bacitracin per lb.	79.00¢ a lb.
Riboflavin mixture, 16.0 gm. of riboflavin per lb.	96.00¢ a lb.
Choline chloride mixture, 25% choline chloride	18.00¢ a lb.
Crystalline aureomycin†	13.33¢ a gm.
Crystalline procaine penicillin	13.00¢ a gm.
Calcium pantothenate	6.00¢ a gm.
Niacin	0.91¢ a gm.

*The B vitamins concentrate used contained 2000, 4000, 9000, 10000 and 60 mg. of riboflavin, pantothenic acid, niacin, choline chloride and folic acid to the pound, respectively.

†The price used for crystalline aureomycin was the same as the cost of aureomycin per gm. in Aurofac 2A at 48 cents a pound.

was fed at the rate of 0.4 percent and thus supplied 0.7 mg. of vitamin B_{12} and 0.68 gm. of aureomycin per 100 pounds of feed. Obviously it contained something beneficial that was not present in the other product, or, if present, was not there in adequate amounts. Presumably the additional response was due to the residue of aureomycin in the product. Table 2 reports the results.

The performance of the pigs on the basal ration in this experiment was below normal. In six other experiments pigs fed a similar ration gained 1.30 pounds daily and required 374 pounds of feed per 100 pounds of gain. The pigs given a B_{12} supplement and those given a B_{12} and antibiotic supplement gained 20.9 and 30.9 percent faster and required 1.6 and 6.1 percent less feed per unit of gain, respectively, than the pigs on similar rations without them in the six experiment.s.

The pigs given a B_{12} supplement with the soybean oil meal ration made as much gain per unit of feed and gained 16.2 percent more rapidly than pigs given meat scraps in place of a part of the soybean oil meal. The pigs given a B_{12} and antibiotic supplement required 4.2 percent less feed per unit of gain and gained 25.8 percent more rapidly than pigs given meat scraps in the place of a part of the soybean oil meal.

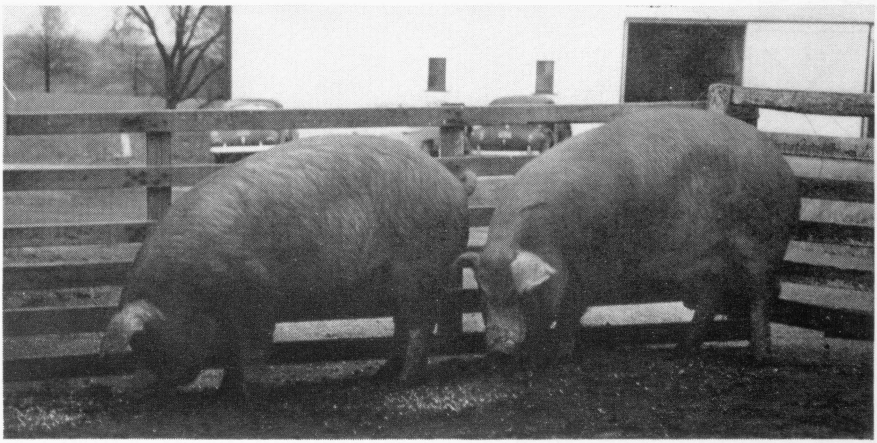

Fig. 1.—Pigs fed a basal ration of corn, soybean oil meal, dried distillers' grain solubles, ground alfalfa, irradiated yeast and minerals with meat scraps, left, and with a B_{12} and antibiotic, chlortetracycline, supplement, right. Their groups gained 1.35 and 1.70 lb. daily and required 366.7 and 351.2 pounds of feed per 100 pounds of gain, respectively.

TABLE 2.—Meat Scraps, a B_{12} Supplement and a B_{12} and Antibiotic Supplement With a Soybean Oil Meal Ration Containing Dried Distillers' Grain Solubles

	1	2	3	4
Experiment started Nov. 29, 1949	Ground shelled corn, dried distillers' grain solubles, soybean oil meal, ground alfalfa, irradiated yeast, and minerals			
Feeds mixed and self fed		**Meat scraps**	**B_{12} supplement**	**B_{12} and antibiotic supplement**
Av. days of age at start	71	70	70	70
Pigs at start	13	13	12	13
Initial weight per pig, lb.	45.3	45.3	45.7	45.0
Pigs at close	11	11	12	13
Final weight per pig, lb.	205.7	210.3	210.8	211.9
Average daily gain, lb.	**1.21**	**1.35**	**1.57**	**1.70**
Days to gain 175 pounds	145	130	112	103
Daily feed per pig, lb.:				
Corn	3.31	3.72	4.15	4.27
Distillers' solubles	0.23	0.25	0.29	0.30
Meat scraps		0.29		
Soybean oil meal	0.76	0.39	0.93	0.97
B_{12} supplement			0.006	
B_{12} and antibiotic supplement				0.02
Ground alfalfa	0.23	0.25	0.29	0.30
Minerals	0.09	0.06	0.12	0.12
Total	4.62	4.96	5.78	5.98
Feed per 100 lb. gain, lb.:				
Corn	273.82	274.60	264.09	250.66
Distillers' solubles	19.15	18.34	18.39	17.56
Meat scraps		21.42		
Soybean oil meal	63.20	29.24	59.24	57.02
B_{12} supplement			0.37	
B_{12} and antibiotic supplement				1.41
Ground alfalfa	19.15	18.34	18.39	17.56
Minerals	7.66	4.79	7.35	7.02
Total	**382.98**	**366.73**	**367.83**	**351.23**
Cost of feed per 100 lb. gain	$11.97	$11.55	$11.65	$11.68

Lot 1—A 48.6 lb. poor doing pig was removed on the 14th day and one which died on the 70th day from hemorrhage from a stomach ulcer was figured as removed on the 56th day when it weighed 127.5 pounds.

Lot 2—A 66.5 lb. poor doing pig was removed on the 28th day and one which died on the 62nd day from hemorrhage from a stomach ulcer was figured as removed on the 56th day when it weighed 95.0 pounds.

Minerals—Iodized salt, 19.2; limestone, 38.4; special steamed bone meal, 38.4; ferrous sulfate, 4.0.

The antibiotic was of greater worth during the latter than during the early part of the experiment. Before and after the pigs averaged 120 pounds in weight those given the B_{12} and antibiotic supplement gained 7.3 and 12.2 percent more rapidly and required 0.4 and 6.2 percent less feed per unit of gain, respectively, than the pigs given the B_{12} supplement which contained no antibiotic.

EXPERIMENT 2

A second experiment in which a B_{12} and antibiotic supplement was fed was started May 24, 1950. Since a comparison had indicated that cobalt was beneficial for pigs that were not on pasture and that were fed soybean oil meal as the protein concentrate cobaltous chloride was included in the minerals. The B_{12} and antibiotic, aureomycin, supplement was fed at the rates of 0.25 and 0.4 percent when meat scraps were and were not included in the ration, respectively. These amounts supplied 0.5 and 0.8 mg. of B_{12} and 0.425 and 0.68 gm. of aureomycin per 100 pounds of feed, respectively. The pigs were carried from approximately 45 to 220 pounds in weight. The results obtained are reported in Table 3.

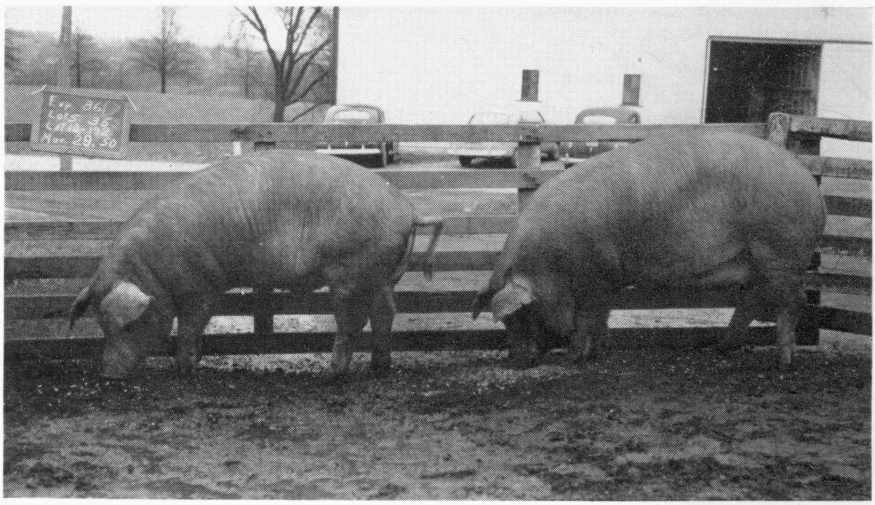

Fig. 2.—Pigs fed corn, soybean oil meal, dried distillers' grain solubles, ground alfalfa, irradiated yeast and minerals, without, left, and with, right, a B_{12} and antibiotic, chlortetracycline, supplement. Groups so fed gained 1.30 lb. and 1.70 lb. daily a head and required 374.0 and 351.2 pounds of feed per 100 pounds of gain, respectively.

TABLE 3.—A Vitamin B_{12} and Antibiotic Supplement and a Natural and Synthetic Source of B Vitamins for Pigs

	1	2	3	4	5	6
	Corn, soybean oil meal, ground alfalfa minerals					
Experiment started May 24, 1950	**Distillers' solubles**	**Meat scraps**	**Distillers' solubles Meat scraps**	**Distillers' solubles**	**B vitamins concentrate**	**B vitamins concentrate Meat scraps**
Feeds mixed and self fed				**B_{12} and antibiotic supplement**	**B_{12} and antibiotic supplement**	**B_{12} and antibiotic supplement**
Av. days of age at start	64	64	64	63	64	65
Pigs at start	14	14	14	14	14	14
Initial weight per pig, lb.	44.7	44.9	44.7	45.0	45.4	45.1
Pigs at close	10	14	14	13	14	14
Final weight per pig, lb.	225.9	218.7	220.6	227.7	221.7	221.1
Average dail gain, lb.	**1.44**	**1.46**	**1.48**	**1.63**	**1.57**	**1.57**
Days to gain 170 pounds	119	117	116	105	108	109
Daily feed per pig, lb.:						
Corn	3.77	4.23	3.96	4.18	4.27	4.45
Distillers' solubles	0.26		0.26	0.29		
B vitamins concentrate					0.01	0.008
Meat scraps		0.36	0.30			0.37
Soybean oil meal	0.89	0.49	0.41	0.92	1.06	0.50
B_{12} and antibiotic supplement				0.02	0.02	0.014
Ground alfalfa	0.26	0.27	0.26	0.29	0.29	0.29
Minerals	0.11	0.08	0.07	0.12	0.13	0.08
Total	5.29	5.43	5.26	5.82	5.78	5.71
Feed per 100 lb. gain, lb.:						
Corn	262.08	289.90	267.64	256.30	271.06	283.13
Distillers' solubles	18.41		17.79	17.84		
B vitamins concentrate					0.62	0.55
Meat scraps		24.45	20.40			23.50
Soybean oil meal	61.97	33.40	27.74	56.31	67.37	32.11
B_{12} and antibiotic supplement				1.43	1.12	0.91
Ground alfalfa	18.41	18.58	17.79	17.84	18.35	18.17
Minerals	7.37	5.25	4.35	7.14	8.54	5.03
Total	**368.24**	**371.58**	**355.71**	**356.86**	**367.07**	**363.40**
Cost of feed per 100 lb. gain	$11.56	$11.57	$11.19	$11.56	$11.95	$11.82

Minerals=Iodized salt, 19.2; limestone, 38.4; special steamed bone meal, 38.4; ferrous sulfate, 3.85; cobaltous chloride, $CoCl_2 \cdot 6H_2O$, 0.15.

Removals: Lot 1, 66.0 lb. pig on 28th day because of prolapse; an 81.0 lb. one on the 28th, an 82.0 lb. one on the 70th and a 169.0 lb. one on the 98th day. These were doing poorly as a result of infectious pneumonia in the group.

Lot 4=135.0 lb. pig removed on the 56th day because it developed an umbilical hernia.

Aurofac was used at the rates of 0.25 and 0.4 percent when meat scraps were and were not included in the ration. It contained 2.0 mg. of B_{12} and 1.7 gm. of aureomycin per pound.

As in earlier experiments (46) dried distillers' grain solubles and meat scraps were approximately equally effective for feeding with corn, soybean oil meal, ground alfalfa, irradiated yeast and minerals to pigs in dry lot. Five percent of dried distillers' grain solubles were included in the ration. The meat scraps and soybean oil meal were fed in proportions which supplied approximately equivalent amounts of protein.

Feeding a B_{12} and antibiotic, aureomycin, supplement and (2) feeding meat scraps in place of a part of the soybean oil meal in rations containing dried distillers' grain solubles increased the rapidity of the gains 13.2 and 2.8 percent and lowered the amount of feed required per 100 pounds of gain 3.1 and 3.4 percent, respectively. Thus, the inclusion of a B_{12} and antibiotic supplement in the ration resulted in faster and practically as efficient gains as the inclusion of meat scraps in the ration.

Pigs fed a B vitamins concentrate at a level which supplied 800, 1600, 3600, and 4000 mg, of riboflavin, calcium pantothenate, niacin, and choline chloride per 100 pounds of feed gained 3.7 percent less rapidly and required 2.9 percent more feed per 100 pounds of gain than the pigs fed dried distillers' grain solubles as a source of B vitamins. The B_{12} and antibiotic supplement was included in the rations for both groups.

Substituting meat scraps for a part of the soybean oil meal in the ration containing a B_{12} and antibiotic supplement and a B vitamins concentrate lowered the feed per unit of gain one percent and made no difference in the rapidity of the gains. With meat scraps in the ration the B vitamins concentrate was fed at a level which supplied 500, 1000, 2250, and 2500 mg. of riboflavin, calcium pantothenate, niacin and choline chloride per 100 pounds of feed, respectively.

Until the pigs averaged approximately 125 pounds in weight, those with a B_{12} and antibiotic, aureomycin, supplement gained 0.2 pound more daily a head and required 32.3 pounds less feed per 100 pounds of gain than those without it. In this period infectious pneumonia was prevalent among the pigs without and not among the pigs with the B_{12} and antibiotic supplement. During the latter part of the experiment the pigs with the B_{12} and antibiotic supplement gained 0.1 pound more daily a head and required 5.2 pounds less feed per 100 pounds of gain than those without the B_{12} and antibiotic supplement.

EXPERIMENT 3

In an experiment started November 28, 1950, pigs fed corn, dried distillers' grain solubles, soybean oil meal, ground alfalfa, irradiated yeast, a vitamin B_{12} supplement and minerals and pigs fed the same ration to which crystalline aureomycin was added gained 1.68 and 1.83 pounds daily a head and required 355.1 and 343.3 pounds of feed per 100 pounds of gain, respectively. The crystalline aureomycin increased the rapidity of the gains 8.9 percent, enabled the pigs to be marketed 9 days earlier and lowered the feed rquired per unit of gain 3.3 percent. It was fed at the rate of 0.5 gm. per 100 pounds of feed.

A ration containing a B vitamins concentrate in which the vitamins were largely from synthetic sources was reasonably satisfactory but was hardly as effective as the one containing dried distillers' grain solubles. The pigs having the concentrate gained 0.07 pound less daily a head and required 15.4 pounds or 4.5 percent more feed per 100 pounds of gain than the pigs having the dried distillers' grain solubles. The concentrate supplied 300, 1000, 1350 and 1500 mg. of riboflavin, calcium pantothenate, niacin, and choline chloride per 100 pounds of feed, respectively. Crystalline aureomycin at the rate of 0.5 gm. and a supplement supplying vitamin B_{12} at the rate of 1.0 mg. per 100 pounds of feed were included in both rations.

Omitting the vitamin B_{12} supplement and replacing a part of the soybean oil meal with fish meal so each supplied approximately equivalent amounts of protein in the ration which contained the B vitamins concentrate increased the rapidity of the gains 0.1 pound daily a head and lowered the feed required per 100 pounds of gain 5.8 pounds or 1.6 percent.

Before they averaged 120 pounds in weight the pigs without and those with crystalline aureomycin in the ration that contained dried distillers' grain solubles gained 1.57 and 1.64 pounds daily a head and required 297.6 and 297.5 pounds of feed per 100 pounds of gain, respectively. Thereafter those without and those with crystalline aureomycin in their ration gained 1.76 and 2.00 pounds daily a head and required 393.7 and 375.5 pounds of feed per 100 pounds of gain, respectively.

EXPERIMENT 4

In an experiment started June 12, 1951, a basal ration of corn, dried distillers' grain solubles, soybean oil meal, ground alfalfa, irradiated yeast and minerals was fed.

TABLE 4.—Crystalline Aureomycin* With a Plant and a Mixed Protein Ration, and (2) a Natural and Synthetic Source of B Vitamins for Pigs

	1	2	3	4
Experiment started Nov. 28, 1950	Corn, soybean oil meal, ground alfalfa, minerals, B_{12} supplement			
Feeds mixed and self fed	**Distillers' solubles**	**Distillers' solubles Crystalline aureomycin**	**B vitamins, Crystalline aureomycin**	**B vitamins† Fish meal Crystalline aureomycin**
Av. days of age at start	67	69	69	66
Pigs at start	14	14	14	14
Initial weight per pig, lb.	49.0	50.3	49.8	49.8
Pigs at close	14	14	14	14
Final weight per pig, lb.	213.6	217.2	221.9	219.4
Average daily gain, lb.	**1.68**	**1.83**	**1.76**	**1.86**
Days to gain 170 pounds	102	93	97	92
Daily feed per pig, lb.:				
Corn	4.30	4.54	4.69	5.14
Pre-mix	0.01	0.01	0.01	0.002
Distillers' solubles	0.30	0.31		
Fish meal				0.43
Soybean oil meal	0.93	1.00	1.14	0.59
Ground alfalfa	0.30	0.31	0.31	0.33
Minerals	0.12	0.13	0.15	0.09
Total	5.96	6.30	6.30	6.58
Feed per 100 lb. gain, lb.:				
Corn	256.08	247.19	266.92	276.05
Pre-mix	0.71	0.69	0.83	0.11
Distillers' solubles	17.76	17.17		
Fish meal				22.99
Soybean oil meal	55.69	54.25	64.67	31.40
Ground alfalfa	17.76	17.17	17.94	17.65
Minerals	7.10	6.87	8.37	4.69
Total	**355.10**	**343.34**	**358.73**	**352.89**
Cost of feed per 100 lb. gain	$11.16	$11.03	$11.71	$11.75

*Chlortetracycline.

†No vitamin B_{12} supplement was added to the ration containing fish meal.

Minerals—Iodized salt, 19.2; limestone, 38.4; special steamed bone meal, 38.4; ferrous sulfate, 4.0.

Pre-mixes of crystalline aureomycin, a B_{12} supplement, the B vitamins and soybean oil meal were prepared so that, including these, 0.4 percent of any given one of the pre-mixes in a particular ration would supply the amounts desired. They were used at rates which supplied 300, 1000, 1350, 1500, 1.0 and 500.0 mg. of riboflavin, calcium pantothenate, niacin, choline chloride, B_{12} and crystalline aureomycin per 100 pounds of total feed.

A vitamin B_{12} supplement used at a rate which supplied 1.0 mg. of B_{12} per 100 pounds of feed made very little if any difference in the performance of the pigs. Those with it gained no faster and required 4.5 pounds or 1.2 percent less feed per 100 pounds of gain than those without it. Cobaltous chloride was included in the mineral mixture used in this experiment. Unless otherwise noted it was also used in the later experiments herein reported.

Pigs given an antibiotic supplement at a rate which supplied 0.45 gm. of aureomycin per 100 pounds of feed gained 0.12 pound more daily a head and required 6.54 pounds or 1.8 percent less feed per 100 pounds of gain than pigs given the same ration without it. Both rations contained the vitamin B_{12} supplement.

As indicated by the performance of the pigs receiving it, meat scraps substituted for a part of the soybean oil meal so each supplied approximately equivalent amounts of protein did not improve a ration of corn, dried distillers' grain solubles, soybean oil meal, ground alfalfa, a B_{12} and antibiotic supplement, irradiated yeast and minerals.

The pigs that were given a B_{12} and antibiotic, aureomycin, supplement with the ration that contained soybean oil meal as the only protein concentrate gained 9.5 percent faster, were ready for market 12 days earlier and made more economical gains than pigs that were self fed a similar ration, except for the distillers' dried grain solubles and the B_{12} and antibiotic supplement, and that were given an average of 0.99 pound of condensed buttermilk daily a head as a drink. With the buttermilk reduced to a 10 percent moisture basis, the pigs that received it required 1.7 percent less feed per unit of gain than those that received the B_{12} and antibiotic supplement. For the ration that contained it to have been as economical as the one that contained the B_{12} and antibiotic supplement, however, it would have been necessary to purchase the condensed buttermilk at a price not exceeding 4.0 cents a pound. It cost 7.0 cents a pound.

Until they reached a weight of approximately 120 pounds the pigs with an antibiotic supplement in their ration gained 0.15 pound more daily a head and required 4.5 pounds less feed per 100 pounds of gain than those without it. From approximately 120 to 220 pounds in weight they gained 0.12 pound more daily a head and required 0.8 pound less feed per 100 pounds of gain than those without it.

EXPERIMENT 5

In an experiment started November 27, 1951, pigs fed a ration of corn, a B vitamins concentrate, soybean oil meal, ground alfalfa, irradiated yeast, and minerals, pigs fed the same ration plus crystalline

TABLE 5.—A B_{12} Supplement, a B_{12} and Antibiotic Supplement and Meat Scraps and a B_{12} and Antibiotic Supplement With a Soybean Oil Meal Ration

	1	2	3	4	5
	Corn, dried distillers' grain solubles, soybean oil meal, ground alfalfa, and minerals				
Experiment started June 12, 1951 Feeds mixed and self fed		**B_{12} supplement**	**B_{12} and antibiotic supplement**	**Meat scraps B_{12} and antibiotic supplement**	Condensed buttermilk*
Av. days of age at start	66	67	67	67	67
Pigs at start	12	12	12	12	12
Initial weight per pig, lb.	41.2	41.3	41.1	41.1	41.0
Pigs at close	12	12	11	11	10
Final weight per pig, lb.	223.7	222.0	220.5	229.2	218.5
Average daily gain, lb.	**1.63**	**1.61**	**1.73**	**1.67**	**1.58†**
Days to gain 180 pounds	111	112	105	108	117
Daily feed per pig, lb.:					
Corn	4.35	4.26	4.47	4.66	4.42
Distillers' solubles	0.30	0.30	0.31	0.31	
Condensed buttermilk					0.99
Meat scraps				0.38	
Soybean oil meal	0.97	0.94	1.01	0.47	0.43
B_{12} supplement		0.005	0.003	0.003	
Antibiotic supplement			0.016	0.015	
Ground alfalfa	0.30	0.30	0.31	0.31	0.28
Minerals	0.14	0.13	0.12	0.05	0.06
Total	6.06	5.93	6.24	6.20	5.48‡
Feed per 100 lb. gain, lb.:					
Corn	267.16	263.97	258.20	279.68	286.25
Distillers' solubles	18.60	18.375	18.05	18.59	
Condensed buttermilk					64.10
Meat scraps				22.63	
Soybean oil meal	59.34	58.56	58.57	28.29	27.99
B_{12} supplement		0.29	0.18	0.19	
Antibiotic supplement			0.90	0.93	
Ground alfalfa	18.60	18.375	18.05	18.59	17.93
Minerals	8.33	7.93	7.01	2.98	3.73
Total	**372.03**	**367.50**	**360.96**	**371.88**	**354.84‡**
Cost of feed per 100 lb. gain	$11.60	$11.61	$11.65	$12.11	$14.04

*No distillers' solubles were included in the ration for the pigs fed condensed buttermilk.

†Daily gain of pigs in lot at close. With the two included until removed, the average gain was 1.54 lb. daily.

‡With condensed buttermilk on a 10 percent moisture basis. As fed, it contained 73 percent moisture.

Minerals—Iodized salt, 19.2; limestone, 38.4; special steamed bone meal, 38.4; ferrous sulfate, 3.9; cobaltous chloride, $CoCl_2 \cdot 6H_2O$, 0.1.

Removals: Lot 3, a 187.0 lb. pig on the 70th day; hurt in the hip. Lot 4, a 48.5 lb. pig on the 14th day at maximum weight; died later. Lot 5, a 55.5 lb. pig on the 14th day, lame; and a 45.0 lb. one on the 28th day; doing poorly.

aureomycin and pigs fed the same ration plus both crystalline aureomycin and a vitamin B_{12} supplement gained 1.58, 1.62 and 1.68 pounds daily a head and required 360, 351 and 344 pounds of feed per 100 pounds of gain, respectively.

Until the pigs reached a weight of approximately 120 pounds, those without either, those with crystalline aureomycin, and those with both crystalline aureomycin and a vitamin B_{12} supplement in their ration gained 1.39, 1.45, and 1.54 pounds daily a head and required 311, 309 and 290 pounds of feed per 100 pounds of gain, respectively.

From approximately 120 to 210 pounds in weight, the pigs with neither, those with crystalline aureomycin, and those with both crystalline aureomycin and a vitamin B_{12} supplement in their ration gained 1.79, 1.83 and 1.82 pounds daily a head and required 403, 391 and 391 pounds of feed per 100 pounds of gain, respectively.

The crystalline aureomycin was fed at the rate of 0.45 gm. per 100 pounds of feed. The B vitamins concentrate was fed at a rate which supplied 300, 600, 1350, 1500, 9 and 75 mg. of riboflavin, calcium pantothenate, niacin, choline chloride, folic acid and pyridoxine hydrochloride, respectively, per 100 pounds of feed.

The pigs that received the B vitamins concentrate and others that received dried distillers' grain solubles gained 1.62 and 1.64 pounds daily a head and required 351 and 354 pounds of feed per 100 pounds of gain. This was a difference of less than 1.3 percent in either the rapidity or the efficiency of the gains. The dried distillers' grain solubles were fed at the rate of 5 percent of the ration. This averaged 18.2 percent of the supplement.

EXPERIMENT 6

In a dry lot experiment started June 20, 1952, pigs fed corn, soybean oil meal, ground alfalfa, and minerals and pigs fed the same ration with a B vitamins concentrate in it gained 1.48 and 1.60 pounds daily a head and required 372 and 349 pounds of feed per 100 pounds of gain, respectively. Crystalline aureomycin, at the rate of 0.45 gm. per 100 pounds of feed did not increase the rapidity of the gains but reduced the amount of feed required per 100 pounds of gain from 349 to 339. pounds.

As indicated by the performance of the pigs, no improvement in the ration resulted from replacing a part of the soybean oil meal with meat scraps so that each supplied equivalent amounts of protein.

TABLE 6.—Dried Distillers' Grain Solubles, (2) a Concentrate of Six B Vitamins, (3) the Latter Plus an Antibiotic, and (4) the Latter Plus an Antibiotic and a B_{12} Supplement With a Soybean Oil Meal Ration

	1	2	3	4
Experiment started Nov. 27, 1951	Corn, soybean oil meal, ground alfalfa, minerals			
Feeds mixed and self fed	**B vitamins concentrate**	**B vitamins concentrate Crystalline aureomycin**	**B vitamins concentrate B_{12} supplement Crystalline aureomycin**	**Distillers' solubles Crystalline aureomycin**
Av. days of age at start	62	64	62	63
Pigs at start	15	15	15	15
Initial weight per pig, lb.	45.6	45.5	45.7	45.7
Pigs at close	15	15	14	15
Final weight per pig, lb.	211.3	209.0	213.3	211.3
Average daily gain, lb.	**1.58**	**1.62**	**1.68**	**1.64**
Days to gain 175 pounds	111	108	105	107
Daily feed per pig, lb.:				
Corn	4.23	4.22	4.30	4.21
Distillers' solubles				0.29
B vitamins concentrate	0.009	0.009	0.009	
B_{12} supplement			0.005	
Soybean oil meal	1.02	1.03	1.03	0.89
Ground alfalfa	0.28	0.28	0.29	0.29
Minerals	0.14	0.14	0.13	0.12
Total	5.68	5.68	5.76	5.80
Feed per 100 lb. gain, lb.:				
Corn	268.01	260.63	256.23	256.57
Distillers' solubles				17.68
B vitamins concentrate	0.54	0.53	0.52	
B_{12} supplement			0.28	
Soybean oil meal	64.74	63.71	61.61	54.19
Ground alfalfa	17.99	17.53	17.18	17.68
Minerals	8.52	8.28	7.87	7.53
Total	**359.80**	**350.68**	**343.69**	**353.65**
Cost of feed per 100 lb. gain	$11.46	$11.42	$11.32	$11.21

For mineral mixure see footnote to Table 5, page 14.

Removals: A 117.0 lb. pig from Lot 3 on the 70th day; died later of adhesions of the intestines apparently from an early injury.

Crystalline aureomycin was fed at the rate of 0.45 gm., the B_{12} supplement at a rate which supplied 1.0 mg., and the B-vitamins concentrate at a rate that supplied 300, 600, 1350, 1500, 9 and 75 mg. of riboflavin, calcium pantothenate, niacin, choline chloride, folic acid and pyridoxine hydrochloride, respectively, per 100 pounds of feed

TABLE 7.—Dried Distillers' Grain Solubles and a Concentrate of Six B Vitamins Without and With Aureomycin in a Soybean Oil Meal Ration

	2	4	6	8	7
	Corn, soybean oil meal, ground alfalfa, minerals				
Experiment started June 20, 1952		**B vitamins concentrate**	**B vitamins concentrate Crystalline aureomycin**	**Meat scraps B vitamins concentrate Crystalline aureomycin**	**Distillers' solubles Crystalline aureomycin**
Feeds mixed and self fed					
Av. days of age at start	66	65	65	64	68
Pigs at start	10	10	10	10	10
Initial weight per pig, lb.	41.7	41.8	41.9	41.8	41.6
Pigs at close	10	10	10	6	8
Final weight per pig, lb.	222.4	223.6	219.9	225.67	226.4
Average daily gain, lb.	**1.48**	**1.60**	**1.60**	**1.61**	**1.65**
Days to gain 180 pounds	122	113	113	112	109
Daily feed per pig, lb.:					
Corn	4.09	4.14	4.02	4.43	4.10
Distillers' solubles					0.28
B vitamins concentrate		0.01	0.01	0.01	
Meat scraps				0.45	
Soybean oil meal	1.02	1.02	1.00	0.53	0.87
Ground alfalfa	0.27	0.28	0.27	0.29	0.28
Minerals	0.14	0.13	0.13	0.10	0.13
Total	5.52	5.58	5.43	5.81	5.66
Feed per 100 lb. gain, lb.:					
Corn	276.21	259.14	251.22	275.45	248.35
Distillers' solubles					17.12
B vitamins concentrate		0.52	0.51	0.54	
Meat scraps				28.01	
Soybean oil meal	68.72	63.67	62.64	32.97	52.37
Ground alfalfa	18.65	17.45	16.97	18.08	17.12
Minerals	9.41	8.31	8.05	6.53	7.54
Total	**372.99**	**349.09**	**339.39**	**361.58**	**342.50**
Cost of feed per 100 lb. gain	$11.50	$11.13	$11.05	$12.05	$10.85

For mineral mixure see footnote to Table 5, page 14.

Crystalline aureomycin, chlortetracycline, was used as the antibiotic. It was fed at the rate of 0.45 gm. per 100 lb. of total feed.

The B vitamins concentrate was fed at the rate of 0.15 of a percent which supplied 300, 600, 1350, 1500, 9 and 75 mg. of riboflavin, calcium pantothenate, niacin, choline chloride, folic acid, and pyridoxine hydrochloride, respectively per 100 pounds of total feed.

Removals: Lot 8—A 138.0 lb. pig on the 56th day; hurt in shoulder; a 121.0 lb. pig on the 56th day; doing poorly; a 221.0 lb. hog on the 84th day; and a 219.5 lb. one on the 98th day, for slaughter. Lot 7—An 89.5 lb. pig on the 42nd day, prolapse; a 134.5 lb. one on the 70th day, doing poorly.

Dried distillers' grain solubles and the B vitamins concentrate were again approximately equally effective for feeding with a soybean oil meal ration. The pigs given the dried distillers' grain solubles were ready for market 4 days earlier and required 0.9 percent more feed per unit of gain than those given the B vitamins concentrate.

From approximately 40 to 120 pounds in weight, the B vitamins concentrate increased the rapidity of the gains 5.3 percent and lowered the feed required per unit of gain 6.0 percent. From approximately 120 to 220 pounds in weight the pigs given the B vitamins concentrate gained 7.9 percent more rapidly and required 8.3 percent less feed per unit of gain than the pigs without it.

Crystalline aureomycin increased the rapidity of the gains 7.8 and 4.8 percent and lowered the feed required per unit of gain 1.3 and 2.1 percent in the first and second periods, or before and after the pigs averaged 120 pounds in weight, respectively.

EXPERIMENT 7

In an experiment started Dec. 2, 1952, pigs fed corn, soybean oil meal, ground alfalfa, irradiated yeast, and minerals, and pigs fed the B vitamins concentrate with the same ration gained 1.55 and 1.62 pounds daily and required 366.6 and 355.5 pounds of feed per 100 pounds of gain, respectively. A vitamin B_{12} and antibiotic, aureomycin, supplement in the ration containing the B vitamins concentrate caused pigs to eat more feed daily a head, gain faster and be ready for market 9 days earlier but made less than 1.0 percent or practically no difference in the amount of feed required per 100 pounds of gain.

Replacing a part of the soybean oil meal with meat scraps so that each supplied approximately equivalent amounts of protein brought about no improvement in the efficiency of the ration.

EXPERIMENT 8

A basal ration of corn, soybean oil meal, ground alfalfa, irradiated yeast and minerals was fed in an experiment started June 16, 1953. Except in that for the first group cobaltous chloride was included in the minerals. The pigs given cobalt in their minerals were ready for market 5 days earlier and required 2.0 percent less feed per 100 pounds of gain than those fed a similar ration without it.

Including a B vitamins concentrate in the basal ration increased the rapidity of the gains 0.05 percent daily a head and enabled the pigs to be marketed 3 days earlier but resulted in no saving in feed per unit of gain. The B vitamins concentrate was fed at a rate which supplied 200,

TABLE 8.—A B Vitamins Concentrate, It and a B_{12} and Antibiotic Supplement and These and Meat Scraps With a Soybean Oil Meal Ration

Experiment started Dec. 2, 1952	2	4	6	8
	Corn, soybean oil meal, ground alfalfa, minerals, and irradiated yeast			
Feeds mixed and self fed		**B vitamins concentrate**	**B vitamins concentrate B_{12} and antibiotic supplement**	**Meat scraps B vitamins concentrate B_{12} and antibiotic supplement**
Av. days of age at start	64	63	62	59
Pigs at start	16	16	16	16
Initial weight per pig, lb.	45.2	45.4	45.5	45.3
Pigs at close	16	16	16	16
Final weight per pig, lb.	219.2	215.4	216.9	218.8
Average daily gain, lb.	**1.55**	**1.62**	**1.75**	**1.77**
Days to gain 180 pounds	116	112	103	102
Daily feed per pig, lb.:				
Corn	4.21	4.236	4.55	4.93
Meat scraps				0.44
Soybean oil meal	1.05	1.08	1.13	0.57
Ground alfalfa	0.28	0.29	0.31	0.32
Minerals	0.15	0.15	0.16	0.08
B vitamins concentrate		0.006	0.006	0.006
B_{12} and antibiotic supplement			0.012	0.013
Total	5.69	5.76	6.17	6.36
Feed per 100 lb. gain, lb.:				
Corn	271.34	261.54	259.95	278.25
Meat scraps				25.11
Soybean oil meal	67.36	66.58	64.83	32.07
Ground alfalfa	18.33	17.78	17.63	17.95
Minerals	9.53	9.24	9.17	4.45
B vitamins concentrate		0.36	0.35	0.36
B_{12} and antibiotic supplement			0.71	0.72
Total	**366.56**	**355.50**	**352.64**	**358.91**
Cost of feed per 100 lb. gain	$11.30	$11.25	$11.43	$11.79

Minerals—Iodized salt, 19.2; limestone, 38.4; special steamed bone meal, 38.4; ferrous sulfate, 3.95; cobaltous chloride, 0.05.

The B vitamins concentrate was fed at a rate that supplied 200, 400, 900, 1000, 6 and 50 mg. of riboflavin, calcium pantothenate, niacin, choline chloride, folic acid, and pyridoxine hydrochloride, respectively, per 100 pounds of feed.

The B_{12} supplement and the antibiotic supplement were fed at rates which supplied 1 mg. of B_{12} and 0.36 gm. of aureomycin per 100 pounds of feed.

TABLE 9.—Cobalt, (2) It and a B Vitamins Concentrate, (3) These and a B_{12} and Antibiotic Supplement, and (4) the Three Plus Meat Scraps With a Soybean Oil Meal Ration

	1	2	3	4	5
	Ground shelled corn, soybean oil meal, ground alfalfa irradiated yeast, and minerals				
Experiment started June 16, 1953					
Feeds mixed and self fed		**Cobalt**	**B vitamins concentrate Cobalt**	**B vitamins concentrate B_{12} and antibiotic supplement Cobalt**	**Meat scraps B vitamins concentrate B_{12} and antibiotic supplement Cobalt**
Av. days of age at start	74	73	74	72	73
Pigs at start	15	16	16	16	16
Initial weight per pig, lb.	47.0	48.0	48.1	47.9	47.8
Pigs at close	15	15	16	15	14
Final weight per pig, lb.	215.5	213.3	217.5	209.7	207.3
Average daily gain, lb.	**1.50**	**1.56**	**1.61**	**1.63**	**1.60**
Days to gain 175 pounds	117	112	109	108	110
Daily feed per pig, lb.:					
Corn	4.18	4.26	4.44	4.42	4.61
Meat scraps					0.40
Soybean oil meal	0.92	0.93	0.96	0.96	0.46
Ground alfalfa	0.27	0.28	0.29	0.29	0.30
B vitamins concentrate			0.01	0.006	0.006
B_{12} and antibiotic suppl.				0.012	0.012
Minerals	0.14	0.14	0.14	0.14	0.11
Total	5.51	5.61	5.84	5.83	5.90
Feed per 100 lb. gain, lb.:					
Corn	277.56	272.80	275.21	270.18	288.02
Meat scraps					24.78
Soybean oil meal	61.16	59.27	59.41	58.99	29.73
Ground alfalfa	18.30	17.94	18.10	17.84	18.43
B vitamins concentrate			0.36	0.36	0.37
B_{12} and antibiotic suppl.				0.71	0.74
Minerals	9.02	8.85	8.93	8.78	6.64
Total	**366.04**	**358.86**	**362.01**	**356.86**	**368.71**
Cost of feed per 100 lb. gain	$11.12	$10.90	$11.26	$11.41	$12.01

Minerals, except for Lot 1—Iodized salt, 19.2; limestone, 38.4; special steamed bone meal, 38.4; ferrous sulfate, 3.9; cobaltous chloride, $CoCl_2 \cdot 6H_2O$, 0.1. That for Lot 1 was the same except that 4.0 lb. of ferrous sulfate and no cobaltous chloride was used.

The B vitamins concentrate was fed at a level that supplied 200, 400, 900, 1000, 6 and 50 mg. of riboflavin, calcium pantothenate, niacin, choline chloride, folic acid and pyridoxine hydrochloride, respectively, per 100 pounds of feed.

The B_{12} supplement and the antibiotic supplement were fed at rates that supplied 1.0 mg. of B_{12} and 0.36 gm. of aureomycin per 100 pounds of feed.

Removals: Lot 2—A 53.0 lb. pig on the 14th day; doing poorly. Lot 4—A 161.0 lb. pig on the 84th day; doing poorly. Lot 5—A 123.0 lb. pig on the 56th day, died later; and a 157.0 lb. pig on the 84th day; doing poorly.

400, 900, 1000, 6 and 50 mg. of riboflavin, calcium pantothenate, niacin, choline chloride, folic acid and pyridoxine hydrochloride, respectively, per 100 pounds of feed.

The addition of a vitamin B_{12} and an antibiotic, aureomycin, supplement to the ration that contained the B vitamins concentrate resulted in only a slight improvement in the performance of the pigs. Those without this addition to their ration and those with it gained 1.61 and 1.63 pounds daily a head and required 362 and 357 pounds of feed per 100 pounds of gain, respectively. This was a reduction of 1.4 percent in the amount of feed required per 100 pounds of gain produced. The vitamin B_{12} and the antibiotic supplement were fed at rates which supplied one mg. of vitamin B_{12} and 0.36 gm. of aureomycin per 100 pounds of feed.

Pigs given a ration that contained the B vitamins concentrate and the B_{12} and antibiotic supplements and in which meat scraps were used in the place of a part of the soybean oil meal so each supplied equivalent amounts of protein gained 98.2 percent as rapidly and required 3.3 percent more feed per 100 pounds of gain than pigs given a similar ration that contained no meat scraps.

EXPERIMENTS 9 AND 10

A ninth dry lot experiment in which soybean oil meal rations without and with an antibiotic in them were compared was started December 1, 1953. Seventeen pigs were used to the lot. They were carried from approximately 42 to 220 pounds in weight. A basal ration of corn, soybean oil meal, ground alfalfa, a B vitamins concentrate, a B_{12} supplement, irradiated yeast and minerals was fed. Before and after the pigs averaged approximately 120 pounds in weight the basal ration contained 21.0 and 15.6 percent of soybean oil meal, 15.5 and 13.5 percent of protein, and 5.0 and 4.5 percent of total ash or minerals, respectively. A mineral mixture of iodized salt, 19.2; limestone, 38.4; special steamed bone meal, 38.4; ferrous sulfate, 3.95; cobaltous chloride, $CoCl_3 . 6 H_2O$, 0.05 was used.

The B vitamins concentrate was fed at a rate that supplied 200, 400, 900, 1000, 6 and 25 mg. of riboflavin, calcium pantothenate, niacin, choline chloride, folic acid and pyridoxine hydrochloride, respectively, per 100 pounds of feed. The B_{12} supplement and the antibiotic, aureomycin, supplement were fed at rates which supplied 0.5 mg. of vitamin B_{12} and 0.45 gm. of aureomycin per 100 pounds of feed. respectively.

Except that corn which contained more protein was used and as a consequence the percentage of corn was higher and the percentage of

TABLE 10.—Omitting the Alfalfa, (2) Including an Antibiotic, and (3) Including Fish Meal but Omitting B_{12} From a Soybean Oil Meal Ration Containing a B_{12} Supplement and a B Vitamins Concentrate

Experiments started Dec. 1, 1953 and June 9, 1954	1	2	3	4
	Ground shelled corn, soybean oil meal, ground alfalfa*, B vitamins concentrate, B_{12} supplement, irradiated yeast, minerals			
	No alfalfa		**Antibiotic supplement**	**Fish meal added, B_{12} omitted**
Av. days of age at start	66	67	67	66
Pigs at start	29	29	29	29
Initial weight per pig, lb.	41.6	41.4	41.4	41.5
Pigs at close	29	29	29	28
Final weight per pig, lb.	217.2	220.3	221.4	224.9
Average daily gain, lb.	**1.72**	**1.70**	**1.76**	**1.68**
Days to gain 180 pounds	105	106	103	108
Daily feed per pig, lb.:				
Corn	4.82	4.63	4.66	4.78
Fish meal				0.34
Soybean oil meal	1.08	1.00	1.01	0.47
Ground alfalfa		0.31	0.31	0.30
B vitamins concentrate	0.006	0.006	0.006	0.006
B_{12} supplement	0.003	0.003	0.003	
Antibiotic supplement			0.008	
Minerals	0.17	0.15	0.14	0.10
Total	6.08	6.10	6.14	6.00
Feed per 100 lb. gain, lb.:				
Corn	280.72	272.07	264.24	284.60
Fish meal				20.38
Soybean oil meal	62.78	58.81	57.33	28.07
Ground alfalfa		17.89	17.41	17.86
B vitamins concentrate	0.35	0.36	0.35	0.36
B_{12} supplement	0.18	0.18	0.17	
Antibiotic supplement			0.44	
Minerals	9.74	8.60	8.29	5.93
Total	**353.77**	**357.91**	**348.23**	**357.20**
Cost of feed per 100 lb. gain	$11.15	$11.14	$11.04	$11.32

*Except Lot 1.

Minerals—Iodized salt, 19.2; limestone, 38.4; special steamed bone meal, 38.4; ferrous sulfate, 3.95; cobaltous chloride, $CoCl_2 \cdot 6H_2O$, 0.05.

The B vitamins concentrate was fed at a rate that supplied 200, 400, 900, 1000, 6 and 25 mg. of riboflavin, calcium pantothenate, niacin, choline chloride, folic acid and pyridoxine hydrochloride, respectively, per 100 pounds of gain.

The B_{12} supplement and the antibiotic supplement were fed at rates that supplied 0.5 mg. of B_{12} and 0.45 gm. of aureomycin per 100 pounds of feed.

Removal: Lot 4, a 136.0-pound pig died on the 55th day.

soybean oil meal was lower, similar rations were fed in an experiment started June 9, 1954. Twelve pigs were used to the lot. Table 10 summarizes the two experiments.

Pigs on the ration that contained the B vitamins concentrate and a B_{12} supplement but no alfalfa gained as rapidly and required 1.1 percent or slightly less feed per 100 pounds of gain than pigs on the ration containing 5 percent of ground alfalfa. Apparently if the proteins, vitamins, and minerals are adequate the performance of pigs is not improved by the inclusion of alfalfa in the ration.

In the experiments started Nov. 27, 1951, and June 20, 1952, crystalline aureomycin was added to soybean oil meal rations that contained a B vitamins concentrate but no vitamin B_{12} supplement. In those started Dec. 2, 1952, and June 16, 1953, a B_{12} and antibiotic, aureomycin, supplement was added to soybean oil meal rations that contained a B vitamins concentrate but no vitamin B_{12} supplement. In the two trials started Dec. 1, 1953 and June 9, 1954, which are reported in Table 10, an antibiotic supplement was added to rations that contained a vitamin B_{12} supplement as well as a B vitamins concentrate.

The pigs fed the antibiotic supplement with the soybean oil meal rations that contained a B vitamins concentrate and a vitamin B_{12} supplement ate a trifle more feed daily a head, made slightly faster gains, were ready for market 3 days earlier and required 9.68 pounds or 2.7 percent less feed per 100 pounds of gain than the pigs on similar rations without the antibiotic supplement.

In the experiment started December 1, 1953, the pigs fed fish meal in place of a part of the soybean oil meal so each supplied equivalent amounts of protein took slightly less feed daily a head, gained a little less rapidly and were ready for market 4 days later than those fed soybean oil meal as the only high-protein feed. Approximately the same amounts of feed per 100 pounds of gain were required by the two groups.

For some reason, the pigs fed fish meal did not do as well at the start as later. Before and after a weight of 120 pounds was reached the pigs having fish meal gained 92.7 and 97.7 percent as rapidly and required 101.3 and 98.4 percent as much feed per unit of gain, respectively, as the pigs without it.

In the experiment started June 9, 1954, the pigs fed fish meal were ready for market 2 days earlier and required 5.3 pounds or 1.5 percent less feed per 100 pounds of gain than those without it. Although the

combined data suggest that the two rations are equally effective, if the findings are broken down in this manner, they suggest a slight difference in efficiency in favor of the ration that contained fish meal. This would agree with the experiment reported in Table 4.

A vitamin B_{12} supplement was included in the basal ration but not in the one that contained fish meal. Fish meal is a relatively good source of vitamin B_{12}.

B VITAMINS CONCENTRATES AND DRIED DISTILLERS' GRAIN SOLUBLES

In earlier dry lot experiments (46) rations of corn, soybean oil meal, irradiated yeast, minerals and 5 percent of sun cured, ground alfalfa were improved by the addition of a feed that was rich in B vitamins. Among feeds of this kind that were tried were dried brewers' yeast, condensed fish solubles and dried distillers' grain solubles. Concentrates in which the B vitamins are derived chiefly from synthetic sources are now available. Some of the experiments herein reported in which rations without and with an antibiotic or a B_{12} and antibiotic supplement were compared, also included comparisons of dried distillers' grain solubles and B vitamins concentrates for feeding with soybean oil meal rations to pigs in dry lot. Perhaps before summarizing the data on an antibiotic or a B_{12} and antibiotic supplement for pigs it will be advisable to present the results of these comparisons and of those on the use of soybean oil meal as against the use of a mixture of meat scraps and soybean oil meal as the protein concentrate for pigs in dry lot.

In the early but not in the later part of two experiments pigs that received a concentrate containing the four B vitamins, riboflavin, calcium pantothenate, niacin, and choline chloride made as rapid and as efficient gains as pigs that received dried distillers' grain solubles. The experiments are reported in Part I of Table 11.

Before an average weight of approximately 120 pounds was reached the pigs having the B vitamins concentrate and those having the dried distillers' grain solubles gained 1.52 and 1.51 pounds daily a head and required 303 and 303 pounds of feed per 100 pounds of gain, respectively. After an average weight of approximately 120 pounds was reached the pigs having the B vitamins concentrate and those having the dried distillers' grain solubles gained 1.78 and 1.93 pounds daily a head and required 410 and 387 pounds of feed per 100 pounds of gain, respectively.

TABLE 11.—Summary of Comparisons of Dried Distillers' Grain Solubles and B Vitamins Concentrates

	Part 1		Part 2	
	Ground shelled corn, B_{12} and antibiotic supplement*, soybean oil meal, ground alfalfa, irradiated yeast, and minerals			
	Dried distillers' grain solubles	**Concentrate of four B vitamins**	**Dried distillers' grain solubles**	**Concentrate of six B vitamins**
Number of experiments	2		3	
Av. days of age at start	67	67	66	66
Pigs at start	28	28	37	37
Initial weight per pig, lb.	47.7	47.6	43.1	43.1
Pigs at close	27	28	34	37
Final weight per pig, lb.	222.3	221.8	217.8	217.9
Average daily gain, lb.	**1.72**	**1.66**	**1.67**	**1.66**
Days to gain 180 pounds	105	109	108	109
Daily feed per pig, lb. :				
Corn	4.34	4.46	4.26	4.38
Distillers' solubles	0.30		0.30	
B vitamins concentrate		0.006		0.009
B_{12} and antibiotic supplement	0.02	0.02	0.006	0.006
Soybean oil meal	0.95	1.09	0.92	1.08
Ground alfalfa	0.30	0.30	0.30	0.30
Minerals	0.12	0.14	0.12	0.13
Total	6.03	6.02	5.91	5.90
Feed per 100 lb. gain, lb. :				
Corn	251.87	269.02	254.99	263.20
Distillers' solubles	17.51		17.66	
B vitamins concentrate		0.37		0.53
B_{12} and antibiotic supplement	1.07	0.92	0.37	0.39
Soybean oil meal	55.31	66.04	55.21	65.00
Ground alfalfa	17.51	18.15	17.66	17.74
Minerals	7.01	8.45	7.35	7.99
Total	**350.28**	**362.95**	**353.24**	**354.85**
Cost of feed per 100 lb. gain	$11.30	$11.83	$11.27	$11.61

*No vitamin B_{12} supplement was fed in the second and third experiment included in the summary in Part 2.

Part 2 of Table 11 reports three experiments in which dried distillers' grain solubles and a concentrate which supplied the six B vitamins, riboflavin, calcium pantothenate, niacin, choline chloride, folic acid and pyridoxine hydrochloride were compared for feeding with soybean oil meal rations to pigs in dry lot.

Pyridoxine has been shown to be needed by young pigs for optimum protein utilization and growth (41A).

Before an average weight of approximately 120 pounds was reached the pigs having the concentrate that supplied the six B vitamins and those having the dried distillers' grain solubles gained 1.49 and 1.49 pounds daily a head and required 315 and 303 pounds of feed per 100 pounds of gain, respectively. After an average weight of approximately 120 pounds was reached the pigs having the concentrate that supplied the six B vitamins and those having the dried distillers' grain solubles gained 1.86 and 1.87 pounds daily a head and required 391 and 398 pounds of feed per 100 pounds of gain, respectively.

For the entire time there was a difference of less than 0.6 percent in either the rapidity or the efficiency of the gains of the pigs fed the B vitamins concentrate and of those fed dried distillers' grain solubles with the soybean oil meal ration. One was as effective as the other.

The supplies of the feeds that are rich in B vitamins are limited. Presumably synthetic B vitamins can be produced in whatever quantities are demanded and their cost will decrease as production increases.

MEAT SCRAPS WITH SOYBEAN OIL MEAL RATIONS CONTAINING A B_{12} AND ANTIBIOTIC SUPPLEMENT

In the experiment reported in Part 1 of Table 12 pigs fed soybean oil meal were ready for market 3 days earlier and required approximately the same amount of feed per unit of gain as pigs fed a mixture of meat scraps and soybean oil meal as the protein concentrate. The meat scraps and soybean oil meal were fed in proportions which supplied equivalent amount of protein. The rations consisted of corn, the protein concentrate, dried distillers' grain solubles, ground alfalfa, a B_{12} and antibiotic supplement, irradiated yeast and minerals.

In the three experiments summarized in Part 2 of Table 12, rations similar to those used in the experiment reported in Part 1 except that they contained a B vitamins concentrate instead of dried distillers' grain solubles were fed. The pigs in the two groups gained at the same rate. Those given soybean oil meal required 1.3 percent less or approximately the same amount of feed per 100 pounds of gain as those given a mixture of meat scraps and soybean oil meal.

TABLE 12.—Summary of Comparisons of Soybean Oil Meal and of Soybean Oil Meal and Meat Scraps in Rations Containing a Source of B Vitamins and a B_{12} and Antibiotic Supplement

	Part 1		Part 2	
	Ground shelled corn, **dried distillers' grain solubles,** B_{12} and antibiotic supplement, soybean oil meal, ground alfalfa, irradiated yeast, and minerals		Ground shelled corn, **B vitamins concentrate,** B_{12} and antibiotic supplement, soybean oil meal, ground alfalfa, irradiated yeast, and minerals	
		Meat scraps		Meat scraps
Number of experiments	1		3	
Av. days of age at start	67	67	67	67
Pigs at start	12	12	46	46
Initial weight per pig, lb.	41.1	41.1	46.3	46.1
Pigs at close	11	11	45	44
Final weight per pig, lb.	220.5	229.2	216.0	215.9
Average daily gain, lb.	**1.73**	**1.67**	**1.65**	**1.65**
Days to gain 180 pounds	105	108	109	110
Daily feed per pig, lb.:				
Corn	4.47	4.55	4.41	4.66
Distillers' solubles	0.31	0.30		
B vitamins concentrate			0.007	0.007
B_{12} and antibiotic supplement	0.019	0.018	0.014	0.013
Meat scraps		0.36		0.40
Soybean oil meal	1.01	0.46	1.05	0.52
Ground alfalfa	0.31	0.30	0.30	0.30
Minerals	0.12	0.05	0.15	0.09
Total	6.24	6.04	5.93	5.99
Feed per 100 lb. gain.:				
Corn	258.20	272.77	266.84	282.91
Distillers' solubles	18.05	18.11		
B vitamins concentrate			0.44	0.42
B_{12} and antibiotic supplement	1.08	1.09	0.84	0.79
Meat scraps		21.90		24.49
Soybean oil meal	58.57	27.37	63.73	31.34
Ground alfalfa	18.05	18.11	17.93	18.17
Minerals	7.01	2.90	8.84	5.33
Total	**360.96**	**362.25**	**358.62**	**363.45**
Cost of feed per 100 lb. gain	$11.65	$12.11	$11.59	$11.87

When the mineral and vitamin requirements were met good quality soybean oil meal and a mixture of good quality soybean oil meal and meat scraps were equally effective as protein concentrates for pigs. These findings were in accord with those of earlier experiments (45) in which no B_{12} and antibiotic supplement was included in the rations.

ADDING A B_{12} AND ANTIBIOTIC SUPPLEMENT TO SOYBEAN OIL MEAL RATIONS

Part 1 of Table 13 summarizes the results of two experiments in which feeding a B_{12} and an antibiotic, aureomycin, supplement with rations of corn, dried distillers' grain solubles, soybean oil meal, ground alfalfa, irradiated yeast and minerals was tried.

The pigs having the B_{12} and antibiotic supplement ate more feed daily a head, gained 9.2 percent more rapidly, were ready for market 10 days earlier, and required 3.1 percent less feed per 100 pounds of gain than those without it. The B_{12} and antibiotic supplement was fed at a rate which supplied 0.8 mg. of vitamin B_{12} and 0.68 gm. of aureomycin per 100 pounds of feed.

ADDING AN ANTIBIOTIC TO RATIONS CONTAINING A B_{12} SUPPLEMENT

Part 2 of Table 13 summarizes three experiments in which feeding crystalline aureomycin or an antibiotic, aureomycin, supplement with rations of ground shelled corn, dried distillers' grain solubles, soybean oil meal, a vitamin B_{12} supplement, ground alfalfa, irradiated yeast, and minerals was tried. In the experiments reported in Part 2, the basal ration contained a B_{12} supplement whereas in those reported in Part 1 the basal rations did not contain a B_{12} supplement.

The pigs on the rations that contained the antibiotic ate 0.27 pound more feed daily a head, gained 8.6 percent more rapidly, were ready for market 8 days earlier and required 11.6 pounds or 3.2 percent less feed per 100 pounds of gain produced than pigs on similar rations without it.

Two comparisons of standard protein rations without and with crystalline aureomycin in them, two of standard protein rations without and with a B_{12} and antibiotic, aureomycin, supplement in them and two of standard protein rations with a B_{12} supplement and without and with an antibiotic, aureomycin, supplement in them are summarized in Tables 24, 25, and 26, respectively. The rations otherwise consisted of corn, soybean oil meal, a B vitamins concentrate, ground alfalfa, irradiated yeast and a mineral mixture that contained cobalt.

TABLE 13.—Part 1: A B_{12} and Antibiotic Supplement With a Soybean Oil Meal Ration Containing Dried Distillers' Grain Solubles

Part 2: An Antibiotic With a Soybean Oil Meal Ration Containing Dried Distillers' Grain Solubles and a B_{12} Supplement

	Part 1		Part 2	
	Ground shelled corn, dried distillers' grain solubles, soybean oil meal, ground alfalfa, irradiated yeast, and minerals			
		B_{12} and antibiotic supplement	**B_{12} supplement**	**B_{12} supplement and antibiotic**
Number of experiments	2		3	
Av. days of age at starte	70	69	70	69
Pigs at start	26	26	38	39
Initial weight per pig, lb.	43.1	43.2	45.5	45.7
Pigs at close	22	24	38	38
Final weight per pig, lb.	224.7	224.4	215.4	216.3
Average daily gain, lb.	**1.53**	**1.67**	**1.62**	**1.76**
Days to gain 180 pounds	118	108	111	103
Daily feed per pig, lb. :				
Corn	4.05	4.31	4.24	4.42
Distillers' solubles	0.28	0.30	0.30	0.31
B_{12} supplement			0.01	
B_{12} and antibiotic supplement		0.02		0.02
Soybean oil meal	0.93	0.96	0.93	0.99
Ground alfalfa	0.28	0.30	0.30	0.31
Minerals	0.12	0.12	0.12	0.12
Total	5.66	6.01	5.90	6.17
Feed per 100 lb. gain, lb. :				
Corn	264.71	257.18	261.19	251.85
Distillers' solubles	18.51	17.94	18.16	17.58
B_{12} supplement			0.72	
B_{12} and antibiotic supplement		1.27*		1.29
Soybean oil meal	60.61	57.36	57.49	56.30
Ground alfalfa	18.51	17.94	18.16	17.58
Minerals	7.86	7.08	7.45	6.96
Total	**370.20**	**358.76**	**363.17**	**351.56**
Cost of feed per 100 lb. gain	$11.76	$11.62	$11.46	$11.44

*Includes 0.08 lb. of B_{12} supplement so as to provide the same amount of B_{12} as was fed a different group.

In the two comparisons summarized in Table 24, no B_{12} supplement was included in either ration. Feeding crystalline aureomycin at the rate of 0.45 gm. per 100 pounds of feed enabled the pigs to be marketed two days earlier or made a difference of only 1.3 percent in the rapidity of the gains. The antibiotic reduced the feed required per 100 pounds of gain 9.34 pounds or 2.6 percent.

In the two comparisons summarized in Table 25, feeding a B_{12} supplement and an antibiotic supplement with the basal ration which contained no B_{12} supplement increased the rapidity of the gains 4.9 percent. This enabled the pigs to be marketed 5 days earlier than those without the B_{12} and antibiotic supplements. In the two trials, adding both a B_{12} supplement and an antibiotic, aureomycin, supplement to the ration reduced the feed required per 100 pounds of gain 4.08 pounds or 1.1 percent. The saving amounted to 0.8 percent in one trial and to 1.4 percent in the other.

In the comparisons summarized in Table 26, the addition of an antibiotic, aureomycin, supplement to a ration that contained a vitamin B_{12} supplement resulted in slightly faster gains and a 3 days earlier marketing time. It reduced the feed required per 100 pounds of gain 9.68 pounds or 2.7 percent.

Some investigators (4, 6, 9, 10, 12, 14, 15, 18, 26, 30) have reported a greater response from an antibiotic when the ration contained a B_{12} supplement. In these trials the antibiotic saved approximately the same amount of feed per 100 pounds of gain regardless of whether a vitamin B_{12} supplement was or was not included in the ration. These savings were 2.7 and 2.6 percent, respectively.

AVERAGE RESULTS OF THE TEN EXPERIMENTS WITHOUT AND WITH AN ANTIBIOTIC IN THE RATION

Part 3 of Table 14 summarizes the ten comparisons of soybean oil meal rations without and with crystalline aureomycin, an antibiotic, aureomycin, supplement or a vitamin B_{12} and an antibiotic, aureomycin, supplement in them that were reported individually. A total of 277 pigs were used in the comparisons. Cobaltous chloride $CoCl_2 . 6 H_2O$, was included in the minerals in eight of the comparisons. Dried distillers' grain solubles were used in four and a B vitamins concentrate that supplied riboflavin, calcium pantothenate, niacin, choline chloride, folic acid and pyridoxine hydrochloride, was used as a source of B vitamins in the remaining six of the ten comparisons.

In two of the trials, crystalline aureomycin was added to rations that contained no vitamin B_{12} supplement. In three of the experiments a B_{12} and antibiotic supplement or a B_{12} supplement and an antibiotic

TABLE 14.—Summary of Comparisons of Dry Lot Rations Without and With an Antibiotic, an Antibiotic Supplement or a B_{12} and Antibiotic in Them

Summary of ten experiments			Ground shelled corn, soybean oil meal, dried distillers' grain solubles or B vitamins concentrate, B_{12} supplement, ground alfalfa, irradiated yeast, minerals
Feeds mixed and self fed			**Antibiotic or B_{12} and antibiotic supplement**
Part 1—To a Weight of Approximately 120 Pounds			
Initial weight per pig,		lb.	44.6	44.7
Final weight per pig,		lb.	122.2	123.3
Average daily gain		lb.	**1.41**	**1.51**
Daily feed per pig, lb. :	Corn		3.10	3.24
	Supplement		1.30	1.36
	Total		4.40	4.60
Feed per 100 lb. gain, lb. :	Corn		220.02	214.41
	Supplement		92.35	90.26
	Total		**312.37**	**304.67**
Feed saved per 100 lb. of gain by antibiotic,		lb.		7.7
Part 2—From a Weight of Approximately 120 Pounds			
Final weight per pig,		lb.	217.6	217.3
Average daily gain,		lb.	**1.83**	**1.91**
Daily feed per pig, lb. :	Corn		5.58	5.66
	Supplement		1.75	1.80
	Total		7.33	7.46
Feed per 100 lb. gain, lb. :	Corn		303.96	296.37
	Supplement		95.48	94.04
	Total		**399.44**	**390.41**
Feed saved per 100 lb. of gain by antibiotic,		lb.		9.0
Part 3—Entire Time			
Average days of age at start			67	67
Pigs at start			138	139
Initial weight per pig, lb.			44.6	44.7
Pigs at close			134	136
Final weight per pig, lb.			217.6	217.3
Average daily gain, lb.			**1.61**	**1.70**
Days to gain 180 pounds			112	106
Daily feed per pig, lb. :	Corn		4.29	4.41
	Supplement		1.52	1.57
	Total		5.81	5.98
Feed per 100 lb. gain, lb. :	Corn		265.91	258.77
	Supplement		94.06	92.30
	Total		**359.97**	**351.07**
Cost of feed per 100 lb. gain			$11.34	$11.33
Feed saved per 100 lb. of gain by antibiotic, lb.				8.9

supplement was added to a basal ration that contained no B_{12} supplement. In the remaining five experiments an antibiotic or an antibiotic supplement was added to a basal ration that contained a vitamin B_{12} supplement.

The pigs that received an antibiotic or a B_{12} and antibiotic supplement ate a little more feed daily a head, gained 5.6 percent more rapidly, were ready for market six days earlier and required 8.9 pounds or 2.5 percent less feed per 100 pounds of gain than pigs on similar rations except for the antibiotic or the B_{12} and antibiotic supplement.

At the manufacturer's price as of April 1, 1954, the cost of adding the antibiotic to the rations practically offset the value of the feed saved so that the feed cost per 100 pounds of gain was approximately the same for the two groups. This left the six days earlier marketing time as the chief advantage from the use of the antibiotic in the ten comparisons. Presumably the pigs were reasonably healthy at the beginning of the tests and remained so during the course of the experiments.

RESPONSE OF YOUNG AND OF OLDER PIGS TO AN ANTIBIOTIC IN THE RATION

Parts 1 and 2 of Table 14 show the average performance of the pigs without and of those with an antibiotic in their rations before and after a weight of approximately 120 pounds was reached. In both the growing and finishing periods the pigs having the antibiotic ate a little more feed and gained approximately 0.1 pound more daily a head than the pigs without it. In the two periods as named, averages of 7.7 and 9.0 pounds, or of 2.5 and 2.3 percent, less feed per 100 pounds of gain were required by the pigs with an antibiotic or a B_{12} and antibiotic supplement than was required by those without it.

In three of the ten experiments summarized in Table 14 a B_{12} and antibiotic supplement was added to a basal ration that contained no B_{12} supplement. In these, the feed saved per unit of gain by the addition was greater before than it was after the pigs averaged 120 pounds in weight. In the seven remaining comparisons crystalline aureomycin was added to a basal ration that contained no B_{12} supplement or an antibiotic, aureomycin, supplement was added to a basal ration that contained a B_{12} supplement. In six of these a greater response from the antibiotic was secured after than was secured before the pigs averaged 120 pounds in weight. Rations containing standard amounts of protein were used in the ten comparisons.

One comparison of high protein rations without and with crystalline aureomycin in them was made. In it the antibiotic saved more feed per unit of gain after than before the pigs averaged 120 pounds in weight.

Two comparisons of low protein rations without and with crystalline aureomycin in them and two comparisons of low protein rations without and with an antibiotic aureomycin supplement in them are reported later in Table 24 and 26. In the latter two the basal rations contained a B_{12} supplement whereas in the first two they did not. In one experiment of each pair, the antibiotic saved more feed per unit of gain before than after, whereas in the other one of each pair it saved more feed per unit of gain after than it did before the pigs averaged 120 pounds in weight.

Two comparisons of low protein rations without and with a B_{12} and antibiotic supplement in them are summarized in Table 25. In each of these the feed saved per unit of gain by the B_{12} and antibiotic supplement was greater before than after the pigs averaged 120 pounds in weight. These two comparisons within themselves provide no indication as to whether the greater response when the pigs were young than when they were older was due to the B_{12}, the antibiotic or to both.

The relative amounts of feed saved per 100 pounds of gain in the growing and in the finishing period in each of the comparisons are shown graphically in Chart 1.

As indicated by the feed saved per unit of gain, a greater response from the antibiotic occurred as often in the finishing as it did in the growing period. Some investigators (4, 6, 8, 9, 14) have reported a greater response from an antibiotic when the pigs were young than when they were older.

Although in the writer's experience there was likely to be as much stimulation from an antibiotic in the later as in the earlier stages of growth, the response from feeding a vitamin B_{12} supplement with soybean oil meal rations to pigs in dry lot was greatest while the pigs were young and decreased as they became older (48). If an antibiotic supplement that contained B_{12} were used with a vitamin B_{12} deficient ration it would be impossible to distinguish between the effect of the B_{12} and the effect of the antibiotic.

A greater response from an antibiotic in the early than in the later part of an experiment could be the result of exposure to infection or to the presence of a sub-clinical infection in the pigs at the beginning of the experiment which the antibiotic helped to ward off or overcome rather than the result of the age of the pigs.

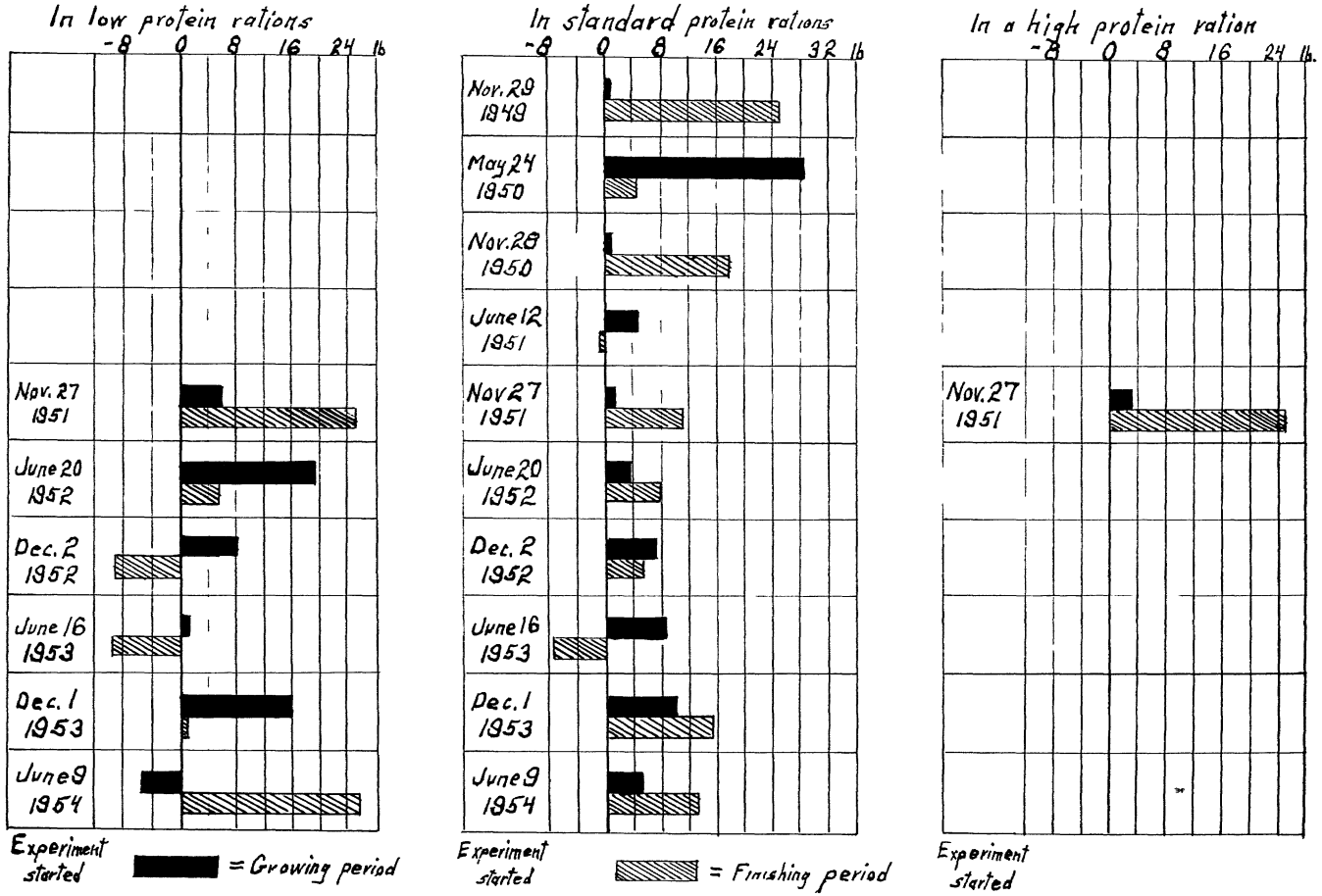

CHART 1.—Feed saved per 100 pounds of gain in the growing period and in the finishing period by an antibiotic.

Feeding an antibiotic to pigs with diarrhea or an enteric disorder often results in a marked improvement in their health and performance. In their review of the value of antibiotics in the nutrition of swine, Braude, Wallace and Cunha (8) reported that "under certain conditions of stress such as inadequate rations and digestion disorders the antibiotic effect is much more pronounced." Although antibiotics may give a greater response with deficient than with good rations their use should not be regarded as an alternative for the use of adequate rations.

The effect of antibiotic feeding is more striking in the case of runts than in the case of normal pigs. In twelve experiments with runts, the average growth stimulation was 82.2 percent (8).

That healthy pigs show less response than runts or pigs with enteric disorders, that different groups of pigs vary in their time of maximum response and that the promotion of growth by different antibiotics reflect differences in their antibacterial properties indicate the response from an antibiotic is the result of its ability to inhibit the growth of microorganisms that are harmful to their host. Enteric infections result in a thickening of the intestinal wall. This interferes with the utilization of feed. A reasonable explanation of the response from an antibiotic is that the antibiotic aids in keeping the intestinal wall in a more healthy and more permeable condition. This would facilitate absorption and result in a saving in feed per unit of gain.

DIFFERENT ANTIBIOTICS IN RATIONS FOR PIGS

Crystalline aureomycin, a terramycin supplement, procaine penicillin and a bacitracin supplement were compared for feeding with a ration of corn, soybean oil meal, ground alfalfa, a B vitamins concentrate, a B_{12} supplement, irradiated yeast and minerals in an experiment started November 28, 1950.

Pre-mixes of a riboflavin mixture, calcium pantothenate, niacin, a dry choline chloride mixture, a B_{12} supplement, soybean oil meal and the particular antibiotic or antibiotic supplement to be used were prepared. These were made up to supply the desired amounts of the antibiotic and of the various B vitamins when the pre-mix constituted 0.4 percent of the ration. The amounts used were such as would supply 300, 1000, 1350, 1500, and 1.0 mg. of riboflavin, calcium pantothenate, niacin, choline chloride, and vitamin B_{12}, respectively, per 100 pounds of feed. Each antibiotic or antibiotic supplement was included in its particular pre-mix at a rate which supplied 0.5 gm. of antibiotic per 100 pounds of feed.

There was no difference in either the rapidity or the efficiency of the gains of the pigs fed procaine penicillin and those fed crystalline aureomycin. The pigs fed the terramycin supplement gained as rapidly but required 2.7 percent more feed per 100 pounds of gain than those fed aureomycin. The pigs fed the bacitracin supplement made both

TABLE 15.—Comparison of Antibiotics For Pigs in Dry Lot

	3	8	9	10
Started Nov. 28, 1950	Corn B vitamins Soybean oil meal Ground alfalfa Minerals B_{12} supplement **Aureomycin**	Corn B vitamins Soybean oil meal Ground alfalfa Minerals B_{12} supplement **Terramycin**	Corn B vitamins Soybean oil meal Ground alfalfa Minerals B_{12} supplement **Procaine penicillin**	Corn B vitamins Soybean oil meal Ground alfalfa Minerals B_{12} supplement **Bacitracin**
Av. days of age at start	69	68	67	67
Pigs at start	14	14	14	14
Initial weight per pig, lb.	49.8	50.1	49.8	49.9
Pigs at close	14	14	14	13
Final weight per pig, lb.	221.9	223.5	224.3	217.7
Average daily gain, lb.	**1.76**	**1.77**	**1.78**	**1.69**
Days to gain 180 pounds	97	97	96	101
Daily feed per pig, lb.:				
Corn	4.69	4.85	4.76	4.64
Pre-mix*	0.01	0.02	0.02	0.02
Soybean oil meal	1.14	1.17	1.14	1.13
Ground alfalfa	0.31	0.33	0.32	0.31
Minerals	0.15	0.15	0.15	0.14
Total	6.30	6.52	6.39	6.24
Feed per 100 lb. gain, lb.:				
Corn	266.92	274.12	267.55	274.86
Pre-mix*	0.83	1.22	0.83	1.04
Soybean oil meal	64.67	66.05	64.26	66.80
Ground alfalfa	17.94	18.42	17.95	18.49
Minerals	8.37	8.60	8.39	8.62
Total	**358.73**	**368.41**	**358.98**	**369.81**
Cost of feed per 100 lb. gain	$11.71	$12.62	$11.72	$11.98

*Other than soybean oil meal.

slower and less efficient gains than those fed aureomycin or those fed procaine penicillin. The results of the one comparison are not regarded as conclusive.

A review of the use of antibiotics in pig feeding by Braude, Wallace and Cunha (8) which analyzed the results of trials reported up to the beginning of 1952, most of which were carried on in the United States, showed that aureomycin and terramycin gave a greater response than penicillin, bacitracin or streptomycin. The authors pointed out, however, that the number of tests available for such comparisons differed widely and that the quantities of antibiotic added were not always the same.

In most of the trials the various antibiotics were fed at the following rates per 100 pounds of feed: aureomycin, 0.45 to 1.0; terramycin, 0.5 to 1.0; penicillin, 0.1 to 1.0; bacitracin, 0.5 to 1.5; and streptomycin, 1.0 to 2.5 gm.

In some of the trials the lower level of penicillin used may have been responsible for a less favorable showing from it than from the aureomycin or terramycin with which it was compared. Briggs, Elrod and Beeson (11) found that with both a mixed protein and an all plant protein concentrate ration 500 mg. (0.5 gm.) were more effective than 250 mg. and that 250 mg. were more effective than 125 mg. of procaine penicillin per 100 pounds of feed. In a later review on antibiotics in nutrition Braude et al. (7) reported that under British conditions a large scale trial with aureomycin and penicillin showed no appreciable difference between the two.

Since it compared favorably with aureomycin and terramycin in a number of experiments when it was fed on an equivalent basis, presumably procaine penicillin inhibits the types of harmful organisms commonly found in the intestinal tract of swine. Apparently it is usually an effective antibiotic for pigs, but possibly, since aureomycin and terramycin have a wider spectral range or inhibit the growth of a wider variety of microorganisms, some instances might occur in which they would prove more effective than procaine penicillin.

Other antibiotics that have been tried by one or more investigators include chloramphenicol or chloromycetin (2, 17, 32, 33, 34, 37, 50, 56, 57, 58, 59) which gave a poor to fair response and neomycin (2, 39, 40, 52) subtilin (52) nisin (1) and rimocidin (41) which had little or no effect. Chloramphenicol has a wide spectral range but is absorbed through the gastric wall so rapidly that it fails to reach the intestinal tract in sufficient quantities to have more than a relatively weak effect on growth and on efficiency of feed utilization.

SECTION 2

An Antibiotic in the Ration of Pigs on Pasture

AN ANTIBIOTIC SUPPLEMENT WITH A MIXED PROTEIN CONCENTRATE

A pasture experiment, in which rations that contained an antibiotic supplement, an antibiotic and a B_{12} supplement and an antibiotic, a B_{12} supplement and a B vitamins concentrate, were compared with a similar ration without them, was started May 22, 1951. Twenty pigs were used to the lot. Each lot was on 1.33 acres of pasture which consisted of a mixture of timothy, alfalfa and a very small amount of ladino clover. A hay crop was removed from the plots the latter part of June. Self feeding was practiced. The corn was shelled and ground and the feeds were mixed to provide rations containing 14 percent of protein before and 12 percent of protein after the pigs averaged approximately 125 pounds in weight. Meat scraps and soybean oil meal in a 1:2 ratio served as the protein concentrate. A mineral mixture of iodized salt, 19.2; limestone, 38.4; special steamed bone meal, 38.4; ferrous sulfate, 3.9; cobaltous chloride, $Co_2 . 6 H_2O$, 0.1 was used. Table 16 gives the results of the experiment.

Pigs fed an antibiotic, terramycin, supplement at a rate which supplied 1.0 gm. of antibiotic per 100 pounds of feed made no more rapid and no more efficient gains than pigs fed a similar ration without it.

Pigs fed the antibiotic and a B_{12} supplement at a rate which supplied one mg. of B_{12} per 100 pounds of feed gained 2.6 percent more rapidly, were ready for market 3 days earlier and required 1.5 percent less feed per 100 pounds of gain than the pigs without them.

The performance of pigs given a B vitamins concentrate as well as the antibiotic and the B_{12} supplement was not appreciably different from that of pigs without these materials included in their ration. The B vitamins concentrate was fed at a rate which supplied 300, 600, 1350, 1500 and 9 mg. of riboflavin, calcium pantothenate, niacin, choline chloride, and folic acid, respectively, per 100 pounds of feed.

Each addition increased the cost of the ration without an adequate compensating increase in the efficiency or in the rapidity of the gains. There was no time when ample quantities of pasture were not available. Presumably, the pigs in the various groups were healthy at the start and remained so throughout the experiment.

TABLE 16.—An Antibiotic Supplement; (2) a B_{12} and Antibiotic Supplement and (3) a B_{12}, Antibiotic Supplement and a B Vitamins Concentrate for Self Fed Pigs on Mixed Pasture

	1	2	3	4
Experiment started May 22, 1951 Corn shelled and ground Feeds mixed and self fed	Corn Protein concentrate Minerals	Corn Protein concentrate **Antibiotic supplement** Minerals	Corn Protein concentrate B_{12} and **antibiotic supplement** Minerals	Corn Protein concentrate B_{12} and **antibiotic supplement B vitamins concentrate** Minerals
Av. days of age at start	55	55	55	56
Pigs at start	20	20	20	20
Initial weight per pig, lb.	32.5	33.1	32.1	32.6
Pigs at close	19	19	19	19
Final weight per pig, lb.	214.7	212.7	208.9	214.7
Average daily gain, lb.	**1.63**	**1.61**	**1.67**	**1.62**
Days to gain 180 pounds	111	112	108	111
Daily feed per pig, lb.:				
Ground shelled corn	4.81	4.76	4.84	4.78
Protein concentrate	0.64	0.64	0.67	0.64
Antibiotic supplement		0.01		
B_{12} and antibiotic supplement			0.02	0.02
B vitamins concentrate				0.01
Minerals	0.14	0.12	0.12	0.11
Total	5.59	5.53	5.65	5.56
Feed per 100 lb. gain, lb.:				
Ground shelled corn	295.12	295.72	289.75	294.82
Protein concentrate	39.27	39.64	39.79	39.70
Antibiotic supplement		0.69		
B_{12} and antibiotic supplement			0.95	0.96
B vitamins concentrate				0.51
Minerals	8.48	7.80	7.35	6.98
Total	**342.87**	**343.85**	**337.84**	**342.97**
Cost of feed per 100 lb. gain	$10.22	$10.69	$10.66	$11.03
Cost of feed and pasture per 100 pounds of gain	$11.45	$11.93	$11.86	$12.27

Pasture was a mixture of alfalfa, timothy and a very small amount of Ladino alover.

Protein concentrate—Meat scraps, 55%, 1; toasted, solvent extracted soybean oil meal, 44%, 2.

Minerals—Iodized salt, 19.2; limestone, 38.4; special steamed bone meal, 38.4; ferrous sulfate, 3.9; cobaltous chloride, $CoCl_2 . 6H_2O$, 0.1.

The antibiotic supplement was Bi-Con TM 5 which is a terramycin supplement containing 5 gm. of terramycin hydrochloride to the pound. It and Merck and Company's B_{12} supplement containing 12.5 mg. of B_{12} per pound were mixed in the ratio of 20:8 for the B_{12} and antibiotic supplement for Lots 3 and 4.

Removals: Lot 1, 177.0 lb. pig on 84th day, lame; Lot 2, 202.5 lb. pig on 98th day, lame; Lot 3, 173.5 lb. pig on 98th day, lame; Lot 4, 66.0 lb. pig on 28th day, lame.

AN ANTIBIOTIC WITH SOYBEAN OIL MEAL AS THE PROTEIN CONCENTRATE

A second pasture experiment in which feeding an antibiotic was tried was started May 22, 1952. Mixed alfalfa, ladino clover and timothy pasture which was clipped late in May and again in August was used. Each lot of 20 pigs was on an acre of pasture. The pigs were fed as much shelled corn as they would eat readily twice a day. A supplement of soybean oil meal, 86; minerals, 14 was fed at the rates of 0.29 and 0.335 pound per head twice a day before and after the pigs averaged 120 pounds in weight, respectively. The mineral mixture was the

TABLE 17.—An Antibiotic for Hand Fed Pigs on Mixed Alfalfa, Ladino and Timothy Pasture

Experiment started May 20, 1952	1	2
Pigs given a definite amount of supplement and a full feed of shelled corn twice daily	Shelled corn Soybean oil meal Minerals	Shelled corn Soybean oil meal **Antibiotic** Minerals
Average days of age at start	58	57
Pigs at start	20	20
Initial weight per pig, lb.	36.7	37.2
Pigs at close	20	20
Final weight per pig, lb.	218.0	224.0
Average daily gain, lb.	**1.44**	**1.48**
Days to gain 180 pounds	126	122
Daily feed per pig, lb.:		
Shelled corn	4.03	4.11
Soybean oil meal	0.53	0.53
Minerals	0.09	0.09
Total	4.65	4.73
Feed per 100 lb. gain, lb.:		
Shelled corn	280.21	277.28
Soybean oil meal	37.06	35.83
Minerals	6.03	5.83
Total	**323.30**	**318.94**
Cost of feed per 100 lb. gain	$ 9.03	$ 9.10
Cost of feed and pasture per 100 pounds of gain	$10.42	$10.45

same as that used in the previous experiment. One group was fed crystalline aureomycin. It was included in the supplement at the rates of 3 and 5 gms. per 100 pounds of supplement, before and after the pigs averaged 120 pounds in weight, respectively. This averaged 0.57 gm. of aureomycin per 100 pounds of total feed. Table 17 shows the results secured.

The pigs given the antibiotic gained 2.8 percent more rapidly, were ready for market 4 days earlier, and required 1.3 percent less feed per 100 pounds of gain than pigs fed a similar ration without it. Stated differently, the performance of the pigs with the antibiotic was not greatly different from the performance of those without it. Based on its prevailing price in an antibiotic supplement, the feed saved by it per 100 pounds of gain produced was not sufficient to cover the cost of the antibiotic.

AN ANTIBIOTIC WITH A STANDARD AND A REDUCED AMOUNT OF PROTEIN

A third experiment in which an antibiotic was fed to pigs on pasture was started May 26, 1953. Twenty pigs were used to the lot. Each lot was on an acre of ladino clover which was clipped a few days before the start of the experiment. Each of three lots was fed a given amount of supplement and as much shelled corn as they would eat readily twice a day. Table 18 gives the results of the experiment.

Before and after they averaged 120 pounds in weight the pigs in Lots 1 and 2 were fed 0.29 and 0.33 pound of supplement per pig twice a day. The supplement was a mixture of soybean oil meal, 86; minerals, 14. The mineral mixture was the same as that used in the other pasture experiments.

Before and after the pigs in Lot 2 averaged 120 pounds in weight they were fed 3 gm. and 5 gm. of crystalline aureomycin, respectively, in each 100 pounds of supplement. This averaged 0.56 gm. of antibiotic per 100 pounds of total feed. The pigs with the antibiotic gained at approximately the same rate and required as much feed per unit of gain as those without it.

Before and after they averaged 120 pounds in weight the pigs of Lot 3 were fed 0.15 and 0.16 pound of supplement per head twice a day. The supplement was a mixture of soybean oil meal, 72.0; minerals, 28. They received 40.6 percent as much protein concentrate daily a head as the pigs in Lot 2. Before and after they reached a weight of 120 pounds the pigs of Lot 3 were fed 6 gm. and 10 gm. of crystalline aureomycin to each 100 pounds of supplement. This averaged 0.55 gm. of antibiotic per 100 pounds of total feed.

TABLE 18.—An Antibiotic With a Standard Protein Ration for Hand Fed Pigs on Ladino Clover Pasture

Experiment started May 26, 1953	1	2	3
Pigs given a definite amount of supplement and a full feed of shelled corn twice daily	Shelled corn Soybean oil meal Minerals	Shelled corn Soybean oil meal Minerals **Crystalline aureomycin**	Shelled corn Soybean oil meal (reduced amount) Minerals **Crystalline aureomycin**
Average days of age at start	62	62	62
Pigs at start	20	20	20
Initial weight per pig, lb.	45.6	45.9	45.8
Pigs at close	20	18	20
Final weight per pig, lb.	214.9	217.2	220.5
Average daily gain, lb.	**1.34**	**1.35**	**1.39**
Days to gain 175 pounds	131	130	127
Daily feed per pig, lb.:			
Shelled corn	3.84	3.93	4.22
Soybean oil meal	0.53	0.54	0.22
Minerals	0.09	0.09	0.09
Total	4.46	4.56	4.53
Feed per 100 lb. gain, lb.:			
Shelled corn	286.16	290.74	304.61
Soybean oil meal	39.68	39.87	16.04
Minerals	6.46	6.49	6.24
Total	**332.30**	**337.10**	**326.89**
Cost of feed per 100 lb. gain	$ 9.32	$ 9.68	$ 8.83
Cost of feed and pasture per 100 pounds of gain	$10.81	$11.16	$10.27

Two pigs out of Lot 2 on 84th day, weight 303.0 lb.

Until the pigs in Lot 3 reached a weight of 120 pounds their ration contained approximately 11.1 percent of protein. Thereafter it contained approximately 10.1 percent of protein. To a weight of 120 pounds the rations for the pigs in Lots 1 and 2 contained approximately 14.2 and 14.5 percent of protein, respectively. From then on their rations each contained approximately 12.0 percent of protein.

Although it was an unusually dry season, the pigs of Lot 3 gained 3 percent faster and required 3 percent less feed per 100 pounds of gain, than those of Lot 2 with a larger amount of protein concentrate.

No lot with a reduced amount of protein and without an antibiotic in their ration was included in the experiment.

A LOW PROTEIN RATION WITHOUT AND WITH AN ANTIBIOTIC IN IT

In an experiment started May 25, 1954, shelled corn was supplemented with (1) minerals, (2) minerals and a small amount of soybean oil meal, (3) minerals, a small amount of soybean oil meal and crystalline aureomycin and (4) minerals and a larger amount of soybean oil meal. There were 20 pigs to the lot. Each lot was on an acre of Ladino clover. The pasture was clipped early in June. With Ladino clover this was unnecessary except to get rid of the few weeds that were present. The pigs were fed a definite allowance of their supplemental mixture and as much shelled corn as they would eat readily twice daily. The minerals were iodized salt, 19.2; pulverized limestone, 38.4; special steamed bone meal, 38.4; ferrous sulfate, 4.0.

To get them to consume their minerals, before and after they averaged 120 pounds in weight, the pigs of Lot 1 were fed 0.15 and 0.16 pound of a mixture of ground shelled corn, 72.0; minerals, 28.0 percent, a head twice daily.

Unfortunately, the rainfall in June, July, and August, 1954, was 50 percent of the average for the same months in the 67 preceding years. As a consequence, an insufficient amount of green material was available, particularly during the latter part of the experiment. During the time ample quantities were available the pigs of Lot 1 ate noticeably larger amounts of pasture than those in the other lots. Before and after the pigs in Lot 1 averaged 120 pounds in weight they gained 101.0 and 82.9 percent as rapidly and required 7.1 and 17.2 percent more feed per 100 pounds of gain than the pigs in Lot 2 having a small amount of soybean oil meal. Having much less pasture than they would have consumed if an ample quantity had been available was probably chiefly responsible for the relatively less favorable showing made by Lot 1 after than before a weight of 120 pounds was reached.

For the entire time the pigs given a small amount of soybean oil meal ate no more feed daily a head but gained more rapidly, were ready for market 12 days earlier, required an average of 10.9 percent less feed per 100 pounds of gain and made more economical gains than those given no soybean oil meal with corn and minerals.

The pigs given a more liberal allowance of soybean oil meal gained faster, were ready for market 6 days earlier and required 1.4 percent less feed per 100 pounds of gain but made less economical gains than those given a smaller allowance of soybean oil meal. Before and after they averaged 120 pounds in weight Lot 4 which was on the more liberal allowance was given 0.29 and 0.33 pound of supplement per head twice daily. Their supplemental mixture was one of soybean oil meal, 86.0; minerals, 14.0.

TABLE 19.—An Antibiotic With a Low Protein Ration for Hand Fed Pigs on Ladino Clover Pasture

Started May 25, 1954	1	2	3	4
	Ladino Clover Pasture			
Pigs fed a definite amount of minerals and protein concentrate and a full feed of shelled corn twice daily	Shelled corn Minerals	Shelled corn Soybean oil meal Minerals	Shelled corn Soybean oil meal **Crystalline aureomycin** Minerals	Shelled corn Soybean oil meal Minerals
Av. days of age at start	61	61	61	60
Pigs at start	20	20	20	20
Initial weight per pig, lb.	43.6	43.7	43.3	43.8
Pigs at close	18	20	19	19
Final weight per pig, lb.	204.2	209.6	204.6	209.0
Average daily gain, lb. :	**1.21**	**1.32**	**1.35**	**1.38**
Days to gain 180 pounds	149	137	133	131
Daily feed per pig, lb. :				
Shelled corn	4.40	4.03	4.15	3.83
Soybean oil meal		0.22	0.22	0.53
Minerals	0.09	0.09	0.09	0.09
Total	4.49	4.34	4.46	4.45
Feed per 100 lb. gain, lb. :				
Shelled corn	362.97	306.45	306.68	278.58
Soybean oil meal		16.79	16.50	38.21
Minerals	7.18	6.53	6.42	6.22
Total	**370.15**	**329.77**	**329.60**	**323.01**
Cost of feed per 100 lb. gain	$ 9.29	$ 8.67	$ 8.89	$ 9.10
Cost of feed and pasture per 100 pounds of gain	$10.94	$10.19	$10.37	$10.55

Removals: Lot 1, 104.5 lb. pig on 56th day; 195.5 lb. pig on 112th day; Lot 3, 115.0 lb. pig on 56th day; Lot 4, 173.0 lb. pig on 112th day.

The pigs with crystalline aureomycin and a small allowance of soybean oil meal ate approximately one-tenth of a pound more feed daily a head, made slightly faster gains and were ready for market 4 days earlier than those with a small allowance of soybean oil meal but without the antibiotic There was practically no difference in the amounts of feed required per unit of gain by the pigs without and by those with the antibiotic.

Lots 2 and 3 were fed a supplemental mixture of soybean oil meal, 72.0; minerals, 28.0. This was fed at the rate of 0.15 and 0.16 pound per head twice daily in the growing and finishing period, respectively. The division was made at a weight of approximately 120 pounds. Before and after they averaged 120 pounds in weight the pigs in Lot 3 were fed 6.0 and 10.0 gms. of crystalline aureomycin, respectively, in each 100 pounds of the supplemental mixtures. This averaged 0.55 and 0.49 gm. for the growing and finishing period, respectively, and 0.52 gm. of crystallin aureomycin for the entire time per 100 pounds of total feed.

SECTION 3

Different Levels of Protein Without and With an Antibiotic in the Ration

EXPERIMENT 1

To secure information as to whether an antibiotic reduces the amount of protein concentrate that is needed by pigs an experiment was started November 27, 1951, in which low, standard, and high protein rations without and with an antibiotic in them were fed. The rations were made up of ground shelled corn, a B vitamins concentrate, soybean oil meal, ground alfalfa, irradiated yeast, and minerals. Ground alfalfa was fed at the rate of 5 percent of the total feed. The minerals were a mixture of iodized salt, 19.2; limestone, 38.4; special steamed bone meal, 38.4; ferrous sulfate, 3.9; cobaltous chloride, $CoCl_2 . 6 H_2O$, 0.1. The minerals were used at rates which kept the mineral content of the rations approximately the same. Irradiated yeast provided vitamin D. It was fed at the rate of 0.01 percent or 0.2 pound per ton of total feed. The B vitamins concentrate was used at a rate which supplied 300, 600, 1350, 1500, 9 and 75 mg. of riboflavin, calcium pantothenate, niacin, choline chloride, folic acid and pyridoxine hydrochloride, respectively, per 100 pounds of feed. Crystalline aureomycin at the rate of 0.45 gm. per 100 pounds of feed was used as the antibiotic.

Alfalfa which contained 15.0, corn which contained 7.6, and soybean oil meal which contained 43.3 percent of protein were used in the experiment. The protein level of the rations was changed by decreasing the corn and increasing the soybean oil meal in the mixtures. The percentages of soybean oil meal and of protein in each ration, before and after the pigs receiving it averaged approximately 120 pounds in weight, and the results secured from the various rations are shown in Table 20.

TABLE 20.—Different Levels of Protein Without and With an Antibiotic in Soybean Oil Meal Rations

Started Nov. 27, 1951	1	2	3	4	5	6
The corn was ground and the feeds were mixed and self fed	Corn, B vitamins concentrate, soybean oil meal, ground alfalfa, irradiated yeast, and minerals					
	Without antibiotic			**With antibiotic**		
Level of protein	**Low**	**Stand-ard**	**High**	**Low**	**Stand-ard**	**High**
Protein to 120 lb., percent	12.4	15.3	18.2	12.4	15.3	18.2
Protein from 120 lb., percent	10.4	13.4	16.3	10.4	13.4	16.3
Soybean oil meal to 120 lb., %	13.0	21.2	29.2	13.0	21.2	29.2
Soybean oil meal from 120 lb., %	7.5	15.8	23.9	7.5	15.8	23.9
Av. days of age at start	63	63	63	63	65	63
Pigs at start	15	15	15	15	15	15
Initial weight per pig, lb.	45.8	45.6	45.5	45.8	45.5	45.4
Pigs at close	15	15	15	15	15	15
Final weight per pig, lb.	209.9	211.3	206.9	213.3	209.0	211.1
Average daily gain, lb.	**1.62**	**1.58**	**1.54**	**1.71**	**1.62**	**1.64**
Days to gain 180 pounds	111	115	118	106	112	110
Daily feed per pig, lb.:						
Corn	4.81	4.23	3.72	4.81	4.22	3.87
B vitamins concentrate	0.009	0.009	0.008	0.009	0.009	0.009
Soybean oil meal	0.58	1.02	1.45	0.59	1.03	1.50
Ground alfalfa	0.29	0.28	0.28	0.29	0.28	0.29
Minerals	0.16	0.14	0.11	0.16	0.14	0.12
Total	5.85	5.68	5.57	5.86	5.68	5.79
Feed per 100 lb. gain, lb.:						
Corn	296.19	268.01	241.85	281.49	260.63	236.12
B vitamins concentrate	0.54	0.54	0.54	0.51	0.53	0.53
Soybean oil meal	35.45	64.74	94.71	34.32	63.71	91.27
Ground alfalfa	18.00	17.99	18.13	17.13	17.53	17.64
Minerals	9.74	8.52	7.34	9.27	8.28	7.19
Total	**359.92**	**359.80**	**362.57**	**342.72**	**350.68**	**352.75**
Cost of feed per 100 lb. gain	$10.77	$11.46	$12.24	$10.51	$11.42	$12.13

When no antibiotic was included in the rations the pigs on the standard surpassed those on the high and the pigs on the low surpassed those on the standard protein ration in daily feed consumption and in rapidity of gains. There was practically no difference in the amounts of feed required per 100 pounds of gain. Apparently so far as the rapidity and the efficiency of the gains were concerned, even the low protein ration contained an adequate amount of protein.

When an antibiotic was used the pigs that received the low again performed as well as those that received the standard or those that received the high protein ration. However, regardless of whether the low, the standard, or the high protein ration was fed, the pigs with the antibiotic gained a little more rapidly and required a little less feed per 100 pounds of gain than those without the antibiotic.

Until a weight of approximately 120 pounds was reached the pigs on the low, those on the standard, and those on the high protein ration with the antibiotic gained 6.0, 4.4 and 3.3 percent faster and required 1.9, 0.5 and 1.7 percent less feed per 100 pounds of gain, respectively, than those on the corresponding ration without the antibiotic. From approximately 120 to 220 pounds in weight the pigs on the low, those on the standard and those on the high protein ration with the antibiotic gained 5.3, 2.0 and 8.2 percent faster and required 6.2, 2.9 and 6.0 percent less feed per 100 pounds of gain, respectively, than those on the corresponding ration without it. For the entire time the pigs on the low, those on the standard, and those on the high protein ration with the antibiotic gained 5.6, 2.5 and 6.5 percent faster and required 4.8, 2.5 and 2.7 percent less feed per 100 pounds of gain, respectively, than those on the corresponding ration without it.

Slaughter and cut-out data which were obtained on representative pigs from each group are presented in Section 4.

EXPERIMENT 2

Low and standard protein rations (1) without either, (2) with a B vitamins concentrate, and (3) with both a B vitamins concentrate and crystalline aureomycin included in them were fed in a second experiment which was started June 10, 1952. Pigs varying more than was desirable but having an average initial weight of approximately 42 pounds were used in the test. The basal rations consisted of ground shelled corn, soybean oil meal, ground alfalfa, irradiated yeast and minerals. The corn, soybean oil meal and ground alfalfa contained 8.0, 45.9 and 16.7 percent of protein, respectively. The B vitamins concentrate was fed at the same level as before. The aureomycin was fed at

TABLE 21.—An Antibiotic and a B Vitamins Concentrate With Low and Standard Protein Soybean Oil Meal Rations

Started June 10, 1952	1	2	3	4	5	6
	Corn, soybean oil meal, ground alfalfa, irradiated yeast, and minerals					
Feeds mixed and self fed			**With B vitamins concentrate**		**With B vitamins concentrate and antibiotic**	
Level of protein	**Low**	**Standard**	**Low**	**Standard**	**Low**	**Standard**
Protein to 120 lb., percent	12.0	16.5	11.9	16.5	11.9	16.5
Protein from 120 lb., percent	10.0	14.5	10.0	14.5	10.0	14.5
Soybean oil meal to 120 lb., %	10.0	21.6	9.8	21.6	9.8	16.5
Soybean oil meal from 120 lb., %	4.8	16.4	4.6	16.4	4.6	16.4
Av. days of age at starte	66	66	64	65	65	65
Pigs at start	10	10	10	10	10	10
Initial weight per pig, lb.	41.8	41.7	41.1	41.8	41.5	41.9
Pigs at close	10	10	10	10	10	10
Final weight per pig, lb.	223.4	222.4	219.7	223.6	223.9	219.9
Average daily gain, lb.	**1.54**	**1.48**	**1.47**	**1.60**	**1.66**	**1.60**
Days to gain 180 pounds	117	122	123	113	109	113
Daily feed per pig, lb.:						
Corn	4.91	4.09	4.80	4.14	5.23	4.02
B vitamins concentrate			0.01	0.01		
B vitamins concentrate with antibiotic					0.01	0.01
Soybean oil meal	0.39	1.02	0.38	1.02	0.41	1.00
Ground alfalfa	0.29	0.27	0.28	0.28	0.31	0.27
Minerals	0.17	0.14	0.17	0.13	0.18	0.13
Total	5.76	5.52	5.64	5.58	6.14	5.43
Feed per 100 lb. gain, lb.:						
Corn	317.96	276.21	327.30	259.14	315.84	251.22
B vitamins concentrate			0.58	0.52		
B vitamins concentrate with antibiotic					0.56	0.51
Soybean oil meal	25.65	68.72	25.52	63.67	24.64	62.64
Ground alfalfa	18.66	18.65	19.20	17.45	18.53	16.97
Minerals	10.90	9.41	11.41	8.31	11.01	8.05
Total	**373.17**	**372.99**	**384.01**	**349.09**	**370.57**	**339.39**
Cost of feed per 100 lb. gain	$10.50	$11.50	$11.21	$11.13	$11.04	$11.05

the rate of 0.45 gm. per 100 pounds of total feed. The percentages of soybean oil meal and of protein in the rations before and after the pigs in each group averaged approximately 120 pounds in weight and the performance of the various groups of pigs are given in Table 21.

The pigs on the low protein basal ration made as much gain per unit of feed and gained 4 percent faster than those on the standard protein basal ration. A better relative showing on the standard and a poorer relative showing on the low protein rations were obtained in the later experiments.

The pigs on the low and the standard protein rations with the B vitamins concentrate in them gained 95.0 and 108.1 percent as rapidly and required 106.8 and 97.2 percent as much feed per unit of gain, respectively, as those on the corresponding rations without the B vitamins concentrate.

The pigs on the low and the standard protein rations with both the B vitamins concentrate and the antibiotic in them gained 12.8 and 0.1 percent faster and required 3.5 and 2.8 percent less feed per 100 pounds of gain than those on the corresponding rations without the antibiotic.

Before an average weight of 120 pounds was reached the pigs on the low and those on the standard protein rations with the B vitamins concentrate and the antibiotic in them gained 18.0 and 7.8 percent faster and required 5.9 and 1.3 percent less feed per 100 pounds of gain than those on the corresponding rations without the antibiotic. After a weight of 120 pounds was reached the pigs on the low and those on the standard protein rations with the B vitamins concentrate and the antibiotic in them gained 108.1 and 95.2 percent as rapidly as and required 1.4 and 2.1 percent less feed per 100 pounds of gain than those on the corresponding rations without the antibiotics. Thus the antibiotic gave a greater response in the early than in the later part of the experiment when a low but not when a standard protein ration was fed.

EXPERIMENT 3

A third experiment in the series was started December 2, 1952. Sixteen pigs with a more nearly uniform initial weight were used to the lot. In this trial both a B_{12} supplement and an antibiotic, aureomycin, supplement were added to the basal rations. An intermediate protein ration with the B_{12} and antibiotic supplements added was included in the comparison. The B vitamins concentrate was fed at a rate which supplied 200, 400, 900, 1000, 6 and 50 mg. of riboflavin, calcium pantothenate, niacin, choline chloride, folic acid and pyridoxine hydrochloride per 100 pounds of feed, respectively. The B_{12} and antibiotic

supplements were fed at rates which supplied 1 mg. of B_{12} and 0.36 gm. of aureomycin per 100 pounds of feed. No pigs were removed from a lot for the slaughter tests until the average final weight was reached. Except for these differences, the plan was similar to that of the preceding experiment. The corn, soybean oil meal, and ground alfalfa contained 7.8, 44.1 and 17.9 percent of protein, respectively. The feed lot results are shown in Table 22.

The pigs on the low protein ration with the B vitamins concentrate gained 13.4 percent faster and required 5.5 percent less feed per unit of gain than the pigs on the low protein ration without it. The pigs on the standard protein ration with the B vitamins concentrate gained 4.2 percent faster and required 3.0 percent less feed per unit of gain than those on the standard protein ration without it.

Without the B vitamins concentrate the standard protein ration resulted in 6.9 percent faster gains, an 8 days earlier marketing time and 2.6 percent greater efficiency of feed utilization than the low protein ration.

The low and the standard protein rations with the B vitamins concentrate and the B_{12} and antibiotic supplements in them resulted in 6.1 and 8.1 percent faster gains and enabled the pigs to be marketed 7 and 9 days earlier than the corresponding rations with the B vitamins concentrate but without the B_{12} and antibiotic supplements. The amounts of feed required per 100 pounds of gain by the pigs on the four rations were practically the same. The difference between the highest and the lowest amount was one percent.

Pigs on the low, intermediate and standard protein rations gained at approximately the same rate and required 356.2, 354.3 and 352.6 pounds of feed per 100 pounds of gain, respectively. The saving in feed was negligible. It did not cover the increased cost that resulted from stepping up the protein content, of the rations.

EXPERIMENT 4

In an experiment started June 16, 1953, low and standard protein rations (1) without cobalt in the minerals, (2) with cobalt, (3) with cobalt and a B vitamins concentrate and (4) with cobalt, a B vitamins concentrate and B_{12} and antibiotic supplements in them were compared.

Reasonably good results were obtained in the two preceding experiments on rations that contained 12.0 and 10.0 percent of protein before and after the pigs averaged 120 pounds in weight. The corn used in one contained 7.8 and in the other, 8.0 percent of protein. The corn, soybean oil meal and ground alfalfa for the 1953 summer experiment

TABLE 22.—A B_{12} and Antibiotic Supplement and a B Vitamins Concentrate With a Low and Standard Protein Soybean Oil Meal Ration

	1	2	3	4	5	7	6
Experiment started Dec. 2, 1952	Corn, soybean oil meal, ground alfalfa, irradiated yeast, and minerals						
Feeds mixed and self fed			With B vitamins concentrate		With B vitamins concentrate and B_{12} and antibiotic supplement		
Level of protein	**Low**	**Standard**	**Low**	**Standard**	**Low**	**Intermediate**	**Standard**
Protein to 120 lb., percent.	12.0	16.0	12.0	16.0	12.0	14.0	16.0
Protein from 120 lb., percent	10.0	14.1	10.0	14.0	10.0	12.0	14.0
Soybean oil meal to 120 lb., %	10.8	21.8	10.3	21.3	10.5	16.0	21.5
Soybean oil meal from 120 lb., %	5.4	16.4	4.9	16.0	4.9	10.6	16.0
Av. days of age at start	62	64	62	63	62	62	62
Pigs at start	16	16	16	16	16	16	16
Initial weight per pig, lb.	45.3	45.2	45.3	45.4	45.4	45.0	45.5
Pigs at close	15	16	16	16	16	16	16
Final weight per pig, lb.	219.5	219.2	218.3	215.4	216.5	218.3	216.9
Average daily gain, lb.	**1.45**	**1.55**	**1.65**	**1.62**	**1.75**	**1.77**	**1.75**
Days to gain 180 pounds	124	116	110	112	103	102	103
Daily feed per pig, lb.:							
Corn	4.62	4.21	4.95	4.23	5.25	4.95	4.55
B vitamins concentrate			0.006	0.006	0.006	0.006	0.006
B_{12} and antibiotic supplement					0.012	0.013	0.012
Soybean oil meal	0.41	1.05	0.44	1.08	0.46	0.82	1.13
Ground alfalfa	0.28	0.28	0.29	0.29	0.31	0.31	0.31
Minerals	0.16	0.15	0.17	0.15	0.18	0.17	0.16
Total	5.47	5.69	5.86	5.76	6.22	6.27	6.17

TABLE 22.—A B_{12} and Antibiotic Supplement and a B Vitamins Concentrate With a Low and Standard Protein Soybean Oil Meal Ration—Continued

Experiment started Dec 2, 1952	1	2	3	4	5	7	6
	Corn, soybean oil meal, ground alfalfa, irradiated yeast, and minerals						
Feeds mixed and self fed			With B vitamins concentrate		With B vitamins concentrate and B_{12} and antibiotic supplement		
Level of protein	**Low**	**Standard**	**Low**	**Standard**	**Low**	**Intermediate**	**Standard**
Feed per 100 lb. gain, lb. :							
Corn	318.08	271 34	300 14	261 54	300 54	279.52	259.95
B vitamins concentrate			0 36	0 36	0 36	0 35	0.35
B_{12} and antibiotic supplement					0 71	0 71	0 71
Soybean oil meal	28.33	67.36	26.82	66 58	26 40	46.25	64.83
Ground alfalfa	18.81	18 33	17.78	17.78	17.81	17 72	17.63
Minerals	10.99	9.53	10.38	9.24	10.40	9.78	9.17
Total	**376.21**	**366.56**	**355.48**	**355.50**	**356.22**	**354.33**	**352.64**
Cost of feed per 100 lb gain	$10.64	$11 30	$10.32	$11.25	$10.63	$11.04	$11.43

contained 8.9, 43.0 and 16.9 percent of protein, respectively. To provide a 10 percent protein ration containing 5 percent of ground alfalfa and corn and soybean oil meal from these supplies would have required only 3 percent of soybean oil meal. Because of the higher protein content of the corn, low protein rations containing 12.5 and 10.5 instead of 12.0 and 10.0 percent of protein before and after the pigs averaged 120 pounds in weight, respectively, were used.

Corn containing as much as 11.0 percent of protein has been produced. A ration made up of it, minerals and 5 percent of alfalfa but containing no protein concentrate would analyze approximately 11.0 percent of protein. Since the protein of corn is relatively high in zein, which is of low nutritional value and is deficient in some of the essential

amino acids, such a ration would not be likely to equal one no higher in protein in which a part of the protein was from a feed the amino acids of which would tend to supplement those of corn. The reasonably satisfactory performance of the pigs on the low protein soybean oil meal rations suggests that soybean oil meal contains the essential amino acids in proportions which make it well adapted for feeding with corn to pigs.

Unlike those on similar rations in some of the earlier experiments the pigs on the standard protein basal ration showed no pronounced deficiency symptoms. There was a wide variability in the rate of gain of those on the low protein basal ration.

The pigs on the low and those on the standard protein rations with cobalt in their minerals gained 9.0 and 3.9 percent faster and required 0.9 and 2.0 percent less feed per 100 pounds of gain, respectively, than those on the corresponding rations without cobalt in their minerals. Before and after it was changed, the low protein basal ration contained 0.07 and 0.04 parts of cobalt per million, respectively. Before and after it was changed, the standard protein basal ration contained 0.11 and 0.06 parts of cobalt per million, respectively.

In three out of four dry lot comparisons a response was secured from including cobalt in a soybean oil meal ration containing a standard amount of protein. In the four comparisons the pigs without and those with the added cobalt gained 1.47 and 1.56 pounds daily a head and required 369 and 356 pounds of feed per 100 pounds of gain, respectively. Added cobalt was of no benefit in two trials on legume pasture.

The pigs on the low protein ration with the B vitamins concentrate gained 1.9 percent faster and required 2.1 percent less feed than those without it. Those on the standard protein ration with the B vitamins concentrate gained 3.2 percent more rapidly and were ready for market 4 days earlier but instead of less, required 0.9 percent more feed per 100 pounds of gain than those without it.

The pigs given the B_{12} and antibiotic supplements with the low protein ration that contained a B vitamins concentrate gained 4.4 percent more rapidly and were ready for market 5 days earlier but required 1.9 percent more feed per 100 pounds of gain than those on the corresponding ration without them.

The pigs given the B_{12} and antibiotic supplements with the standard protein ration that contained a B vitamins concentrate gained 1.3 percent more rapidly, were ready for market one day earlier and required 1.4 percent less feed per 100 pounds of gain than those on the corresponding ration without them.

TABLE 23.—Added Cobalt, a B Vitamins Concentrate and a B_{12} and Antibiotic Supplement With Low and Standard Protein Soybean Oil Meal Rations

	1	2	3	4	5	6	7	8
Experiment started June 16, 1953	Corn, soybean oil meal, ground alfalfa, irradiated yeast, minerals							
Feeds mixed and self fed			**Cobalt**		**Cobalt B vitamins concentrate**		**Cobalt B vitamins concentrate B_{12} and antibiotic supplement**	
Level of protein	**Low**	**Standard**	**Low**	**Standard**	**Low**	**Standard**	**Low**	**Standard**
Protein to 120 lb., percent	12.5	16.0	12.5	16.0	12.5	16.0	12.5	16.0
Protein from 120 lb., percent	10.5	14.0	10.5	14.0	10.5	14.0	10.5	14.0
Soybean oil meal to 120 lb., %	10.2	20.4	10.2	20.4	9.6	19.8	9.6	19.8
Soybean oil meal from 120 lb., %	4.4	14.5	4.4	14.5	3.8	13.9	3.8	13.9
Av. days of age at start	74	74	73	73	72	74	72	72
Pigs at start	16	15	15	15	16	16	16	16
Initial weight per pig, lb.	47.9	47.0	48.6	48 0	47.9	48.1	47.9	47.9
Pigs at close	13	15	15	15	16	16	16	15
Final weight per pig, lb.	214.3	215.5	216.5	213.3	219.0	217.5	215.4	209.7
Average daily gain, lb.	**1.38**	**1.50**	**1.50**	**1.56**	**1.53**	**1.61**	**1.59**	**1.63**
Days to gain 180 lb.	131	120	120	116	118	112	113	110

TABLE 23.—Added Cobalt, a B Vitamins Concentrate and a B_{12} and Antibiotic Supplement With Low and Standard Protein Soybean Oil Meal Rations—Continued

	1	2	3	4	5	6	7	8
Experiment started June 16, 1953	Corn, soybean oil meal, ground alfalfa, irradiated yeast, minerals							
Feeds mixed and self fed	Cobalt				Cobalt B vitamins concentrate		Cobalt B vitamins concentrate B_{12} and antibiotic supplement	
Level of protein	**Low**	**Standard**	**Low**	**Standard**	**Low**	**Standard**	**Low**	**Standard**
Daily feed per pig, lb.:								
Corn	4.50	4.18	4.86	4.26	4.84	4.44	5.15	4.42
B vitamins concentrate					0.006	0.006	0.006	0.006
B_{12} and antibiotic supplement							0.012	0.012
Soybean oil meal	0.35	0.92	0.37	0.93	0.37	0.96	0.37	0.96
Ground alfalfa	0.26	0.27	0.28	0.28	0.28	0.29	0.30	0.29
Minerals	0.15	0.14	0.17	0.14	0.16	0.14	0.18	0.14
Total	5.26	5.51	5.68	5.61	5.66	5.84	6.02	5.83
Feed per 100 lb. gain, lb.:								
Corn	326.89	277.56	323.88	272.80	316.61	275.21	323.24	270.18
B vitamins concentrate					0.37	0.36	0.38	0.36
B_{12} and antibiotic supplement							0.75	0.71
Soybean oil meal	25.01	61.16	24.87	59.27	24.37	59.41	23.31	58.99
Ground alfalfa	19.11	18.30	18.94	17.94	18.54	18.10	18.88	17.84
Minerals	11.18	9.02	11.08	8.85	10.83	8.93	11.06	8.78
Total	**382.19**	**366.04**	**378.77**	**358.86**	**370.72**	**362.01**	**377.62**	**356.86**
Cost of feed per 100 lb. gain	$10.70	$11.12	$10.63	$10.90	$10.67	$11.26	$11.16	$11.41

Removals: Lot 1, two pigs 112th day, 483.5 lb.; one pig 119th day, 222.0 lb.; Lot 8, one pig 84th day, 161.0 lb.

In this trial, adding a B vitamins concentrate and B_{12} and antibiotic supplements to low and standard protein rations that contained cobalt resulted in a 7 and a 6 day earlier marketing time but in more costly gains.

LOW AND STANDARD PROTEIN RATIONS WITHOUT AND WITH CRYSTALLINE AUREOMYCIN IN THEM

Table 24 summarizes the two comparisons of low and standard protein rations without and with crystalline aureomycin added to the basal rations that contained no B_{12} supplement. The average percentages of protein in the rations before and after the pigs averaged approximately 120 pounds in weight and the average percentages of soybean oil meal required to provide these percentages of protein are shown in the table.

With a low protein ration, the antibiotic saved an average of 15.61 pounds of feed per 100 pounds of gain. With a standard protein ration it saved an average of 9.34 pounds of feed per 100 pounds of gain. The pigs on the low and those on the standard protein ration with an antibiotic in it were ready for market 9 and 2 days earlier, respectively, than were those on the corresponding rations without the antibiotic in them. They also made slightly more economical gains than the pigs in the corresponding groups without the antibiotic.

The pigs on the low protein rations without and with an antibiotic in them were ready for market two days later and 5 days earlier and required 4.2 and 2.5 percent more feed per 100 pounds of gain, respectively, than those on the standard protein rations without and with an antibiotic in them. Both groups on the low protein rations made more economical gains than those on the standard protein rations.

LOW AND STANDARD PROTEIN RATIONS WITHOUT AND WITH A B_{12} AND ANTIBIOTIC SUPPLEMENT IN THEM

Table 25 summarizes the two comparisons of low and standard protein rations without and with both a B_{12} and an antibiotic, aureomycin, supplement added to basal rations that contained no B_{12} supplement. It also gives the results with low and standard protein rations that contained no B vitamins concentrate.

As indicated by the rapidity and the efficiency of the gains, a B vitamins concentrate was of greater benefit with a low than with a standard protein ration. In the two experiments the pigs on the basal standard protein, soybean oil meal rations did reasonably well and

TABLE 24.—Summary: An Antibiotic, Crystalline Chlortetracycline, With Low and With Standard Protein Rations

	1	2	3	4
	Ground shelled corn, B vitamins concentrate, soybean oil meal, ground alfalfa, irradiated yeast, and minerals			
	Without antibiotic		**With antibiotic** (crystalline aureomycin)	
Level of protein	**Low**	**Standard**	**Low**	**Standard**
Percent of protein:				
To 120 lb.	12.2	15.8	12.2	15.7
From 120 lb.	10.2	13.9	10.2	13.9
Percent of soybean oil meal:				
To 120 lb.	11.7	21.4	11.7	21.4
From 120 lb.	6.2	16.1	6.1	16.0
Number of experiments	2	2	2	2
Av. days of age at start	63	64	64	64
Pigs at start	25	25	25	25
Initial weight per pig, lb.	43.9	44.1	44.1	44.1
Pigs at close	25	25	25	25
Final weight per pig, lb.	213.8	216.2	217.5	213.4
Average daily gain, lb.	**1.55**	**1.59**	**1.69**	**1.61**
Days to gain 175 pounds	113	111	104	109
Daily feed per pig, lb.:				
Corn	4.81	4.20	4.99	4.14
B vitamins concentrate	0.009	0.008	0.009	0.008
Soybean oil meal	0.48	1.02	0.51	1.02
Ground alfalfa	0.29	0.28	0.30	0.28
Minerals	0.16	0.13	0.17	0.13
Total	5.75	5.64	5.98	5.58
Feed per 100 lb. gain, lb.:				
Corn	309.27	264.26	295.94	256.68
B vitamins concentrate	0.56	0.53	0.53	0.52
Soybean oil meal	31.27	64.29	30.25	63.26
Ground alfalfa	18.50	17.77	17.72	17.30
Minerals	10.45	8.43	10.00	8.18
Total	**370.05**	**355.28**	**354.44**	**345.94**
Cost of feed per 100 lb. of gain	$10.95	$11.32	$10.73	$11.24
Feed saved by antibiotic per 100 pounds of gain, lb.			15.61	9.34

showed no deficiency symptoms. But, since in a number of earlier experiments (45) a source of B vitamins was helpful in maintaining the health of the pigs and in enabling them to grow and develop normally, using a vitamin B-rich feed or a B vitamins concentrate with standard protein soybean oil meal rations for pigs in dry lot is considered advisable. Iodized salt was not used in some of the earlier experiments and cobalt was not included in the minerals.

The pigs on a low protein ration with a B_{12} and antibiotic supplement in it ate a little more feed daily a head, gained 5.0 percent more rapidly and were ready for market 6 days earlier but required an average of 3.75 pounds or 1.0 percent more feed per 100 pounds of gain than those on the low protein ration that contained no B_{12} and antibiotic supplement.

The pigs on the standard protein ration with a B_{12} and antibiotic supplement in it ate a little more feed daily a head, gained 4.3 percent more rapidly, were ready for market 5 days earlier and required an average of 4.08 pounds or 1.1 percent less feed per 100 pounds of gain than those on the standard protein ration that contained no B_{12} and antibiotic supplement.

It did not pay to use a B_{12} and antibiotic supplement in either of the two experiments.

The low protein rations were less effective but because of the smaller percentage of relatively high priced protein concentrate they contained were more economical than were the standard protein rations.

LOW AND STANDARD PROTEIN RATIONS CONTAINING A B_{12} SUPPLEMENT WITHOUT AND WITH AN ANTIBIOTIC SUPPLEMENT IN THEM

In experiments started December 1, 1953, and June 9, 1954, an antibiotic, aureomycin, supplement was added to low and standard protein basal rations that contained a B_{12} supplement and differed in this respect from the basal rations used in the experiments reported in Tables 24 and 25. The antibiotic supplement was fed at a rate which supplied 0.45 gm. of aureomycin per 100 pounds of total feed. The results of the two experiments are summarized in Table 26.

The use of an antibiotic supplement with low and with standard protein rations that contained a B_{12} supplement resulted in faster gains, enabled the pigs to be marketed 6 and 3 days earlier and saved 8.31 and 9.68 pounds of feed per 100 pounds of gain produced, respectively.

TABLE 25.—Summary: A Vitamin B_{12} and Antibiotic Supplement With Low and With Standard Protein Rations

	1	2	3	4	5	6
	Ground shelled corn, soybean oil meal, ground alfalfa, irradiated yeast, and minerals					
			B vitamins concentrate		**B vitamins concentrate, B_{12} and antibiotic supplement**	
Level of protein	**Low**	**Standard**	**Low**	**Standard**	**Low**	**Standard**
Percent of protein:						
To 120 lb.	12.2	16.0	12.2	16.0	12.2	16.0
From 120 lb.	10.1	14.0	10.3	14.0	10.3	14.1
Percent of soybean oil meal:						
To 120 lb.	10.5	21.2	10.2	20.8	10.4	21.0
From 120 lb.	4.9	15.5	4.6	15.1	4.6	15.3
Number of experiments	2	2	2	2	2	2
Av. days old at start	68	69	67	69	67	67
Pigs at start	31	32	32	32	32	32
Initial weight per pig, lb.	46.9	46.6	46.6	46.7	46.7	46.7
Pigs at close	30	31	32	32	32	31
Final weight per pig, lb.	217.7	216.4	218.7	216.5	215.9	213.4
Average daily gain, lb.	**1.48**	**1.56**	**1.59**	**1.62**	**1.67**	**1.69**
Days to gain 175 pounds	119	113	111	109	105	104
Daily feed per pig, lb.:						
Corn	4.74	4.24	4.89	4.34	5.20	4.48
Soybean oil meal	0.39	0.99	0.40	1.02	0.41	1.05
Ground alfalfa	0.28	0.28	0.29	0.29	0.31	0.30
B vitamins concentrate			0.006	0.006	0.006	0.006
B_{12} and antibiotic supplement					0.012	0.012
Minerals	0.16	0.14	0.17	0.14	0.18	0.15
Total	5.57	5.65	5.76	5.80	6.12	6.00
Feed per 100 lb. gain, lb.:						
Corn	320.89	272.08	308.34	268.36	311.77	264.87
Soybean oil meal	26.66	63.56	25.60	63.00	24.87	62.02
Ground alfalfa	18.87	18.15	18.15	17.94	18.34	17.74
B vitamins concentrate			0.36	0.36	0.37	0.35
B_{12} and antibiotic supplement					0.73	0.71
Minerals	11.03	9.21	10.61	9.09	10.73	8.98
Total	**377.45**	**363.00**	**363.06**	**358.75**	**366.81**	**354.67**
Cost of feed per 100 lb. gain	$10.63	$11.11	$10.49	$11.25	$10.89	$11.42
Feed saved by antibiotic per 100 pounds of gain, lb.					—3.75	4.08

Pigs on the low protein ration without an antibiotic supplement in it were ready for market 7 days later than those on a standard protein ration without an antibiotic supplement in it. Pigs on the low protein ration with an antibiotic supplement in it were ready for market 4 days later than those on a standard protein ration with an antibiotic in it. Again the low protein rations proved less effective but more economical than the standard protein rations.

AVERAGE RESULTS OF SIX EXPERIMENTS WITH DIFFERENT LEVELS OF PROTEIN WITHOUT AND WITH AN ANTIBIOTIC IN THE RATIONS

Table 27 summarizes the results of the six comparisons of low and standard protein rations without and with crystalline aureomycin, a B_{12} and antibiotic, aureomycin, supplement or an antibiotic, aureomycin, supplement in them. Soybean oil meal was used as the high-protein feed in each of the six comparisons. The low protein rations ranged from 12.0 to 12.5 percent of protein before and from 10.0 to 10.5 percent of protein after a weight of approximately 120 pounds was reached. The standard protein rations ranged from 15.5 to 16.5 percent of protein before and from 13.5 to 14.5 percent of protein after a weight of approximately 120 pounds was reached. Variations in the protein content of the corn used necessitated varying the amounts of soybean oil meal used to provide rations that contained specified amounts of protein. Both the average percentages of protein and the average amounts of soybean oil meal required to supply these percentages are shown in the table.

The pigs on the low protein rations with an antibiotic in them were ready for market 6 days earlier and required 6.06 pounds, or 1.64 percent, less feed per 100 pounds of gain than those on the low protein rations without an antibiotic in them. The pigs on the standard protein rations with an antibiotic in them were ready for market 3 days earlier and required 7.58 pounds, or 2.12 percent, less feed per 100 pounds of gain than those on the standard protein rations without an antibiotic in them.

In one trial in which standard and high protein rations without and with crystalline aureomycin in them were compared the antibiotic saved as much feed per 100 pounds of gain produced when a high protein as when a standard protein ration was used. In six experiments, an antibiotic saved as much feed per unit of gain in standard protein as it did in low protein rations. The data did not indicate that an antibiotic has a specific protein sparing action. If an antibiotic spares protein it should have saved more feed per unit of gain with low protein rations

TABLE 26.—Summary: An Antibiotic Supplement With Low and With Standard Protein Rations Containing a Vitamin B_{12} Supplement

	1	2	3	4
	Ground shelled corn, B vitamins concentrate, B_{12} supplement, soybean oil meal, ground alfalfa, irradiated yeast, and minerals			
	Without antibiotic supplement		**With antibiotic supplement**	
Level of protein	**Low**	**Standard**	**Low**	**Standard**
Percent of protein in ration:				
To 120 lb.	12.0	15.5	12.0	15.5
From 120 lb.	10.0	13.5	10.0	13.5
Percent of soybean oil meal in ration:				
To 120 lb.	10.7	19.9	10.7	19.7
From 120 lb.	4.5	14.1	5.2	14.4
Number of experiments	2	2	2	2
Av. days of age at start	66	67	67	68
Pigs at start	29	29	29	29
Initial weight per pig, lb.	41.4	41.4	41.6	41.4
Pigs at close	27	29	26	29
Final weight per pig, lb.	225.6	220.3	222.5	221.4
Average daily gain, lb.	**1.61**	**1.70**	**1.68**	**1.76**
Days to gain 180 pounds	113	106	107	103
Daily feed per pig, lb.:				
Corn	5.11	4.63	5.22	4.66
B vitamins concentrate	0.006	0.006	0.006	0.006
B_{12} supplement	0.003	0.003	0.003	0.003
Antibiotic supplement			0.008	0.008
Soybean oil meal	0.43	1.00	0.46	1.01
Ground alfalfa	0.30	0.31	0.31	0.31
Minerals	0.17	0.15	0.17	0.14
Total	6.02	6.10	6.18	6.14
Feed per 100 lb. gain, lb.:				
Corn	318.44	272.07	309.85	264.24
B vitamin concentrate	0.37	0.36	0.37	0.35
B_{12} supplement	0.19	0.18	0.18	0.17
Antibiotic supplement			0.46	0.44
Soybean oil meal	26.61	58.81	27.23	57.33
Ground alfalfa	18.75	17.89	18.34	17.41
Minerals	10.63	8.60	10.25	8.29
Total	**374.99**	**357.91**	**366.68**	**348.23**
Cost of feed per 100 lb. gain	$10.85	$11.14	$10 85	$11.04
Feed saved by antibiotic per 100 pounds gain, lb.			8.31	9.68

TABLE 27.—Summary of Six Comparisons of Low and Standard Protein Rations Without and With an Antibiotic, an Antibiotic Supplement or a Vitamin B_{12} and Antibiotic Supplement in Them

	1	2	3	4
	Ground shelled corn, B vitamins concentrate, soybean oil meal, ground alfalfa, irradiated yeast, and minerals			
	Without antibiotic		**With antibiotic**	
Level of protein	**Low**	**Standard**	**Low**	**Standard**
Percent of protein:				
To 120 lb.	12.15	15.75	12.16	15.73
From 120 lb.	10.16	13.81	10.16	13.80
Percent of soybean oil meal:				
To 120 lb.	10.9	20.7	10.9	20.7
From 120 lb.	5.1	15.1	5.2	15.2
Number of experiments	6	6	6	6
Av. days of age at start	66	67	66	67
Pigs at start	86	86	86	86
Initial weight per pig, lb.	44.1	44.2	44.2	44.1
Pigs at close	84	86	83	85
Final weight per pig, lb.	219.4	217.7	218.5	216.1
Average daily gain, lb.	**1.58**	**1.64**	**1.68**	**1.69**
Days to gain 180 pounds	111	107	105	104
Daily feed per pig, lb.:				
Corn	4.94	4.40	5.15	4.44
B vitamins concentrate	0.007	0.004	0.007	0.007
B_{12} supplement	0.001	0.001	0.003	0.003
Antibiotic supplement			0.005	0.005
Soybean oil meal	0.44	1.01	0.46	1.03
Ground alfalfa	0.29	0.29	0.30	0.30
Minerals	0.17	0.14	0.17	0.14
Total	5.85	5.85	6.10	5.92
Feed per 100 lb. gain, lb.:				
Corn	312.16	268.47	306.52	262.29
B vitamins concentrate	0.42	0.41	0.41	0.40
B_{12} supplement	0.07	0.06	0.20	0.19
Antibiotic supplement			0.29	0.28
Soybean oil meal	27.56	61.92	27.25	60.72
Ground alfalfa	18.46	17.87	18.16	17.49
Minerals	10.57	8.73	10.35	8.51
Total	**369.24**	**357.46**	**363.18**	**349.88**
Cost of feed per 100 lb. gain	$10.75	$11.26	$10.83	$11.24
Feed saved per 100 pounds by antibiotic*, lb.			6.06	7.58

*Or antibiotic supplement or, in two trials, a B_{12} and antibiotic supplement.

than with rations that contained larger amounts of protein, which was not the case. An antibiotic does sometimes spare both protein and other nutrients—that is it sometimes has a general feed sparing action.

SECTION 4

Effect of an Antibiotic and of Amount of Protein on Leanness of Hogs

YIELDS OF PORK CUTS OF HOGS FED LOW, STANDARD, AND HIGH PROTEIN RATIONS WITHOUT AND WITH AN ANTIBIOTIC IN THEM

To secure information on the effect of the amount of protein and the effect of an antibiotic in the ration on the leanness or the quality of the pork produced, representative pigs from the various lots in the six experiments with the different levels of protein without and with an antibiotic in them were sent to the Meats Laboratory, Ohio State University for slaughter tests. These tests were made under the supervision of Professors L. E. Kunkle and V. R. Cahill.

Usually five or six pigs from each lot were submitted for the slaughter tests. The pigs were weighed from the feed lots in the morning, trucked approximately 90 miles to the Meats Laboratory, weighed on arrival and then weighed again the following morning at the time of slaughter. The warm carcasses were weighed as they were placed in the cooler, where they were usually left for 48 to 72 hours before they were cut. The chilled carcasses were then weighed and the weights of the various cuts were obtained. Measurements of the back fat thickness at the seventh vertebra and of the length of the carcass from the first rib to the aitch bone were also secured.

An attempt was made to have each animal slaughtered when its shrunk weight would be between 200 and 220 pounds. This sometimes necessitated the removal of one or more animals for slaughter before the lot from which it came was discontinued at an average weight of approximately 220 pounds.

Since high as well as standard and low protein rations were fed in the experiment reported in Table 20, the measurements and slaughter and cut-out data for the pigs from this trial are summarized separately in Table 29.

The lean cuts from the carcasses of the hogs that had received low, standard and high protein rations without an antibiotic in them accounted for 50.4, 50.7, and 51.5, whereas the fat for lard accounted

TABLE 28.—Summary by Periods of Six Comparisons of Low and Standard Protein Rations Without and With an Antibiotic, an Antibiotic Supplement or a Vitamin B_{12} and Antibiotic Supplement in Them

	1	2	3	4
	Ground shelled corn, B vitamins concentrate, soybean oil meal, ground alfalfa, irradiated yeast, and minerals			
	Without antibiotic		**With antibiotic**	
Level of protein	**Low**	**Standard**	**Low**	**Standard**
Period 1—To an average weight of approximately 120 pounds				
Percent of protein	12.15	15.75	12.16	15.73
Percent of soybean oil meal	10.9	20.7	10.9	20.7
Pigs at start	86	86	86	86
Initial weight per pig, lb.	44.1	44.2	44.2	44.1
Final weight per pig, lb.	124.3	122.3	123.2	122.7
Average daily gain, lb.	**1.36**	**1.43**	**1.48**	**1.51**
Daily feed per pig, lb.:				
Corn	3.62	3.16	3.84	3.28
Supplement	0.84	1.25	0.90	1.29
Total	4.46	4.41	4.74	4.57
Feed per 100 lb. gain, lb.:				
Corn	266.86	221.48	259.75	217.02
Supplement	61.93	87.51	60.74	85.73
Total	**328.79**	**308.99**	**320.49**	**302.75**
Feed saved per 100 pounds by antibiotic, lb.			8.3	6.2
Period 2—From an average weight of approximately 120 pounds				
Percent of protein	10.16	13.81	10.16	13.80
Percent of soybean oil meal	5.1	15.1	5.2	15.2
Initial weight per pig, lb.	124.3	122.3	123.2	122.7
Final weight per pig, lb.	219.4	217.7	218.5	214.9
Average daily gain, lb.	**1.85**	**1.86**	**1.89**	**1.88**
Daily feed per pig, lb.:				
Corn	6.47	5.70	6.52	5.67
Supplement	0.98	1.68	1.01	1.68
Total	7.45	7.38	7.53	7.35
Feed per 100 lb. gain, lb.:				
Corn	350.42	306.95	345.31	300.94
Supplement	52.98	90.20	53.29	89.21
Total	**430.40**	**397.15**	**398.60**	**390.15**
Feed saved per 100 pounds by antibiotic, lb.			4.8	7.0

TABLE 29.—Yields of Pork Cuts of Hogs Fed Low, Standard and High Protein Rations Without and With an Antibiotic in Them

	1	2	3	4	5	6
	Corn, B vitamins concentrate, soybean oil meal, ground alfalfa, irradiate yeast, and minerals					
	Without antibiotic			With antibiotic		
Level of protein	**Low**	**Stand-ard**	**High**	**Low**	**Stand-ard**	**High**
Number of pigs	6	7	6	6	5	6
Av. days old at slaughter	178	173	175	175	173	171
Av. daily gain from birth, lb.	1.24	1.25	1.24	1.24	1.26	1.29
Av. weight from feed lot, lb.	220.5	216.8	216.0	216.7	218.0	220.8
Av. weight on arrival, lb.	217.3	213.1	212.5	213.8	213.0	217.7
Av. weight at slaughter, lb.	209.3	208.1	205.3	208.2	206.4	211.8
Av. warm dressed weight, lb.	167.5	163.3	159.7	166.2	161.5	162.9
Av. chilled dressed weight, lb.	163.5	160.3	156.8	163.2	159.0	158.7
Percent of total cuts:						
Skinned hams	17.8	18.1	18.4	17.7	18.3	18.4
Trimmed loins	15.5	15.6	15.6	15.0	15.2	15.8
New York shoulders	14.2	14.3	14.9	14.2	15.4	15.1
Lean trimmings	2.9	2.7	2.6	2.6	2.8	2.5
Total lean cuts	**50.4**	**50.7**	**51.5**	**49.5**	**51.7**	**51.8**
Trimmed bellies	14.9	15.6	15.1	15.1	14.6	14.8
Jowls	3.1	3.1	3.2	3.3	3.1	2.9
Fat for lard	**25.2**	**24.0**	**23.4**	**25.7**	**23.8**	**23.9**
Spare ribs	1.9	2.1	2.2	2.1	2.2	2.2
Miscellaneous cuts	4.5	4.5	4.6	4.3	4.6	4.4
Av. weight of total cuts, lb.	162.5	158.6	156.1	162.6	158.0	157.9
Cuts, percent of slaughter weight	77.6	76.2	76.0	78.1	76.6	74.6
Four primal cuts:						
Percent of slaughter weight	48.4	48.4	48.6	48.5	48.7	47.8
Percent of total cuts	62.4	63.5	63.9	62.1	63.6	64.1
Av. length, in.	29.0	28.7	29.6	29.9	29.5	29.4
Av. thickness of back fat, in.	1.67	1.68	1.52	1.83	1.65	1.67

for 25.2, 24.0, and 23.4 percent of the total weight of the cuts, respectively. The lean cuts from the carcasses of the hogs that had received low, standard, and high protein rations with an antibiotic in them accounted for 49.5, 51.7 and 51.8, whereas the fat for lard accounted for 25.7, 23.8, and 23.9 percent of the total weight of the cuts, respectively.

The lean cuts from the carcasses of the hogs that had been on the low, the standard and the high protein rations with an antibiotic in them made up 0.9 percent less and 1.0 and 0.3 percent more of the total weight of the cuts than those from the carcasses of the hogs that had been on the low, the standard and the high protein rations without an antibiotic in them. The fat for lard from the carcasses of the hogs that had been on the low, the standard and the high protein rations with an antibiotic in them made up 0.5. –0.2 and 0.5 percent more of the weight of the total cuts than that from the carcasses of the hogs that had been on the low, the standard and the high protein rations without an antibiotic in them.

These data indicated that low protein rations resulted in somewhat fatter hogs than standard or high protein rations but that an antibiotic had little effect on the fatness of hogs that were slaughtered at a given weight.

YIELDS OF PORK CUTS OF HOGS FED LOW AND STANDARD PROTEIN RATIONS WITHOUT AND WITH COBALT IN THE MINERALS

A comparison of low and standard protein rations that were made up of corn, soybean oil meal, ground alfalfa, irradiated yeast and a mineral mixture with no cobalt in it was reported in Table 23. Comparisons of similar rations except that cobalt was included in the minerals were reported in Tables 21, 22, and 23. Representative animals from these groups were submitted for slaughter tests. The data for them are presented in Table 30.

The lean cuts and the fat for lard from the carcasses of hogs that had received a standard protein ration with no cobalt in the minerals accounted for 51.5 and 25.4 percent of the total weight of the cuts. On the other hand, the lean cuts and the fat for lard from the carcasses of hogs that had received a low protein ration with no cobalt in the minerals accounted for 47.4 and 28.5 percent of the total weight of the cuts, respectively. Thus, when neither additional B vitamins nor cobalt was included in their rations the carcasses from the hogs fed a standard protein ration carried 4.1 percent more of lean cuts and 3.1 percent less of fat for lard than did those from hogs fed a low protein ration.

The lean cuts and the fat for lard from carcasses of hogs that had received standard protein rations with cobalt included in the minerals but with no B vitamins concentrate in them accounted for 51.4 and 24.7 percent of the total weight of the cuts, respectively. Whereas the lean cuts and the fat for lard from the carcasses of hogs that had received low

protein rations with cobalt included in the minerals but with no B vitamins concentrate in them accounted for 49.2 and 26.7 percent of the total weight of the cuts, respectively. These are differences of 2.2 percent more of the lean cuts and of 2.0 percent less fat for lard in favor of the standard over the low protein rations.

TABLE 30.—Yields of Pork Cuts of Hogs Fed Low and Standard Protein Rations Without and With Cobalt in the Minerals

	1	2	3	4
	Corn, soybean oil meal, ground alfalfa, irradiated yeast, and minerals			
	Without cobalt in minerals		**With cobalt in minerals**	
Level of protein	**Low**	**Standard**	**Low**	**Standard**
Number of pigs	5	7	16	15
Av. days old at slaughter	209	197	186	181
Av. daily gain from birth	1.08	1.12	1.19	1.20
Av. weight from feed lot, lb.	225.9	220.3	220.1	218.0
Av. weight on arrival, lb.	221.4	216.4	215.7	213.6
Av. weight at slaughter, lb.	213.8	210.4	209.5	208.3
Av. warm dressed weight, lb.	171.4	166.1	165.4	163.9
Av. chilled dressed weight, lb.	166.4	160.9	160.7	159.0
Percent of total cuts:				
Skinned hams	16.4	17.9	17.4	18.2
Trimmed loins	13.8	15.0	13.7	14.6
New York shoulders	15.1	16.2	15.8	16.1
Lean trimmings	2.1	2.4	2.3	2.5
Total lean cuts	**47.4**	**51.5**	**49.2**	**51.4**
Trimmed bellies	15.1	13.7	14.5	14.3
Jowls	3.1	2.6	3.1	2.8
Fat for lard	**28.5**	**25.4**	**26.7**	**24.7**
Spare ribs	2.0	2.2	2.1	2.3
Miscellaneous cuts	3.9	4.6	4.4	4.5
Av. weight of total cuts, lb.	166.1	160.5	160.3	158.6
Cuts, percent of slaughter weight	77.7	76.3	76.5	76.1
Four primal cuts:				
Percent of slaughter weight	46.9	47.9	46.9	48.2
Percent of total cuts	60.4	62.8	61.3	63.3
Av. length, in.	29.9	30.6	29.5	29.9
Av. thickness of back fat, in.	1.82	1.66	1.77	1.71

EFFECT OF AN ANTIBIOTIC ON THE LEANNESS OF HOGS

Table 31 summarizes the slaughter and cut-out data and carcass measurements of representative hogs from each of the four lots in the six comparisons of low and standard protein rations without and with an antibiotic in them.

Carcasses of hogs that had received standard protein rations with an antibiotic in them had an average back fat thickness of 1.79 inches. They contained 50.6 percent of lean cuts and 25.3 percent of fat for lard. Carcasses of hogs that had received standard protein rations without an antibiotic in them had an average back-fat thickness of 1.76 inches. They contained 50.5 percent of lean cuts and 25.2 percent of fat for lard.

Carcasses of hogs that had received low protein rations with an antibiotic in them had an average back-fat thickness of 1.92 inches. They contained 48.4 percent of lean cuts and 27.5 percent of fat for lard. Carcasses of hogs that had received low protein rations without an antibiotic in them had an average back-fat thickness of 1.81 inches. They contained 48.8 percent of lean cuts and 27.1 percent of fat for lard.

There was an average of 0.1 inch less thickness of back-fat, of 0.4 of a percent less fat for lard and of 0.4 of a percent more of lean cuts in favor of the carcasses of the hogs that had received low protein rations without an antibiotic over the carcasses of the hogs that had received low protein rations with an antibiotic.

An antibiotic had no adverse effect on the leanness of the hogs that had received the standard protein rations and little if any adverse effect on the hogs that had received the low protein rations. Those from each group were slaughtered when they were of approximately the same weight.

Based on the prices used for the cuts, the hogs that had received an antibiotic and those that had not received an antibiotic with standard protein rations were worth $22.05 and $21.90 per 100 pounds, respectively. The hogs that had received an antibiotic and those that had not received an antibiotic with low protein rations were worth $21.74 and $21.83 per 100 pounds, respectively.

TABLE 31.—Effect of an Antibiotic in the Feed on the Leanness of Hogs

	1	2	3	4
	Corn, soybean oil meal, ground alfalfa, B vitamins concentrate, irradiated yeast, and minerals			
	Without antibiotic		**With antibiotic**	
Level of protein	**Low**	**Standard**	**Low**	**Standard**
Number of pigs	34	33	34	34
Av. days old at slaughter	182	179	174	174
Av. daily gain from birth	1.22	1.23	1.25	1.26
Av. weight from feed lot, lb.	221.2	219.3	217.7	219.8
Av. weight on arrival, lb.	216.7	214.9	213.6	215.7
Av. weight at slaughter, lb.	210.7	209.1	208.6	211.5
Av. warm dressed weight, lb.	168.0	164.2	166.6	166.2
Av. cold dressed weight, lb.	163.7	160.0	162.5	162.4
Percent of total cuts:				
Skinned hams	17.3	17.8	17.0	18.1
Trimmed loins	13.8	14.4	13.8	14.6
New York shoulders	15.2	15.6	15.2	15.6
Lean trimmings	2.5	2.5	2.3	2.3
Total lean cuts	**48.8**	**50.3**	**48.4**	**50.6**
Trimmed bellies	14.7	14.7	14.6	14.7
Jowls	3.0	2.8	3.1	2.8
Fat for lard	**27.1**	**25.2**	**27.5**	**25.3**
Spare ribs	2.1	2.3	2.1	2.2
Miscellaneous cuts	4.3	4.6	4.3	4.4
Av. weight of total cuts, lb.	163.2	159.5	161.9	161.9
Cuts, percent of slaughter weight	77.5	76.3	77.6	76.5
Four primal cuts:				
Percent of slaughter weight	47.3	47.7	47.1	48.2
Percent of total cuts	61.0	62.6	60.7	63.0
Av. length, in.	29.5	29.5	29.4	29.8
Av. thickness of back fat, in.	1.81	1.76	1.92	1.79
Value per 100 lb. of slaughter wt.	$21.83	$21.90	$21.74	$22.05
Value per 100 lb. of total cuts	$28.18	$28.70	$28.02	$28.80

Four primal cuts = Skinned hams, trimmed loins, New York shoulders and trimmed bellies.

Prices used, Tables 31 and 32 = Skinned hams, 46.0; trimmed loins, 44.0; New York shoulders, 33.0; lean trimmings, 32.0; trimmed bellies, 31.0; jowls, 13.0; fat for lard, 9.0; spare ribs, 38.0; miscellaneous cuts, 3.0 cents a pound.

EFFECT OF THE AMOUNT OF PROTEIN ON THE LEANNESS OF HOGS

Table 32 summarizes the slaughter and cut-out data and carcass measurements of the representative hogs from the various lots of the different experiments classified according to the protein content of the ration they received.

The carcasses of hogs that had received low, standard and high protein rations contained 48.6, 50.7 and 51.6 percent of lean cuts and 27.3, 25.2 and 23.6 percent of fat for lard, respectively. Those in each of the three groups as named had an average back-fat thickness of 1.85, 1.75 and 1.59 inches, respectively.

Within the limits used in the experiments, and when the hogs were of a given type and were slaughtered at a given weight, leanness of carcass was directly related to the level of protein in the ration. Or, conversely, fatness was directly related to lowness of protein in the ration. Doubtless there would be a point, determined for each individual by its heredity, beyond which an increase in the amount of protein in the ration would no longer result in an increase in the leanness of the carcass.

The hogs in these tests were of similar breeding and type and were slaughtered at similar weights but had received different amounts of protein. In their case the fatter the hogs the higher was the dressed yield. This tended to partially offset the influence of leanness on the worth of the hogs.

SUMMARY

In two comparisons a concentrate of four B vitamins fed at rates that supplied 300, 1000, 1350 and 1500 mg. or more of riboflavin, calcium pantothenate, niacin and choline chloride, respectively, per 100 pounds of feed was less effective than dried distillers' grain solubles for feeding with a soybean oil meal ration that contained five percent of ground alfalfa.

In three comparisons a concentrate of six B vitamins fed at a rate that supplied 300, 600, 1350, 1500, 9, and 75 mg. of riboflavin, calcium pantothenate, niacin, choline chloride, folic acid and pyridoxine hydrochloride, respectively, per 100 pounds of feed was as effective as five percent of dried distillers' grain solubles for feeding with a soybean oil meal ration that contained five percent of ground alfalfa.

TABLE 32.—Effect of Amount of Protein on Leanness of Hogs

	1	2	3
	Corn, soybean oil meal, ground alfalfa, irradiated yeast and minerals without or with cobalt, a B vitamins concentrate and an antibiotic or a B_{12} and antibiotic supplement		
Level of protein	**Low**	**Standard**	**High**
Number of pigs	90	89	12
Average days of age at slaughter	181	178	173
Average daily gain from birth, lb.	1.22	1.23	1.26
Av. weight from feed lot, lb.	220.1	219.3	218.4
Av. weight on arrival, lb.	215.8	215.1	215.1
Av. weight at slaughter, lb.	210.0	210.0	208.6
Av. warm dressed weight, lb.	167.3	165.1	161.3
Av. chilled dressed weight, lb.	162.9	160.8	157.7
Percent of total cuts:			
Skinned hams	17.1	18.0	18.4
Trimmed loins	13.8	14.5	15.0
New York shoulders	15.3	15.8	15.7
Lean trimmings	2.4	2.4	2.5
Total lean cuts	**48.6**	**50.7**	**51.6**
Trimmed bellies	14.6	14.6	14.9
Jowls	3.1	2.8	3.1
Fat for lard	**27.3**	**25.2**	**23.6**
Spare ribs	2.1	2.3	2.3
Miscellaneous cuts	4.3	4.5	4.5
Av. weight of total cuts, lb.	162.5	160.3	157.0
Cuts, percent of slaughter weight	77.4	76.4	75.3
Four primal cuts:			
Percent of slaughter weight	47.1	48.0	48.2
Percent of total cuts	60.9	62.9	64.0
Average length, inches	29.5	29.8	29.5
Average thickness of back fat, inches	1.85	1.75	1.59
Value per 100 lb. of slaughter weight	$21.73	$21.98	$21.97
Value per 100 lb. of total cuts	$28.09	$28.79	$29.20

When each was fed with corn, ground alfalfa, minerals, irradiated yeast and dried distillers' grain solubles, or a B vitamins concentrate to pigs in dry lot, soybean oil meal produced as rapid and as efficient gains as a mixture of soybean oil meal and meat scraps. The soybean oil meal and meat scraps were fed in a ratio that supplied equivalent amounts of protein.

In ten dry lot experiments, pigs fed aureomycin, an aureomycin supplement, or a B_{12} and aureomycin supplement gained 5.6 percent more rapidly, were ready for market 6 days earlier, on the average, and required 8.9 pounds or 2.5 percent less feed per 100 pounds of gain than similar pigs without an antibiotic in their ration. At the 1954 manufacturers' price the saving in feed approximately offset the cost of the antibiotic.

Presumably the rations were adequate and the pigs were relatively healthy. Under conditions of stress, such as those caused by poor management practices, by improper or inadequate rations or by the presence of pathogenic organisms that the antibiotic will help control, the response from an antibiotic is greater.

In six of the ten experiments, a greater response from the antibiotic was secured after than was secured before the pigs reached a weight of 120 pounds. The antibiotic saved an average of 7.7 and 9.0 pounds or 2.5 and 2.3 percent of feed per 100 pounds of gain before and after the pigs averaged 120 pounds in weight, respectively.

Apparently there was no inter-relation between the age of the pigs and the amount of response secured from an antibiotic. The degree of response secured from the use of an antibiotic in the feed appeared to depend on the time the pigs were or had been exposed to an infection which the antibiotic helped to control.

The findings were in accord with the hypothesis that antibiotics in the feed are growth permitting rather than growth promoting—that is that they tend to enable animals to grow according to their innate ability by inhibiting the development of harmful organisms in the intestinal tract.

The response from including a vitamin B_{12} supplement in the ration was greatest when the pigs were young and decreased as they became older. Less response was securd from a vitamin B_{12} supplment when cobalt was than when it was not included in the minerals.

With no vitamin B_{12} supplement in the ration crystalline aureomycin reduced the feed required per 100 pounds of gain 2.6 percent. With a vitamin B_{12} supplement in the ration an antibiotic, aureomycin, supplement reduced the feed required per 100 pounds of gain 2.7 percent. The response from an antibiotic was independent of the presence or absence of a vitamin B_{12} supplement in the ration.

Self fed pigs on pasture with an antibiotic, terramycin, supplement in their ration gained 1.2 percent less rapidly and required 0.3 percent more feed per 100 pounds of gain than pigs on a similar ration without the antibiotic.

With pigs on pasture that were full fed twice daily, those with crystalline aureomycin in their ration were ready for market 4 days earlier in one trial and one day earlier in another than those without it. The pigs with the antibiotic required 1.3 percent less feed per 100 pounds of gain in one trial and 1.4 percent more in the other than pigs without the antibiotic. The pigs received an average of 0.265 pound of soybean oil meal and 0.045 pound of minerals per head per feed.

In a trial on Ladino clover pasture in which the pigs received an average of 0.11 pound of soybean oil meal and 0.045 pound of minerals plus a full feed of shelled corn per head per feed, those given crystalline aureomycin were ready for market 4 days earlier but required practically the same amount, 330 pounds, of feed per 100 pounds of gain.

In the four pasture experiments, pigs with an antibiotic in their rations gained 2.1 percent more rapidly, were ready for market 2 days earlier, on the average, and required 0.7 percent less feed per 100 pounds of gain than pigs on similar rations without the antibiotic. Including an antibiotic in the ration did not pay in any one of the four pasture experiments. The terramycin supplement was fed at a rate that supplied 1 gm. of terramycin per 100 pounds of feed. Crystalline aureomycin was fed at average rates that ranged from 0.5 to 0.58 gm. per 100 pounds of feed.

Except as it saved feed in general, there was no evidence to indicate that an antibiotic has a protein sparing action. In six dry lot trials, an antibiotic saved as much feed per unit of gain in standard as in low protein rations and in one it saved as much in a high as it did in a standard protein ration.

When they were adequate in vitamins and minerals, relatively low protein rations either without or with an antibiotic in them were surprisingly effective.

In six comparisons of low and standard protein rations without an antibiotic in them the pigs on the low protein rations were ready for market 4 days later and required 3.3 percent more feed per 100 pounds of gain but made more economical gains than those on the standard protein rations.

In six comparisons of low and standard protein rations with an antibiotic in them, the pigs on the low protein rations were ready for market one day later and required 3.8 percent more feed per 100 pounds of gain but made more economical gains than those on the standard protein rations.

Before and after the pigs averaged 120 pounds in weight, the low protein rations contained approximately a half and a third as much soybean oil meal or protein concentrate as the standard protein rations.

Pigs fed an intermediate protein ration gained as rapidly, required 0.5 percent more, or approximately the same amount of feed per 100 pounds of gain and made more economical gains than pigs fed a standard protein ration.

The low, intermediate and standard protein rations contained 12.2, 14.0 and 15.7 percent of protein before and 10.2, 12.0 and 13.8 percent of protein, respectively, after the pigs averaged approximately 120 pounds in weight.

A greater variation in the rate of gain of the individual pigs and a greater saving in feed per unit of gain from the added protein in the growing than in the finishing period indicated that the rations containing 12.2 percent were too low in protein for the optimum performance of pigs under 120 pounds in weight. Based on their performance, the intermediate or 14 percent protein ration appeared to be adequate. It contained 16.0 percent or three-fourths as much soybean oil meal as the standard protein rations.

The carcasses from hogs fed low protein rations without and with an antibiotic in them yielded 48.8 and 48.4 percent in lean cuts and 27.1 and 27.5 percent in fat for lard, respectively. The average back-fat thickness of the carcasses from the two groups of hogs as named was 1.81 and 1.92 inches.

The carcasses from hogs fed standard protein rations without and with an antibiotic in them yielded 50.3 and 50.6 percent in lean cuts, including the lean trimmings and 25.2 and 25.3 percent in fat for lard, respectively. The average back-fat thickness of the carcasses from hogs as named was 1.76 and 1.79 inches, respectively.

An antibiotic had no effect on the leanness of the carcasses of hogs fed standard or high protein rations and little or no effect on the leanness of the carcasses of hogs that were fed low protein rations.

Carcasses from representative hogs fed low, standard and high protein rations yielded 48.6, 50.7 and 51.6 percent in lean cuts, including the lean trimmings, and 27.3, 25.2 and 23.6 percent in fat for lard, respectively. As named they had average back-fat thicknesses of 1.85, 1.75 and 1.59 inches, respectively. With hogs of a given type and weight and within the levels tried, leanness of carcass was directly related to the amount of protein in the ration. Or, conversely, with hogs of a given type and weight fatness of carcass was directly related to lowness of protein in the ration.

When they were of a given type and weight, the leaner the hogs the lower was their dressing percentage. This tended to partially offset the influence of leanness on the worth of the hogs a pound on foot.

Based on their weights at slaughter and on the prices used for the various cuts, representative hogs fed low, standard and high protein rations were worth $21.73, $21.98 and $21.97 a 100 pounds, respectively. The chilled carcasses of representative hogs fed low, standard and high protein rations were worth $28.09, $28.79 and $29.20 a 100 pounds, respectively.

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