

T H E S I S

PROTEIN SUPPLEMENTS IN THE HOG FATTENING
RATION UNDER EASTERN COLORADO
CONDITIONS

Submitted by

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I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER
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INTRODUCTION

Non-irrigated eastern Colorado is primarily a grain producing area. The 1931 Colorado year book reports that this section produces 91 percent of the corn, 94 percent of the winter wheat, 69 percent of the spring wheat and 72 percent of the barley grown within the state. In addition to these, eastern Colorado grows a large tonnage of (Proso) hog millet.

All of these grains are well adapted to livestock feeding, especially the fattening of hogs. Corn, wheat, barley and hog millet are all carbonaceous in nature and the small amount of protein they contain is not sufficient to balance the fattening ration. If these grains are to be utilized as feed for stock it is essential that a protein supplement be added to the grain ration to insure the maximum gains and minimum cost of gains. Up to the present time no suitable home-grown high protein feed has been found in eastern Colorado to replace tankage, which generally is considered a standard protein supplement. Sudan grass is comparatively high in protein if cut before it reaches maturity and there is a possibility that this roughage can replace alfalfa meal in a triple mixture composed of two parts tankage, one part cottonseed meal and one part alfalfa meal. Soybeans, flaxseed and pinto

beans can be grown in this section of Colorado. Chemical analyses show these crops to be high in protein content. However, these feeds have important shortcomings that may limit their use as protein supplements.

During the years that the Colorado Experiment Station has conducted experimental feeding tests, its policy has been to conduct investigational work with the particular feeds that seemed to hold the immediate interest of the practical feeder and to obtain such knowledge regarding local feeds and feed combinations that would result in financial gain for the practical livestock man.

In 1930 the Colorado Experiment Station outlined feeding tests to determine the value of adding a protein supplement to a grain ration in the dryland section of eastern Colorado, and to study the relative value of commercial protein supplements and home-mixed protein supplements in this section.

This thesis is a study of the pig fattening experiments that were conducted by the Colorado Experiment Station in cooperation with the United States Department of Agriculture at Akron, Colorado from 1930 to 1932, inclusive. Its purpose is to show the value of adding a protein supplement to a grain ration for fattening pigs and to show the relative value of commercial protein supplements when compared to home-

mixed protein supplements and to home-grown high protein concentrates for supplementing grain in a hog fattening ration under the dry farming conditions of eastern Colorado.

The author was a resident fellow in immediate charge of the 1933 experiments, and did the feeding of the hogs under the direction of Professor H. B. Osland, Associate in Animal Investigations for the Colorado Agricultural Experiment Station.

REVIEW OF LITERATURE

The Value of a Protein Supplement

It has long been known and accepted that grains commonly used for feeding swine are not only low in protein content but that these proteins are incomplete in that they do not contain all the amino acids needed for growth. Because of this fact, pigs do not make rapid and economical gains on any grain unless it is supplemented with some high protein feed that will supply the specific substances in which the grains are deficient. Experimental work has shown that feeds of animal origin usually contain proteins that are more nearly complete in their amino acid content than are the proteins of feeds of plant origin. Therefore, tankage or meat meal, and dairy by-products usually excel as protein supplements for swine.

Regarding the protein requirements of growing pigs, Henry and Morrison (1) state, "Since pigs grow rapidly, they need an abundant supply of protein in their rations, to furnish the building material for the rapidly developing muscular tissues and the internal organs as well. Furthermore, the supply of protein must not only be ample in amount, but also the proteins must be of the right quality."

Smith (11) presents an average of 35 experiments

in which a total of 594 pigs with an average initial weight of 118 pounds were used to show the value of adding a standard protein supplement to a corn ration. In these experiments the pigs fed corn gained an average of .96 pounds a day as compared to 1.46 pounds per day for pigs fed corn with a protein supplement. The pigs on grain only, consumed 544.1 pounds of feed for each 100 pounds of gain produced, while the pigs fed corn with a protein supplement required only 436.2 pounds of feed to make unit gains.

From this it is seen that the addition of a protein supplement to a grain ration saved 20 percent of the feed required to produce 100 pounds of gain and enabled the pigs to reach a weight of 220 pounds in 36 days shorter time.

The literature contains many experiments that prove the value of adding a protein supplement to a grain ration, but it does not seem necessary to present these experiments here because the value of a protein supplement in a pig fattening ration is universally known and accepted.

Cottonseed Meal

Cottonseed meal is not generally considered a safe feed for pigs as it contains a compound called gossypol which is more poisonous to them than to other livestock. Henry and Morrison (1) state, "When cottonseed meal makes up as much as one-third of the

concentrate ration for pigs, they thrive at first, but after a few weeks become sick and die."

Because cottonseed meal is much cheaper in many sections of the country than tankage or other high protein concentrates that are satisfactory for supplementing grain in hog-fattening rations several stations have done work in an attempt to find a safe way of feeding it.

In an experiment to determine what percent of cottonseed meal could safely be fed to fattening pigs, Bohstedt, Bethke, and Edgington (7) at the Ohio Agricultural Experiment Station fed lots of 5 pigs each, rations of corn, supplemented with different percentages of cottonseed meal. The concentrates were fed in a mixture, one lot receiving 80 percent corn and 20 percent cottonseed meal while the other was fed 75 percent corn and 25 percent cottonseed meal. The following table adapted from their data gives the feed consumed per unit gain:

<u>Feed for 100 Pounds of Gain</u>		
<u>Ration</u>	<u>Corn</u>	<u>Cottonseed Meal</u>
Lot 1. Corn 80 percent, cotton- seed meal 20 percent	403.2	100.8
Lot 2. Corn 75 percent, cotton- seed meal 25 percent	329.3	109.7

The lot in which cottonseed meal made up 20 percent of the ration remained thrifty thruout the feeding period and apparently suffered no ill effects from the cottonseed meal. However, in the lot in which the grain mixture contained 25 percent cottonseed meal, the pigs became less thrifty as the feeding period progressed. One pig died from the poisoning effects on the 67th day and another on the 78th day. The remaining pigs, altho they did not succumb, had rough unthrifty coats and failed to make satisfactory gains.

Hale (8) at the Texas Agricultural Experiment Station in two tests found a ration that contained not more than 9 percent cottonseed meal could be fed to brood sows, boars, suckling, growing and fattening pigs without any bad effects. The following table was adapted from their data:

<u>Ration</u>	<u>Feed for 100 Pounds of Gain</u>		
	<u>Milo Chops</u>	<u>Tankage</u>	<u>Cottonseed Meal</u>
Lot 1. Milo Chops, 90 parts Tankage, 10 parts	354	39.3	
Lot 2. Milo Chops, 87 parts Tankage, 4 parts Cottonseed Meal, 9 parts	348	16.0	36.0
Lot 3. Milo Chops, 86 parts Tankage, 2 parts Cottonseed Meal, 12 parts	348	8.0	48.7
Lot 4. Milo Chops, 85 parts Cottonseed Meal, 15 parts	347		61.0

In this experiment with 60-pound pigs the lot receiving 10 parts of tankage made an average daily gain of 1.85 pounds; the lot that was fed four parts tankage and nine parts cottonseed meal gained 1.63 pounds a day; the lot fed a mixture composed of two parts tankage and 12 parts cottonseed meal made a daily gain of 1.49 pounds; while Lot No. 4, fed 15 parts of cottonseed meal gained only 1.29 pounds a day. In the lot that received 15 percent cottonseed meal, one pig died on the 16th day and another was taken from the experiment on the 19th day because it became affected with the thumps and was unthrifty, both being clear cases of cottonseed meal poisoning. In Lot No. 3, when 12 percent cottonseed meal with two percent tankage was fed no deaths nor extreme unthriftiness resulted, however, this lot did not make as rapid nor as economical gains as the lot that received nine parts of cottonseed meal mixed with four parts of tankage as a supplement.

In two experiments at the Arkansas Agricultural Experiment Station, Dvorachek, Sandhouse and Hunt (9) fed lots of 105-pound pigs for 46 days on cottonseed meal as the sole supplement to corn in a comparison to tankage. The protein supplements were mixed with ground corn in the proportion of 90 parts of corn to 10 parts of tankage and 85 parts of corn to 15 parts of cottonseed meal. This mixture was self-fed free-choice with salt and a mineral mixture.

The pigs fed tankage as a supplement to corn outgained the pigs fed cottonseed meal only slightly. Both lots seemed equally thrifty and made satisfactory gains. In the case of these rather large pigs fed a comparatively short period no toxic effect from the cottonseed meal was apparent. The authors of this work, however, expressed the opinion that if they had fed these pigs on this ration for 90 to 100 days ill effects may have resulted.

It seems that cottonseed meal can be used successfully in the hog-fattening ration if it does not make up more than one-half the protein supplement.

Hale (8) at the Texas Agricultural Experiment Station found that pigs fed a double mixture composed of one-half cottonseed meal and one-half tankage by weight gained 1.90 pounds a day while similar pigs fed tankage as the protein supplement gained 1.80 pounds. The following table was adapted from Hale's data.

<u>Feed for 100 Pounds of Gain</u>			
<u>Ration</u>	<u>Milo</u>	<u>Tankage</u>	<u>Double Mixture</u>
Lot 1. Ground Milo, Tankage	341.0	35.4	
Lot 2. Ground Milo, Double Mixture	328.9		47.0

Altho 7.6 pounds more double mixture were required to produce 100 pounds of gain the use of it saved 12.1 pounds of corn in producing this gain.

One ton of double mixture replaced 1506.38 pounds of tankage and 514.89 pounds of corn.

Hale(8) concludes that it is safe and satisfactory to feed cottonseed meal in this mixture free-choice in a self-feeder.

Soybeans

The seeds of the soybeans are high in protein and the soybean plant can be successfully grown on corn-belt farms even where alfalfa and other legumes have failed. Cultivation of soybeans extend from the southern states into sections of Colorado on the west. Because of this extensive cultivation they have come into use as a protein supplement to grain in rations for swine. Considerable investigations have been conducted recently by experiment stations to determine the relative value of soybean seeds as a protein supplement to corn and other grains when compared to tankage alone and in combinations, and to study their effect on the quality of pork produced.

Henry and Morrison (1) state, "Soybeans contain nearly as much crude protein as linseed meal and the protein is well balanced so that it supplements the proteins of the cereal grains quite efficiently." They give the chemical composition on a digestible nutrient basis as follows:

	Dry Matter Percent	Protein Percent	Carbo- hydrate Percent	Fat Percent	Total Digestible Nutrients Percent
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Soybean seed	90.1	33.2	24.7	16.1	94.1
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They find, however, that soybeans are low in calcium, and that their high fat content sometimes make them rather unpalatable to swine receiving them continuously.

Ferrin and Johnson (13) at the Minnesota Agricultural Experiment Station point out that soybean seeds contain 35 percent protein and 18 percent oil. It would require one-fifth as much soybeans as corn to balance the ration and if they are fed in such large amounts for four or more weeks, soft pork is sure to result. They conclude that if soybeans are low in price they are satisfactory for feeding the breeding stock, as brood sows relish them and their high energy content makes them well suited for suckling pigs.

In comparing soybeans to tankage as a supplement to corn Henry and Morrison (1) give the following table to show the average of eleven trials:

	<u>Feed for 100 Pounds of Gain</u>		
	<u>Corn</u>	<u>Tankage</u>	<u>Soybeans</u>
Lot 1. Corn, Soybeans	336		71
Lot 2. Corn, Tankage	340	46	

The pigs fed soybeans made an average daily gain of 1.43 pounds while the pigs fed tankage gained an average of 1.58 pounds. In these trials one ton of ground soybeans replaced 1300 pounds of tankage and 100 pounds of corn.

In trials run by Weaver (2) at the Missouri Agricultural Experiment Station pigs fed a ration of corn and soybeans gained 1.1 pounds while those fed corn and tankage gained 1.2 pounds a day. While 17.8 pounds more soybeans were required, yet 21.0 pounds less corn was required to produce 100 pounds of gain. One ton of soybeans replaced 1000 pounds of tankage and 1167.0 pounds of corn.

Robison (3) at the Ohio Agricultural Experiment Station reports an average of seven trials in which soybeans were compared to tankage as a protein supplement to corn. The following adapted table shows the feed required per unit gain:

<u>Feed for 100 Pounds of Gain</u>		
	<u>Corn</u>	<u>Protein</u>
Lot 1. Corn, Tankage	357.4	38.6
Lot 2. Corn, Soybeans	355.6	69.9

The tankage lot outgained the soybean lot by 0.3 pounds per day, the gains being 1.68 pounds and 1.38 pounds for these lots, respectively. In the

production of 100 pounds of gain, 31.3 pounds of soybeans saved 1.8 pounds of corn. One ton of soybeans replaced 1104.4 pounds of tankage and 51.5 pounds of corn, but the tankage enabled the pigs to reach a weight of 220 pounds 15 days sooner than did the soybeans.

Tomhave (4) concludes that the mixing of tankage with ground soybeans is the most efficient method of utilizing soybeans as a swine feed. This ration produced as large daily gains as did tankage when fed as a supplement to corn.

Bull, and others (5) in trials conducted from 1925 to 1929 inclusive, found that pigs fed tankage as a supplement to corn gained 17 percent more rapidly than did similar pigs fed soybeans as a supplement to corn, and that they require 12 percent more of the soybean ration to produce unit gains. They conclude, however, that considering only the economy of gains pigs utilize soybeans rather efficiently after they reach a weight of 100 pounds.

From Vestal's (6) summary of six experiments in fattening spring pigs on alfalfa pasture it is found that the pigs fed tankage made a daily gain of 1.67 pounds while pigs fed soybeans gained only 1.37 pounds a day.

	<u>Feed for 100 Pounds of Gain</u>		
	<u>Corn</u>	<u>Tankage</u>	<u>Soybeans</u>
Lot 1. Corn, Soybeans	335		38
Lot 2. Corn, Tankage	339	32	

In these tests, one ton of soybeans replaced 1201.52 pounds of tankage and 210.53 pounds of corn. The soybeans had a feed replacement value of 64 percent that of tankage according to the author.

The above table adapted from Vestal's summary table shows that it required 6 pounds more of the soybeans to produce 100 pounds of gain than it did of tankage, but that the soybeans saved 4.0 pounds of corn in producing this gain.

Soybeans when fed in sufficient amounts to supplement corn in a hog-fattening ration usually produce soft pork. From the trials of Bull and others at the Illinois Agricultural Experiment Station (5) it is found that in all cases hogs fed soybeans to supplement a corn ration produced soft pork. They state that pigs fed corn and tankage until the pigs weigh 115 pounds and finish on corn and soybeans produced soft pork, and that pigs fed corn and soybeans until they weighed 150 pounds and finished on corn and tankage also produced soft pork. They advise the feeding of soybeans to brood sows as it seems to have no effect upon the pigs

produced.

Robison (3) concludes, "Soybeans, fed to pigs from weaning to the time they are ready for market, in sufficient amounts to provide protein to balance grains, are likely to cause soft pork."

Flaxseed

The flax crop of the United States is produced largely in the spring-wheat areas of Minnesota, North and South Dakota and Montana, with small quantities being grown in northeastern Colorado. A bulletin (10) published by the Minnesota Extension Service lists the average flax production of the United States from 1924 to 1928 inclusive, as 16,838,000 bushels. The high commercial value of linseed oil under normal price conditions, limits the utilization of the raw flaxseed as a feed for livestock.

The reserve building material of flaxseed is stored in the forms of oil and pentosans and not in the form of starch as is the case with most seeds. Henry and Morrison (1) refer to the feeding of flaxseed to calves but make no mention of it being fed to other livestock. A number of feeders in the vicinity of Fort Collins, Colorado utilized raw flaxseed as a part of the protein supplement in the fattening ration for lambs and cattle. All of these feeders gave the

impression that flaxseed was a good feed, but they all cautioned that it must be fed with care to prevent throwing the animals off feed and causing digestive disorders.

Very little experimental work has been conducted to determine the feeding value of flaxseed for livestock. The two experiments quoted below seem to be the extent of the work relative to the feeding of flaxseed to fattening pigs.

Robison and Thatcher (12) at the Ohio Agricultural Experiment Station compared flaxseed to linseed oil meal in an experiment with two lots of five pigs each. A grain mixture of 92.8 percent barley and 7.2 percent ground flaxseed was compared to a barley-linseed oil meal mixture that supplied the same amount of protein. The pigs fed flax in the grain mixture gained slightly more and required less feed to produce 100 pounds of gain than did the pigs that were fed the grain mixture containing linseed oil meal.

In a feeding trial conducted at the Minnesota Agricultural Experiment Station (15) ground flaxseed was compared to tankage as a protein supplement to barley, corn and oats for fattening pigs. The station reports, "Tankage proved distinctly superior to the flaxseed, and the results indicated that the latter is not a practical feed for swine."

Morton (14) at the Wyoming Agricultural Experiment Station fed flaxseed to two lots of three lambs each. From his work he concluded that alfalfa, corn, turnips, and flaxseed seemed to make a satisfactory ration for lambs as indicated by this one year's work.

The results from an experiment conducted to determine the feeding value and characteristics of flax as a protein supplement to hog millet in a pig fattening ration are reported in this thesis. This experiment was undertaken to answer inquiries relative to the possibility of feeding flaxseed to pigs.

Joseph (16) at the Montana Agricultural Experiment Station in one trial, found that flaxseed as a supplement with grain in a ration for pigs weighing a little over 100 pounds showed no advantage over a ration of grain only.

THE EXPERIMENTS

The Colorado Experiment Station in cooperation with the United States Department of Agriculture at the U. S. Government Station, Akron, Colorado has conducted swine fattening experiments since 1928. During this time much valuable data pertaining to the value of certain feeds and feed combinations for fattening swine have been accumulated. It is the purpose of this thesis to assemble for careful analysis the phases of these experiments which offer information regarding the feeding values of protein supplements.

In all comparisons here presented, a 60 percent protein tankage when fed with a grain mixture of ground corn and ground hog millet or when fed with ground hog millet alone is considered as the standard (check) ration and all other feed combinations are compared to it.

OBJECTS OF THE EXPERIMENTS

1. To determine the value of adding a protein supplement to a corn and hog millet ration for fattening pigs.

2. To study the relative efficiency of home-mixed and commercial protein supplements in the hog-fattening ration.

3. To determine the value of home-grown high protein feeds for supplementing grain in the hog-fattening ration.

4. To study the effects of soybeans and flaxseed on the quality of pork produced.

THE 1930 EXPERIMENT

Pigs Used

Grade Poland-China pigs were purchased from a local breeder early in November and were carried on a maintenance ration until the experiment started on December 13. The pigs were wormed and vaccinated for hog cholera before they were started on experiment. They were fed 120 days on the test.

Feeds Used

All feeds used were self-fed free-choice in separate compartment self-feeders. The corn and hog millet was ground and mixed half and half by weight.

The corn used was a No. 5 yellow corn containing 10.51 percent protein and an average of 19.25 percent moisture during the feeding period.

The hog millet was a yellow variety weighing 56 pounds per bushel and was of excellent quality. It contained 12.78 percent protein and 13.85 percent moisture.

A guaranteed 60 percent protein digester tankage was fed. It showed an average moisture content of 8.30 percent thruout the feeding period.

Triple mixture composed of two parts tankage, one part cottonseed meal and one part alfalfa meal contained 44 percent protein and 8.55 percent moisture.

The protein supplement fed to Lot No. 8 was a guaranteed 50 percent protein meat and bone meal tankage. It contained an average of 8.13 percent moisture thruout the feeding period.

Mineral mixture was a simple mixture of 40 parts steamed bone meal, 40 parts high calcium carbonate limestone and 20 parts of salt. It was self-fed to all lots.

A No. 4 stock salt was self-fed.

Chemical Analysis of Grains Used

The chemical analyses of feeds used in these experiments were made by the chemist for the State Dairy Commission.

	Moisture	Crude Protein	Crude Fiber	N-free Extract	Crude Fat	Ash	No. of Samples
	%	%	%	%	%	%	
Corn	19.25	10.51	2.74	62.77	3.25	1.48	2
Hog Millet	13.85	12.78	8.19	57.96	3.46 - 3.76		2

Rations Fed

From this year's experiment the comparative results of four of the lots are presented. The rations fed the lots under consideration are as follows:

Lot 4. Ground corn, ground hog millet, triple mixture, mineral mixture and salt.

Lot 6. Ground corn, ground hog millet, mineral mixture and salt.

Lot 7. Ground corn, ground hog millet, tankage (60 percent protein), mineral mixture and salt.

Lot 8. Ground corn, ground hog millet, meat and bone meal tankage (50 percent protein), mineral mixture and salt.

The Allotment.

The pigs were allotted according to their weight, sex, origin, breed, type and condition and were placed in dry lots equipped with automatic watering tanks, separate compartment self-feeders, and a straw shed for each lot.

Weights were taken for three successive days at the beginning and end of the experiment and averages of the three used as the initial and final weights respectively. Individual weights of all pigs were taken each 30 days during the experiment. No ten-day lot weights were taken.

Discussion of Results



Lot No. 7

Lot No. 7 was fed 60 percent protein tankage as a supplement to a ration of corn and hog millet mixed half and half. They made an average daily gain of 1.91 pounds thruout the 120-day fattening period.



Lot No. 6

Lot No. 6 was fed a ration of ground corn and ground hog millet mixed half and half. No protein supplement was fed. These pigs made an average daily gain of 0.62 of a pound during the 120-day fattening period.

No Protein vs. Tankage

Table No. 1 shows the value of adding tankage to a ration of ground corn and ground hog millet when fed mixed half and half by weight.

Lot Number	6	7
Ration Fed		Ground Corn
Minerals and salt	Ground Corn	Ground
self-fed	Hog Millet	Hog Millet
		Tankage (60% protein)
No. of days on feed	120	120
No. of pigs per lot	10	10
Weight at start	68.8	70.3
Final weight	143.3	299.2
Total gain	74.6	228.9
Daily gain	0.62	1.91
Daily feed fed (pounds)		
Ground corn	2.24	4.13
Ground hog millet	2.24	4.13
Tankage		.42
Mineral mixture	.011	.003
Salt	.033	.004
Feed required per 100 pounds gain		
Ground corn	360.2	216.3
Ground hog millet	360.2	216.3
Tankage		22.0
Mineral Mixture	1.74	.15
Salt	5.36	.21
No. of day required for 70- pound pig to reach 220 pounds	242	79

Discussion of Table No. 1

The importance and necessity of supplementing home-grown grains with a high protein feed to balance the ration is pointed out in Table No. 1. The addition of 60 percent protein tankage to a ration of corn and hog millet mixed half and half produced three times

greater gains thruout the 120-day fattening period. The pigs fed a straight grain ration produced 74.6 pounds of gain per head during the period, while the pigs fed tankage in addition to the grain mixture gained 228.9 pounds during the same period.

One ton of tankage, in this comparison replaced 13,081.8 pounds of corn, 13,081.8 pounds of hog millet, 144.6 pounds of mineral mixture and 468.2 pounds of salt. The use of tankage enabled the pigs to reach a weight of 220 pounds 163 days sooner than did the pigs that did not receive any protein supplement.

While no deaths occurred among the pigs fed only grain they were decidedly unthrifty in appearance and failed to make satisfactory gains. They were sold as feeder hogs at the end of the 120-day feeding period.



Lot No. 4

Lot No. 4 was fed triple mixture composed of two parts tankage, one part cottonseed meal and one part alfalfa meal as a protein supplement to a ration of corn and hog millet mixed half and half. These pigs gained an average of 1.97 pounds a day thruout the 120-day fattening period.

Triple Mixture vs. Tankage

Table No. 2 shows the value of triple mixture when fed in a ration of ground corn and ground hog millet mixed half and half as compared to tankage fed with the same grain ration.

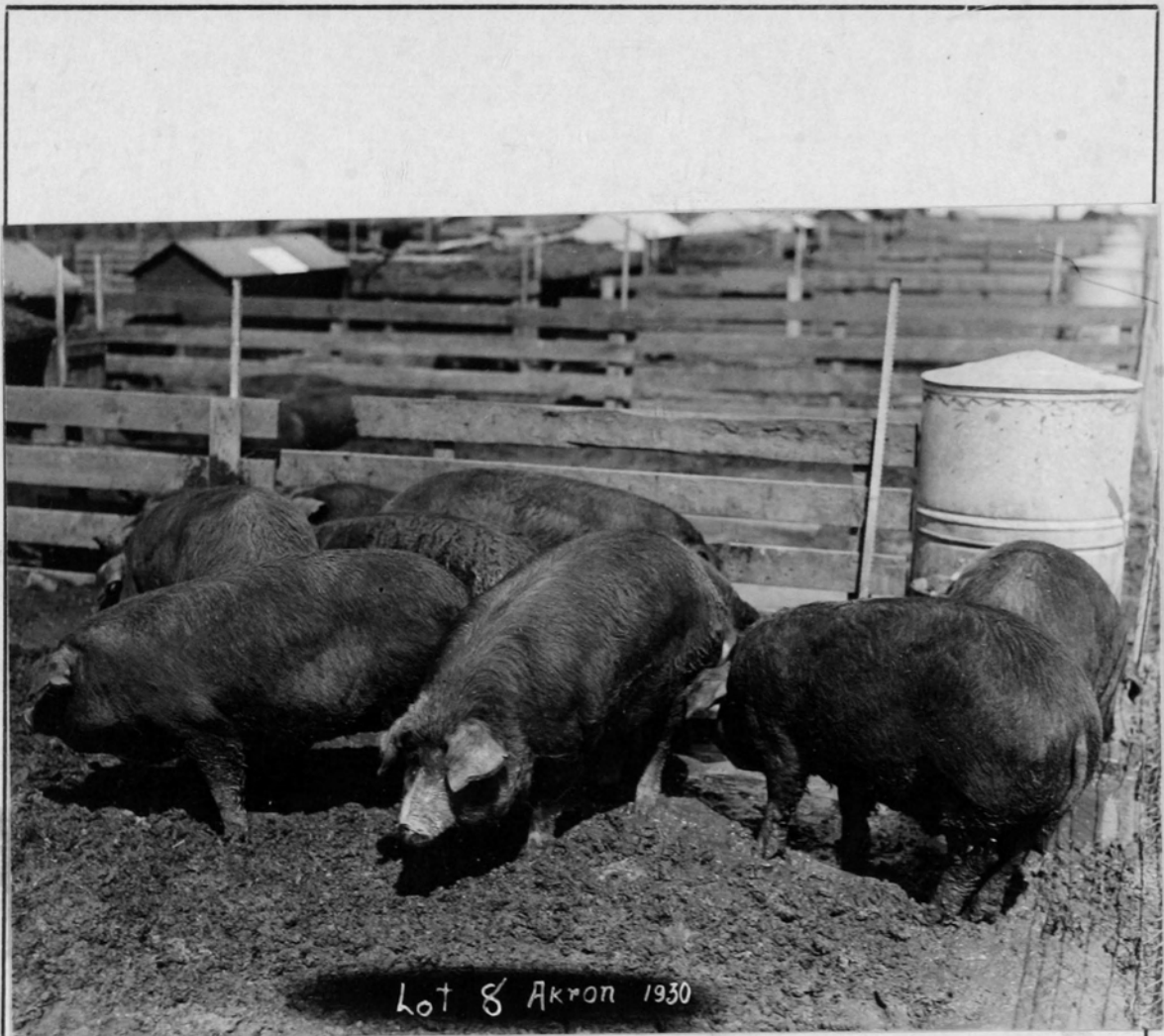
Lot Number	4	7
Ration Fed	Ground Corn	Ground Corn
Minerals and salt	Ground	Ground
self-fed	Hog Millet	Hog Millet
	Triple Mixture	Tankage (60% protein)
No. of days on feed	120	120
No. of pigs per lot	10	10
Weight at start	69.4	70.3
Final weight	305.6	299.2
Total gain	236.2	228.9
Dairy gain	1.97	1.91
Daily feed fed (pounds)		
Ground corn	4.21	4.13
Ground hog millet	4.21	4.13
Tankage		.42
Triple mixture	.64	
Mineral mixture	.003	.003
Salt	.003	.004
Feed required per 100 pounds gain		
Ground corn	214.0	216.3
Ground hog millet	214.0	216.3
Tankage		22.0
Triple mixture	32.8	
Mineral mixture	.17	.15
Salt	.13	.21
No. of days required for 70-pound pigs to reach 220 pounds	76	79

Discussion of Table No. 2

This comparison shows that a triple mixture composed of one-half tankage, one-fourth cottonseed meal, and one-fourth alfalfa meal when used to supple-

ment a ration of corn and hog millet mixed half and half produced slightly larger gains than 60 percent protein tankage. The pigs that were fed triple mixture as a supplement to their grain ration gained 236.2 pounds during the 115-day feeding period as compared to 228.9 pounds for the lot fed the same grain supplemented with tankage. While 4.6 pounds less grain was required to produce 100 pounds of gain where triple mixture formed the protein supplement, 10.8 pounds more of the supplement was required.

One ton of triple mixture replaced 1341.5 pounds of tankage plus 280.5 pounds of the grain mixture and 6.10 pounds of salt. The use of triple mixture enabled the pigs to reach a weight of 220 pounds three days sooner than the tankage-fed pigs. This difference is small and probably not very significant.



Lot No. 8

Lot No. 8 was fed 50 percent protein meat and bone meal tankage as protein supplement to a ration of corn and hog millet mixed half and half. These pigs gained an average of 2.05 pounds a day thruout the 120-day fattening period.

Meat and Bone Meal
Tankage (50% protein) vs. Tankage (60% protein)

Table No. 3 shows the value of 50 percent protein meat and bone meal tankage when fed as a supplement to corn and hog millet mixed half and half as compared to 60 percent protein tankage fed with the same grain.

Lot Number	8	7
	Ground Corn	
Ration Fed	Ground	Ground Corn
Minerals and salt	Hog Millet	Ground
self-fed	Meat and Bone	Hog Millet
	Meal Tankage	Tankage (60%
	(50% Protein)	Protein)
No. of days on feed	120	120
No. of pigs per lot	10	10
Weight at start	69.4	70.3
Final weight	315.1	299.2
Total gain	245.7	228.9
Daily gain	2.05	1.91
Daily feed fed (pounds)		
Ground corn	4.27	4.13
Ground hog millet	4.27	4.13
Tankage (60% protein)		.42
Meat and bone meal tankage		
(50% protein)	.56	
Mineral mixture	.002	.003
Salt	.003	.004
Feed required per 100 pounds		
gain		
Ground corn	208.3	216.3
Ground hog millet	208.3	216.3
Tankage (60% protein)		22.0
Meat and bone meal tankage		
(50% protein)	27.5	
Mineral mixture	.09	.15
Salt	.14	.21
No. of days required for 70-		
pound pigs to reach 220		
pounds	73	79

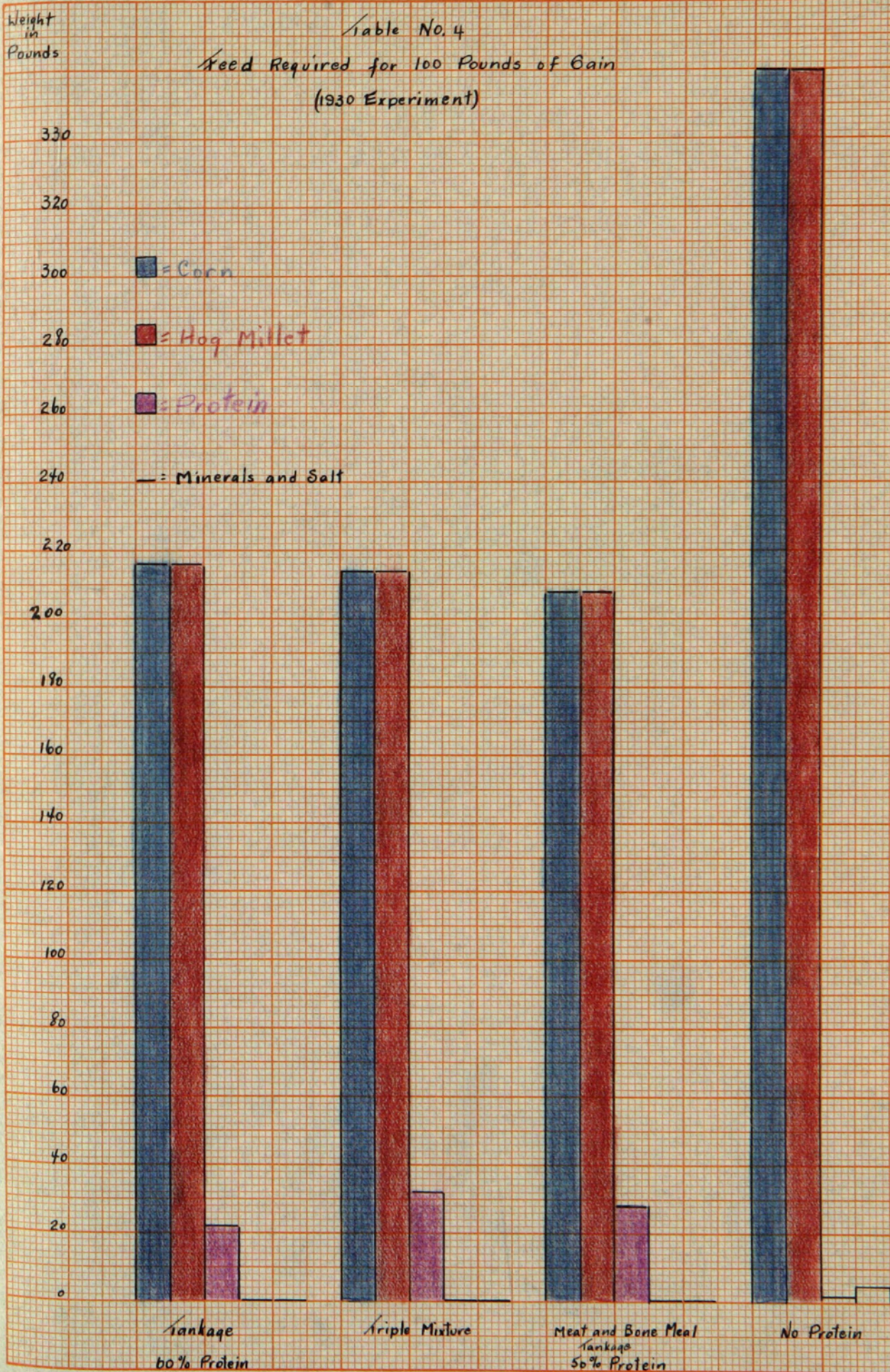
Discussion of Table No. 3

That 50 percent protein meat and bone meal tankage when fed as a protein supplement to corn and hog millet mixed half and half produced 0.14 pounds larger daily gains than did 60 percent protein tankage fed in this same combination is pointed out in Table No. 3. It is noted that 16.00 pounds less grain was used and 5.5 pounds more 50 percent protein meat and bone meal tankage was required to produce 100 pounds gain.

One ton of 50 percent protein meat and bone meal tankage replaced 1600 pounds of 60 percent protein tankage, 581.8 pounds corn, 581.8 pounds hog millet, 7.27 pounds mineral mixture and 7.27 pounds of salt. The 50 percent protein meat and bone meal tankage fed in this ration enabled the pigs to reach a weight of 220 pounds only six days sooner, which is not a very significant difference.

In this experiment 50 percent protein meat and bone meal tankage was just as efficient in producing gains as 60 percent protein tankage. However, this was conducted only during 1930, and further experimental work should be conducted before any definite conclusion can be drawn.

Table No. 4
Feed Required for 100 Pounds of Gain
(1930 Experiment)



Discussion of Table No. 4

Table No. 4 shows that the use of either of these three protein supplements in combination with corn and hog millet mixed half and half reduced the amount of grain required to produce 100 pounds of gain by approximately two-fifths in this year's experiment.

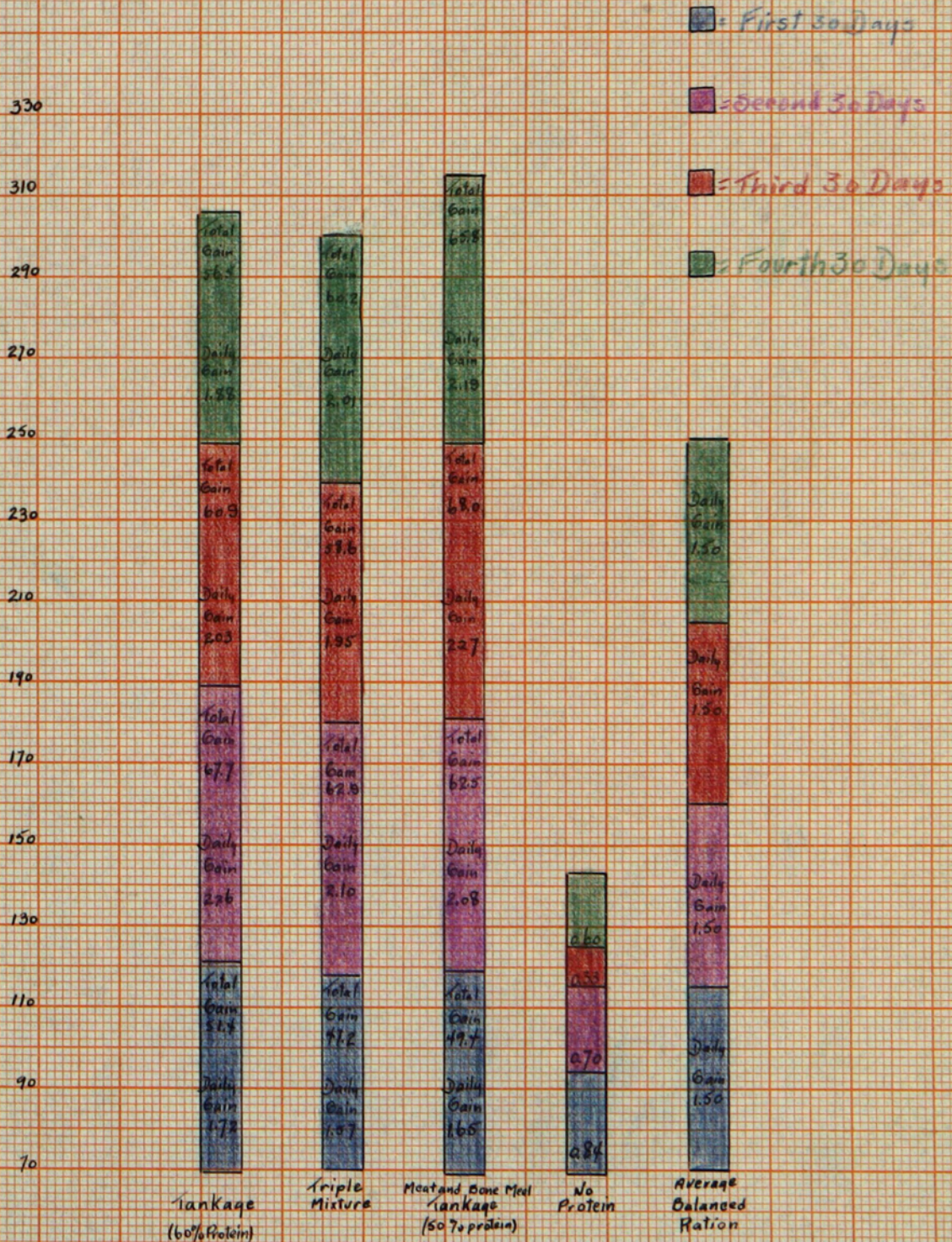
The lot, in which 60 percent tankage formed the protein supplement, required 216.3 pounds of corn, 216.3 pounds of hog millet, 22 pounds of tankage and less than one-quarter of a pound each of salt and mineral mixture to produce 100 pounds of gain. The lot that received triple mixture as a supplement to the grain required 214.0 pounds of corn, 214.0 pounds of hog millet, 32.8 pounds of triple mixture and a very little less mineral mixture and salt than the tankage lot. Where 50 percent protein meat and bone meal tankage formed the protein supplement, 208.3 pounds of corn, 208.3 pounds of hog millet, 27.5 pounds of tankage, and less than one-quarter of a pound of each mineral mixture and salt were required for each 100 pounds of gain produced.

In these three cases the differences in feed required per 100 pounds gain are only slight. However, the pigs that were not fed a protein supplement required about two-fifths more grain to produce 100

pounds of gain. They consumed 360.3 pounds of corn, 360.3 pounds of hog millet, 1.74 pounds of mineral mixture and 5.36 pounds of salt for each 100 pounds of gain.

Table No. 5
Rate of Gain
(1930 Experiment)

Weight
in
Pounds



Discussion of Table No. 5

Table No. 5 points out the fact that the lot of pigs that received no protein supplement as part of their ration gained only one-third as much in the 120-day feeding period as did either of the lots to which a protein supplement was added.

The lot in which 60 percent protein tankage formed the protein supplement, gained 51.4 pounds during the first 30 days or an average daily gain of 1.72 pounds. They gained a total of 67.7 pounds or 2.26 pounds daily gain, during the second 30-day period, and 2.03 pounds per day during the third period, and 56.5 pounds or 1.88 pounds per day during the fourth period of the 120-day feeding trial. Where triple mixture supplied the protein the pigs gained 47.2 pounds during the first 30-day period, 62.9 pounds the second, 58.6 pounds the third and 65.8 pounds the fourth 30-day period, or an average daily gain of 1.65 pounds, 2.08 pounds, 2.27 pounds and 2.19 pounds respectively for the four periods. The lot fed 50 percent protein meat and bone meal tankage gained 49.4 pounds the first period, 62.5 pounds the second, 68.0 pounds the third and 65.8 pounds the fourth 30 days, which equals a daily gain of 1.65 pounds, 2.08 pounds, 2.27 pounds and 2.15 pounds respectively for these periods.

When the lot receiving no protein supplement is examined it is found that the pigs gained 25.3 pounds the first 30 days, 21.1 pounds the second, 10.0 pounds the third, and 18.1 pounds the fourth 30-day period. The daily gains for these respective periods are as follows: 0.84 pounds the first period, 0.70 pounds the second, 0.33 pounds the third and 0.60 pounds the fourth 30-day period.

Judging from experimental work a daily gain of 1.50 pounds may be considered as a fair average for pigs fed a balanced ration for a 90 to 120-day feeding period. When these four lots are compared to this standard it is noted that all lots that received a protein supplement with their grain ration are well above this average. On the other hand the straight grain fed pigs made one-half of the standard gain of 1.50 pounds only during the first 30-day period.

Table No. 6

Number of Days Required for 70 Pound Pig to Reach 220 Pounds
(1930 Experiment)

Number
of
Days

240

220

200

180

160

140

120

100

80

60

40

20

0

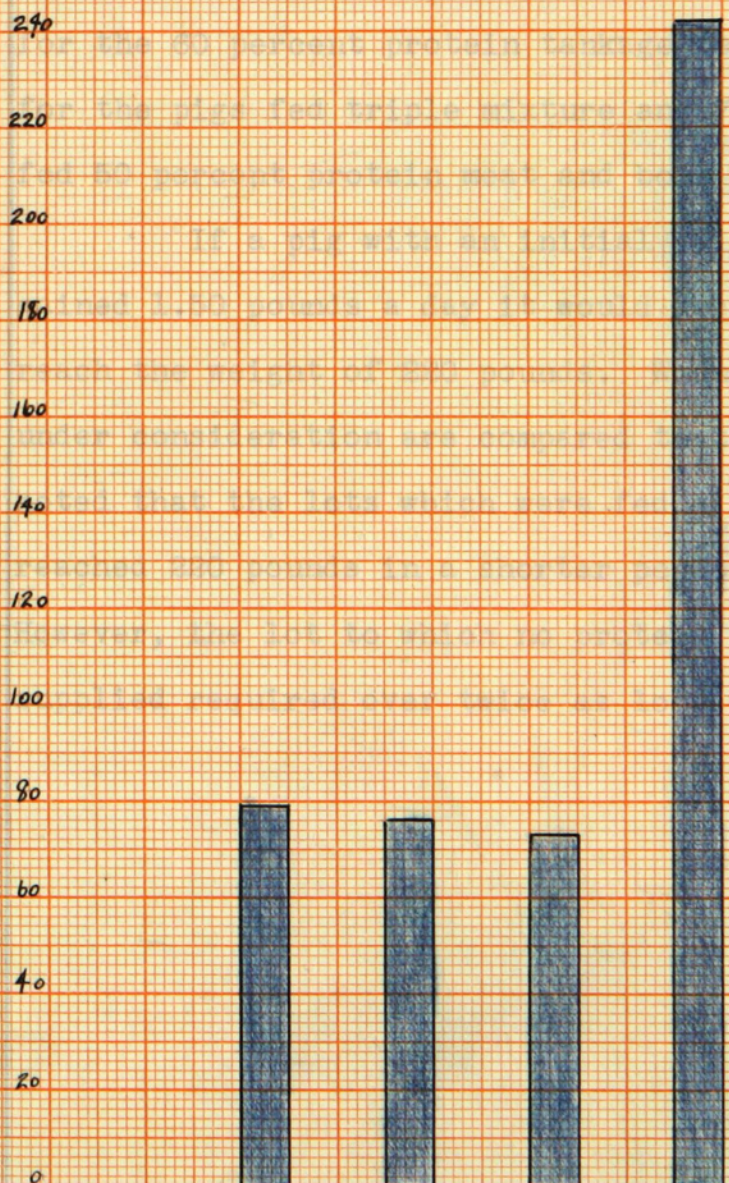
Tankage
(60% Protein)

Triple
Mixture

Tankage
(50% Protein)
Meat and Bone Meal

No
Protein

Average
Balanced
Ration



Discussion of Table No. 6

Table No. 6 shows clearly that it took practically three times as long for the pigs fed a straight grain ration to reach a weight of 220 pounds as it did either of the lots that received some protein supplement together with the grain ration.

It took the straight grain fed pigs 242 days to reach a weight of 220 pounds as compared to 79 days for the 60 percent protein tankage-fed pigs, 76 days for the pigs fed triple mixture and 73 days for the pigs fed 50 percent protein meat and bone meal tankage.

If a pig with an initial weight of 70 pounds gained 1.50 pounds a day it would require 100 days to reach the weight of 220 pounds. When the four lots under consideration are compared to this standard, it is noted that the lots which were fed a protein supplement reached 220 pounds in a shorter period than 100 days. However, the lot to which no protein supplement was supplied required over twice as long to reach 220 pounds.

THE 1931 EXPERIMENT

The results of four lots from the 1931 experiment are included in this thesis. Three of these are merely repetitions of the previous year's work using 60 percent protein tankage, triple mixture and a lot fed a ration of only corn and hog millet. The other lot of pigs were fed a mixture of one-half tankage and one-half cottonseed meal as the protein supplement to corn and hog millet mixed half and half by weight.

Pigs Used

The pigs for this experiment were high grade Poland-China pigs purchased from a local breeder at a weight of 47 pounds. They were treated for worms and vaccinated for hog cholera before being placed on the experiment.

Feeds Used

All feeds used were self-fed free-choice in separate compartment self-feeders, the corn and hog millet being ground and mixed half and half by weight before it was put in the self-feeder.

The corn was a locally grown No. 1 yellow corn with a weight of 55.5 pounds per bushel and an average moisture content of 13.64 percent.

The hog millet was a yellow variety weighing 59.0 pounds per bushel and having 10.28 percent moisture

thruout the feeding period. It was finely ground before being mixed with the corn.

The tankage was guaranteed 60 percent protein and was obtained from Armour and Company.

The triple mixture composed of two parts tankage, one part cottonseed meal and one part alfalfa meal contained 44 percent protein.

The double mixture made up of one-half tankage and one-half cottonseed meal by weight contained 51 percent protein.

Mineral mixture was composed of 40 parts steamed bone meal, 40 parts high calcium carbonate limestone and 20 parts salt.

All lots had access, also, to a No. 4 stock salt.

Chemical Composition of Feeds Used.

The chemical analyses were conducted by the chemist for the State Dairy Commission.

	Water %	Crude Protein %	Crude Fiber %	N-free Extract %	Crude Fat %	Ash %	No. of Samples
Corn	13.64	9.87	2.25	68.93	3.84	1.50	2
Hog Millet	10.28	9.17	10.52	61.80	3.81	4.43	2
Alfalfa Meal	10.22	13.95	45.30	19.02	1.43	10.08	2

Rations Fed

Lot 4. Ground corn, ground hog millet, triple mixture, (one-half tankage, one-fourth cottonseed meal, one-fourth alfalfa meal) mineral mixture, and salt.

Lot 6. Ground corn, ground hog millet, mineral mixture and salt.

Lot 7. Ground corn, ground hog millet, tankage (60 percent), mineral mixture, and salt.

Lot 9. Ground corn, ground hog millet, double mixture (one-half tankage, one-half cottonseed meal), mineral mixture and salt.

The Allotment

The pigs were allotted according to weight, sex, origin, breed, type and condition and were placed in dry-lots equipped with automatic watering tanks, separate compartment self-feeders and a temporary straw shed for each lot.

Weights were taken for three successive days at the start and at the finish of the experiment and average of the three used as the initial and final weights respectively. Individual weights of all pigs were taken each 30 days during the experiment. Ten-day lot-weights were not taken.

DISCUSSION OF RESULTS

No Protein vs. Tankage (60 Percent Protein)

Table No. 7 shows the value of adding 60 percent protein tankage to a ration of corn and hog millet mixed half and half by weight.

Lot Number	6	7
Ration Fed	Ground Corn	Ground Corn
Minerals and salt	Ground	Ground
self-fed	Hog Millet	Hog Millet
No. of days on feed	115	115
No. of pigs per lot	7	7
Weight at start*	58.8	47.0
Final weight	92.6	244.6
Total gain	33.8	197.6
Daily gain	.29	1.72
Average daily feed (pounds)		
Ground corn	1.57	3.05
Ground hog millet	1.57	3.05
Tankage		.51
Mineral mixture	.028	.007
Salt	.026	.003
Feed required per 100 pounds		
gain		
Ground corn	533.7	177.5
Ground hog millet	533.7	177.5
Tankage		29.6
Mineral mixture	9.44	.43
Salt	8.89	.18
No. of days required for 45-		
pound pigs to reach 220		
pounds	602	102
* Difference in initial weight due to deathloss of		
small pigs in lot No. 6.		

Discussion of Table No. 7

Because pigs with smaller initial weights were used in this experiment the necessity of adding a protein supplement to a grain ration was even more emphatically

pointed out than in the previous test. The addition of 60 percent protein tankage to a grain mixture of one-half corn and one-half hog millet produced approximately six time greater gains during the 115-day feeding period. The pigs fed the grain mixture gained 33.8 pounds during the period, as compared to 197.6 pounds gain for the pigs fed tankage in addition to the grain mixture.

The no-protein-fed pigs produced an average daily gain of .29 pounds. At this rate of gain it would have required 603 days for these pigs to reach 220 pounds, which is considered a desirable market weight.

The addition of 29.6 pounds of tankage in this ration saved 712.4 pounds of grain in the production of 100 pounds of gain when compared to the no-protein ration. One ton of 60 percent protein tankage replaced 24,067.6 pounds of corn, 24,067.6 pounds of hog millet, 60.9 pounds of mineral mixture and 58.9 pounds of salt.

In the no-protein lot three of the pigs died during the first 20 days, a fourth the 41st day, and a fifth after it had been on this ration 69 days. These all seemed to be clear cases of malnutrition as post mortem examinations showed no indications of disease. The remaining pigs became more unthrifty as the feeding period progressed. They consumed large quantities of mineral mixture and salt and rooted more than any of the

other lots in an effort to satisfy their depraved appetites. These pigs not only lacked in finish but also in normal growth at the end of the 115-day feeding period. They were all sold as either feeder pigs or disposed of as culls.

Triple Mixture vs. Tankage

Table No. 8 shows a comparison of triple mixture and 60 percent protein tankage when fed in a ration of corn and hog millet mixed half and half.

Lot Number	4	7
Ration Fed	Ground Corn	Ground Corn
Minerals and salt	Ground	Ground
self-fed	Hog Millet	Hog Millet
	Triple Mixture	Tankage
No. of days on feed	115	115
No. of pigs per lot	7	7
Weight at start	45.8	47.0
Final weight	215.7	244.6
Total gain	168.9	197.6
Daily gain	1.47	1.72
Average daily feed (pounds)		
Ground corn	2.76	3.05
Ground hog millet	2.76	3.05
Tankage		.51
Triple mixture	.77	
Mineral mixture	.004	.007
Salt	.003	.003
Feed required per 100 pounds gain		
Ground corn	187.7	177.5
Ground hog millet	187.7	177.5
Tankage		29.6
Triple mixture	52.5	
Mineral mixture	.25	.43
Salt	.19	.18
No. of days required for 45-pound pigs to reach 220 pounds	119	102

Discussion of Table No. 8

The pigs fed triple mixture composed of two parts tankage, one part cottonseed meal and one part alfalfa meal as a protein supplement to a ration of corn and hog millet mixed half and half gained approximately 85 percent as much during the 115-day period as did the

pigs fed tankage. The tankage-fed pigs gained 197.6 pounds as compared to 168.9 pounds for the pigs fed triple mixture. It required 22.9 pounds more protein supplement and 20.4 pounds more grain to produce 100 pounds of gain in the triple-mixture-fed lot.

One ton of triple mixture replaced 1127.6 pounds of tankage and 6.7 pounds of mineral mixture but required 151.6 pounds more corn and 151.6 pounds more hog millet to produce unit gains.

In this experiment triple mixture was not equal to tankage in producing gains, in that Lot No. 4 made only 85 percent as large gains as did Lot No. 7. In the previous test triple-mixture-fed pigs made equal gains to tankage-fed pigs. This difference may be caused by an abnormality in either the tankage lot or in the triple-mixture lot.

Triple mixture containing one-fourth alfalfa meal by weight is a slightly more bulky protein supplement than is tankage. However, considering the amount of this feed consumed the additional bulk received in this ration is small, and it is not likely that this would cause so great a difference in the gains of these two lots. In view of these results and the results of the previous year's experiment it will be necessary to do more work before definite conclusions should be drawn.

Double Mixture (50-50) vs. Tankage

Table No. 9 shows the comparative value of double mixture and tankage fed as supplements to the grain ration of corn and hog millet mixed half and half.

Lot Number		
Ration Fed	Ground Corn Ground Hog Millet Double Mixture (50-50)	Ground Corn Ground Hog Millet Tankage
No. of days on feed	115	115
No. of pigs per lot	7	7
Weight at start	45.8	47.0
Final weight	223.5	244.6
Total gain	177.7	197.6
Daily gain	1.55	1.72
Average daily feed (pounds)		
Ground corn	2.47	3.05
Ground hog millet	2.47	3.05
Tankage		.51
Double mixture (50-50)	.75	
Mineral mixture	.001	.007
Salt	.003	.003
Feed required per 100 pounds gain		
Ground corn	159.6	177.5
Ground hog millet	159.6	177.5
Tankage		29.6
Double mixture (50-50)	48.6	
Mineral mixture	.06	.43
Salt	.18	.18
No. of days required for		
45-pound pigs to reach		
220 pounds	113	102

Discussion of Table No. 9

In studying Table No. 9 it is found that the lot fed double mixture as a protein supplement gained 177.7 pounds in the 115-day period as compared to 197.6 pounds for the lot fed tankage. Altho the use of double mixture in Lot No. 9 reduced the grain required for

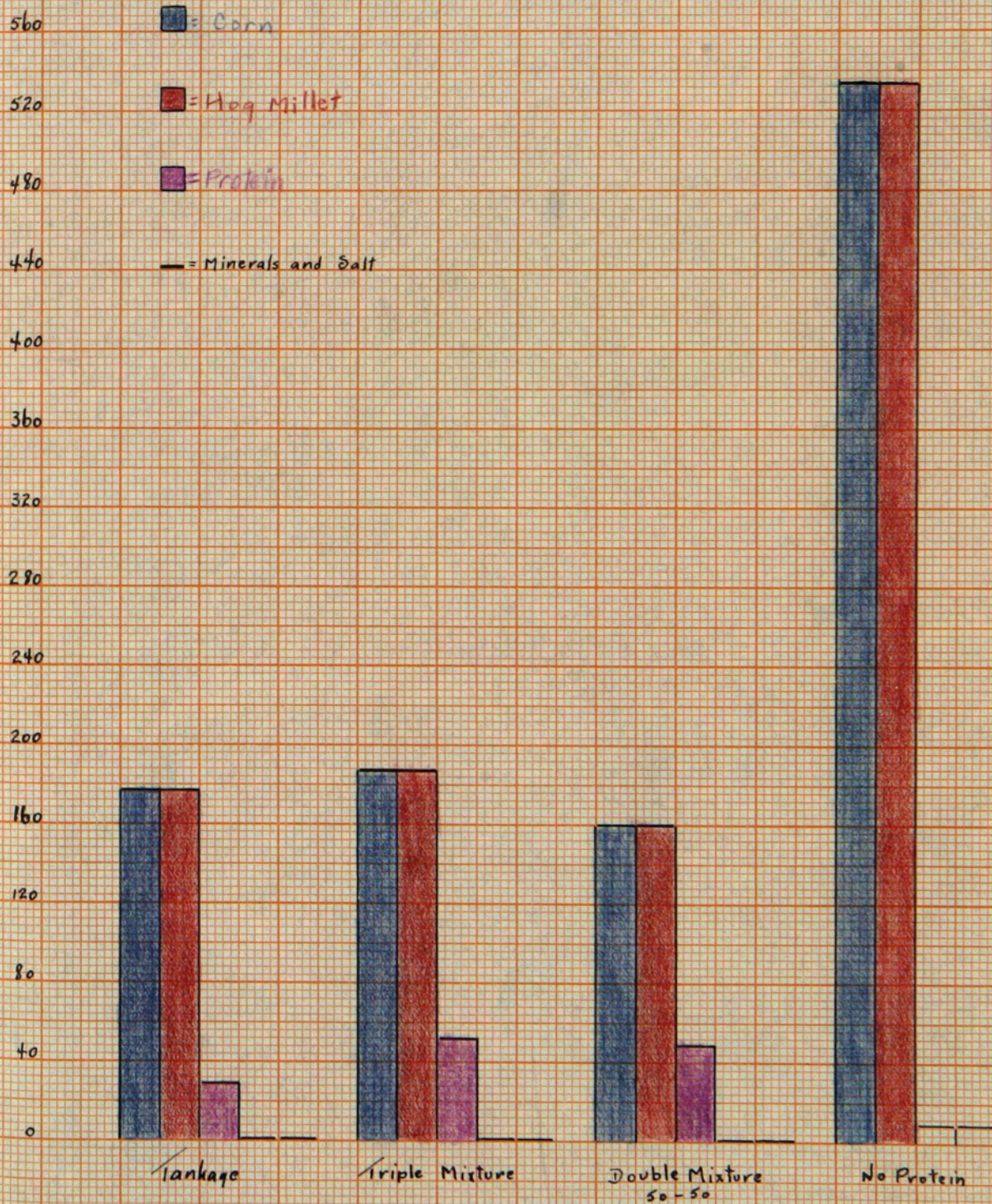
each 100 pounds of gain 35.8 pounds, yet 19.0 more pounds of double mixture were necessary to produce unit gains.

One ton of double mixture replaced 1218.1 pounds of tankage, 736.6 pounds of corn, 736.6 pounds of hog millet and 15.2 pounds of mineral mixture.

The double mixture caused some scouring among the pigs, especially the smaller ones, when they were first put on feed, however, they made satisfactory gains and exhibited no other detrimental effects from the cottonseed meal contained in the protein mixture. As the pigs increased in weight the scouring decreased, so that after the 30-day period no digestive disorders were noticed.

Table No. 10
Feed Required for 100 Pounds of Gain
(1931 Experiment)

Weight
in
Pounds



Discussion of Table No. 10

Table No. 10 shows that the pigs fed a corn-hog millet ration required practically three times as much grain for each 100 pounds of gain produced as either of the lots that were supplied with some form of a protein supplement.

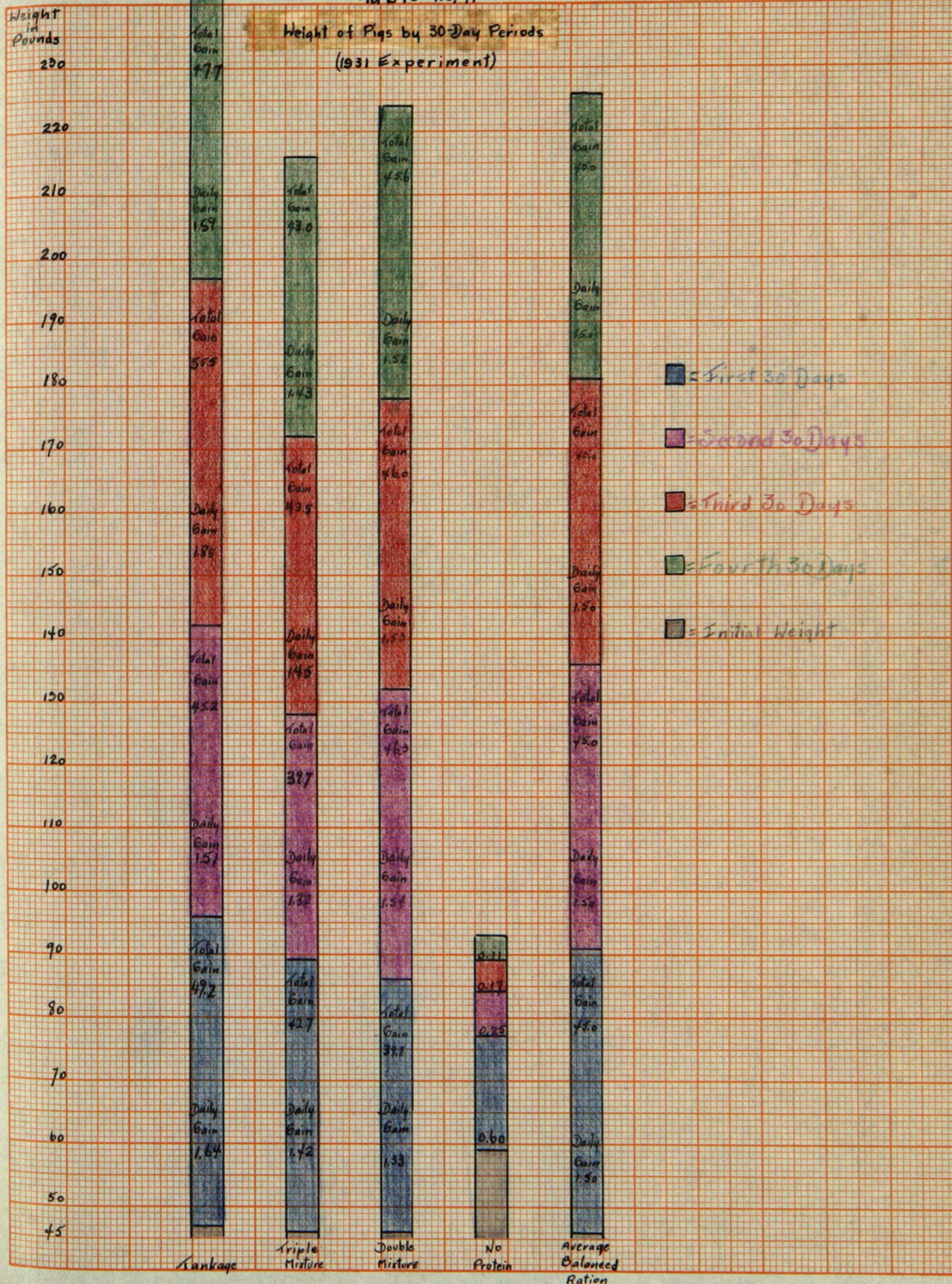
From this table it is noted the no-protein lot consumed 533.7 pounds of corn, 533.7 pounds of hog millet, 9.4 pounds of mineral mixture and 8.9 pounds of salt to produce 100 pounds of gain. The tankage fed pigs required 177.5 pounds of corn, 177.5 pounds of hog millet, 29.6 pounds of tankage, 0.43 pounds of mineral mixture and 0.18 pounds of salt to make the same unit gains. The lot in which triple mixture supplied the protein, 187.7 pounds of corn, 187.7 pounds of hog millet, 52.5 pounds of triple mixture, 0.25 pounds of mineral mixture and 0.19 pounds of salt were required for each 100 pounds of gain. The pigs fed double mixture required 159.6 pounds of corn, 159.6 pounds of hog millet, 48.6 pounds of double mixture, 0.06 pounds of mineral mixture and 0.18 pounds of salt to produce 100 pounds of gain.

It is noted that there were only relatively small differences in the feed required to produce 100 pounds of gain when the lots supplied with a protein supplement

are compared. However, practically three times as much grain was necessary to produce unit gains in the no-protein-fed lot.

Table No. 11

Height of Pigs by 30-Day Periods
(1931 Experiment)



Discussion of Table No. 11

Table No. 11 shows a comparative study of the total gains and average daily gains of the different lots by 30-day periods.

During the first 30 days the tankage-fed pigs gained 49.2 pounds or an average of 1.64 pounds per day, as compared to 42.7 pounds or 1.42 pounds per day for the triple-mixture lot, 39.8 pounds or 1.33 pounds per day for the double mixture lot, and 18.0 pounds or .60 pounds per day for the pigs fed a straight grain ration.

Double mixture composed of one-half tankage and one-half cottonseed meal caused some scouring among the pigs the first 30-day period. It seems that this retarded the rate of gain as these pigs made consistently larger gains the last three periods than they made during the first. No scouring was noted after the first 30 days.

The no-protein lot made practically three times as large gains the first 30 days as they made during any of the successive periods. It seems possible that these pigs had nutrients stored in their bodies to help carry them a short period and that as this reserve diminished the rate of gain decreased. Chart No. 11, showing the decreasing rate of gain as the feeding period progressed, upholds this explanation.

The second 30 days the tankage-fed pigs gained a total of 45.2 pounds or an average daily gain per pig of 1.51 pounds, as compared to a total gain of 39.7 pounds or an average daily gain per pig of 1.32 pounds for the triple mixture lot, 46.3 pounds of gain or 1.54 pounds daily gain for the double mixture lot, and a total gain of 7.6 pounds or .25 pounds per head per day for the no-protein lot.

It was pointed out earlier that no scouring was noted in the double mixture lot after the first 30 days. This lot outgained all other lots during the second period, indicating that cottonseed meal in the protein mixture had no ill effects upon the pigs this period.

It is noted that the no-protein lot made less than half as large gains as they made the first period.

The third 30-day period, the pigs fed tankage made a total gain of 55.5 pounds or an average daily gain per pig of 1.85 pounds. This is the largest gain made by any lot in this experiment during a 30-day period. The triple mixture lot gained 43.5 pounds or an average daily gain of 1.45 pounds, the double mixture lot gained 46.0 pounds or 1.53 pounds as an average for each pig per day, and the no-protein lot gained only 5.0 pounds during the 30 days or an average of .17 pounds per day. This is a smaller gain than these pigs made even during the second 30-day period.

The last 30 days of the experiment the pigs fed tankage gained 47.7 pounds, or an average of 1.59 pounds per day. The pigs fed triple mixture made a total gain of 43.0 pounds, or an average daily gain of 1.43 pounds. The pigs fed double mixture made a total gain of 45.6 pounds or 1.52 pounds a day. The no-protein-fed pigs gained only 3.2 pounds or an average daily gain of .11 pounds, which is considerable lower than their gains during the third 30-day period.

In comparing these gains to the adopted standard of 1.50 pounds of gain per head per day it is found that the tankage-fed pigs gained more than the average during all periods. The fact that the pigs fed triple mixture did not come up to the standard gain is a reversal of last year's results as was pointed out (page 28), and more work need be done to varify any conclusions that may be drawn.

Table No. 12

Number of Days Required for 45 Pound Pig to Reach 220 Pounds.
(1931 Experiment)

Number
of
Days

600
560
520
480
440
400
360
320
280
240
200
160
120
80
40
0

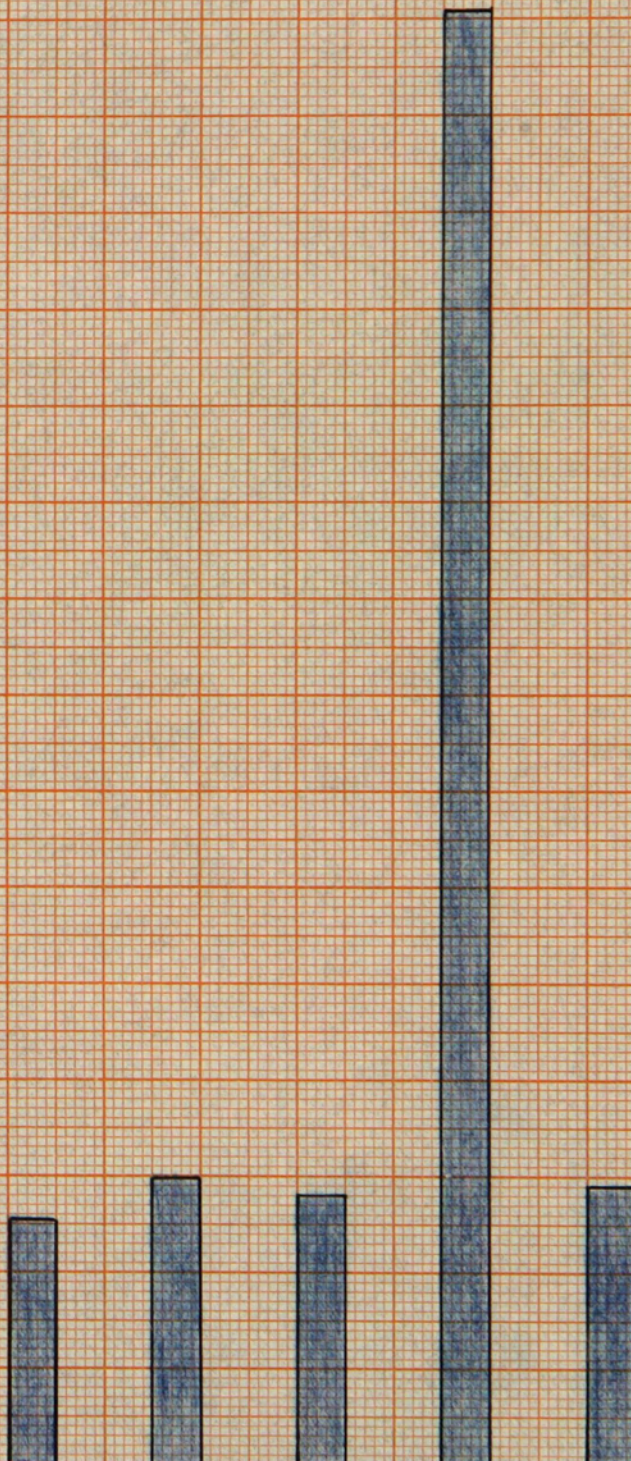
Lanbage

Triple
Mixture

Double
Mixture

No
Protein

Average
Balanced
Ration



Discussion of Table No. 12

Table No. 12 presents a comparison of the number of days required for these various lots to reach a weight of 220 pounds. The column labeled "Average Balanced Ration" illustrates that it would require 117 days for a 45 pound pig to reach a weight of 220 pounds if it gained at the rate of 1.5 pounds a day.

Considering the different lots of pigs the table shows that it took 102 days for the pigs fed tankage, 119 days for the pigs fed triple mixture, 113 days for the pigs fed double mixture, and 603 days for the pigs fed no protein supplement to reach 220 pounds. The differences in the number of days required for the pigs fed a protein supplement to reach 220 pounds were relatively small, but the no-protein-fed pigs required practically five times as long to reach this desired weight.

THE 1932 EXPERIMENT

From the 1932 experiment the results of seven lots were presented. The lots comparing tankage, triple mixture composed of one-half tankage, one-fourth cottonseed meal, and one-fourth alfalfa meal, and double mixture made up of one-half tankage and one-half cottonseed meal are repetitions of the previous year's work.

Results are also presented of one year's work comparing a double mixture of two-thirds tankage and one-third cottonseed meal, a flax mixture of two-thirds tankage and one-third flaxseed, ground soybeans and ground flaxseed used as supplements with hog millet.

Pigs Used

The pigs used in this experiment were high-grade and purebred Poland-China pigs. They were purchased from a local breeder on October 10th and were held on a maintenance ration of barley until October 28th when they were started on the experiment at a weight of 71 pounds. They were treated for worms and vaccinated for hog cholera before they were allotted for the experiment.

Feeds Used

All feeds were fed free-choice in separate compartment self-feeders.

The hog millet was a yellow variety, locally grown, with a weight of 54.0 pounds per bushel and a moisture content of 10.46 percent. It was finely ground

thru a hammer mill before it was placed in the self-feeder.

A guaranteed 60 percent protein tankage was used.

Double mixture composed of two-thirds tankage and one-third cottonseed meal by weight contained 52.70 percent protein and 7.88 percent moisture. This was a home-mixed protein supplement.

Double mixture composed of one-half tankage and one-half cottonseed meal by weight was also a home-mixed protein. It contained 51.54 percent protein and 7.84 percent moisture.

Triple mixture composed of one-half tankage, one-fourth cottonseed meal and one-fourth alfalfa meal contained 42.86 percent protein and 8.29 percent moisture.

The flax was grown in north-eastern Colorado and it was good plump seed. A chemical analysis (page 62) showed 22.84 percent protein and an average of 8.91 percent moisture during the feeding period. The flax was ground very fine with a hammer mill.

At the beginning of the experiment 10 parts of ground flax seed was mixed with 90 parts of grain by weight. This ratio was gradually increased until it was thought that no detrimental effects would result from feeding ground flaxseed in a separate compartment of the self-feeder.

Flax mixture was composed of two parts tankage and one part ground flaxseed by weight for an average of the experiment. Here again great care was exercised at the beginning of the test and the mixture was fed in the following proportions:

	<u>60% Protein Tankage</u>	<u>Ground Flaxseed</u>
At start	75 percent	25 percent
At 8th day	70 percent	30 percent
At 43rd day	65 percent	35 percent
At 51st day	60 percent	40 percent
At 88th day	50 percent	50 percent

The soybeans were grown in eastern Colorado and were of a yellow variety. Chemical analysis showed them to contain 30.40 percent protein and an average of 8.91 percent moisture during the experiment. They were ground and self-fed free-choice at all times.

Mineral mixture was composed of 40 parts steamed bone meal, 40 parts high calcium carbonate limestone and 20 parts salt. All lots had access to this mixture at all times.

A No. 4 stock salt was self-fed.

Chemical Analysis of Feeds Used

	Water %	Crude Protein %	Crude Fiber %	N-free Extract %	Crude Fat %	Ash %	No. of Samples
Hog Millet	10.62	10.39	10.48	60.09	4.36	4.06	2
Soybeans	8.60	28.79	8.78	33.08	15.27	5.50	2
Flaxseed	6.72	22.84	14.09	24.69	27.01	4.70	2
Alfalfa Meal	9.41	12.25	36.12	33.93	1.37	6.93	2
Tankage	8.65	56.90	1.61	2.47	8.84	21.55	2
Cottonseed Meal	7.07	44.30	7.69	25.69	8.46	6.81	2

Rations Fed

Lot 5. Ground hog millet, double mixture (two-thirds tankage, one-third cottonseed meal), mineral mixture and salt.

Lot 6. Ground hog millet, double mixture (one-half tankage, one-half cottonseed meal), mineral mixture and salt.

Lot 7. Ground hog millet, triple mixture (one-half tankage, one-fourth cottonseed meal, one-fourth alfalfa meal), mineral mixture and salt.

Lot 8. Ground hog millet, tankage (60 percent protein), mineral mixture and salt.

Lot 9. Ground hog millet, flax mixture (two-thirds tankage, one-third flaxseed), mineral mixture and salt.

Lot 10. Ground hog millet, soybeans, mineral mixture and salt.

Lot 11. Ground hog millet, ground flaxseed, mineral mixture and salt.

The Allotment

The pigs were allotted according to their weight, sex, origin, type, breed and condition, and were placed in drylots equipped with automatic watering tanks, separate compartment self-feeders and a temporary straw shed for each lot.

Weights

The pigs were weighed three successive days at the start and at the end of the experiment and averages of the three were used as the initial and final weights respectively. Individual weights of all pigs were taken each 30 days during the experiment. No 10-day lot weights were taken.

DISCUSSION OF RESULTS



Lot No. 8.

Lot No. 8 was fed 60 percent protein tankage as a protein supplement to hog millet. These pigs gained an average of 1.58 pounds per head per day thruout the 90-day fattening period.



Lot No. 7.

Lot No. 7 was fed a triple mixture composed of two parts tankage, one part cottonseed meal, and one part alfalfa meal as a protein supplement to hog millet. These pigs gained an average of 1.71 pounds per head per day thruout the 90-day fattening period.

Triple Mixture vs. Tankage

Table No. 13 shows the value of triple mixture as compared to tankage when fed as a protein supplement to a hog millet ration

Lot Number	7	8
	Hog Millet	
Ration Fed	Triple	Hog Millet
Minerals and salt self-fed	Mixture	Tankage
No. of pigs per lot	7	7
No. of days on feed	90	90
Weight at start	71.3	73.8
Final weight	224.9	216.3
Total gain	153.6	142.6
Daily gain	1.71	1.58
Average daily feed (pounds)		
Ground hog millet	6.30	5.94
Tankage		.63
Triple mixture	.81	
Mineral mixture	.01	.01
Salt	.01	.02
Feed required per 100 pounds of gain		
Ground hog millet	369.3	374.7
Tankage		39.5
Triple mixture	47.5	
Mineral mixture	.51	.70
Salt	.75	.96
No. of days required for 70-pound pigs to reach 220 pounds	88	95

Discussion of Table No. 13

From Table No. 13 it is seen that pigs fed triple mixture, composed of two parts tankage, one part cottonseed meal and one part alfalfa meal, outgained pigs fed tankage by .13 pound per head per day. Considering feed required per unit gain the use of 8.0 additional pounds of triple mixture instead of tankage saved only

5.4 pounds of hog millet in the production of 100 pounds of gain. This probably indicates that triple mixture is not as efficient as tankage pound for pound, yet it does produce a greater rate of gain than tankage.

One ton of triple mixture replaced 1163.2 pounds of tankage, 227.4 pounds of hog millet, 8.0 pounds of mineral mixture and 8.8 pounds of salt in the production of unit gains.



Lot No. 6.

Lot No. 6 was fed a double mixture composed of one-half tankage and one-half cottonseed meal as a protein supplement to hog millet. They gained 1.70 pounds per head per day thruout the 90-day fattening period.

Double Mixture (50-50) vs. Tankage

Table No. 14 shows the comparative values of double mixture (50-50) as compared to tankage when fed in a ration with hog millet.

Lot Number	6	8
	Hog Millet	
Ration Fed	Double	
Minerals and salt self-fed	Mixture	Hog Millet
	(50-50)	Tankage
No. of pigs per lot	7	7
No. of days on feed	90	90
Weight at start	72.8	73.8
Final weight	225.5	216.3
Total gain	152.7	142.6
Daily gain	1.70	1.58
Average daily feed (pounds)		
Ground hog millet	5.73	5.94
Tankage		.63
Double mixture (50-50)	.92	
Mineral mixture	.01	.01
Salt	.01	.02
Feed required per 100 pounds of gain		
Ground hog millet	337.6	374.7
Tankage		39.5
Double mixture (50-50)	54.0	
Mineral mixture	.70	.70
Salt	.84	.96
No. of days required for 70-pounds pigs to reach 220 pounds	88	95

Discussion of Table No. 14

The pigs fed a double mixture composed of one-half tankage and one-half cottonseed meal made an average daily gain of 1.70 pounds as compared to 1.58 pounds for the tankage-fed pigs. These pigs required 37.1 pounds less hog millet, but 14.5 pounds more protein supplement to make 100 pounds of gain than did the pigs fed tankage.

This comparison indicates that pound for pound tankage is more efficient supplement, however, the rate of gain, is considerably greater when double mixture instead of tankage is used.

One ton of this double mixture replaced 1463.0 pounds of tankage, 1374.1 pounds of hog millet and 4.4 pounds of salt.

Double mixture caused no scouring among the pigs in this experiment as it did the previous year. The fact that the pigs used in the 1932 test were larger probably accounts for this difference.



Lot No. 5

Lot No. 5 was fed double mixture composed of two parts tankage and one part cottonseed meal as a protein supplement to hog millet. The pigs in this lot made an average daily gain of 1.62 pounds per head thruout the 90-day fattening period.

Double Mixture (65-35) vs. Tankage

Table No. 15 shows the comparative values of double mixture (65-35) and tankage when fed in a ration as a supplement to hog millet.

Lot Number	5	8
	Hog Millet	
Ration Fed	Double	Hog Millet
Minerals and salt self-fed	Mixture	Tankage
	(65-35)	
No. of pigs per lot	7	7
No. of days on feed	90	90
Weight at start	73.0	73.8
Final weight	218.7	216.3
Total gain	145.7	142.6
Daily gain	1.62	1.58
Average daily feed (pounds)		
Ground hog millet	5.84	5.94
Tankage		.63
Double mixture (65-35)	.84	
Mineral mixture	.01	.01
Salt	.01	.02
Feed required per 100 pounds of gain		
Ground hog millet	360.7	374.7
Tankage		39.5
Double mixture (65-35)	51.7	
Mineral mixture	.66	.70
Salt	.88	.96
No. of days required for 70-pound pigs to reach 220 pounds	93	95

Discussion of Table No. 15

Pigs fed double mixture composed of two parts tankage and one part cottonseed meal, made only slightly larger gains than did pigs fed tankage as a supplement to hog millet. While they required 12.2 pounds more double mixture to produce 100 pounds of gain, they consumed 14.0 pounds less hog millet. This again indicates a

greater efficiency of tankage pound for pound but, also a somewhat lower rate of gain when tankage is used as the protein supplement.

One ton of the double mixture replaced 1528.1 pounds of tankage, 541.6 pounds of hog millet and 3.87 pounds of salt. The difference between the amounts of mineral mixture consumed by these two lots was insignificant.



Lot No. 9.

These pigs were fed a flax mixture composed of two parts tankage and one part ground flaxseed for an average of the fattening period as a protein supplement to hog millet. They made an average daily gain per head of 1.78 pounds thruout the 90-day fattening period.

Flax Mixture vs. Tankage

Table No. 16 shows the comparative values of flax mixture and tankage when fed in a ration as a supplement to hog millet.

Lot Number	9	8
Ration Fed Minerals and salt self-fed	Hog Millet Flax Mixture	Hog Millet Tankage
No. of pigs per lot	7	7
No. of days on feed	90	90
Weight at start	71.5	73.8
Final weight	232.1	216.3
Total gain	160.6	142.6
Daily gain	1.78	1.58
Daily feed fed (pounds)		
Ground hog millet	6.72	5.94
Tankage		.63
Flax mixture	.79	
Mineral mixture	.01	.01
Salt	.01	.02
Feed required per 100 pounds gain		
Ground hog millet	376.8	374.7
Tankage		39.5
Flax mixture	44.9	
Mineral mixture	.67	.70
Salt	.76	.96
No. of days required for 70- pound pig to reach 220 pounds	84	95

Discussion of Table No. 16

The lot of pigs fed flax mixture composed of two parts tankage and one part flaxseed made the largest gains of any lot of pigs in the 1932 experiment. They gained 160.6 pounds per head in the 90-day period as compared to 142.6 pounds per head for the pigs fed tankage. However, they required 5.4 pounds more protein

supplement and 2.1 pounds more hog millet to produce 100 pounds of gain. In this comparison flax mixture produced more rapid gains than tankage, but was not as efficient in that more feed was required to produce unit gains.

Each ton of flax mixture replaced 1759.5 pounds of tankage and 8.9 pounds of salt, but required 93.5 pounds more hog millet in the production of unit gains.

No ill effects due to flaxseed in the mixture were apparent at any time, and the pigs were just as well finished at the end of the test as were pigs fed tankage. Slaughter tests showed that flax mixture produced pork of the same quality as did tankage.



Lot No. 10

Lot No. 10 was fed ground soybeans as a protein supplement to a hog millet ration. These pigs gained an average of 1.37 pounds per pig per day during the 90-day fattening period.

Soybeans vs. Tankage

Table No. 17 shows the comparative values of soybeans and tankage when fed in a ration as a protein supplement to hog millet.

Lot Number	10	8
Ration Fed Minerals and salt self-fed	Hog Millet Soybeans	Hog Millet Tankage
No. of pigs per lot	7	7
No. of days on feed	90	90
Weight at start	71.5	73.8
Final weight	194.4	216.3
Total gain	122.9	142.6
Daily gain	1.37	1.58
Daily feed fed (pounds)		
Ground hog millet	5.25	5.94
Tankage		.63
Soybeans	1.47	
Mineral mixture	.02	.01
Salt	.03	.02
Feed required per 100 pounds gain		
Ground hog millet	384.7	374.7
Tankage		39.5
Soybeans	107.6	
Mineral mixture	1.51	.70
Salt	2.21	.96
No. of days required for a 70- pound pig to reach 220 pounds	109	95

Discussion of Table No. 17

The pigs fed ground soybeans in addition to hog millet gained only about 87 percent as much as the tankage-fed pigs. During the 90-day fattening period, they gained 122.9 pounds as compared to 142.6 pounds for the tankage lot. Ten pounds more hog millet and 68.1 pounds more protein supplement was required to produce 100 pounds of

gain than was required by the tankage-fed pigs. This indicates that soybeans are not as efficient a protein supplement as tankage.

One ton of soybeans replaced 734.2 pounds of tankage, but required 185.9 pounds more hog millet, 15.1 pounds more mineral mixture, and 23.2 pounds more salt, to produce unit gains.

Only small quantities of soybeans were consumed during the first two weeks of the experiment. However, after the pigs became accustomed to them, they ate the soybeans very readily.

Even tho the pigs had access to salt, and minerals at all times, they rooted a great deal in the dry lot during the test, which probably indicates that their ration was lacking in some nutrient.

The sides of pork were graded by the packing-house meat grader, and all were classed as undesirably soft. Four of the sides were graded medium soft, four were graded soft, and the balance were graded oily.



Lot No. 11

Lot No. 11 was fed ground flaxseed as a protein supplement to a ration of hog millet. These pigs gained only .94 of a pound per head per day thruout the 90-day fattening period.

Flaxseed vs. Tankage

Table No. 18 shows the value of ground flaxseed as compared to tankage when fed as a protein supplement to hog millet.

Lot Number	11	8
Ration Fed	Hog Millet	Hog Millet
Minerals and salt self-fed	Flaxseed	Tankage
No. of pigs per lot	7	7
No. of days on feed	90	90
Weight at start	74.9	73.8
Final weight	159.4	216.3
Total gain	84.5	142.6
Daily gain	.94	1.58
Daily feed fed (pounds)		
Ground hog millet	4.08	5.94
Tankage		.63
Flaxseed	.80	
Mineral mixture	.02	.01
Salt	.02	.02
Feed required per 100 pounds gain		
Ground hog millet	435.1	374.7
Tankage		39.5
Flaxseed	85.0	
Mineral mixture	2.47	.70
Salt	1.78	.96
No. of days required for a 70-pound pig to reach 220 pounds	160	95

Discussion of Table No. 18

Unsatisfactory gains were made when ground flaxseed was used as the protein supplement to hog millet. Pigs fed flaxseed gained only .94 pounds per head per day thruout the 90-day feeding period. These pigs required 60.4 pounds more hog millet and 45.5 pounds more protein supplement for each 100 pounds of gain

produced than tankage-fed pigs. One ton of ground flaxseed replaced 929.4 pounds of tankage, but required 1421.2 pounds more hog millet, 4.16 pounds more mineral mixture, and 1.93 pounds more salt to produce unit gains. This shows rather conclusively that ground flaxseed is not nearly as efficient a protein supplement with hog millet as tankage considering both rate of gain and feed per 100 pounds gain.

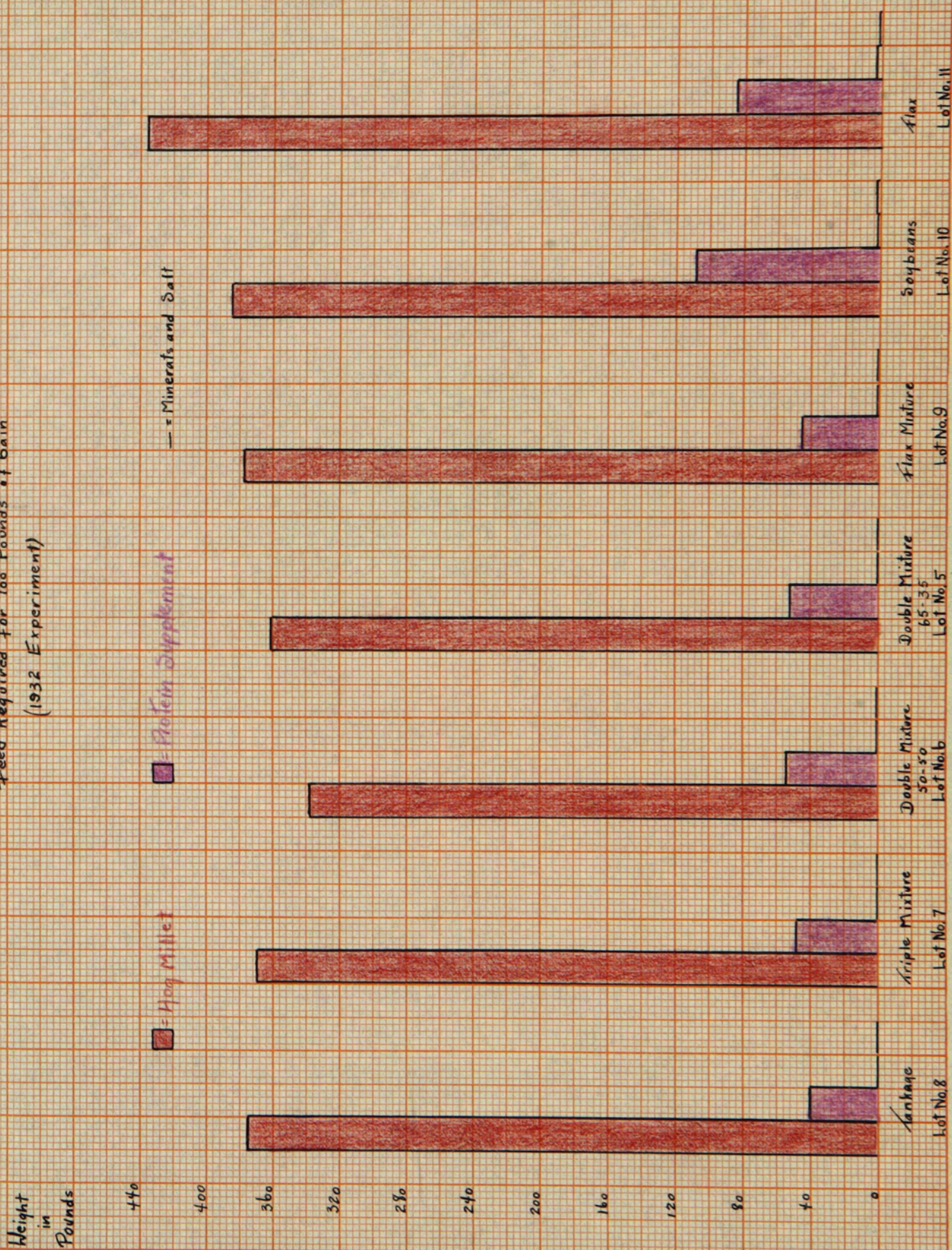
Ten parts of ground flaxseed was at first mixed with 90 parts of ground hog millet. The proportion of ground flaxseed was gradually increased until it was thought that no ill effects would results from self-feeding it. Then, it was placed in a separate compartment of the self-feeder. Ground flaxseed fed in this manner did not cause scours or any other ill effects. However, this ration seemingly lacked the palatability of the other rations fed in this test, because the pigs consumed smaller quantities of grain and more minerals and salt than pigs in other lots. Altho minerals and salt were supplied at all times the pigs rooted the dry lot a great deal, probably indicating a deficiency in the ration.

The sides of these pigs were also, graded after the carcasses had chilled 72 hours. Reports of the packing-house meat grader show that all the sides of

bacon from these pigs were oily, and the fat was decidedly yellow in color. Indications are that the yellow color as well as the oily pork can be attributed to flaxseed in the ration.

It must be kept in mind, however, that this data is based on only one year of work and that this test should be duplicated to varify these results.

Table No. 19
Feed Required for 100 Pounds of Gain
(1932 Experiment)



Discussion of Table No. 19

From this table it is seen that the tankage, triple mixture and flax-mixture lots required practically equal amounts of grain to produce 100 pounds of gain, but that both of the double-mixture lots required less grain to produce unit gains. It will also be seen that tankage is the most efficient protein supplement, that flax mixture ranks second, triple mixture third, and there are only small differences between the two double mixtures.

Lot No. 8, consumed 374.7 pounds of hog millet and 39.5 pounds of tankage to produce 100 pounds of gain, as compared to 369.3 pounds of hog millet and 47.5 pounds of triple mixture for Lot No. 7, 337.6 pounds of hog millet and 54.0 pounds of double mixture for Lot No. 6, 360.7 pounds of hog millet and 51.7 pounds of double mixture for Lot No. 5, and 376.8 pounds of hog millet and 44.9 pounds of flax mixture for Lot No. 9. The differences in the minerals and salt required by these lots are exceedingly small.

When Lot No. 10 is compared to the tankage-fed lot it is noted that the soybean-fed lot required only 10.0 pounds more hog millet for each 100 pounds of gain produced, but that 68.1 pounds more protein supplement, .81 pounds more mineral mixture, and 1.25 pounds more salt were required per unit gain.

Considerably more grain was required for each 100 pounds of gain produced by the pigs fed ground flaxseed than by any other lot. These pigs required 70.4 pounds more hog millet, 45.5 pounds more protein supplement, 1.77 pounds more mineral mixture, and .82 pounds more salt to produce 100 pounds of gain than tankage-fed pigs.

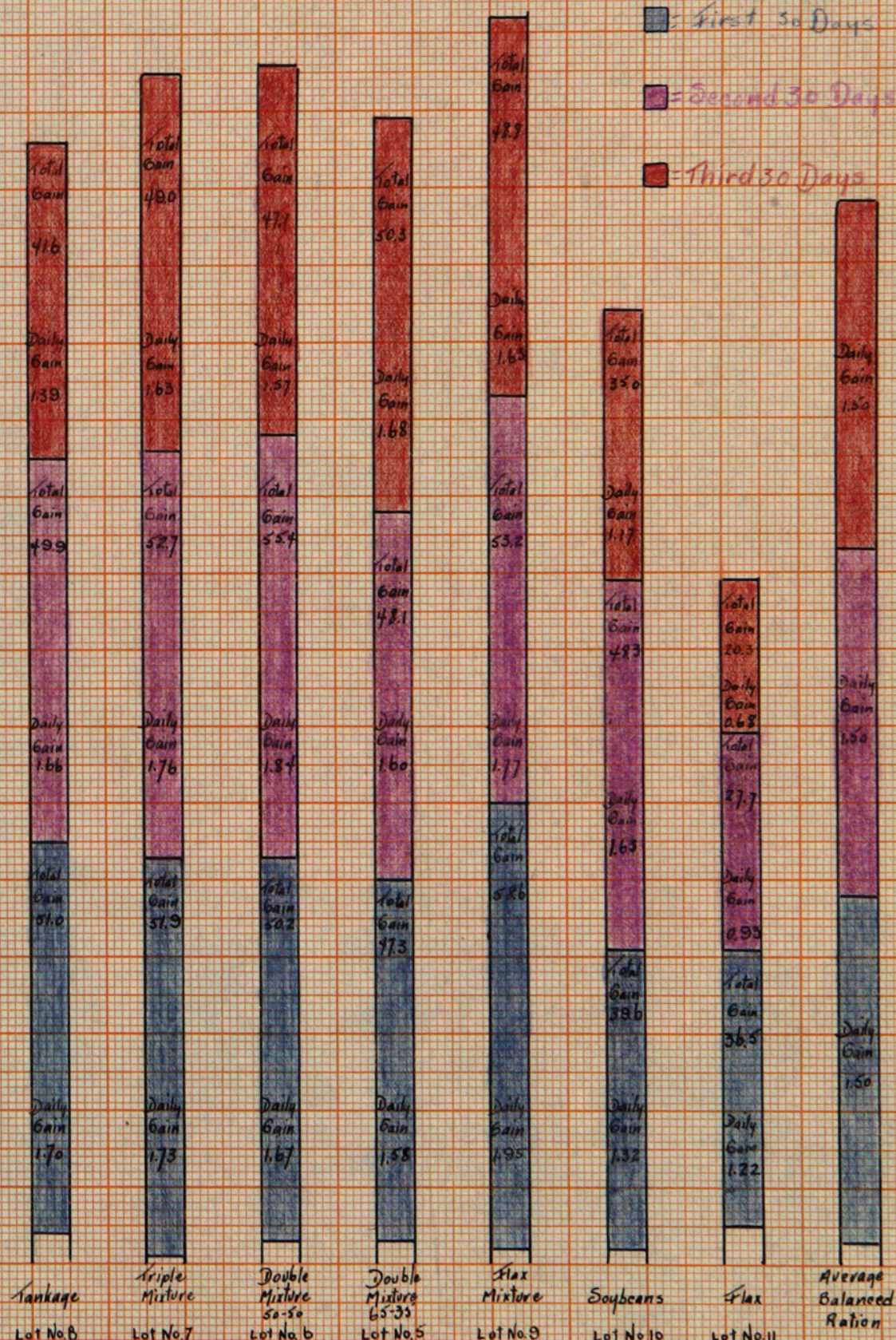
These feed requirements per unit of gain indicate that tankage is the most efficient protein supplement in this experiment, and that flax mixture, triple mixture and the double mixtures can be rated in that order. The differences in the home-mixed protein supplements, however, are not large and they may be within the realm of experimental error. The most outstanding differences shown by this table are the inefficiency of the two home-grown protein supplements, soybeans and flaxseed. When they were used to supplement ground hog millet both the grain and the protein requirements per unit gain were higher than when tankage or a home-mixed protein supplement was used to balance the ration.

Table No. 20
Rate of Gain
(1932 Experiment)

Weight
in
Pounds

230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70

■ = First 50 Days
■ = Second 30 Days
■ = Third 30 Days



Discussion of Table No. 20.

The lot fed tankage and the lot fed a double mixture of two parts tankage and one part cottonseed meal made practically equal gains in the 90-day period. The lots fed triple mixture and a double mixture of one-half tankage and one-half cottonseed meal outgained the tankage, while the flax mixture lot made larger total gains than any other lot in this experiment. Both the soybean and the flaxseed lot are well below the others, flaxseed being the lowest.

During the first 30 days of the experiment, Lots No. 6, No. 7 and No. 8 varied only 1.7 pounds in total gain, or only .07 pounds in average daily gain. However, Lot No. 5 gained 3.7 pounds less than Lot No. 8, or .12 pounds per head per day. Lot No. 9, outgained the tankage lot 7.6 pounds, or .25 pounds per head per day. The soybean and flaxseed lots made practically equal gains during this period. The tankage lot outgained the soybean lot 14.1 pounds, or a difference of .58 pounds per head per day.

The first two weeks of the experiment the pigs fed ground soybeans consumed only small amounts of them, but after this period they began eating them more readily. This fact probably explains why the pigs fed soybeans did not outgain the flax-fed pigs very noticeably during the first 30-day period.

The second 30-day period it is seen that Lot No. 6 and Lot No. 7 were fairly close in total gain but that they both outgained the tankage lot, while Lot No. 5 gained only 1.8 pounds less than the tankage-fed lot. During this period the soybean lot gained only 1.6 pounds less for the period than the tankage lot, or a difference in average daily gain of only .03 pounds. But, the tankage lot outgained the flax lot 22.2 pounds or .73 pounds per head per day.

During this period Lot No. 10 were eating much larger quantities of soybeans than they ate during the early part of the experiment. This may account, at least in part, for their large gains during this period.

It seems the flaxseed ration was not as palatable to the pigs as it was the first 30 days, because they did not consume as much grain and they began rooting the dry lot. During this period the flaxseed proportion of the ration was increased until it made up 35 percent of the ration.

The last 30 days of the experiment Lots No. 6, No. 7 and No. 9 made about equal gains, outgaining the tankage lot about seven pounds. Lot No. 5 made the largest gains of any lot during this period, outgaining the tankage lot 8.7 pounds, or a difference in average daily gain of .24 pounds. The tankage lot gained 16.6 pounds, or .39 pounds per head per day more than the

soybean lot, and 21.3 pounds, or .71 pounds per head per day more than the flaxseed lot.

In Lot No. 11 ground flaxseed was self-fed free-choice during this period. The pigs consumed smaller amounts of grain than they did in either of the other periods and they did a great deal of rooting in the pen. The pigs fed ground soybeans did considerable rooting in the dry lot probably indicating that their ration was also, deficient in some respect.

This comparison shows that in this year's experiment triple mixture and double mixture of one part tankage and one part cottonseed meal are about equal in their ability to produce gain, but that they are more efficient than tankage, while a double mixture of two parts tankage and one part cottonseed meal is just as efficient as tankage. Flax mixture produced a greater rate of gain than tankage or the other home-mixed protein supplements.

Both of the home-grown protein supplements produced a low rate of gain as compared to tankage. They were considerably below the standard rate of gain of 1.5 pounds per day.

Table No. 21

Number of Days Required for 70 Pound Pig to Reach 220 Pounds
(1932 Experiment)

Number
of
Days

160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

Rankage

Lot No. 8

Triple
Mixture

Lot No. 7

Double
Mixture
50-50

Lot No. 6

Double
Mixture
65-35

Lot No. 5

Flax
Mixture

Lot No. 9

Soybeans

Lot No. 10

Flax

Lot No. 11

Averaged
Balanced
Ration



Discussion of Table No. 21

From Table No. 21 it is seen that all the lots in this experiment reached an average weight of 220 pounds in less than 100 days with the exceptions of the lot fed soybeans, and the lot fed ground flaxseed as the protein supplement. Lot No. 8 reached a weight of 220 pounds in 95 days, as compared to 88 days for both Lot No. 7 and Lot No. 6, 93 days for Lot No. 5, 84 days for Lot No. 9, 109 days for Lot No. 10 and 160 days for Lot No. 11.

In this experiment the home-mixed protein supplements enabled the pigs to reach a weight of 220 pounds in a shorter time than tankage. However, the pigs fed soybeans required 14 days longer, and the pigs fed ground flaxseed required 65 days longer to reach this desired weight.

This comparison shows that the home-mixed protein supplements produce more rapid gains than tankage, but that tankage produces a much greater rate of gain than either of the home-grown protein supplements.

SUMMARY

In summarizing these three years' of experimental work with protein supplements for hog fattening rations under eastern Colorado conditions, averages are used in discussing the tests conducted. One of these comparisons was made for a period of three years, others for a two-year series, and some are only one year's results.

Triple Mixture vs. Tankage

Average of three years' results 1930-1932

Table No. 22

Ration fed	Corn	Corn
Minerals and salt self-fed	Hog Millet	Hog Millet
	Tankage	Triple Mixture
No. of days on feed	108.33	108.33
No. of pigs per lot	8	8
Weight at start	64.1	63.0
Final weight	261.0	255.5
Total gain	196.9	192.5
Daily gain	1.82	1.78
Average daily feed (pounds)		
Grain	6.77	6.75
Tankage	.52	
Triple mixture		.74
Mineral mixture	.007	.006
Salt	.009	.005
Feed required per 100 pounds gain		
Grain	387.4	390.9
Tankage	30.4	
Triple mixture		44.3
Mineral mixture	.43	.31
Salt	.45	.36
No. of days required for a 60-pound pig to reach 220 pounds	88	90

In the three year summary (Table No. 22) comparing tankage and triple mixture as protein supplements with a grain ration it will be seen that tankage-fed pigs gained 196.9 pounds during the 108-day period as compared to 192.5 pounds for the pigs fed triple mixture. This is a difference of 4.4 pounds in favor of tankage. Biometrical analysis show that the difference in this rate of gain factor is insignificant. In other words, triple mixture produces the same rate of gain as tankage when used to balance this grain ration.

In the production of each 100 pounds of gain 13.9 pounds more triple mixture and 3.5 pounds more grain was required than in the lot fed tankage. From these three years' results it seems safe to conclude that pound for pound triple mixture is not quite as efficient as tankage, altho it does produce the same rate of gain.

Then, the relative prices of these two protein supplements should be the factor that decides which will be fed.

Double Mixture vs. Tankage

Average of two years' results 1931-1932

Table No. 23

Ration fed Minerals and salt self-fed	Corn Hog Millet Tankage	Corn Hog Millet Double Mixture
No. of days on feed	102.5	102.5
No. of pigs per lot	7	7
Weight at start	59.3	58.3
Final weight	251.6	224.4
Total gain	172.2	166.2
Daily gain	1.68	1.62
Average daily feed (pounds)		
Grain	6.02	5.34
Tankage	.57	
Double mixture		.84
Mineral mixture	.009	.006
Salt	.012	.007
Feed required per 100 pounds gain		
Grain	364.9	328.4
Tankage	34.6	
Double mixture		51.3
Mineral mixture	.57	.38
Salt	.57	.51
No. of days required for a 60-pound pig to reach 220-pounds	95	99

In the two year summary (Table No. 23) comparing tankage and a double mixture of one-half tankage and one-half cottonseed meal as protein supplements to a grain ration it is seen that they produced practically equal gains in the 102.5-day period. This difference of .06 pounds per head per day in favor of tankage is not a significant difference as is shown by biometrical analysis.

In considering feed requirements per 100 pounds of gain it will be noted that while tankage-fed pigs required 36.5 pounds more grain, they required 16.7 pounds less protein supplement to make unit gains. It would seem from this comparison that double mixture is not quite as efficient as tankage, considering the amounts required to produce unit gains.

The relative prices of these protein supplements would probably determine which one will be fed.

No-Protein vs. Tankage

Average of two years' results 1950-1951

Table No. 24

Ration fed	Corn	Corn
Minerals and salt self-fed	Hog Millet	Hog Millet
	Tankage	
No. of days on feed	117.5	117.5
No. of pigs per lot	3.5	7
Weight at start	60.7	65.9
Final weight	173.7	128.8
Total gain	216.0	62.9
Daily gain	1.84	.54
Average daily feed (pounds)		
Ground corn	3.59	1.91
Ground hog millet	3.59	1.91
Tankage	.47	
Mineral mixture	.005	.02
Salt	.004	.03
Feed required per 100 pounds gain		
Ground corn	196.9	447.0
Ground hog millet	196.9	447.0
Tankage	25.8	
Mineral mixture	.29	5.59
Salt	.20	7.13
No. of days required for a 60-pound pig to reach 220 pounds	87	296

From the two-year summary (Table No. 24) comparing a grain ration to a grain ration supplemented with tankage, it is shown that tankage increased the total gain for the 117.5-day fattening period over three times, a difference of 1.30 pounds per head per day. This is a very significant difference as shown by biometrical analysis.

The fact that tankage-fed pigs consumed an average of 3.36 pounds more grain per head per day than no-protein-fed pigs shows that a straight grain ration was not as palatable as a grain-tankage ration. The no protein-fed pigs consumed 5.30 pounds more mineral mixture and 6.93 pounds more salt than the tankage-fed pigs for each 100 pounds of gain produced. These pigs did much rooting in the drylot probably indicating that their ration was deficient in some respect.

When the feed required per 100 pounds of gain is considered it is seen that the addition of 35.8 pounds of tankage saved 500.2 pounds of grain in the production of unit gains. It also, reduced the minerals required 5.30 pounds, and the salt 6.93 pounds in producing these gains.

In this comparison the addition of tankage to a grain ration enabled the pigs to reach a desired weight of 220 pounds in 209 days less time.

Even after these pigs had been fed for 117.5-day fattening period they failed to show any tendency toward becoming finished, and some of them had not been able to maintain normal growth. At the end of this fattening period they were sold as feeders or disposed of as culls.

The addition of tankage to a grain ration increased the rate of gain three times and saved approximately 55 percent of the grain required per unit gain.

Double Mixture vs. Tankage

Double mixture composed of two parts tankage and one part cottonseed meal, when fed as a protein supplement with hog millet was not as efficient as tankage. Altho the pigs fed double mixture consumed 14.0 pounds less hog millet to produce 100 pounds of gain, they required 12.2 pounds more supplement than tankage-fed pigs, to produce unit gains.

The lot of pigs fed this double mixture gained 3.1 pounds more during the 90-day fattening period than the tankage-fed pigs, or a difference of .04 pounds per head per day. However, biometrical analysis shows that this is an insignificant difference.

Flax Mixture vs. Tankage

A flax mixture composed of two parts tankage and one part ground flaxseed as a protein supplement with hog millet was not as efficient as tankage, because more grain and more supplement were required by these pigs to produce 100 pounds of gain. The flax-mixture lot produced an average daily gain of .20 pounds more than the tankage lot.

Biometrical analysis shows that this difference of .20 pounds per pig per day for so small a number of individuals is not a significant difference. However, it should be remembered that mathematical analysis is adapted for consideration of a relatively large number of cases and it should not be relied upon entirely when applied to a small number. In other words, this difference in gain probably is significant and should future work agree with these results, then, biometrical analysis will, no doubt show a difference of this magnitude to be significant.

Soybeans vs. Tankage

Soybeans fed as a supplement with hog millet were not as efficient as tankage. The soybean-fed pigs required 10.0 pounds more hog millet, 68.1 pounds more soybeans, .81 pounds more mineral mixture, and 1.25 pounds more salt for each 100 pounds of gain produced than tankage-fed pigs. The tankage lot produced an

average of .21 pounds more per head per day than the soy-bean lot.

Here again, the application of biometrical analysis to these gains shows an insignificant difference between them, however, as in the above case, it probably should be considered significant for this year's work. The experiment should be repeated to verify the results.

Altho the lot of pigs fed soybeans consumed large amounts of minerals and salt, they did considerable rooting in the drylot, probably indicating a deficiency in the ration.

Soybeans self-fed free-choice caused soft pork.

Flaxseed vs. Tankage

Unsatisfactory gains were produced when ground flaxseed was used as a protein supplement to hog millet. Flaxseed-fed pigs gained only .94 pounds per head per day during the 90-day period as compared to an average daily gain of 1.58 pounds for tankage-fed pigs. These pigs required 60.4 pounds more hog millet, 45.5 pounds more protein supplement, 1.77 pounds more mineral mixture, and .82 pounds more salt to produce 100 pounds of gain than pigs fed tankage. They did much rooting in the drylot, even tho minerals and salt were supplied at all times.

The fact that flaxseed produced oily pork and a yellow-colored fat largely condemns its use as a sole protein supplement with hog millet.

CONCLUSIONS

1. The addition of tankage to a grain ration of corn and hog millet mixed half and half produced three times greater gains than grain alone and resulted in the saving of approximately 55 percent of the grain mixture. This saving was even greater when 45-pound instead of 65-pound pigs were used.

2. The results of one year's work indicate that 50 percent meat and bone meal tankage was just as efficient in producing gains as 60 percent protein tankage when fed as a supplement with the same grain combination. However, more work need be done to varify this.

3. Triple mixture, composed of two parts tankage, one part cottonseed meal and one part alfalfa meal was not quite as efficient as tankage pound for pound, but it did produce an equal rate of gain.

4. Double mixture composed of one-half tankage and one-half cottonseed meal is not quite as efficient as tankage when fed as a supplement to hog millet. Care should be taken when this mixture is fed to pigs weighing less than 50 pounds because of its tendency to cause digestive disturbances with very small pigs.

5. Results of one year's work show that there was no particular advantage in using a mixture of two parts tankage and one part cottonseed meal rather than

a half and half mixture of these supplements, because indications are that this mixture is not as efficient as a half and half mixture or tankage pound for pound in the hog fattening ration.

6. One year's work indicates that flax mixture was not as efficient as tankage pound for pound when used to supplement a grain ration of hog millet, altho, it did produce a greater rate of gain.

7. Soybeans, when fed as a supplement to hog millet produced only 86 percent as much gain as tankage fed with this same grain ration. This feed self-fed free-choice caused soft pork, and therefore largely condemned itself as a sole protein supplement with hog millet.

8. It does not seem desirable to use flaxseed as the only protein supplement to a grain ration, because the gain produced was unsatisfactory, and the pork produced was oily and the fat yellow in color.

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