THE INFLUENCE OF HIGH AND MEDIUM PROTEIN LEVELS ON THE RATE AND ECONOMY OF GAIN IN WEANLING PIGS

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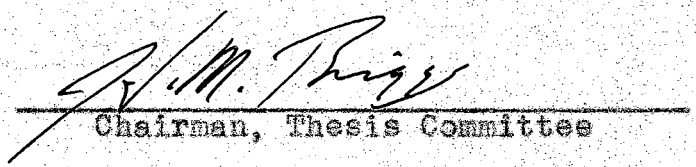

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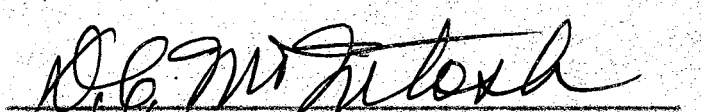

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PREFACE

Problems relating to the nutritive requirements of swine, along with those of other farm animals, have engaged the attention of scientific investigators since 1850. During the third quarter of the last century, the concept was firmly established that the fundamental nutritive needs of the animal body were primarily for energy, with enough protein for maintenance and the building of muscle tissue. Many of the early investigations on feed requirements were done by German investigators, according to the United States Department of Agriculture (1939). The feeding standards formulated by Wolff (1864), which have come down to the present day in various modifications, was first published in 1864. These standards listed the amount of digestible crude protein, carbohydrates, and fat required daily by the different classes of farm animals including swine.

Probably the first major advance of recent times in swine nutrition was the discovery that an exclusive diet of corn or other cereal grains supplied too little protein. Satisfactory nutrition requires that protein be supplied in not only the right amount but of the required quality. Protein feeds are necessary to maintain and build body tissue. It is primarily the body building material, and it must be provided for the growth of the hair, skin, hoofs, and internal organs which are all chiefly composed of protein.

Proteins are composed of simpler substances called amino acids, which may be referred to as, "The building stones of the body." These amino acids are carried from the digestive tract

to nourish the various body tissues. Each tissue selects from the mixture of amino acids in the blood the particular amounts and kinds of acids that it needs. It is evident that not only must the feed provide a sufficient amount of digestible protein, but that the protein must be of proper quality, or that there must be adequate amounts of each of the essential amino acids.

Many farmers still do not realize or appreciate the importance and value of adding protein to livestock rations, particularly that of weanling pigs. They either do not know or do not care that cereal grains do not make a complete ration for swine. Home-grown protein feeds are usually not so abundant as carbohydrate feeds and it is often necessary to purchase them. Although protein feeds are higher in price than carbohydrate feeds, the increased cash outlay usually is justified because it results in increased rate of gain and better utilization of feed per unit gain than when unsupplemented rations are fed. The deficiency of grains in protein is corrected by adding protein-rich feeds such as milk and milk-products, tankage, fish meal, soybean oil meal, linseed meal, or cottonseed meal to the cereal part of the ration. It is generally considered an economical practice to supply at least one protein supplement from a plant source and one from an animal source, as the former source is usually cheaper. Some animal protein is usually considered essential because they contain some so-called essential amino acids, which are not ordinarily found in vegetable protein.

Hogs grow more rapidly in relation to their weight than other farm animals, consequently, their feed requirements change rapidly. Within a few weeks there is a change from the high

protein requirement of growth to the lower protein requirement of the relative mature fattening pig. From the standpoint of nutrition the period from weaning to one hundred pounds in live weight is a very critical one. Under farm conditions the weanling pig is frequently taken from an excellent source of protein, the sow's milk, and placed on a ration not only lower in quantity of protein but also poorer in quality as well. As a result there follows a period of six to eight weeks when the pigs make slow and expensive gains. It is with this period that we are concerned.

Since protein-rich feeds are generally more expensive than carbohydrate feeds, it is important to know the minimum and optimum protein levels required by the pig at various stages of growth and fattening. In spite of the fact that considerable work has been done relative to these facts, we still need more information. This series of experiments was designed to determine the effect of the level of protein intake on the growth and economy of gains in weanling pigs of different weights and breeds.

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Jesse M. Barbre, Jr.

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REVIEW OF LITERATURE

The idea that energy and protein were the only essentials to be considered in feed requirements persisted until shortly after 1900. Earlier investigators thought it was merely necessary to supply a sufficient amount of fats, carbohydrates, and proteins to make a completely satisfactory ration. Later it was found that protein from different sources produced different results. These qualitative differences in proteins were recognized early in the present century. Oklahoma workers, Burtis and Malone (1901) demonstrated that it paid to feed pig rations that consisted of 20 per cent cottonseed meal. Later McDonald and Malone (1908), working at the same station found that corn alone is not a good ration for hogs. They state:

> "The growing animal requires a certain proportion of muscle building material along with the fattening nutrients of the food. From the farmers standpoint, the important functions of the proteins are the production of lean meat, tendons, wool, hair, and building up and maintaining the vital organs of the body."

Waters and associates working at the Kansas Station discovered that the limited protein content of corn was one of the principal reasons why it cannot be depended upon as a sole feed for growing pigs. Armsby (1912) stated that, "The chief function of the feed aside from a minimum of protein, is to supply energy." With the recognition of the fact that the proteins in corn were of low quality because of the absence of certain amino acids, numerous hog-feeding trials were conducted which demonstrated the value of various supplementary feeds rich in protein.

Mitchell and Hamilton (1929) conducted swine-type studies and concluded that growing pigs of 100 pounds weight required 0.029

pound of protein for maintenance and 0.103 pound for growth, or a total of 0.132 pound daily. On the basis of a biological value of 50 per cent for proteins of their ration of corn, shorts, and tankage, the digestible protein required was established as 0.264 pound. The digestible protein in the ration constituted approximately 67 per cent of the total protein; hence the requirement of total protein was 0.396 pound.

Armsby (1917) gave the digestible protein requirements per day of growing and fattening swine as, 50 pound pig 0.30 pound, 100 pound pig 0.38; while Fraps (1932) of the Texas Station, gave the requirement of a 50 pound pig as 0.355, and a 100 pound pig as 0.495 pound. According to the feeding standards of Morrison (1936), the 50 pound pig requires 0.35 to 0.43 pound of digestible protein, and the 100 pound pig requires 0.50 to 0.60 pound per head daily. Ellis and Zeller (1939) estimate the daily protein requirements for a 50 pound pig as 0.40 pound and for a 100 pound pig as 0.60 pound.

Stonaker and Connell (1943) working at the Colorado Experiment Station recommended the amount of protein as two-thirds of a pound daily per fattening hog. These workers ran two experiments limiting the amount of protein to two-tenths of a pound per pig per day, which showed that they definitely could not reduce the protein to such a low level for the greatest economy and efficiency of gain.

Carrol and Burroughs (1937) studied the protein requirement of a ration to produce maximum efficiency as judged by rate and economy of gain. They compared rations containing 22, 18, and

14 per cent protein for pigs weighing 50 to 75 pounds, 19, 15, and 11 per cent for weights of 75 to 100 pounds, 16, 12, and 8 per cent for weights of 100 to 150 pounds, and 14, 10, and 8 for weights of 150 to 200 pounds. Pigs weighing 50 to 75 pounds that received a 22 per cent (high) protein ration made more economical gains than pigs receiving the 18 or 14 per cent protein rations. At weights of 75 and 100 pounds, the gains made on the 19 and 15 per cent protein rations were approximately the same, while gains made on rations of 11 per cent protein were distinctly lower. The total feed required to produce 100 pounds of gain was in favor of the group receiving the 15 per cent protein level. As the pigs put on the next 50 pounds gain or weighed from 100 to to 150 pounds, the medium percentage of protein resulted in the optimum rate and economy of gain. In the heaviest weight studied, or from 150 to 200 pounds the rate and economy of gain and feed consumption during this period favored the higher percentage of protein fed, or the 14 per cent level.

Robison(1940) in a preliminary trial studied the effects of high protein levels on pigs. He used four 70 pound pigs and fed them 13 weeks on a 42 per cent protein ration. Unless an exceptionally laxative condition is considered harmful no ill effects were observed. In a later trial he used ten pigs per lot with an initial weight of 60 to 71 pounds and an average age of 66 days in comparing the effects of protein levels of 9.0, 17.3, 25.6, 34.2, and 51.0 per cent. He reported that scouring was prevalent and persisted among the pigs fed the 26 per cent and higher levels of protein and each increase above that level made scouring increasingly severe. So far as was observed the scouring had no

serious detrimental effect on the pigs. With each increase above 26 per cent of protein, there was a decrease in the rate and economy of gains although a 51 per cent protein level still produced more rapid gains than did a 9 per cent protein ration when fed to lighter pigs. To approximately 90 pounds in weight, the 26 and 34 per cent protein rations were more effective than the smaller or larger protein allowance. Between the weights of approximately 90 to 125 pounds, the 17 per cent was as effective as the 26 and 34 per cent protein rations. Above 125 pounds the rations containing 14 and 17 per cent of protein produced more rapid gains per unit of feed than those containing more protein. Pigs fed excessively high protein levels shrank more in transit, dressed less, and carried only slightly more lean than pigs fed medium protein levels. The low level of protein resulted in excessive fatness rather than normal growth. The kidneys, livers, and spleens were approximately 48, 23, and 24 per cent larger, respectively, for pigs fed 51 per cent protein than they were from those pigs fed optimum protein levels. Although the kidneys, livers, and spleens were enlarged, they did not appear abnormal.

Ferrin (1941) fed three lots of ten pigs weighing approximately 50 pounds each, varying amounts of protein concentrates. Lot 1 received 0.20 pound per pig daily of equal parts dry rendered tankage and soybean oil meal, while lot 2 received 0.40 pound per pig daily of the same mix, and lot 3 was self-fed the same protein supplement. All lots were self-fed corn and had free access to rape pasture. The average gain of the pigs in the three lots varied in direct proportion to the amounts of the protein mixture fed. Lot 1 made the lowest and least economical gains of

1.20 pound per day for a 91 day feeding period. Lot 2 gained 1.30 pounds per day for the period. Pigs in lot 3 were the most efficient lot of the trial gaining at the rate of 1.75 pound per head daily. They required 19.34 per cent less feed than lot 1 and 13.44 per cent less feed than lot 2 per unit of gain.

Keith and Miller (1940) conducted an experiment to determine the most economical protein level for pigs of various weights. They fed 130 pound pigs rations containing 10 and 15 per cent protein. The pigs receiving the 15 per cent ration averaged 32 per cent greater gain than the pigs fed the 10 per cent protein ration. A second trial was conducted using protein levels of 15, 20, and 25 per cent for pigs weighing approximately 84 pounds. Pigs fed the 20 per cent ration made more rapid and economical gains than pigs fed either the 15 or 25 per cent protein rations. In a third trial protein levels of 12, 17, and 22 per cent protein rations were compared. The most economical protein level for pigs from weaning to the average weight of 70 pounds was found to be the 22 per cent at the price of feeds that existed at the time of these experiments. They concluded, however, that if the price of protein is high as compared to corn, a ration containing 17 per cent protein might be the most economical. The pigs fed a high protein ration during the weanling period were more thrifty and stronger than those fed at lower protein levels. As pigs increased in weight the optimum percentage of protein was found to be less. The most economical level for pigs between weights of 75 and 125 pounds was found to be between 17 and 20 per cent protein, and the most economical protein in the ration for pigs between 125 and 200 pounds was found to be approximately 15

per cent. They concluded that the percentage of protein recommended for pigs above the weight of 100 pounds will depend upon the future use of the pig. If the pig was to be retained for breeding purposes, a high protein ration was recommended regardless of cost.

Crampton (1939) reports that increased percentages of protein in the ration increased the gains for pigs from weaning to 100 pounds in weight, within a given level of daily feed consumption. He studied data from 480 pigs and reported that pigs weighing 30 to 100 pounds required protein levels of 15 to 16 per cent, while pigs weighing from 100 to 200 pounds required 14 to 15 per cent protein in the ration. Crampton also divided a feeding period into intervals and during the first thirty days after weaning, a ration containing 17 per cent protein was found to be the most satisfactory for full-fed pigs. During the next thirty days a protein level of 14 per cent for full-fed pigs proved sufficient. With half-fed pigs, a slightly greater efficiency of food utilization resulted when the protein level remained at 17 per cent.

Hughes and Ittner (1942) reported that barley, unsupplemented with a protein concentrate, was less efficient for growth and fattening than rations containing casein and skim milk. Feeding casein at low levels (1.5%) resulted in increased rates of gain, and the pigs consumed less feed for a unit of gain than those fed barley with no protein supplement. Their gains were, however, far below those of pigs receiving fluid skim milk. When skim milk powder composed 3.5 per cent of the ration, the value was similar to that of rations in which casein composed 1.5 per cent. In none of the experiments did the pigs receiving experimental rations do so well as those fed the check ration of barley supplemented with salt, vitiamin A,

and fluid milk.

Kyzer and Clyburn (1943) started three lots of pigs at an average initial weight of approximately 44 pounds. One lot received only skim milk as supplement while the other two lots were fed protein supplement free choice and two levels of skim milk. The average daily gains were 1.22, 1.24, and 1.33 pounds daily, respectively. The results indicated that the medium level of protein supplied by the protein supplement and skim milk was superior to skim milk alone or the protein supplement and the greater allowance of skim milk.

Thompson and Hillier (1946) studied the protein requirements of young pigs to produce maximum efficiency as judged by rate and economy of gain. They recommended a 27 per cent protein ration for 35 to 50 pound pigs, 24 per cent for 50 to 80 pound pigs, and a 21 per cent protein ration for 80 to 120 pound pigs.

Woodman, Evans, and Turpett (1937) conducted an experiment to determine the influence of three protein levels on growth and carcass quality in bacon pigs. They considered the period of feeding up to 200 pounds live weight as a whole and found the differences in protein level gave rise to no significant differences of mean rate of live weight increase and efficiency of food conversion. Only in the earliest stage of the feeding period did the pigs in the low protein show a slightly, though significantly, lower rate of gain than the pigs on medium and high levels. Such differences did not exist by the time the pigs had attained 60 pounds live weight. The results confirmed an earlier finding that there was little to be gained in respect to the protein of lean in the carcass by increasing the level of protein supply beyond that ordinarily used in good feeding. From the standpoint of both growth

and fattening, the high protein diet gave practically the same results as the medium protein diet. They found that the gilts in the experiment produced somewhat leaner carcasses than barrows from the same litter.

Day (1914) reported a number of experiments with the six leading breeds of swine. The Duroc Jersey averaged first in average daily gains with 1.014, Yorkshire 1.010, Berkshire 0.978, Tamworth 0.918, Poland China 0.905, and Chester Whites 0.902 pounds. In economy of gains the breeds ranked in the following order in feed required per hundred gain: Berkshire 378.4 pounds, Tamworth 390.2 pounds, Yorkshire 395.2 pounds, Duroc Jersey 396.02 pounds, Chester White 400.7 pounds, and Poland China 401.8 pounds.

Rommel (1904), of the U. S. D. A. Bureau of Animal Industry, averaged results from eight experiment stations and stated that the average amount of feed required to produce 100 pounds gain of the six leading breeds of swine was; Tamworth 344 pounds, Chester White 347 pounds, Poland China 357 pounds, Berkshire 369 pounds, Yorkshire 407 pounds, and Duroc Jersey 418 pounds. He also analyzed a three year experiment conducted at the Iowa station comparing the average daily gains of the breeds and ranked them in the order of first, Yorkshires; second, Berkshire and Duroc Jersey (tied); fourth, Tamworth; fifth, Poland China; and sixth, Chester Whites. In this experiment Yorkshires had the least cost per pound of gain followed by the Poland China, Duroc Jersey, Berkshire, Tamworth, and Chester Whites.

Curtis and Craig (1900) found cross-bred pigs very economical in gain and they were followed in economy by Duroc Jersey, Berkshire, Tamworth, and Chester Whites in the order named.

Robison (1940) found Yorkshires to gain more rapidly and more economically than the Duroc Jerseys.

Winters, Jordan, and Kiser (1934), of Minnesota, studied cross-bred pigs and purebred pigs for rate and economy of gain. Their data was gathered from 300 purebreds, 184 cross-breds, 117 double-cross pigs, and 61 back-cross pigs. All three types of cross-bred pigs reached market weight approximately 20 days earlier than the purebreds with which they were compared, and they made their gains on approximately 10 per cent less feed.

EXPERIMENTAL OBJECTIVES

This experiment was conducted in three series for the following purposes:

1. To determine the effect of the level of protein intake on the growth and economy of gain in weanling pigs.
2. To determine the effect of breed, Duroc Jersey and Hampshire, on the rate and economy of gain in weanling pigs.

METHOD OF PROCEDURE

Twenty head each of purebred Duroc Jersey and Hampshire weanling pigs of uniform age, type, and quality were used in each of the three trials of this experiment. The pigs were wormed, vaccinated, and all boar pigs were castrated at the age of six weeks. All four lots of pigs of each trial were kept in the same barn on concrete floor until they averaged 100 pounds in weight. No bedding was used except in cold weather. All lots of pigs were self-fed free-choice. Clear water and a simple mineral mixture of equal parts of steamed bone meal, ground limestone, and salt was kept before the pigs at all times.

The first trial started May 11, 1946 when the average age of the pigs was 66 days. The second and third trials started when the average age of the pigs was 56 days. The second trial ran from November 2, 1946 to January 22, 1947; while the third trial was conducted from May 5, 1947 until July 30, 1947.

The feeds used in these experiments were barley, meat scraps, soybean meal, and alfalfa meal. Alfalfa meal constituted five per cent of all the rations, but the other feeds varied to give the desired percentage of protein. The amounts of soybean meal

and meat scraps were always equal in each ration.

The feed components and the percentage of protein in each of the various rations fed are shown in table I. All of the feed was analyzed before mixing and then a composite sample was analyzed before the experimental feeding started. The crude protein contents are given in table II.

The following feeding schedule was used:

	Duroc Jerseys		Hampshires	
Lot No.	I	II	III	IV
Protein Level	High	Med.	High	Med.
Before 65 lbs.	20%	16%	20%	16%
65-100 lbs.	18%	14%	18%	14%

The pigs were weighed at the start of each trial and at seven day intervals thereafter. The mixed rations were weighed when each addition was made and weighbacks were made each week when the pigs were weighed. The weekly feed consumptions and gains in weight are given in tables VI, VII, and VIII.

Table I THE EXPERIMENTAL RATIONS FED WEANLING PIGS

	Total Amt. of Feed, lbs.	Amt. of Protein supplied, lbs.
Ration I 20% Protein		
Alfalfa Meal 5%	150	18.75
Barley	1910	191.00
Meat Scraps	470	197.40
Soybean Meal	470	193.17
	3000	600.32
Ration II 18% Protein		
Alfalfa Meal 5%	150	18.75
Barley	2100	210.00
Meat Scraps	375	157.50
Soybean Meal	375	154.12
	3000	540.37
Ration III 16% Protein		
Alfalfa Meal 5%	150	18.75
Barley	2290	229.00
Meat Scraps	280	117.60
Soybean Meal	280	115.80
	3000	480.43
Ration IV 14% Protein		
Alfalfa Meal 5%	150	18.75
Barley	2480	248.00
Meat Scraps	185	77.70
Soybean Meal	185	76.03
	3000	420.48

Table II THE CRUDE PROTEIN CONTENT OF FEEDSTUFFS AND MIXTURES FED WEANLING PIGS

	Feed	Crude Protein
First Trial		
May 2, 1946	Alfalfa	21.0%
	Barley	12.7
	Meat Scraps	45.9
	Soybean Meal	46.1
June 12, 1946	20% Mixture	24.5
	16% Mixture	18.4
Second Trial		
Oct. 16, 1946	Alfalfa	15.2
	Gr. Barley	9.8
	Meat Scraps	45.9
	Soybean Meal	47.8
Nov. 20, 1946	20% Mixture	23.4
	16% Mixture	19.7
	18% Mixture	22.2
	14% Mixture	15.9
Third Trial		
April 30, 1947	Alfalfa	16.5
	Barley	12.3
	Meat Scraps	45.6
	Soybean Meal	48.9
May 7, 1947	20% Mixture	22.9
	16% Mixture	20.2
July 9, 1947	18% Mixture	22.4
	14% Mixture	15.5

Analysis made by the Chemistry Department of Cameron State Agricultural College

EXPERIMENTAL RESULTS

The gain and total feed consumption of the pigs in the first trial are given in table III. The gain and feed consumption of the pigs by weekly periods is given in table VI. The experimental results of the second trial are given in tables IV and VII, while the results of the third trial are given in tables V and VIII.

The average performance of Duroc Jerseys and Hampshire pigs fed high and medium protein levels for the three trials is given in table IX.

Table III THE PERFORMANCE OF DUROC JERSEY AND HAMPSHIRE PIGS FED MEDIUM AND HIGH LEVELS OF PROTEIN IN THE FIRST TRIAL
(May 11, 1946 to August 24, 1946)

	Lot I		Lot II		Lot III		Lot IV	
Weight	Under 65 lbs.	65-100 lbs.	Under 65 lbs.	65-100 lbs.	Under 65 lbs.	65-100 lbs.	Under 65 lbs.	65-100 lbs.
Breed	Duroc Jersey		Duroc Jersey		Hampshire		Hampshire	
Protein Level	20%	18%	16%	14%	20%	18%	16%	14%
No. Pigs in Lot	10	10	10	10	10	10	10	10
Av. Age of Pigs (days)	66	126	66	131	66	138	66	147
Days Fed	60	29	65	30	72	28	81	24
Weight (lbs.)								
Av. Initial	22.4	65	24	65	18	65	19.5	65
Av. Final	65	100	65	100	65	100	65	100
Av. Da. Gain	0.71	1.21	0.65	1.16	0.65	1.54	0.56	1.46
Feed Consumed (lbs.)								
Total Organic	1246	1029	1429	1195	1635	1083	1604	1106
Av. Da. "	2.08	3.55	2.2	3.98	2.27	4.05	1.98	4.60
Min. Consumed	100	50	100	50	100	50	100	50
Av. Da. Min.	0.17	0.14	0.15	0.17	0.14	0.19	0.12	0.21
Per Cwt. Gain	315.9	297.9	372.9	358.7	361.9	315.1	374.5	350.5
Cost per Cwt. Gain	$11.78	$10.85	$13.06	$12.09	$13.77	$11.41	$13.14	$11.23

Feed Prices

Alfalfa	$20.00 Ton	Soybean Meal	$4.10 Cwt.
Barley	3.50 Cwt.	1-1-1 Mineral Mix	2.07 Cwt.
Meat Scraps	6.00 Cwt.		

Table IV THE PERFORMANCE OF DUROC JERSEY AND HAMPSHIRE PIGS FED MEDIUM AND HIGH LEVELS OF PROTEIN IN THE SECOND TRIAL
(November 2, 1946 to January 22, 1947)

	Lot I		Lot II		Lot III		Lot IV	
Weight	Under 65 lbs.	65-100 lbs.	Under 65 lbs.	65-100 lbs.	Under 65 lbs.	65-100 lbs.	Under 65 lbs.	65-100 lbs.
Breed	Duroc Jersey		Duroc Jersey		Hampshire		Hampshire	
Protein Level	20%	18%	16%	14%	20%	18%	16%	14%
No. Pigs in Lot	10	10	10	10	10	10	10	10
Av. Age of Pigs (days)	56	100	56	104	56	102	56	104
Days Fed	44	24	48	27	46	31	48	33
Weight (lbs.)								
Av. Initial	29	65	31	65	28.8	65	27.3	65
Av. Final	65	100	65	100	65	100	65	100
Av. Da. Gain	0.82	1.46	0.71	1.30	0.78	1.13	0.79	1.06
Feed Consumed (lbs.)								
Total Organic	990	882	848	996	904	1315	906	1333
Av. Da. "	2.25	3.68	1.77	3.69	1.97	4.24	1.89	4.04
Min. Consumed	97	43	95	45	103	43	100	41
Av. Da. Min.	0.22	0.14	0.20	0.17	0.22	0.14	0.21	0.12
Per Cwt. Gain	300.1	264.3	277.3	297.3	279.7	356.4	264.7	392.5
Cost per Cwt. Gain	$10.35	$8.80	$6.96	$9.28	$9.65	$11.87	$8.55	$12.25

Feed Prices

Alfalfa Hay	$20.00 Ton	Soybean Meal	$4.50 Cwt.
Barley	3.00 Cwt.	1-1-1 Mineral Mix	2.07 Cwt.
Meat Scraps	6.00 Cwt.		

Table V. THE PERFORMANCE OF DUROC JERSEY AND HAMPSHIRE PIGS FED MEDIUM AND HIGH LEVELS OF PROTEIN IN THE THIRD TRIAL
(May 3, 1947 to July 30, 1947)

	Lot I		Lot II		Lot III		Lot IV	
	Under 65 lbs.	65- 100 lbs.	Under 65 lbs.	65- 100 lbs.	Under 65 lbs.	65- 100 lbs.	Under 65 lbs.	65- 100 lbs.
Weight								
Breed	Duroc Jersey		Duroc Jersey		Hampshire		Hampshire	
Protein Level	20%	18%	16%	14%	20%	18%	16%	14%
No. Pigs in Lot	10	10	10	10	10	10	10	10
Av. Age of Pigs (days)	56	112	56	116	56	121	56	113
Days Fed	56	24	60	21	65	23	56	26
Weight (lbs.)								
Av. Initial	27.3	65	26.8	65	27.7	65	27	65
Av. Final	65	100	65	100	65	100	65	100
Av. Da. Gain	0.67	1.46	0.64	1.66	0.57	1.52	0.68	1.35
Feed Consumed (lbs.)								
Total Organic	1064	1289	1057	1319	1210	1284	1183	1221
Av. Da. "	1.90	5.37	1.76	6.28	1.86	5.58	2.11	4.69
Min. Consumed	96	48	93	41	90	46	87	41
Av. Da. Min.	0.17	0.20	0.16	0.20	0.14	0.20	0.16	0.16
Per Cwt. Gain	307.7	382	301	388.5	348.5	380	334.2	360.5
Cost per Cwt. Gain	$10.62	$12.72	$9.72	$12.12	$12.02	$12.65	$10.79	$11.25

Feed Prices

Alfalfa Hay	$20.00 Ton	Soybean Meal	$4.50 Cwt.
Barley	3.00 Cwt.	1-1-1 Mineral Mix	2.07 Cwt.
Meat Scraps	5.00 Cwt.		

Table VI. THE WEEKLY GAIN IN WEIGHT AND FEED CONSUMPTION OF EXPERIMENTAL WEANLING PIGS IN TRIAL ONE

			Lot I			Lot II			Lot III			Lot IV	
Weight	Period	No. days on Feed	% Protein in Ration	Gain	Feed	% Protein in Ration	Gain	Feed	% Protein in Ration	Gain	Feed	% Protein in Ration	Gain	Feed
	1	7	20	90	260	16	72	200	20	27	116	16	38	190
	2	14	"	56	175	"	11	220	"	6	188	"	11	200
	3	21	"	71	110	"	74	200	"	64	188	"	55	150
	4	28	"	40	165	"	17	125	"	21	100	"	29	110
Below	5	35	"	37	156	"	40	170	"	58	153	"	1	131
65#	6	42	"	37	190	"	36	152	"	59	165	"	56	160
	7	49	"	84	190	"	18	150	"	12	175	"	28	165
	8	56	18	34	173	"	98	212	"	80	169	"	78	180
	9	63	"	52	216	14	34	145	"	38	181	"	24	138
	10	70	"	74	180	"	32	212	"	23	200	"	24	180
65-	11	77	"	131	270	"	71	180	18	199	310	14	93	195
100#	12	84	"	68	190	"	55	270	"	34	260	"	51	215
	13	91				"	165	270	"	75	183	"	103	200
	14	98				"	37	118	"	125	300	"	128	320
	15	105										"	87	176
Total Experiment				774	2275		760	2624		821	2688		806	2710

Table VII THE WEEKLY GAIN IN WEIGHT AND FEED CONSUMPTION OF EXPERIMENTAL WEANLING PIGS IN TRIAL TWO

			Lot I			Lot II			Lot III			Lot IV	
Weight	Period	No. Days on Feed	% Protein in Ration	Gain	Feed	% Protein in Ration	Gain	Feed	% Protein in Ration	Gain	Feed	% Protein in Ration	Gain	Feed
	1	7	20	45	127	16	35	90	20	41	125	16	40	113
	2	14	"	50	127	"	75	143	"	85	160	"	60	138
	3	21	"	55	144	"	45	140	"	56	147	"	57	152
Below	4	28	"	66	198	"	39	116	"	41	119	"	47	129
65#	5	35	"	84	219	"	58	169	"	55	164	"	62	175
	6	42	"	40	175	"	72	190	"	50	189	"	57	199
	7	49	18	77	190	14	47	225	18	62	154	14	53	187
65-	8	56	"	47	125	"	27	130	"	29	115	"	29	120
100#	9	63	"	58	230	"	61	218	"	80	264	"	49	199
	10	70	"	78	237	"	101	311	"	85	313	"	86	367
	11	77	"	110	100	"	130	112	"	75	225	"	110	460
	12	84							"	60	244			
Total Experiment				710	1872		690	1844		718	2219		650	2239

Table VIII THE WEEKLY GAIN IN WEIGHT AND FEED CONSUMPTION OF EXPERIMENTAL WEANLING PIGS IN TRIAL THREE

			Lot I			Lot II			Lot III			Lot IV	
Weight	Period	No. Days on Feed	% Protein in Ration	Gain	Feed	% Protein in Ration	Gain	Feed	% Protein in Ration	Gain	Feed	% Protein in Ration	Gain	Feed
	1	7	20	45	134	16	66	166	20	57	138	16	55	150
	2	14	"	55	209	"	40	165	"	38	152	"	65	216
	3	21	"	49	174	"	38	150	"	40	160	"	41	163
Below	4	28	"	41	121	"	28	100	"	34	102	"	37	109
65#	5	35	"	43	150	"	33	118	"	35	131	"	34	129
	6	42	"	25	112	"	45	143	"	36	127	"	20	100
	7	49	"	35	164	"	54	215	"	45	170	"	15	126
	8	56	18	84	230	14	86	240	"	72	230	"	46	190
	9	63	"	90	250	"	65	254	18	75	260	14	69	246
65-	10	70	"	86	258	"	125	289	"	75	270	"	117	280
100#	11	77	"	112	336	"	100	324	"	104	300	"	123	330
	12	84	"	60	215	"	50	212	"	101	354	"	100	365
	13	91	"						"	20	100			
Total Experiment				727	2353		730	2376		732	2494		722	2404

Table IX THE AVERAGE PERFORMANCE OF DUROC JERSEY AND HAMPSHIRE PIGS FED MEDIUM AND HIGH LEVELS OF PROTEIN IN THREE TRIALS

	Lot I		Lot II		Lot III		Lot IV	
Weight	Under 65 lbs.	65-100 lbs.	Under 65 lbs.	65-100 lbs.	Under 65 lbs.	65-100 lbs.	Under 65 lbs.	65-100 lbs.
Breed	Duroc Jersey		Duroc Jersey		Hampshire		Hampshire	
Protein Level	20%	18%	16%	14%	20%	18%	16%	14%
Tot. No. Pigs	30	30	30	30	30	30	30	30
Av. Age of Pigs (days)	59	112	59	118	59	120	59	121
Av. Days Fed	53	26	58	26	61	27	62	28
Weight (lbs.)								
Av. Initial	22.9	65	27.2	65	24.8	65	24.6	65
Av. Final	65	100	65	100	65	100	65	100
Av. Da. Gains	0.73	1.38	0.66	1.37	0.67	1.33	0.68	1.29
Feed Consumed (lbs.)								
Av. Tot. Organic	1100	1066	1111	1170	1250	1217	1231	1220
Av. Da. "	2.07	4.15	1.89	4.5	2.05	4.5	1.99	4.4
Av. Mineral	98	47	96	45	98	46	96	44
Av. Da. Mineral	0.19	0.18	0.17	0.17	0.16	0.17	0.15	0.16

DISCUSSION

Results secured in these experiments as summarized in table IX, indicate that a ration containing 20 per cent crude protein will induce slightly more rapid gains in Duroc Jersey pigs weighing less than 65 pounds, than a ration containing 16 per cent protein. Pigs receiving the 20 per cent protein level, or lot I, gained 11 per cent more than pigs of the same weight and breed that were fed the 16 per cent protein ration and designated as lot II. There was practically no difference in the average economy of gains secured at the two protein levels.

Weanling Hampshire pigs, weighing under 65 pounds and designated as lot III, did not show the increase in gain at the higher protein level of 20 per cent. In fact similar pigs fed a 16 per cent ration in lot IV had a slight advantage in both rate and economy of gain.

In the average of the three trials, summarized in table IX, Duroc Jersey pigs weighing from 65 to 100 pounds and receiving an 18 per cent protein ration gained at about the same rate as similar pigs fed a 14 per cent ration, but the latter pigs required 10 per cent more feed. Pigs of the Hampshire breed gained slightly faster when fed the 16 per cent ration, but did not exhibit greater economy in the amount of feed required per unit of gain.

The data presented in tables III, IV, and V were averaged for the three separate trials and are presented in table IX, a summary table for the three trials. The first three tables cover the three specific trials and show the cost of a hundred pounds gain on the different rations. The cost varied with the price of feed ingredients as well as with the rate and economy of gain. In most cases

the gains made in the higher protein levels proved to be more expensive per unit of live weight increase at the feed prices charged in the experiments. The prices charged were current market prices in existence at the time of the respective trials.

Considerable variation existed in the gain of the pigs in the different lots. The average gain made by the pigs of the two breeds from weanling to 65 pounds and from 65 to 100 pounds is given in table X. The probable error of the average gain is also given. The size of the probable errors and the small differences in the mean gains indicate the observed differences probably were not significant.

TABLE X THE AVERAGE GAIN (With P. E. of Mean) OF DUROC JERSEY AND HAMPSHIRE PIGS FED MEDIUM AND HIGH LEVELS OF PROTEIN

	Lot I	Lot II	Lot III	Lot IV
Breed	Duroc Jersey		Hampshire	
	Entire Trial--Weaning-100 Pounds			
Protein Level	20% & 18%	16% & 14%	20% & 18%	16% & 14%
Trial I	65.83 ± 5.54	55 ± 7.05	58.57 ± 6.85	53.67 ± 6.1
Trial II	64.09 ± 3.83	63 ± 6.41	61.67 ± 3.50	58.64 ± 4.19
Trial III	61.67 ± 5.11	61 ± 5.59	57.31 ± 4.87	60.83 ± 6.73
	Below 65 Pounds			
Protein Level	20%	16%	20%	16%
Trial I	60.71 ± 5.75	46.25 ± 7.09	39 ± 5.07	34 ± 4.32
Trial II	58.33 ± 3.94	53.33 ± 4.61	56 ± 8.69	55 ± 2.25
Trial III	42.14 ± 1.36	45.57 ± 2.96	45 ± 3.17	40 ± 1.62
	65-100 Pounds			
Protein Level	18%	14%	18%	14%
Trial I	73 ± 7.93	66.66 ± 12.75	107.5 ± 20.9	93 ± 6.97
Trial II	71 ± 6.2	75 ± 12.04	66.67 ± 5.62	63 ± 8.84
Trial III	89 ± 4.89	87 ± 7.71	77 ± 8.81	102 ± 7.69

Duroc Jersey pigs made slightly more rapid average daily gains than did Hampshires when both were fed 20 per cent protein rations just after weaning. The Duroc Jerseys gained an average of 0.06 pound more per day and the Hampshires required an average of 1¼ per cent more feed per unit gain. When the same age pigs were fed at the medium protein level of 16 per cent, Duroc Jersey pigs did not have an advantage over Hampshires in average daily gains. The latter breed, however, required 11 per cent more feed per hundred pounds gain.

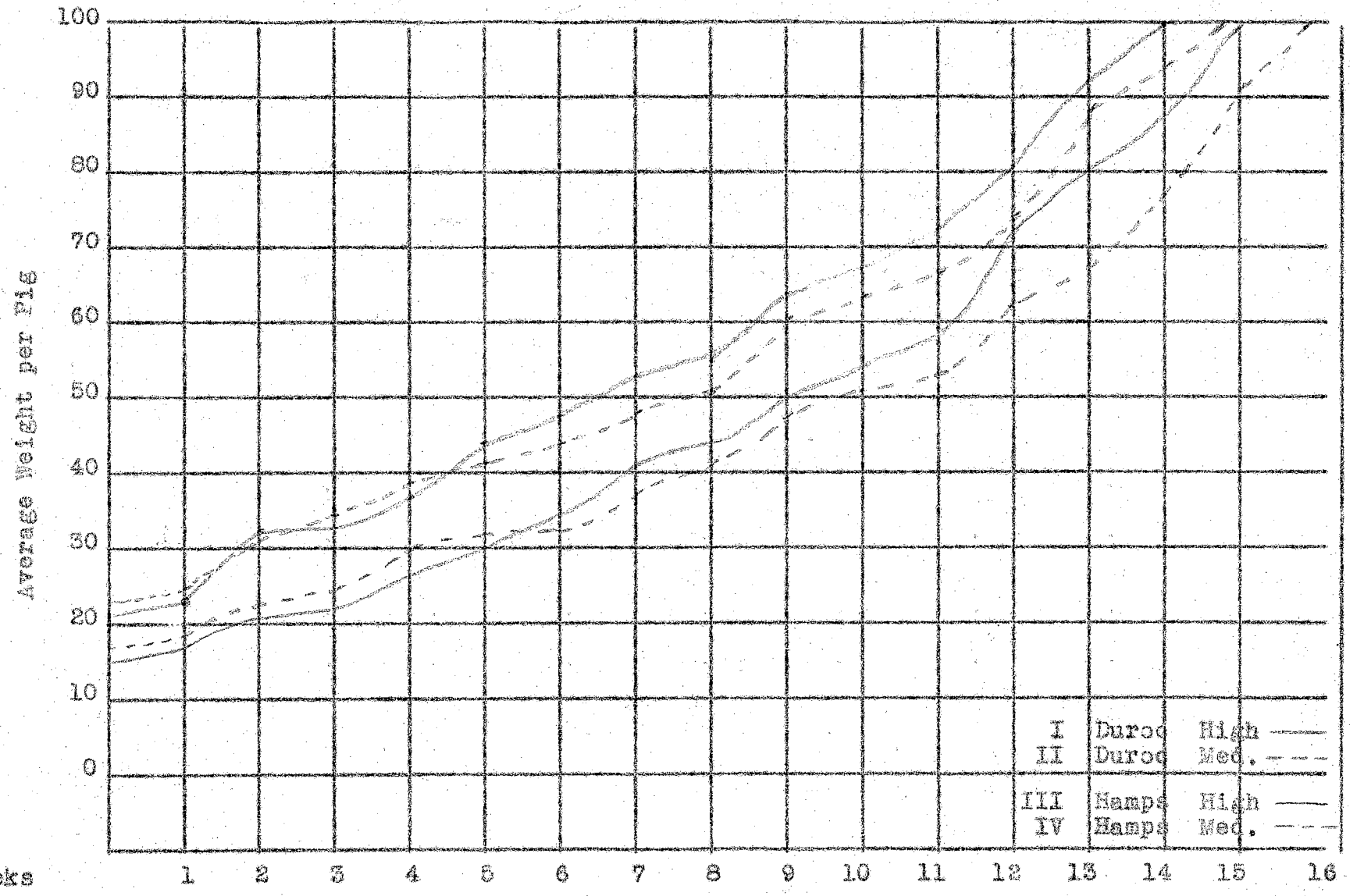
Hampshires failed to gain as rapidly from 65 to 100 pounds as did the Duroc Jerseys. At the heavier weight, Duroc Jersey pigs fed a ration containing a high level, or 18 per cent protein gained 0.05 pound more per head daily than did the Hampshires receiving the same ration. The Hampshires required 11¼ per cent as much feed than did the breed with which they were compared. When fed a medium protein level of 14 per cent, Duroc Jerseys gained 0.08 pounds more per head daily at the heavier weights studied than did the Hampshires. The latter ate 10¼ per cent as much feed per unit gain.

The number of weeks required for the various lots to reach 65 pounds and 100 pounds is given in tables VI, VII, and VIII. In the first trial, presented in table VI, it will be observed that it took the Hampshire pigs considerably longer to reach each weight than it did the Duroc Jerseys. In the second trial, the weekly gains given in table VII indicate there was little difference between the breeds. In the third trial presented in table VIII, it required Hampshires about one week longer to reach each weight. The weight increases of the various lots

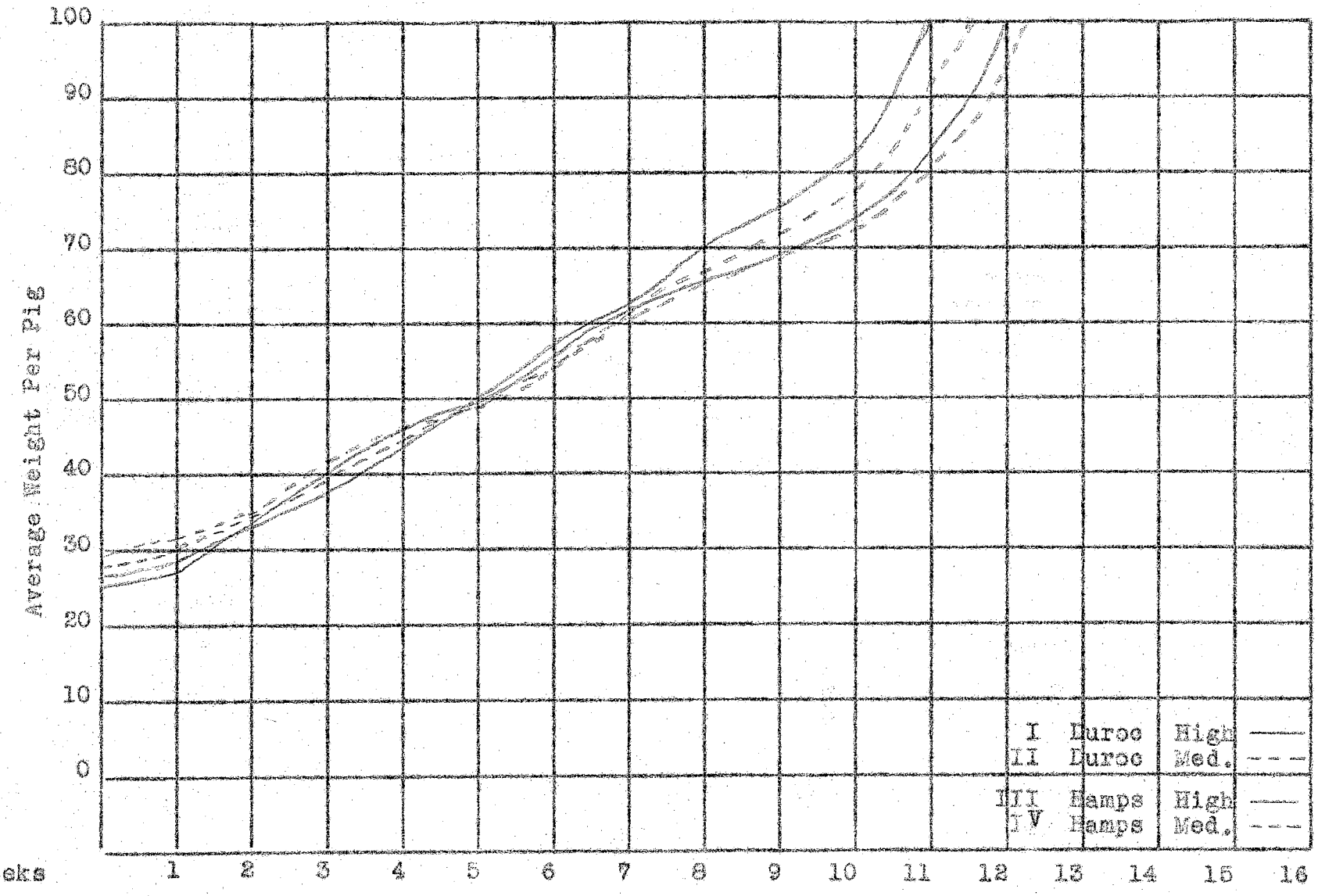
for the three trials are graphically presented in graphs I, II, and III. An increased length of time required to get a hog to a desired weight is an important consideration if there is a possibility of a decline in the market price.

GRAPH I

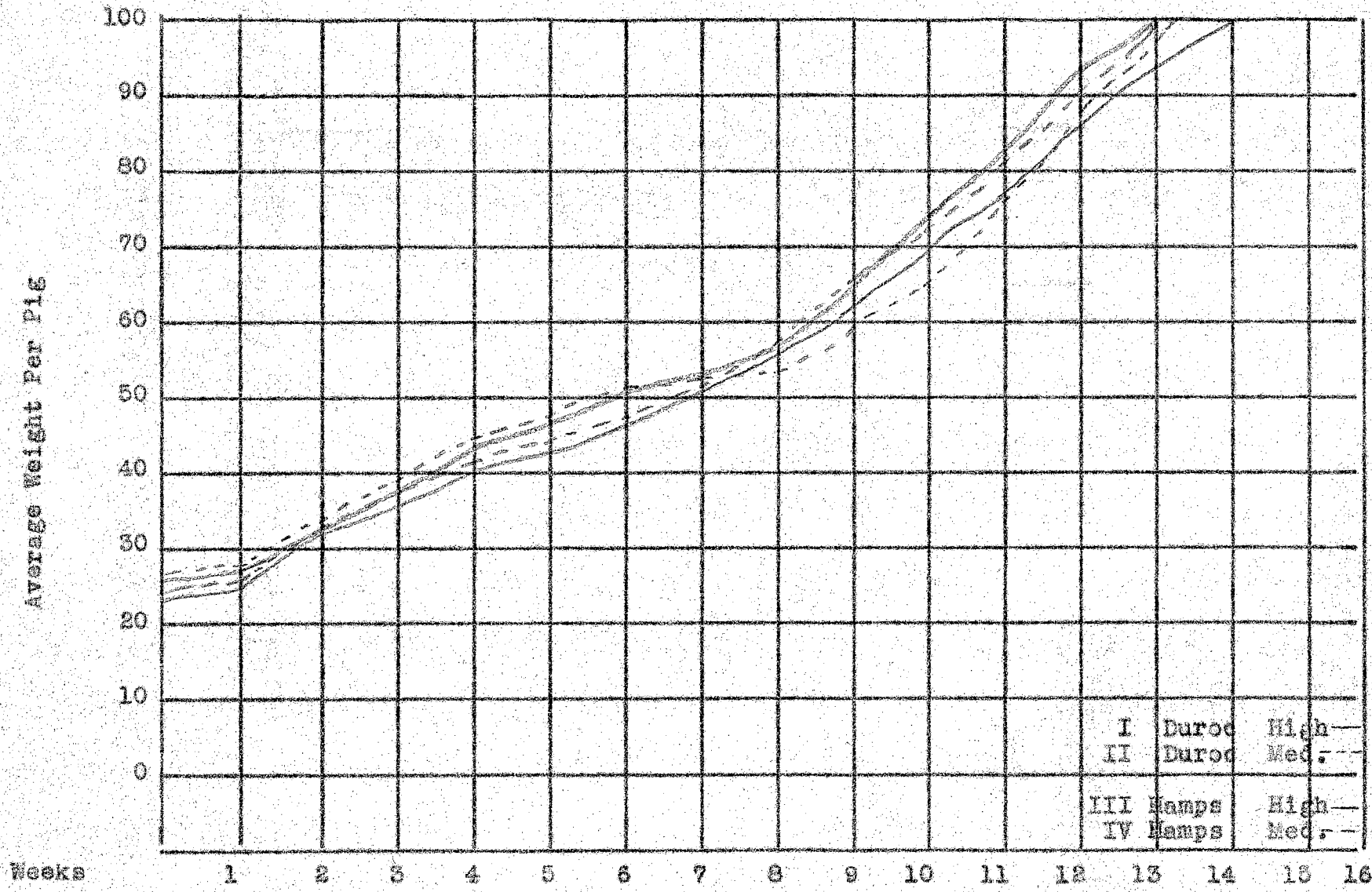
THE INCREASE IN WEIGHT OF PIGS OF DUROC JERSEY AND HAMPSHIRE BREEDS FED HIGH AND MEDIUM LEVELS OF PROTEIN IN TRIAL I



GRAPH II THE INCREASE IN WEIGHT OF PIGS OF DUROC JERSEY AND HAMPSHIRE BREEDS FED HIGH AND MEDIUM LEVELS OF PROTEIN IN TRIAL II



GRAPH III THE INCREASE IN WEIGHT OF PIGS OF DUROC JERSEY AND HAMPSHIRE BREEDS FED HIGH AND MEDIUM LEVELS OF PROTEIN IN TRIAL III



Live weight increase is apparently influenced by the weather. By comparing tables III, IV, and V, it will be noted that all lots made more economical gains and required less time to reach the 100 pound live weight in the second trial, reported in table IV, and conducted from November 2, 1946 to January 22, 1947, than in either of the other two trials. It is possible the difference in climatic conditions, particularly temperature, may have caused some difference in rapidity and economy of gain. The mean temperature for the first trial was 77.3°F., for the second 43°F., and for the third 74°F. These observations are in agreement with Sheppard (1929) who stated that during August, when the temperature was high, the pigs loafed 6.5 hours per day; whereas in October when the temperature was lower, they were up eating from 6:30 a. m. until 6:00 p. m. Hale (1935), of Texas, confirmed Sheppards work when he found summer-fed pigs made 8 per cent less gain for the feed consumed than did pigs fed in cooler weather.

SUMMARY

The Duroc Jersey pigs under 65 pounds in weight that received the 20 per cent protein level ration gained 11 per cent more than the pigs of the same weight and breed fed the 16 per cent protein level ration. Hampshire pigs of the same weight did not improve their rate and economy of gain with the same increase in protein. The Duroc Jersey pigs weighing from 65 to 100 pounds, and receiving 18 per cent protein gained at about the same rate as similar pigs fed a 14 per cent ration. The latter pigs, however, required 10 per cent more feed. Hampshires of similar weight gained slightly faster when fed the higher level of protein. The high cost of protein feeds resulted in the higher protein levels being more expensive per unit of gain.

Weanling Duroc Jersey pigs made slightly more rapid average daily gains than did Hampshires on 20 per cent protein level rations but they did not have an advantage over Hampshires in average daily gains on 16 per cent protein level rations. Duroc Jerseys gained more rapidly from 65 to 100 pounds than did the Hampshires. In both weight levels the Hampshires required more feed per 100 pounds gain.

Fall pigs gained more rapidly and economically than did spring pigs when fed similar rations in dry-lot.

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