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FORMULATING RATIONS FOR SWINE

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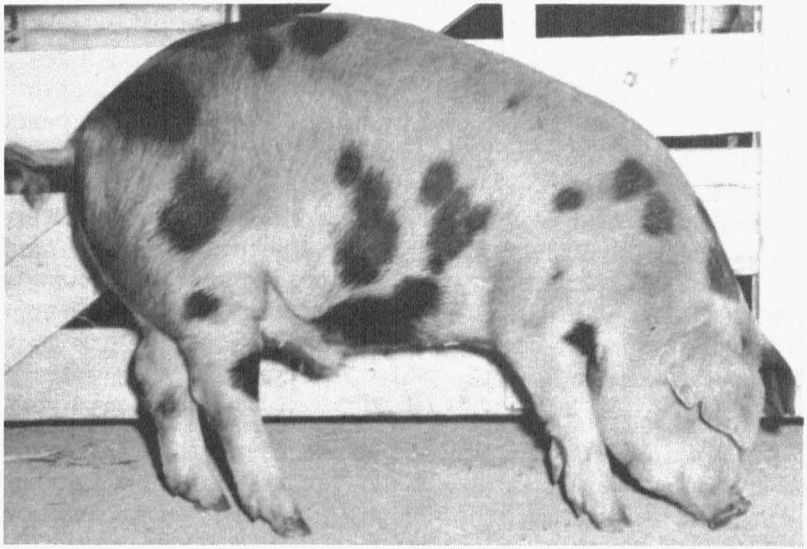


This barrow on a well-balanced ration weighed 222 pounds at 4½ months of age.

The importance of proper feeding in efficient pork production is emphasized by the fact that approximately 80 per cent of the total cost of producing pork may be attributed to feed costs. Since rate and economy of gains are so largely dependent upon the kind of feeds fed, the use of well balanced rations becomes a "must" for successful pork production.

Definition of a Balanced Ration

A balanced ration is usually thought of as being one in which there is a proper balance or ratio between the proteins and the other energy producing nutrients such as the fats and carbohydrates. The latter two nutrients are the most economical in supplying most of the heat and energy requirements of the body. They cannot be changed into proteins by the animals. The proteins necessary for maximum growth of swine must be present in the feed.

When eaten by animals, these proteins are digested and broken down into simpler substances known as amino acids. From the digestive tract they are taken into the blood stream and thence to the various body cells where they either replace broken down or worn out tissues or build up new tissue in the process of growth. More protein is needed in the ration of young, growing animals than in mature ones because in the process of growth a large amount of protein is needed for building new tissue.

A Balanced Ration May Not Be Nutritionally Complete

Although a ration may contain the proper ratio between protein and non-protein feeds, this does not guarantee that it is nutritionally complete. Such a ration may not contain adequate amounts of vitamins, minerals or good quality proteins. These nutrients must be carefully supplied in the feed to meet the requirements of the animal. A mineral mixture containing equal parts of salt, bone meal and ground limestone fed free choice to swine should meet most of their mineral requirements. Good quality legume pasture, alfalfa meal or good quality legume hay when pasture is not available will help supply most of the known vitamins in amounts needed to support proper growth and reproduction under most farm conditions. The addition to the ration of proteins from an animal source will help insure that the proper quality of protein is present to support maximum growth.

Nutritional Requirements of Swine Are High

Swine require more complete rations than do other farm animals such as cattle and sheep. A number of factors are responsible for this. In the first place, swine are fed more concentrated feeds such as corn and other grains than are other farm animals. These feeds are more likely to be deficient in vitamins, proteins and minerals than are roughages such as pasture or good legume hay. Since swine also grow more rapidly than other farm animals their food requirements for proteins are higher. Growing, fattening swine often make daily gains of 7½ to 8½ pounds per 1,000 pounds body weight to a market weight of 225 pounds. In direct contrast, fattening steers will often make daily gains of only 2½ to 3 pounds per 1,000 pounds of body weight even when on full feed.

An additional factor responsible for the high nutrient requirements of swine is that they breed, reproduce and lactate at a more immature age than most other farm animals. Gilts are often bred at 7 to 8 month of age while heifers are usually more than twice this age before they are bred for the first time. Still another factor responsible for the high nutrient requirements of swine is that they have comparatively small stomachs and are not able to digest

bulky feeds as are cattle and sheep, which have larger, more complex stomachs. Because of this fact, cattle and sheep are able to synthesize a number of vitamins and proteins through the action of certain micro-organisms in their digestive tract. Swine are not able to do this to any great extent. These nutrients must be supplied in their feeds in proper quantity and quality for maximum performance.

Protein Requirements for Swine

For many years numerous feeding trials have been conducted to determine the protein requirements of different classes of livestock. As a result of these studies protein requirements have been determined for hogs of different classes and ages, and standards have been devised for these animals. These standards are given in Table 1 and may be used as guides for formulating rations along with recommendations for other nutrients given on page 7 of this

TABLE 1.--DIGESTIBLE PROTEIN REQUIREMENTS FOR SWINE ACCORDING TO AGE AND CLASS (FROM MORRISON'S FEEDS AND FEEDING)

Approximate Weight of Animal	% Digestible Protein Required in Ration	Lbs. Digestible Protein Required Per Day
For growing and fattening pigs:		
30 lbs.	18 -- 20	.26 -- .30
50 lbs.	16 -- 19	.37 -- .41
75 lbs.	14 -- 17	.45 -- .51
100 lbs.	13 -- 16	.55 -- .61
150 lbs.	12 -- 13	.63 -- .71
200 lbs.	10 -- 11	.67 -- .75
250 lbs.	10 -- 11	.74 -- .83
300 lbs.	10 -- 11	.77 -- .87
For wintering pregnant gilts:		
200 lbs.	11 -- 12	.43 -- .48
250 lbs.	11 -- 12	.50 -- .56
300 lbs.	11 -- 12	.57 -- .64
For wintering older pregnant sows:		
300 lbs.	10 -- 11	.44 -- .50
400 lbs.	10 -- 11	.55 -- .61
500 lbs.	10 -- 11	.64 -- .72
600 lbs.	10 -- 11	.73 -- .82
For brood sows nursing litters:		
300 lbs.	12 -- 14	1.23 -- 1.32
400 lbs.	12 -- 14	1.30 -- 1.39
500 lbs.	12 -- 14	1.40 -- 1.50
600 lbs.	12 -- 14	1.53 -- 1.64

Reduce protein 3% when pigs are on good pasture.

circular. The protein requirements are set up so they have an upper and a lower limit. This is done because even pigs from the same litter and the same weight vary considerably in their protein needs. Furthermore, different samples of the same kind of feed vary in composition. The protein standards, then, must be designed to meet more nearly the needs of all animals rather than single individuals and must be flexible in order to meet the variation in different feeds which are used in the ration.

Chemical Composition and Digestibility of Feeds

Most commercial feeds purchased on the market have a tag attached which includes a statement of the minimum percentages of crude protein, nitrogen free extract (N.F.E.), fat, and the maximum amount of crude fiber which the feed contains. This represents a chemical analysis of that particular feed, and does not mean that all of these materials may be digested by the animals to which the feed is fed. However, enough digestion trials on feeds have been run so that an approximate digestibility of most feeds may be determined by comparing the nutrient content on the bag with the composition of a similar feed shown in Tables 2 to 6 inclusive. For example, if you buy meat and bone scraps with a crude protein content of 50 per cent or more, compare this with a similar feed in Table 2 and you find that a feed of this composition contains approximately 41.8 per cent digestible protein. This latter figure should be used in calculating a balanced ration. The term, crude protein, includes all nitrogenous compounds regardless of whether or not they are

TABLE 2.--THE COMPOSITION OF PROTEIN FEEDS

Feed	Digestible Protein (D. P.) (per cent)
Corn Gluten Feed, 25% protein grade	22.9
Cottonseed Oil Meal, 43% protein grade	34.2
Fish Meal, average of all kinds	56.2
Linseed Oil Meal	30.8
Liver Meal	58.9
Meat Scraps or dry rendered tankage	
60% crude protein grade	49.9
55% crude protein grade	45.8
Meat and Bone Scraps	
50% crude protein grade	41.8
45% crude protein grade	38.0
Soybean Oil Meal	37.2
Tankage	
60% crude protein grade	51.5
50% crude protein grade	43.6
40% crude protein grade	36.5
Yeast	42.4

actually proteins, whereas digestible protein represents the percentage of these compounds which are actually digested and absorbed into the body of the animal.

The percentage of crude fiber on the bag is an approximate guide to the digestibility of any feed. A high percentage of crude fiber is usually associated with a lower percentage of digestible nutrients. This is especially true in feeds for swine because, as has been previously mentioned, swine are unable to digest fiber to any great extent in contrast to cattle, sheep and horses. Therefore, in selecting feeds for swine the fiber content should be considered in addition to its protein content. If two soybean meals are available on the market, the one containing the smallest percentage of fiber and the largest percentage of crude protein should be purchased, providing there is little or no difference in the price of each feed. The same rule applies for many other feeds.

Why Mix Feeds?

A mixture of feeds is often used for a number of reasons. In the first place, a mixture of nitrogenous supplements often supplies better quality proteins than a single feed. Some feeds may be lacking in one or more of the amino acids which are necessary for proper growth. Usually no two protein concentrates are deficient in the same amino acids so a combination of two or more feeds, especially from both vegetable and animal sources, usually makes the protein supplement more complete.

Mixtures of protein feeds are also often used to reduce production costs. Tankage alone often costs twice as much as soybean meal, yet a mixture of the two usually gives as good or better results than when either is fed alone. By using a mixture of the two protein concentrates, the cost may be reduced considerably as compared to tankage alone, yet the high level of quality is maintained.

TABLE 3.--THE COMPOSITION OF ENERGY FEEDS

Feed	Digestible Protein (D. P.) (per cent)
Barley	10.0
Corn	6.6
Corn and Cob Meal	5.3
Kafir or Milo	8.8
Oats	9.4
Rye	10.0
Wheat	11.1
Wheat Bran	13.7
Wheat Shorts	15.0
Wheat Standard Middlings	15.0

At times a mixture of grains or energy feeds may be used to advantage. Oats alone are too fibrous for rapid and economical gains in swine. However, experiments have shown that ground oats mixed with corn may be fed at the rate of one-fourth to one-third of the total ration without reducing gains. Other feeds such as rye when fed alone to swine are unpalatable, yet if this grain is mixed with corn or some other more palatable grain the mixture may be fed with good results.

There is still another advantage to using a mixture of feeds. By using grain mixtures, a farmer can take advantage of a crop rotation including corn, oats, and wheat and can use these feeds to advantage as they become available on the farm.

TABLE 4.--THE COMPOSITION OF DRY ROUGHAGES

Feeds	Digestible Protein (D. P.) (per cent)
Alfalfa Hay, very leafy	12.6
Alfalfa Hay, leafy	11.7
Alfalfa Meal, 20% crude protein grade	16.1
Alfalfa Meal, 17% crude protein grade	13.8
Clover Hays:	
Ladino	14.2
Red	7.1
Lespedeza	6.4

TABLE 5.--THE COMPOSITION OF GREEN ROUGHAGES (PASTURES)

Feeds	Digestible Protein (D. P.) (per cent)
Alfalfa, all kinds	3.4
young to 10 inches high	4.4
Barley	3.8
Bluegrass, growing	3.9
Brome grass, smooth, good pasture	3.7
Clovers:	
Ladino	3.7
Red	2.8
Sweet; before bloom	3.2
White	3.8
Lespedeza; before bloom	2.0
Rape	2.4
Rye, pasture, growing	4.0
Wheat, pasture, growing	3.6

Formulating the Ration

In the preceding discussion it has been emphasized that formulating a satisfactory ration involves much more than merely supplying the energy and protein nutrients in proper ratio or pro-

portion. In the way of a summary the following procedure should be followed in formulating rations for swine.

1. Select high quality, palatable feeds which are the cheapest sources of nutrients at any given time.
2. Use a mixture of feeds whenever possible to make use of available feeds on the farm, to supply a variety of proteins and to reduce the cost of protein supplements. The quality of protein may usually be improved by using at least 25 per cent of a good animal protein in the supplement. However, when tankage or meat scraps are scarce and costly, only 10 per cent of these animal proteins may be used in the protein supplement.
3. Mineral requirements should be met by feeding free choice a mineral mixture consisting of equal parts of steamed bone meal, ground limestone and salt.
4. Good quality pasture is an excellent source of vitamins for swine of all classes and ages. The grazing season may be prolonged in the winter months by seeding small grains such as rye and wheat for pasture. When pasture is not available, rations for growing, fattening pigs should contain 7 to 10 per cent of alfalfa meal or good quality legume hay. Rations for pregnant sows and gilts should contain up to 10 to 15 per cent of either of these feeds.

A good protein supplement for hogs not on pasture would consist of the following feeds:

50 pounds of soybean oil meal or other vegetable protein mixtures.

25 pounds of animal proteins in the form of tankage or meat scraps.

25 pounds of dehydrated alfalfa meal or good quality legume hay.

If good pasture is available a satisfactory protein supplement would contain the following:

75 pounds of soybean oil meal or mixtures of other vegetable proteins.

25 pounds of animal proteins in the form of tankage, meat scraps or other feeds from an animal source.

When the above feeds have been selected to meet the vitamin, mineral and protein requirements, the proper balance between the

TABLE 6.--THE COMPOSITION OF SOME SPECIALTY FEEDS

Feeds	Digestible Protein (D. P.) (per cent)
Buttermilk	3.3
Buttermilk, condensed, 30% dry matter	9.8
Skimmilk	3.4
Skimmilk, dried	31.2
Whey	0.8
Whey, dried	11.0

protein and energy, or carbonaceous feeds, may be found by means of the so called "square" method for balancing rations.

The Square Method of Balancing Rations for Swine

The following is an outline of the different steps involved in balancing a ration by the square method.

1. Place the desired percentage of digestible protein in the center of the square as shown in Example I. This figure, 15 per cent digestible protein, was taken from Table 1 and represents the desired amount of digestible protein in a ration for pigs weighing 75 to 100 pounds.

2. Place the percentage of digestible protein in the grain (example corn—6.6 per cent) in the upper left hand corner of the square.

3. At the lower left hand corner, place the percentage of digestible protein in the protein concentrate (example, tankage—51.5 per cent.) If a mixture of protein concentrates is used, place the average percentage of protein in the mixture here (Example II.)

4. In a criss-cross manner, subtract the smaller figure from the larger and place the remainder at the corner. These figures represent the amount of each feed, or proportions of feeds, which are required to give the desired amount of digestible protein in the center of the square.

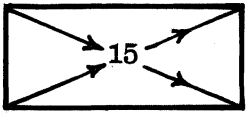
EXAMPLE I

PROBLEM: In what proportions would one mix corn and tankage so that the mixture would contain approximately 15 per cent digestible protein? Such a mixture would be suitable for a 75 to 100 pound pig as shown in Table 1.

1. Look up the composition of corn and tankage in Table 2.

Digestible protein in No. 2 yellow corn..... 6.6%

Digestible protein in standard tankage.....51.5%



Therefore, a combination of 36.5 lbs. of corn and 8.4 lbs. of tankage will give a mixture which contains approximately 15 per cent digestible protein. In order to convert this to percentages of each of these feeds (the percentage really means the amount of each feed in 100 pounds of the mixture) divide the pounds of corn (36.5) by the total weight of the mixture (44.9) and multiply by

100 which will give 81.3 per cent of corn. Likewise, the number of lbs. of tankage (8.4) divided by the total weight of the mixture (44.9) multiplied by 100 will give 18.7 per cent tankage.

EXAMPLE II

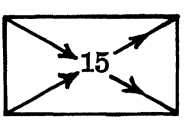
PROBLEM: How to figure a ration if a mixture of protein concentrates is used. In what proportions would one mix soybean oil meal, alfalfa meal, tankage and corn to obtain a mixture containing approximately 15 per cent digestible protein? (75 to 100 pound pig, Table 1).

First, determine the percentage of digestible protein in the mixture of these three feeds as for example, 1 part soybean oil meal, 1 part alfalfa meal and 2 parts tankage, by looking up their protein content in Table 2 which would be as follows:

100 pounds of soybean oil meal	37.5 lbs. D. Protein
100 pounds of alfalfa meal	16.1 lbs. D. Protein
200 pounds of tankage	103.0 lbs. D. Protein
400 pounds of the mixture	156.6 lbs. of D. P.

156.6 divided by 400 x 100 gives 39.1, the percentage of protein in this mixture of three feeds, or the number of pounds of protein in 100 pounds of the mixture.

Use the figure (39.1 per cent) as it was used for tankage in Example 1.



Therefore, a combination of 8.4 pounds of this protein mixture with 24.1 pounds of corn will give a ration consisting of 15 per cent digestible protein. To obtain the percentages of each of the feeds in the total ration, 24.1 lbs. of corn divided by 32.5 (total amount of mixture) times 100 would give 74.2 per cent of corn in the ration. Likewise, 8.4 lbs. of protein mix divided by 32.5 (the total amount of mix) times 100 would give 25.8 per cent of the protein in the ration. Since the protein mixture contained one part of soybean oil meal, one part of alfalfa meal and two parts of tankage, of the 25.8 pounds of protein mixture there would be one-fourth each of soybean oil meal and alfalfa meal and two-fourths of tankage in 100 pounds of the ration. Therefore, the ration would contain the following

amounts of each of these feeds in proper proportion to give approximately 15.0 per cent digestible protein.

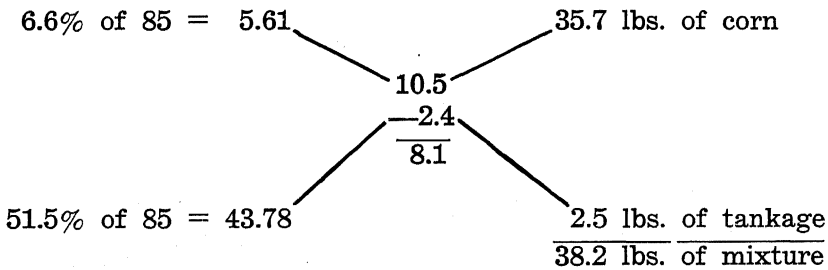
Feeds	Per cent or pounds per 100
Corn	74.2
Soybean oil meal	6.5
Alfalfa meal	6.5
Tankage	12.8
TOTAL	100.00

This method can be used for any mixture of feeds as long as their percentage composition of digestible protein is known.

EXAMPLE III

PROBLEM: To include a definite amount of a certain feed in the ration. In this example a ration for a 400-pound, pregnant brood sow should contain approximately 15 per cent of alfalfa meal; the remainder of the ration is to be made up of corn and tankage. According to the figures in Table 1 this ration should contain 10.5 per cent of digestible protein.

1. Follow the procedure outlined in Example I. Set down 10.5 in the middle of the square as shown below. Subtract from this the amount of digestible protein (2.4 pounds) in 15 pounds of alfalfa meal. This would be 10.5-2.4 or 8.1 pounds. The amount of digestible protein to be supplied by corn and tankage.



2. Since 15 per cent of the rations must be alfalfa meal, or 15 pounds of each 100 pounds, the remaining 85 pounds must be made up of corn and tankage. Multiply 85 by the percentage of digestible protein in corn (6.6) or (.066 x 85 = 5.61). Following this same procedure for tankage we would have (51.5 x 85 = 43.78). Place these figures at the corners of the square as illustrated above, and follow the procedures shown in Example 1.

3. As in the previous example subtract the smaller figure from the larger and place the results in the right hand corner as shown above.

4. To obtain the percentage of corn in the mixture divide the amount of corn, 35.7 by 38.2 and multiply by 100.

$$\left.\begin{matrix}35.7\\38.2\end{matrix}\right\} \times 100 = \left.\begin{matrix}93.46\\\%\end{matrix}\right\} \text{ of corn}$$

Likewise

$$\left.\begin{matrix}2.5\\38.2\end{matrix}\right\} \times 100 = \left.\begin{matrix}6.54\\\%\end{matrix}\right\} \text{ tankage}$$

As mentioned before, 15 pounds in every 100 pounds of the ration must be alfalfa meal and 85 pounds is to be made up of corn and tankage. From the above figures it is learned that 93.46 per cent of this 85 pounds is corn and 6.54 per cent is tankage. With these figures in mind 100 pounds of the complete ration would contain:

85 x 93.46 = 79.44 lbs. of corn
85 x 6.54 = 5.56 lbs. of tankage
15 lbs. of alfalfa meal.
100 pounds

This mixture should contain approximately 10.5 per cent of digestible protein.

NOTE:—It is not necessary to carry the figures out to the second decimal such as 38.21; for practical purposes such figures may be rounded off to 38.

How Much to Feed

Once the ration for a particular class of swine has been balanced, it is not difficult to figure how much of the ration should be fed. For illustration, from Table 1 it is learned that the sow in the preceding example required between 0.55 and 0.61 pounds of digestible protein per day. For convenience the figure 0.6 pounds may be used. The ration figured in Example III contains 10.5 pounds of digestible protein per 100 pounds, or .105 of a pound of digestible protein per pound of ration. Divide the amount of digestible protein in one pound of the ration into the amount required by the sow to determine the quantity of ration to be fed daily $\left(\frac{0.6}{.105} = 5.7 \text{ lbs.}\right)$ It should be mentioned here that many other factors will contribute to the determination of the best level of feeding, and that the amount determined in the above manner should serve only as a guide.