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GRAIN RATIONS FOR DRY LOT HOG FEEDING

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GRAIN RATIONS FOR DRY LOT HOG FEEDING.

By E. B. Forbes.

Summary.

1. The object of these tests was to compare linseed oilmeal, wheat middlings (shipstuff), wheat bran, oats, bone meal and gluten feed as supplements to corn, and to compare soaked corn, corn meal, and corn and cob meal, with whole corn, for dry lot hog feeding.

2. In all 122 pigs were fed in nineteen lots of from five to ten each, for periods of from 60 to 90 days. Twelve lots were fed in the spring, five in midsummer and two during the fall. (page 44.)

3. Linseed oilmeal and wheat middlings are the two most profitable grain supplements to corn for dry-lot hog feeding which were included in these tests. (page 68.) There is no great difference in the profit but, purchased in quantity, the advantage appears to be with the linseed oilmeal. (page 70). Oilmeal is more expensive but is more efficient. One pound of oilmeal replaced from 3.85 to 7.1 pounds of corn according as it was fed with five or twenty pounds of corn. (page 74.)

4. Gluten feed was not so valuable as a supplement to corn as linseed oilmeal. (pages 57, 64, 68.)

5. Bran was profitably used in small proportion with corn but was not as useful for fattening hogs as some other supplements. (pages 68, 71, 74, 78.)

6. Bone meal fed with whole corn effected a marked saving in the grain requirements per pound of gain. (pages 52, 57, 64.)

7. Oats were not as satisfactory as other supplements used. (pages 74, 78.)

8. Whole corn, by itself, proved to be an expensive feed for dry-lot pork production. (pages 68, 72, 74, 81.)

9. Grinding and soaking of corn both returned profit on the labor expended in preparation. Soaking is some-

what less efficient than grinding but its cost is so slight that greater profit will usually result from this method of preparation. (pages 68, 74, 81.)

10. Corn and cob meal seems not to be a profitable hog food. (page 68.)

11. All of the supplements used with corn except oats reduced the grain requirements per pound of gain to a smaller amount than that required of corn alone. (pages 52, 57.)

12. The balanced ration of corn and linseed oilmeal was the most efficient and profitable ration tested. (pages 52, 57, 68, 69.)

13. The advantages of the supplemented rations over those of corn alone increase with the cost of feeds. (pages 67-72.)

14. The smaller the proportion in which the supplement was fed, the greater was the amount of corn replaced by each pound of the amendment; but the larger proportions of the supplements affected greater total saving of corn and greater reduction in expense of making pork. Some expensive supplements may be fed with corn at a profit if used in small enough proportion. (pages 73-76.)

15. Palatability and allied characteristics render some rations that are poor in protein, more efficient than others which are more nearly balanced but not possessing these other desirable qualities. (pages 52, 53, 54.)

16. Summer feeding in the dry-lot in Missouri, appears to cost much more for each pound of increase, than dry-lot feeding in spring or fall. (pages 65, 66.)

17. Poorly fattened corn-fed hogs dressed higher percentages of carcass to live weight than much fatter hogs which had been fed on more nearly balanced rations. (page 83, 84.)

18. Unduly bulky foods lower the profit for both the farmer and packer; the hog that returns the greatest profit to the farmer is the one that eats the greatest amount of digestible nutriment; the hog that returns the greatest profit to the packer is the one that eats the smallest amount of the most concentrated ration. (pages 83-88.)

FOR FINANCIAL DISCUSSION, SEE PAGES 67-82.

GRAIN RATIONS FOR DRY-LOT HOG FEEDING.

By E. B. Forbes, Assistant Professor of Animal Husbandry.

INTRODUCTION.

The American Corn Belt has an advantage in the matter of profitable pork production over all other agricultural regions in the world. Naturally enough the mainstay of the pork producer in this region is corn, since it is now and probably always will be our cheapest grain food. Indeed our corn is so cheap that foreigners buy it, ship it half way round the world and then find profit in its use for meat production.

Corn, however, is not a complete and perfect food for the fattening hog, still less for the growing animal. Hence the matter of feeds to be used with corn, supplementary to it, is of greatest importance to those whose livelihood depends upon its economical utilization. The fact that corn alone is not our most profitable feed for fattening hogs, even though usually the cheapest, that this is not universally accepted, and that a somewhat general lack of knowledge exists regarding profitable supplements to be used with corn, have led to the prosecution of this work. The subject of preparation of corn for hog feeding also receives consideration and some results of work on this phase of the subject are here presented.

By way of introduction to the subject-matter of this bulletin, it has been deemed timely to make mention of a few cardinal points of pig feeding and animal nutrition generally, and to discuss them briefly in such way as to make clear the significance of observations to be made on the results of these experiments.

The Hog in Nature.

In the state of nature we find that the wild hog, from which our domesticated breeds of swine have descended, is an omnivorous feeder; that is, he eats a great variety of foods; not only everything that is edible but apparently anything that is eatable, including green vegetation, starchy roots of plants, fungi, nuts, fruits, insects, mice, worms,

snakes, dead fish, clams, crawfish and even carrion of all sorts. In accordance with the omnivorous feeding habit of the animal, we find that his teeth are adapted not only to the grinding of grain but also to the tearing of flesh; the crowns of the four forward molars being sharp, as in the cat family, while the three hinder ones are broad and are furnished with tubercles on the grinding surface as in the cow. So we find the tendency of the hog to select his food in variety so deeply rooted in inheritance, as even to make its impress upon the character of the teeth. Such a deep-seated tendency would seem to demand careful attention from those whose interests are so intimately connected with the greatest well-being of the hog.

We, of the Corn Belt, realizing that our great advantage in pork production over other regions lies in the possession of our corn, are apt to miss the greatest possible profit by too severe adherence to this one grain feed for the hog at all times and for all purposes. This common method of feeding often becomes a source of waste and it seems that the big leak in the bucket may be most easily stopped by the purchase of a small amount of some one of certain higher priced feeds.

Corn as a Hog Food.

Foods eaten by animals contain three general classes of nutrients, each of which is used in certain definite proportions in a measure irrespective of the comparative amounts in which they may be present in the food. These are (1) mineral matter or ash, used most largely in the formation of bone; (2) proteids, which are essential and largely used in the formation of lean meat; and (3) starch, fat and sugar, substances of similar composition and all used for the production of fat and the maintenance of bodily heat and activity. Ash or mineral matter is present in varying proportion in each and every tissue and fluid of the body and is an essential constituent even when present in minute proportion. The proteids are also essential to the making of every tissue in the body, especially during the formative period of the animal's growth, but none the less essential, though used in smaller proportion, during the fat-

tening process. Fattening animals can use large amounts of starch, sugar and fat because it is from such nutrients that fat is formed, but mineral matter and protein are also absolutely necessary.

Corn is certainly the most efficient fattening food which we have, but we find that it is too poor in protein and in mineral matter to supply the needs of even the fattening hog. It is the poorest of all our grains in mineral matter. Since other grains are richer in these nutrients, we find that mixed rations are more economical of grain, when used in pork production, than corn alone, supplying, as they do, the three classes of nutrients more nearly in the proportions in which they are used. Nearly all of our ordinary hog foods contain plenty of mineral matter. It is usually only when we confine our hogs to corn alone that we starve them for bone food.

Professor H. Snyder[1] concludes that the ash of corn is entirely indigestible by swine. If this be true then corn is still less efficient as a bone food than its ash content would indicate. It is a fact, however, accepted by physiologists[2] that the ash of the feces contains salts which have been digested from the alimentary tract and later returned to it by virtue of the important excretory functions of the intestine. Hence our usual method of estimate of digestibility of nutrients may not be applied to the ash of foods, especially where as in corn its amount is very small.

We find that when we starve a hog for bone food, the damage done is much more profound than is evidenced merely by the weakening of the bones. The whole nutritive process is so disturbed that the food, though it be in correct proportion as regards flesh- and fat-forming constituents, does not serve the needs of the animal and is not used with economy. Aside from the matter of general nutrition, as connected with and influenced by bone development, we want strong bones on account of the following considerations: If the bones are insufficiently nourished

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[1]Minn. Bul. 26, p. 28.

[2]Lafayette B. Mendel, "Some Aspects of the Newer Physiology of the Gastrointestinal Canal." Journ. Am. Med. Assn., Nov. 19, 1904.

they either fail to reach their proper length and thus decrease the scale of the animal, or they develop so weak that they afford insufficient attachments for the muscles and the animal breaks down, as we say. Such a hog is apt to arrive on the market a cripple; in the show ring he is at such a disadvantage as to be practically debarred, and on the farm he is inactive and hence a poor rustler, and his period of usefulness as a breeder is much curtailed. Hogs not so fed as to produce a good strong, healthy development of bone are not in a normal state of nutrition and are not the most economical producers of pork. Professor Henry has proven that both size and strength of bone are easily influenced by the chemical composition of the foods used.

Variety in Food.

In a general way, no thinking man fails to appreciate the fact that variety in the ration must add to the satisfaction of the animal consuming it, and feeders of animals other than hogs usually act accordingly, believing that the pleasure of the animal fills the pocket of the feeder. The hog, however, because of his ravenous appetite and lack of particularity as to what he eats, seems usually to be accounted as insensible to such fine comforts as are provided our other meat-making animals. This is a difficult question upon which to get direct experimental evidence, but careful observation leads us to believe that variety in the ration means just as much to a hog as to a dairy cow. This fact becomes more easily appreciated when we consider just how and why this matter of variety in food effects animals.

Every kind of food entering the alimentary tract of an animal stimulates the digestive organs to activity of a sort dependent upon the nature of the food. The various muscular, secretive, absorptive and assimilative appliances used in the handling and appropriation of food, are called upon to act in certain definite ways dependent upon the nature of work to be done. Is it not apparent that in the case of an omnivorous feeder like the hog, adapted by nature to the consumption of a great many kinds of food, we can get much more work out of the animal's digestive apparatus by diversifying the demands made upon it? Just as

in the case of the city pavement, the hog's digestive organs will wear evenly and stand up to the strain as long as the load is well distributed, but permit all the burdens to run in the same ruts and dissolution promptly ensues. This matter is of especial importance with the hog because this animal is notoriously subject to diseases of the digestive tract.

Then further, the animal body has need for a very considerable diversity of nutrients. We usually speak of them as consisting of but three sorts, proteids, carbohydrates and fats. Sometimes we mention mineral matter or ash as also necessary, but usually we consider only the above mentioned organic nutrients of our food stuffs. It is true, however, that there are a great many mineral substances found in the body, some in large amounts, other in minute quantities, but most of them present because they are necessary, and some of those found in the smallest proportion, iron for instance, being absolutely essential to some of the most important bodily functions.

We do not usually consider the necessity of providing the animal with these mineral nutrients, because they are generally found in superabundant measure in the ordinary foods of the farm. We trust to luck that the right ones will be present, and so they are in any mixed ration we would be likely to compound, but not in a straight corn ration. Where corn is bound to be our principal hog food, the necessity of supplementing it with other kinds of nutriment at once becomes apparent.

Bulk in Food.

The hog consumes more food in relation to his weight than any other farm animal; he also makes more meat from the food which he eats than any other animal would make from the same quantity of food. This advantage of hogs over other meat-makers, requiring for its realization the consumption of more food than other animals eat, necessitates our attention to the mechanical character and palatability of the ration, and this fact impresses us most deeply when we remember that the hog is in no wise fitted for the consumption of bulky feed.

There are considerable differences both as to bulk and

palatability among our common hog feeds and it is true that in spite of the hog's great fondness for corn we can compound a ration of which a hog will consume a much greater amount than of corn alone and from which he will make much more meat from a given amount of feed.

Hogs eat very little of the roughage of our farms. We could not afford to raise them if it were not true that they use our grain economically. Much of their economy of production is due to the great amount of feed which they can eat. This capacity to eat a larger amount of feed in proportion to weight than any other animal, is one of the most valuable assets of the hog, this greater amount being used in smaller proportion for maintenance than in the case of the smaller rations of other animals. There is more left from which to make meat. Hence we see that bulk and palatability are matters of prime importance in hog feeding and are considerations which must affect our choice of feeds to be used.

Palatability.

Palatability affects the digestibility of food, as has been proven by J. P. Pawlow, the Russian physiologist, and his associates. Their experimental work is of such practical value as to warrant a somewhat extended notice here, especially since this important scientific work has never before been presented to stock feeders. From these results may be drawn some very valuable and interesting suggestions regarding hog feeding.

The idea that the secretion of the digestive juices is controlled by the nervous system and susceptible of influence by sensory impressions was first advanced by F. Bidder and C. Schmidt in 1852, but has since been demonstrated many times over in a great number of physiological laboratories. Foremost among students of the physiology of the digestive organs is J. P. Pawlow of St. Petersburg, Russia. He and his associates have advanced and experimentally proven many revolutionary ideas concerning the work of the digestive glands. Their experiments have been very largely with dogs which are anaesthetized and operated upon in order to fit them for these studies.

Method of Experimentation. The various operations to which dogs are subjected are as follows: (1) In order to obtain the salivary secretions with purity, the ducts leading from the secreting glands are brought to the surface and healed into openings in the skin in such manner that they discharge their secretions externally. (2) In order to get pure gastric juice, the oesophagus is cut across, the lower end closed and the upper end, which connects with the mouth, is brought to the surface and healed into an opening in the skin, so that food upon being swallowed, passes directly out of the body, through this hole in the neck and falls into the dish from which it is eaten. Dogs thus operated upon eat the same food over and over again, by the hour, with every evidence of satisfaction and often live the usual length of life in perfect health. The pure, unmixed gastric juice is withdrawn when wanted for study by way of a direct opening made through the abdominal wall into the stomach. This opening is closed with a metallic cannula. Through it the animal is given its nourishment. (3) Further, a small portion of the stomach may be made into a pouch also opening externally, so that the secreting surfaces, formerly on the inside of the stomach, and still acting in harmony with it, are accessible from the outside, though all communication between this pouch and the remainder of the stomach is cut off. (4) An opening into the intestine similar to that made into the stomach and similarly closed by a metallic cannula, makes possible a study of digestion in this organ. (5) The work of the pancreas may be studied by bringing the pancreatic duct, with the portion of the intestine surrounding its opening, to the surface and stitching it into an opening in the skin, as in the case of the ducts from the salivary glands.

The Psychic Secretion of Digestive Juices. Studies upon dogs thus prepared give evidence of the fact that any sensory impression, as through seeing, smelling or tasting, which suggests to the dog the idea of food, causes a secretion of the digestive juices. This reflex secretion caused by the suggestion of food is called the "psychic secretion," and an allowance of food chewed as usual but swallowed directly out of the body by way of the oesophageal fistula is called a "false meal."

The fact of the psychic secretion of gastric juice was first observed by Richet in 1878[3], but by many others since that time. The operation of gastrotomy has been successfully accomplished on a dog at the University of Missouri and this psychic secretion is easily demonstrable with this subject. J. B. Pawlow[4] has found that the more eagerly a dog indulges in the "false meal" above described, the greater will be the amount and digestive power of the gastric secretion. The sensation of keen hunger seems to enrich the psychic secretion of gastric juice both in acid and in pepsin. This fact is of great importance to the stock feeder, indicating as it does that a keen appetite is requisite to most efficient digestion.

Dr. Chigin[5], whose work is freely quoted by Pawlow, has found that during the eating of the "false meal" the amount of gastric juice secreted is proportionate to the amount and palatability of the food eaten. He finds that dogs usually prefer raw meat to cooked meat and accordingly secrete more gastric juice during a "false meal" of the former than of the latter. Some dogs, however, prefer that the meat be cooked and these are found to secrete more juice during the "false meal" of the cooked meat. Similarly, certain dogs prefer bread to meat and such individuals secrete more juice during a "false meal" of bread, though with most dogs the preference and the abundant secretion of gastric juice are with the meat.

To understand just how palatability affects digestibility cannot fail to impress upon us the importance of considering this characteristic of the foods we offer to our live stock, and also the futility of trying to get the greatest profit out of feeding stock upon foods which they do not regard with favor. It seems quite likely that we have overworked the idea that "the animal is a machine" to just this extent, that we have come to regard its nutrition too completely as a mechanical process.

Pawlow and Mme. Schumow-Simanowski[6] found that

[3]Journal de l'Anatomie et de la Physiologie, 1878.

[4]The Work of the Digestive Glands.

[5]The Secretory Work of the Stomach of the Dog. (Arch. des Sciences Biolog. T. III, 401.)

[6]Die Innervation der Magendrusen beim Hunde (Arch. fur Anat. u. Physiol. 1895).

severing the pneumogastric nerves caused the animal to cease responding, as above noted, to sensory impressions, proving beyond a doubt that the influences effective for the control of the secretion of digestive juices are truly psychic and reflex activities.

As far back as 1843 Blondlot introduced sugar directly into the stomach, by way of a gastric fistula. It caused no secretion whatever of gastric juice, but when fed by way of the mouth the secretion was abundant.

Pawlow introduced into the stomach of a dog, by way of a gastric fistula, a number of bits of meat strung upon a string, without the knowledge of the dog. Another dog was fed in the same way but in addition he was given a "false meal" of meat to chew. In two hours the strings with the pieces of meat attached were withdrawn and the meat weighed. The second dog had digested five times as much meat as the first, this difference being due to the psychic secretion induced in this animal, by means of the taste of the meat in the mouth and the act of mastication and swallowing. J. O. Lobassow[7] has conducted the same experiment with the same result. Rapidity of digestion means economy of food, because of greater completeness of the process and smaller waste through bacterial fermentation. Hence we are warranted in the belief that taste as affecting palatability and rapidity of digestion is a matter of prime importance in animal feeding.

Adaptability of the Digestive Secretions.

The secretions of the digestive glands seem to be peculiarly adaptive to the particular necessities of the moment. Dr. Chigin proves that the rate, duration and quantity of gastric secretion depend upon the nature of the food; and still further and more remarkable, that when dogs were fed on bread, milk or meat, in each case the juices secreted by the stomach contained in accentuation the ferments requisite to the digestion of those particular foods, for instance, the protein of bread is more difficult of digestion than the protein of meat and occasions a greater secretion of pepsin.

[7]Secretion gastrique chez le Chien. (Arch. d. Sci. Biol., V, 425.)

Dr. A. A. Walther[8] has made similar observations on the activities of the pancreas.

Pawlow and his associates who have done many years of exceedingly careful work upon this subject, are of the opinion that there exists the most complete harmony between the composition of the digestive juices secreted and the particular needs of the animal for the digestion of the food to be acted upon. This idea is supported by a great mass of experimental evidence which has not yet been disproven, though certain physiologists[9] have advanced some theoretical objections, both to certain details of conclusion and methods of work. As long as these objections do not rest upon experimental evidence they can hardly be considered as seriously vitiating the monumental work of Pawlow.

This matter of adaptability of the digestive juices to special uses is of importance in stock feeding as it affects the subject of variety in the ration. If the digestive organs react differently to different foods, it would seem that the greatest total efficiency of these organs would require that the burden of work be distributed by diversity in kind.

Changes of Food.

Commenting upon experiments conducted by J. Jablonski,[10] Pawlow says,[11] "When, in feeding animals, the kind of food is altered, and the new diet maintained for a length of time, it is found that the ferment content of the (pancreatic) juice becomes from day to day more and more adapted to the requirements of the food. If, for example, a dog has been fed for weeks on nothing but milk and bread, and is then brought onto an exclusively flesh diet, which contains more proteid but scarcely any carbohydrate, a continuous increase of the proteid ferment in the (pancreatic) juice is to be observed."

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[8]Le travail secretoire du pancreas. (Arch. d. Sci. Biol., VIII, 1899.)

[9]Dr. Siegfried Rosenberg. Biochemisches Centralblatt. Bd. II, Nos 21 & 22. Dr. A. F. Hornborg. Skandinavisches Archiv. fur Physiologie, XV, 209 (1904).

[10]The Influence of a Diet of Milk and Bread Upon the Activity of the Pancreas. (Archiv. d. Sci. Biolog., IV, 377.)

[11]The Work of the Digestive Glands, pp. 41, and 43.

"A change of diet in the case of one dog may very soon manifest itself in altered properties of the (pancreatic) juice, while in that of another, the remolding of the pancreas takes place in the slowest manner. In such cases as the latter, an abrupt transition from one régime to a different one can often produce serious illness."

"When under the influence of a given diet, this or that condition of the pancreas had been established in our experiment animals, in characteristic form, we were able, by altering the feeding, to reverse it several times in one and the same animal."

These experiments are of interest to the feeder as indicating the way in which changes of food affect our animals, requiring, as Pawlow proves that they do, an actual physiological readjustment, such as cannot fail to occasion an expenditure of energy and a loss of headway.

Stimulation of the Digestive Organs.

Regarding the mechanical condition of foods, it would seem from the results of Pawlow's work that it is of importance as affecting palatability, penetrability by digestive fluids and adaptability to the physical movements of the organs of digestion, but most decidedly not as commonly believed, by virtue of a capacity mechanically to stimulate secretion. Pawlow has subjected this point to exhaustive and convincing study. The mucous membrane of the stomach, so far as secretory activity goes, is perfectly indifferent to mechanical excitation.

Aside from the psychic causes of secretion as above noted, the only influences capable of stimulating the secretory glands are the chemical natures of the food substances. Lobassow has found that water, meat extractives, milk and gelatine are chemical excitants of the gastric glands. Dr. Chigin finds that such carbohydrates and hydrocarbons as starch, fat, cane sugar and grape sugar, have no stimulating effect upon the gastric glands. This is natural since no important chemical changes in these substances take place in the stomach. He also finds that their digestion in the intestine is begun by the psychic secretion, and that juices for their further transformation are secreted by virtue of the stimulatory effect of the products of digestion by the

psychic secretion, this being the important cause of initiating digestive activity. This fact again emphasizes the importance of palatability, since it is responsible for the psychic secretion which sets in motion the machinery of digestion.

Lobassow has determined that glucose and fats are inhibitory to gastric activity but that fats stimulate pancreatic secretion.

Bayliss and Starling[12] have shown that acids stimulate the pancreatic secretion through the agency of a substance "secretin," produced by their action upon the mucous membrane of the small intestine.

Salt.

Regarding salt for hogs; this is a matter upon which little emphasis is usually put, but it is doubtless one of those important trifles which we may consider with profit.

Salt is a normal constituent of animal tissue and of the blood, plays an important part in the stimulation of the internal organs, and is the source of the chlorine of the hydrochloric acid in the gastric juice. It is always present in the urine whether present in the food or not, and death may be caused if complete absence of salt in the ration obtains during a considerable time. The presence of potassium salts in the food causes a diminution in the amount of common salt or sodium chloride in the body and so would require that it be furnished in the food in larger quantity than would otherwise be necessary. G. Bunge[13] has shown us that this is true and also just how the action takes place.

Roots, grains and roughage are rich in potassium salts, sulphates, carbonates and phosphates. These pass into the blood and there form partial reactions with the common salt always present, the products being substances not normal to the blood. These and other substances normal to the blood, but present in undue quantity, are removed by the kidneys. Hence the presence of potassium salts in the food has caused an elimination of common salt

[12]Proc. Royal Society, London, Vol. LXIX, 1902 p. 352. Centralbatt f. Physiologie, Bd. XV, 1902, p. 682.

[13]Lehrbuch der Physiologischen und Pathologischen Chemie. p. 108-109.

from the blood by way of the kidney. The partial reaction involved may be illustrated by the following formula taken from a discussion of this matter in the American Text Book of Physiology[14]:

$$K_2CO_3 + 2\,NaCl = 2KCl + Na_2CO_3.$$

The last two substances require common salt for their formation, but neither being normal constituents of the blood, both are eliminated from it by the kidneys. Hence we may expect increasing need for common salt in the ration, with increasing amounts of potassium salts contained therein.

METHOD OF EXPERIMENTATION.

Quarters.

The quarters in which lots 1-12 and 18 and 19 were fed were small yards with cement floors, connected with open sheds. The yard and shed space available to each lot of five pigs amounted to 144 square feet of floor. The quarters were regarded as being much too restricted for good results but were the only ones obtainable. No earth was within reach of the hogs in these lots and they developed a ravenous craving for mineral matter, evidencing it by the persistence with which they worked away on their cement floors. Lots 13-17 were fed during the summer months, when profit would have dictated that we feed on pasture, but for purposes of comparison with lots 1-12, they were fed in dry-lots. Each lot of ten pigs had the run of a yard, eight square rods in extent, and for shade each lot had shed space 25 feet long and 16 feet wide. These hogs had plenty of range, and shade, but had access to no green feed.

Weather Influences.

During the feeding of lots 1-12 the weather was as usual in Missouri in the late winter and spring. The days became very warm in May, however, and the heat together with the close quarters and monotonous fare was very hard on the lots getting corn alone. They suffered a great

[14]American Text Book of Physiology, p. 964.

loss of appetite and only came back to their feed after receiving a tonic in the shape of a bit of green grass. Though this departure from the plan of the experiment was much regretted, previous experience indicated that this measure was absolutely essential to the continuance of the work on any terms. It is a fact appreciated by those who have tried it, that it is very difficult to keep a lot of young pigs alive and healthy for 90 days, on corn alone, in close pens, without access to either earth or vegetation. Each pig received in all 7 pounds of green grass, cut and fed in the pen. The amount of nutriment contained was inconsequential, but as a tonic it had the desired effect.

Lots 13-17 were fed in midsummer, but had more range and better shade than lots 1-12. They were kept reasonably comfortable even during the hottest weather by a liberal and constant supply of water.

Lots 18 and 19 were fed in the fall and the weather was ideal for this purpose.

Character of Pigs.

The pigs in lots 1-12 were common as to quality, the bulk of them having but one cross of improved blood in their veins; the remainder were probably two crosses removed from unimproved stock.

Lots 13-17 were of better quality and as hogs run, the country over, would average about fair, though appreciably inferior to pure-bred stock as feeders. Lots 18-19 were mostly pure-breds and were fed for class use in stock judging.

At the time the experiments were started, lots 1-12 averaged 115 pounds in weight and were probably about ten months old. Lots 13-17 averaged 127 pounds in weight and were also ten months of age. Lots 18 and 19 weighed 137 pounds each and were six months old. The pigs as a whole were grade Poland Chinas with some admixture of Duroc Jersey, Berkshire, Chester White, Yorkshire and a generous portion of "hazel splitter."

Basis of Selection.

The basis of selection at the time the pigs were divided into lots was sixfold. They were assorted, over and over, with the greatest care, in order that each lot represent a fair average of the whole on the basis of age, weight, quality, condition, sex and breed. No unhealthy pigs were used. The preliminary feeding extended over periods of from four to six weeks with the various sets.

Method of Feeding.

The pigs were fed twice daily, morning and evening, at regular times, the ground feed being mixed with water, just enough so that the feed would pour handily. All grain was fed in square-bottomed, wooden troughs; and water was given twice daily as soon as the grain was eaten. In hot weather the pigs were also given water at noon in order that it be before them at all times.

Salt was supplied **ad libitum** in small boxes; nothing else was fed in addition to the grain and water except in lot 11, where bone meal was mixed with the salt and allowed in unlimited quantity, though account was kept of the amount consumed.

The quantity of food allowed was in each case gauged by the appetite of the pigs, the intention being to feed at all times as much as they would clean up thoroughly and promptly. This was very difficult to do in the case of some of the less palatable rations, corn and cob meal for instance. The lots getting oats also required a liberal time allowance.

The general method of feeding was probably a more severe test on the lots getting corn alone than upon any of the others, because they suffered most keenly from a lack of variety and mineral matter in the ration; the results, however, give us a basis for a true comparison of the rations fed under these conditions, for each lot was treated in every way the same except for the differences in the feed. Many a hog has been fed under just these conditions and tests such as this series bring out very clearly, but still fairly, some facts about straight corn feeding which though commonly understood are not quite as commonly heeded.

Records.

The pigs were weighed every thirty days at 6 a. m., always before feeding, being driven a short distance onto platform scales for this purpose.

The ground grains were mixed in large quantity but each daily allowance was weighed when fed.

Samples for analysis were taken from each food used and the chemical work was done in accordance with the method of the Association of Official Experiment Station Chemists. The quality of the grain used is indicated by these analyses.

DISCUSSION OF EXPERIMENTS.

The feeding tests here reported were conducted at various times during the year 1904, the following tabular statement displaying the plan of work followed:

Lot No	Date	Pigs in Lot.	Ration
1	Mch. 14—June 12	5	Corn meal 5 parts; linseed oil meal 1 part.
2	Mch. 14—June 12	5	Corn meal 20 parts; linseed oil meal 1 part.
3	Mch. 14—June 12	5	Corn meal 2 parts; wheat middlings 1 part.
4	Mch. 14—June 12	5	Corn meal 4 parts; wheat middlings 1 part.
5	Mch. 14—June 12	5	Corn meal 2 parts; ground oats 1 part.
6	Mch. 14—June 12	5	Corn meal 4 parts; ground oats 1 part.
7	Mch. 14—June 12	5	Corn meal 4 parts; wheat bran 1 part.
8	Mch. 14—June 12	5	Corn and cob meal.
9	Mch. 14—June 12	5	Corn meal.
10	Mch. 14—June 12	5	Soaked whole shelled corn.
11	Mch. 14—June 12	5	Shelled corn; bone meal.*
12	Mch. 14—June 12	5	Shelled corn.
13	July 6—Sep. 4	10	Corn meal 5 parts; linseed oil meal 1 part.
14	July 6—Sep. 4	10	Corn meal 10 parts; linseed oil meal 1 part.
15	July 6—Sep. 4	10	Corn meal 20 parts; linseed oil meal 1 part.
16	July 6—Sep. 4	10	Corn meal 2 parts; wheat middlings 1 part.
17	July 6—Sep. 4	10	Corn meal 4 parts; wheat middlings 1 part.
18	Oct. 7—Dec. 6	6	Corn meal 5 parts; linseed oil meal 1 part.
19	Oct. 7—Dec. 6	6	Corn meal 5 parts; { linseed oil meal ½ part gluten feed ½ part.
Total		122	

*The bone meal was fed ad libitum. In 90 days each pig ate 6.2 lbs. of this feed.

Two lines of work are embodied in this series of tests; the preparation of corn, and a comparison of supplements to corn for fattening hogs. The methods of preparation which were tested are in common use and the supplements fed are certain of those, which at present market prices, were deemed to be worth the cost. The pigs were fed in lots from five to ten each. It is not supposed that results from the feeding of so few individuals in a lot are entirely conclusive, but in order to arrive at a comparison of a considerable number of rations, one with another, and all on the same basis, it seemed advisable to divide the available animals into many small lots rather than a few larger ones, and to rely on frequent repetition of the tests to lend geater accuracy to the results. The conclusions drawn from this one year's work are therefore presented as temporal, rather than final, and may be modified by subsequent investigation. The corn fed in most of these rations was ground, partially because grain was so expensive as to warrant grinding and also because the gains produced would be more rapid.

It will be noted that a considerable number of the rations used are compounded from the same feeds used in different proportions. The object in so doing was to test the relative efficiency of rations containing different amounts of protein, in such way as to give us definite figures showing what the proportion of protein in the ration should be with given cost of feeds. This is in recognition of the well-known fact that the balanced ration may be so much more expensive than one containing less protein, that the advantage of one over the other will not warrant the added cost. It is true, however, that current opinion much underestimates the value of a balanced ration and that it is from every point of view the cheapest and best at times when many would think it impossible to feed it with profit.

CHEMICAL COMPOSITION OF FEEDS*
TABLE I.

No	Feeds	Water per ct.	Protein NX6 25 per ct.	Fiber per ct.	Nitrogen free Extract per ct.	Ether Extract per ct.	Ash per ct.	Where used. Lots
1	Corn	13.89	8.62	1.70	70.84	3.65	1.30	1—12
2	Corn meal	15.22	8.25	1.20	72.73	1.40	1.20	1—12
3	Corn and cob meal	15.16	6.75	7.05	68.16	1.60	1.28	1--12
4	Linseed oil meal	7.94	30.00	8.00	38.83	9.45	5.78	1—12
5	Wheat middlings	9.28	15.00	4.40	63.07	4.30	3.95	1—12
6	Wheat bran	20.66	15.75	7.10	46.05	4.30	6.14	1—12
7	Oats, ground	10.02	9.75	10.20	62.30	4.05	3.68	1—12
8	Corn meal	13.03	8.25	1.35	72.72	3.35	1.30	13—17
9	Wheat middlings	9.35	13.10	3.20	68.98	2.80	2.57	13—17
10	Linseed oil meal	8.94	34.50	7.65	39.77	3.90	5.24	13—17
11	Corn meal	12.85	8.44	1.25	73.31	2.85	1.30	18—19
12	Gluten feed	8.78	24.19	7.85	55.63	1.80	1.75	18—19
13	Linseed oil meal	8.94	34.50	7.65	39.77	3.90	5.24	18—19

*Analyses by Dr. Paul Schweitzer.

These analyses show the corn to be of a lower quality than the average, the percentages of protein and oil being low, while the high water content may have been due either to immaturity, or to the dampness of the season during which the experiments progressed.

The corn meal, (No. 2) and corn and cob meal, (No. 3) were abnormally low in oil. A certain small reduction in the oil content of corn meal is due to volatilization of the lighter components by the heat evolved in grinding. This, however, does not explain the low oil content of these meals, for the corn and cob meal which was ground three times before it was fine enough to feed, has a higher oil content than the corn meal. The true explanation lies in the fact that during the very warm, damp spring months covered by these experiments, these meals heated slightly in storage, not to such extent as perceptibly to injure their feeding quality, but enough, it seems, greatly to modify their composition. The more compact corn meal lost more by this deterioration than the comparatively loose and open corn and cob meal. These analyses do not represent normal feeds, but as the samples were taken with great

care that they truly represent the feeds used in this experiment, they will be used as the basis of our computation.

The linseed oil meal, (No. 4), used with lots 1-12, was a good average sample of old process meal, as now manufactured. The oil meal, (No. 10), used with lots 13-17 and 18 and 19, was bought for old process meal, but the oil content is considerably less than half that of the first sample, though the protein is high, somewhat above the average for new process meal. This lot was clearly not as represented.

The middlings, (Nos. 5 and 9) were from a local mill. They contained somewhat more flour and less oil and protein than average samples, No. 5 being somewhat narrower in nutritive ratio than No. 9, though the difference is not very great.

The wheat bran contained a phenomenally high percentage of water, as reference to the above analytical table will show.

The oats, (No. 7) were poor in protein and fat but contained more nitrogen-free extract and fiber than do average samples. They weighed 24 pounds to the bushel, had been shipped from Northern Iowa for seed purposes, and seemed to be better than any obtainable in this region, the previous season having been a poor one for this crop.

The corn meal (No. 8) used with lots 13-17 was of a different lot from the above and of lower quality. It came from a car-load of shelled corn purchased in midsummer. This load had apparently heated in the elevator, as the kernels were not sound at the heart. This deterioration is evidenced by the low fat and protein content.

The corn, (No. 11) used with lots 18 and 19 was low in oil and protein, and higher in starch than average samples, and was not quite up to standard as to amount of nutriment contained.

The gluten feed (No. 12) used with lot 19 was a very good average sample of this by-product.

DIGESTIBILITY OF FEEDS
TABLE II.

Feeding Stuffs	Number of trials	Dry Matter per ct.	Protein NX 6.25 per ct.	Crude fiber per ct.	Nitrogen free extract per ct.	Ether Extract per ct.	Authority
Corn	1	83.0	69.0	38.0	89.0	46.0	Maine Exp. Sta.
Corn meal	2	90.0	88.0	39.0	94.0	80.0	" " "
Corn and cob meal	1	75.5	75.7	28.5	83.6	82.0	" " "
Linseed oil meal	2	77.5	86.0	12.0	85.0	80.0	Minn. Exp. Sta.
Wheat middlings	2	76.5	73.5	36.5	86 8		" " "
Wheat bran	1	53.7	75.8	26.9	56.0	65.4	" " "
Gluten feed	5	86.3	85.6	78.0	89.2	84.4	O. E. S. Bul. 77
Oats	3	59.5	71.8	52.8	62.6	69.2	" " " " "

The tests of digestibility of corn, corn meal and corn and cob meal were made at the Maine Experiment Station upon flint corn. While we have access to such results from the use of the dent corn raised in the west, the differences between the various tests reported are greater than the differences between the coefficients of digestibility of the feeds; hence in order that the figures used represent the same corn tested by the same method, we have chosen to base our computation on these figures obtained from flint corn, though the digestibility of this variety of corn is probably somewhat lower than in the dent corn used in these experiments and commonly throughout the Corn Belt. The tests with wheat middlings at the Minnesota Station are incomplete inasmuch as no figure is reported representing the digestibility of the ether extract. For purposes of computation we have assumed the digestibility of the ether extract of middlings to be the same as in bran.

The feeding tests with gluten feed and oats were made with ruminants, no figures representing the digestibility of these feeds with swine being accessible to the writer.

In the absence of any digestion experiments with soaked corn we are obliged to assume for purposes of computation that the nutrients are digestible in the same degree as in corn meal. It is a generally accepted fact that grinding and soaking, as methods of preparation, are about equally effective, and in accord with this belief we find in

this experiment that the grain requirement per pound of increase was less than four per cent greater with soaked, than with ground corn.

The extreme scarcity of evidence on the subject of digestibility of even our commonest feeds with swine, is such that we are not warranted in close comparison of computations based upon these figures. After careful consideration of these digestion trials, and a few others, the above are selected as the most satisfactory for our purposes.

DIGESTIBLE NUTRIENTS AND FERTILIZING CONSTITUENTS IN 100 POUNDS FEED.
TABLE III

No.	Feeds	Dry matter in 100 pounds.	Digestible Nutrients in 100 pounds			Fertilizing Constituents in 100 pounds*			Market cost of fertilizing constituents.†	Market cost of phosphoric acid and potash.
		Lbs.	Protein. Lbs.	Carbohydrates. Lbs.	Ether Extract. Lbs.	Nitrogen. Lbs.	Phosphoric acid. Lbs.	Potash. Lbs.	Dollars	Dollars.
1	Corn	86.11	5.95	63.71	1.68	1.38	.5005	.325	.2546	.0346
2	Corn meal	84.78	7.26	68.83	1.12	1.32	.462	.300	.24318	.032
3	Corn and cob meal	84.84	5.11	59.01	1.31	1.08	.4679	.3585	.2076	.0348
4	Linseed oil meal	92.06	25.8	33.97	7.56	4.80	1.555	1.156	.8822	.1142
5	Wheat middlings	90.72	11.03	56.35	2.81	2.4	1.46	1.149	.4884	.1044
6	Wheat bran	79.34	11.94	27.69	2.81	2.52	2.837	1.584	.5880	.1848
7	Oats, ground	89.98	7.00	44.39	2.80	1.56	.841	.644	.3122	.0626
8	Corn meal	86.97	7.26	68.88	2.68	1.32	.5005	.325	.2458	.0346
9	Wheat middlings	90.65	9.63	61.06	1.83	2.10	.95	.748	.4076	.0716
10	Linseed oil meal	91.06	29.67	34.72	3.12	5.52	1.47	1.13	.9928	.1096
11	Corn meal	87.15	7.43	69.42	2.28	1.35	.462	.300	.248	.032
12	Gluten feed	91.22	20.81	55.74	1.52	3.87	.06	.34	.6369	.0177
13	Linseed oil meal	91.06	29.67	34.72	3.12	5.52	1.47	1.13	.9928	.1096

*The analyses of ash upon which these computations were based are from compilations by Roberts in "The Fertility of the Land". The *amount* of ash was determined for these experiments.

†The following valuations for the fertilizing constituents are assumed to represent market cost: Nitrogen 16 cents per pound; phosphoric acid 4 cents per pound; and potash 4.5 cents per pound.

Estimating these feeds on the basis of their energy value, thus reducing all the nutrients to starch equivalent, it is as though they possessed the following percentages of digestible starch:

1.	Corn	76.67
2.	Corn meal	82.41
3.	Corn and cob meal	69.81
4.	Linseed oil meal	90.81
5.	Wheat middlings	79.63
6.	Wheat bran	52.34
7.	Oats, ground	61.61
8.	Corn meal	86.20
9.	Wheat middlings	79.89
10.	Linseed oil meal	89.82
11.	Corn meal	86.04
12.	Gluten feed	90.60
13.	Linseed oil meal	89.82

The main points of interest in these figures are, (1) the low nutritive value of bran and oats, due to the large proportion of fiber contained; (2) the poor quality of the corn, and (3) the high nutritive value of the oil meal and gluten feed, due very largely to their high protein content.

Of interest to the man who makes use of the manure produced by his hogs, either by scattering it upon his land or by raising some green crop, as rape or soja beans in the hog lots, are the figures relative to the fertility value of these feeds. At the ordinary market prices for fertilizers, the fertility value of a ton of oil meal of this analysis is $19.86; a ton of bran is worth $11.76; a ton of corn only $5.10; and a ton of gluten feed $12.74. If we consider that nitrogen should be left out of account because we can get it for nothing in a leguminous crop, and figure only upon the mineral elements of fertility, we still have oil meal worth as a fertilizer $2.19, bran $3.70, corn $0.69 and gluten feed $0.35.

These mineral elements of fertility are those which constitute the "bone-food" in the ration and the comparison of these feeds on the basis of mineral elements of fertility, rates them in order of their content of bone forming constituents. On this basis bran, middlings and oilmeal rate very high, while corn ranks decidedly low, and gluten feed contains only about half as much ash as corn. Linseed oilmeal contains 6.5 times as much bone food as gluten feed.

TOTAL DIGESTIBLE NUTRIENTS AND GAIN IN LIVE WEIGHT

TABLE IV.

Lot No	Rations	Digestible Protein. Lbs.	Digestible Carbohydrates. Lbs.	Digestible ether extract. Lbs	Total Digestible Nutrients. Lbs.	Digestible Nutrim't per lb gain Lbs.	Nutritive ratio of ration.
1	Corn meal 5 parts; linseed oilmeal 1 part.	260.16	1601.98	53.13	1915.27	2.872	1:6.65
2	" " 20 " " " 1 "	179.75	1482.77	31.50	1694.02	3.302	1:8.11
3	" " 2 " wheat middlings 1 part	204.01	1549.15	39.33	1792.49	3.201	1:8.05
4	" " 4 " " " 1 "	179.87	1488.86	32.72	1701.45	3.490	1:8.71
5	" " 2 " ground oats 1 part	121.01	1023.7	28.34	1173.08	4.469	1:9.02
6	" " 4 " " " 1 "	122.96	1089.87	24.9	1237.73	4.509	1:9.35
7	" " 4 " wheat bran 1 "	151.25	1120.4	26.9	1298.54	3.463	1:7.83
8	Corn and cob meal	63.98	738.8	16.4	819.18	6.183	1:12.16
9	Corn meal	137.14	1300.2	21.16	1458.5	4.289	1:9.85
10	Soaked whole shelled corn	118.48	1123.3	18.28	1260.07	4.46	1:9.85
11	Shelled corn; bone meal, *ad libitum**	79.58	852.12	22.47	954.17	4.677	1:11.38
12	Shelled corn	75.27	805.93	21.25	902.45	4.945	1:11.38
13	Corn meal 5 parts; linseed oilmeal 1 part	464.5	2669.69	116.33	3250.52	3.665	1:6.35
14	" " 10 " " " 1 "	424.64	3004.68	124.25	3553.57	3.942	1:7.77
15	" " 20 " " " 1 "	358.7	2897.32	116.36	3372.38	4.138	1:8.85
16	" " 2 " wheat middlings 1 "	407.5	2756.94	99.7	3264.13	4.447	1:7.35
17	" " 4 " " " 1 "	317.87	2766.69	103.16	3187.71	4.688	1:9.48
18	" " 5 " linseed oilmeal 1 "	249.83	1427.31	54.28	1731.42	2.962	1:6.23
19	" " 5 " { linseed oilmeal ½ part { gluten feed ½ part	241.70	1653.47	57.54	1952.71	3.447	1:7.41

*6.2 lbs. bone meal per head in 90 days.

Rations 1-12 were fed at the same time and under the same conditions, and so are comparable, the one with the other. An arrangement of these rations by number, as below, in order of excellence or desirability from a number of points of view, allows us to deduce therefrom certain general principles of interest.

Dig. Nut. Per Pound Gain. Lbs.	Daily Feed Per Head. Lbs.	Ave. Daily Gain. Lbs.	Nutritive Ratio.
1-2.87	1-5.59	1-1.48	1-1:6.65
3-3.2	3-5.32	3-1.24	7-1:7.83
2-3.3	2-5.26	2-1.16	3-1:8.05
7-3.46	4-5.00	4-1.08	2-1:8.11
4-3.49	7-4.39	7- .91	4-1:8.71
9-4.29	9-4.20	9- .76	5-1:9.02
10-4.46	6-3.84	6- .65	6-1:9.35
5-4.47	5-3.75	10- .61	9-1:9.85
6-4.51	10-3.63	5- .58	10-1:9.85
11-4.68	12-3.01	11- .45	11-1:11.38
12-4.95	8-2.98	12- .41	12-1:11.38
8-6.18	11-2.97	8- .32	8-1:12.16

Number 1 was the best ration from every point of view; the pigs ate the most of it, gained the most, at the least expenditure of food, and the nutritive ratio was the narrowest.

Number 7 ranking second in narrowness of nutritive ratio, ranked from fourth to fifth as regards other points. It was a fibrous and comparatively unpalatable ration. The gains made by lots two and three took less nutriment, though not so nearly balanced rations.

Lots 2 and 3, having rations of about the same nutritive ratio, compare in all respects according to the amount of feed eaten.

Rations numbers 5 and 6, both narrower in nutritive ratio than numbers 9 and 10, required a larger expenditure of digestible nutriment per pound of gain. Number 9, a wider ration than numbers 5 and 6, was more palatable and less bulky, was eaten in larger quantity and with it gains

were made at less cost in food. Number 10, wider in nutritive ratio than numbers 5 and 6, was less palatable, though less bulky, and though eaten in smaller quantity the total amount of digestible nutriment was slightly greater and the gains in weight were made at a slightly smaller expenditure of nutriment, probably because of the larger amount of nutriment and the smaller energy requirement for mastication and digestion.

Numbers 5 and 6, both of corn and oats, but number 5 the narrower, were bulky and unpalatable rations. Number 6 contained less oats, was more palatable and made the larger gain, but at about the same expense in nutriment.

Number 8 was a less efficient ration than numbers 11 and 12, because the presence of the corn-cob rendered it both unpalatable and much more bulky.

These figures show us that the average daily gain was not in accordance with the nutritive ratio, but rather with the amount of feed eaten, in a measure irrespective of its apparent food value per pound.

The expenditure of digestible nutriment per pound of gain was not closely in accord with the nutritive ratio, failures of correspondence apparently being due; (1) to differences in the amount of feed eaten, the maintenance requirement of the animal being a larger proportion of the smaller ration; (2) to differences in palatability which affect the digestibility of the ration (see pp. 35-37); (3) to differing effects of digested nutrients of the various feeds upon the vital activities of the living tissues (see pp. 55-56); (4) to differences in fiber content, affecting the energy requirement for mastication and digestion; and (5) probably also to differences in food value of similar nutrients from the different sources.

It seems probable that the efficiency of a ration depends not only upon its nutritive ratio, but also among other considerations, upon the bulk, mechanical condition, fiber content, palatability and size of the ration, the source of the nutrients and their effect upon the vital activities of the animal tissues.

We see another illustration of these facts in comparing rations 14 and 16. Lot 16, with the narrower and slightly

more bulky ration, ate less feed than the pigs in lot 14. The gain was much cheaper with the wider and more palatable ration. It would seem that anything we can do to make the food acceptable to the hog, and to get him to relish a large quantity of it, would yield us a certain amount of financial return from the care bestowed.

There is another aspect of the subject of animal nutrition which receives almost no treatment whatsoever from writers on stock feeding, though much more generally considered by physicians and physiologists. This is the matter of the particular effect of specific digested nutrients upon the life activities of living tissues.

The whole subject of medicinal treatment depends upon the ability which some substances have to affect the amount and kind of activity of tissues or organs whose operations require modification.

The astonishing sensitiveness of the animal body to influence by some drugs is proof sufficient that its tissues do not regard with indifference the chemical natures of the substances brought to them in the circulation. It is also worthy of note that under normal conditions of health, the most important activities of the body, such as circulation, nutrition and nervous control, are profoundly affected as to the degree and kinds of their action by the secretions of the ductless glands, the thyroid and the pituitary and suprarenal bodies.

The inorganic salts are also found to be of especial importance to the body because of their control over the circulation and other important functions. It seems certain that at least some of our foods must have influences, other that purely nutritive ones, over the life activities of the body.

These effects, both nutritive and regulative, are especially noticeable in abnormal and extreme cases as with drugs, and the normal methods of reaction of the tissues to the usual nutrients brought to them are such commonplaces as to occasion little notice and less study.

Linseed oilmeal may properly be said to possess mildly "medicinal" properties, in addition to its great nutritive value, in the sense of stimulating the tissues to more effi-

cient utilization of the nutriment with which it is associated. This property of oilmeal expresses itself in a laxative and tonic tendency and an inclination to induce growth. These characteristics of this feed are very generally known to feeders of all kinds of live stock, among whom it is known as a "conditioner," and explain its use as the basis of most of the patent stock foods on the market. The great usefulness of small amounts of oilmeal fed with corn as in these experiments can be most satisfactorily accounted for by referring a portion of the effect to these above mentioned characteristics of this feed.

FEED AND GAINS IN WEIGHT.

TABLE V.

Lot No.	Ration.	No. of pigs in lot.	Length of experiment Days	Av. initial weight. Lbs.	Av. final weight. Lbs.	Daily grain per head. Lbs.	Daily gain per head. Lbs.	Grain per cwt. gain. Lbs.	Gain per 56 lbs. grain. Lbs.
1	Corn meal 5 parts; linseed oilmeal 1 part.	5	90	116	259.5	5.585	1.483	376.6	14.84
2	Corn meal 20 parts; linseed oilmeal 1 part.	5	90	118	209.4	5.256	1.160	430.3	12.992
3	Corn meal 2 parts; wheat middlings 1 part.	5	90	114	226	5.323	1.244	427.8	13.104
4	Corn meal 4 parts; wheat middlings 1 part.	5	90	117	212.5	4.998	1.083	460.4	12.152
5	Corn meal 2 parts; ground oats 1 part.	5	90	120	172.5	3.749	.583	642.7	8.736
6	Corn meal 4 parts; ground oats 1 part.	5	90	111	166	3.842	.649	621.5	9.016
7	Corn meal 4 parts; wheat bran 1 part.	5	90	111	188	4.394	.908	492.1	11.368
8	Corn and cob meal.	5	90	111.5	135	2.981	.322	944.9	5.927
9	Corn meal.	5	90	114.5	182.5	4.198	.755	555.6	10.024
10	Soaked, whole, shelled corn.	5	90	115	171.5	3.627	.628	577.7	9.688
11	Shelled corn; bone meal.*	5	90	114.2	153	2.972	.453	655.6	8.512
12	Shelled corn.	5	90	115	151.9	3.012	.405	693.2	8.064
13	Corn meal 5 parts; linseed oilmeal 1 part.	10	60	123.75	207.8	7.04	1.478	476.3	11.76
14	Corn meal 10 parts; linseed oilmeal 1 part.	10	60	131.4	209.4	7.61	1.5025	506.7	11.05
15	Corn meal 20 parts; linseed oilmeal 1 part.	10	60	126	204.7	7.18	1.358	528.6	10.64
16	Corn meal 2 parts; wheat middlings 1 part	10	60	126	213.5	6.93	1.223	566.8	9.88
17	Corn meal 4 parts; wheat middlings 1 part.	10	60	128	218.85	6.85	1.133	604.4	9.26
18	Corn meal 5 parts; linseed oilmeal 1 part.	6	60	130	227.4	6.23	1.624	383.7	14.60
19	Corn meal 5 parts; linseed oilmeal ½ part; gluten feed ½ part.	6	60	144.2	238.6	6.45	1.574	410.	13.66

* 6.2 lbs. bone meal per head in 90 days.

The amount of gain made by hogs is a matter of much importance, irrespective of cost, because of its bearing upon the time, the risk, the interest on the investment, and the general desirability of quick returns; this is, however, an item that we are unable to consider in a financial statement of the cost of pork production, because there is no regular increase or decrease in value per pound with increase in weight. The constantly shifting market conditions, placing the premium first on the 300 pound hog and then again on the 140 pound animal, may place the highest price upon the animal that has made the poorest gain in weight. No one set of market conditions may fairly be used as a basis of estimate and an average would mean nothing at all. We are obliged to consider that this is a factor of the problem which is impossible of satisfactory reduction to figures.

Linseed Oilmeal.

Linseed oilmeal was used in a number of rations because it is, at ordinary prices of grains, the cheapest vegetable source of digestible protein available, as a complete supplement to corn, for hog feeding; cottonseed meal being left out of consideration because of the fact that it is not usually considered a safe or useful hog food, and gluten meal being left out because it is so poor in mineral matter that, by itself, it does not contain those nutrients which a supplement to corn for hogs must contain.

Linseed oilmeal is very little used with hogs in this country. It is fed in small quantities to pure bred swine by a few breeders, as much for a tonic and laxative as otherwise, and is ordinarily considered as much too expensive to yield a profit when fed to fattening hogs. The results of this work tend to show that its value and the range of its profitable usefulness have been much underestimated. In order to buy linseed oilmeal at a reasonable price it is necessary to purchase it in sufficient amount to warrant shipment from the factory. It is so commonly used as a "conditioner," rather than as a feed, that when purchased in small quantities at feed stores it comes more nearly at drug prices than at prices comparable with those of other

grain foods. In Missouri, however, no difficulty need be experienced on this score, because linseed oilmeal is manufactured both in St. Louis and Kansas City and freight rates do not prohibit its use.

Lot number 1 made the best gain in the series 1-12, and considering the fact that the pigs were fed for 90 days, the increase is very creditable to the ration fed. The amount of feed eaten was greater than with any other lot, in this first series, and the grain requirement per 100 pounds of increase was exceptionally low for hogs of this weight fed in the dry lot, without milk or green feed. We ordinarily consider that we make about ten pounds of pork to the bushel of corn. With this lot of pigs, weighed in at 116 and out at 260 pounds, we made 14.84 pounds of pork from each 56 pounds of grain. There are on record very few experiments with oilmeal as a hog food. The general opinion is that it is too high priced to be used with profit. Others say that it makes the pigs rheumatic. Others say that "it is not a hog food." During the last year we have fed it to 102 experimental hogs and have had no trouble from it.

In its effect upon the pigs it was much more inclined to induce growth than any other feed used and would finish the hogs at a greater weight than that produced by rations of other grains. Pigs receiving oilmeal were as much superior to others in a general appearance of thrift, as are horses and cattle receiving it superior to those getting only corn for concentrates. The uniform excellence of pigs finished with oilmeal in the ration, was such that visitors insisted that these pigs must have been the best to start with, but this was not the case. Every precaution was taken to sort them fairly. The packers were interested to know whether or not this feed would produce an oily carcass, as soft pork is the bane of the packer who kills hogs from the Southwest. No lot of pigs yielded more firm and white fat than did those receiving oilmeal, no one of them being in any way below standard and all being conspicuously uniform in the thickness, hardness and whiteness of the fat.

This ration was less bulky and slightly more nitro-

genous than number 3 and we ought always to get greater gains from it. Lots 13 and 16, in which ten pigs were fed, received the same rations as lots 1 and 3 and the comparison is the same.

Ration number 2, containing only one part of oilmeal to twenty of corn, was not so effective in any way as number 1, but was almost as good in every way as number 3, containing one-third of wheat middlings. The rations fed to lots 15 and 16 are the same as those fed to lots 2 and 3, and in this second trial the ration of corn twenty parts and oilmeal one part, was more efficient than the ration of corn two parts and middlings one part. The very small amount of oilmeal was effective entirely out of proportion to the nutriment contained in it. We made in lot 9, ten pounds of pork from 56 pounds of corn meal, but in lot 2, made 13 pounds of pork when 2.66 pounds of oilmeal were substituted for the same weight of corn meal; that is, the value in the ration, of the difference between 2.66 pounds of corn and the same weight of oilmeal is represented by three pounds of pork, this being partially due to the greater quantity consumed of the more palatable ration.

Lot 18, the same as lot 1, almost exactly duplicates the latter as regards cost of gains, and re-enforces our conclusions drawn from lot 1. The average daily gain with lot 18 was the largest in the whole series of experiments.

Wheat Middlings.

Wheat middlings have for years been considered as without a rival as a supplement to corn for hogs and it has been included in these tests on the grounds of general availability and usefulness, an especial point in its favor being, that since it is produced in every part of the country, it never requires to be shipped from a distance, as does linseed oilmeal, the area of production of which is much more restricted.

Ration number 3 in which two parts of corn meal were fed with one part of middlings, makes profitable use of this feed. It turned out a fatter bunch of hogs than even number 1, as it was less inclined to induce growth. Ration number 3 was very slightly superior to ration num-

ber 2, but the same feeds in rations 15 and 16 show the advantage to be with the one twenty-first part of oilmeal, as a supplement.

In lot 4, where the smaller proportion of middlings was fed, we get a very fair gain at moderate expenditure of feed. The smaller proportion of the supplement goes the further in the sense of saving more corn per pound of middlings.

Oats.

Oats were fed in these tests because of availability. They are more likely to be used in hog feeding than some other feeds, the acquisition of which involves a cash outlay and hauling from town. It is ordinarily considered that oats are too valuable for horses to warrant their use with hogs, but they required to be tested along with the more promising feeds. Cheap grades of oatmeal are very largely used in fitting fine hogs for show, and steamed whole oats are highly valued by some breeders of pure-bred swine. Neither of these preparations are likely to come into common use with feeders of hogs for market; hence the oats were ground, to break the hull and to insure digestion, and were fed mixed with the ground corn.

In rations 5 and 6 we see evidence of the fact that oats of the quality fed do very little good in the ration for fattening hogs. From the results of the feeding of these two lots we should say that the fewer such oats there are in the ration, the better it is. After 90 days feeding, the pigs were still in stock condition. Without the hull of the oat this would probably have been a superior ration.

Wheat Bran.

Wheat bran is ordinarily fed to hogs only to prevent their fattening, as in the case of brood sows. Numerous experiments for the purpose of testing the value of bran as a food for fattening hogs prove very conclusively that it is not of value in the proportions as fed in those tests, most of which have made use of bran in considerable amount, as though to furnish an appreciable proportion of the nutriment. In this experiment bran was fed for an-

other purpose, in much smaller quantity and with very fair profit.

Ration number 7 was one-fifth wheat bran and was much better than number 6, containing the same proportion of oats, or number 8, containing the same proportion of corn cob, and was also better than any preparation of corn alone, but appreciably less effective than number 4 containing the same proportion of middlings. It was a considerably more effective ration than number 9 consisting of pure corn meal and made profitable use of bran in the ration of the fattening hog, by virtue of the added variety, palatability, protein and mineral matter, though the bulk and the fiber content were also increased.

Corn-and-Cob Meal.

Corn-and-cob meal has had advocates for many years, and some experiments with this feed, tested in opposition to pure corn meal, have clearly proven the fact that it may be more useful for fattening purposes than corn alone. When used with cattle, it is about as valuable as the same number of pounds of pure corn meal and the results of tests have been, in general, consistent. In this case it is merely a question as to whether a bushel of ear corn can be made into corn-and-cob meal at no greater cost than the value of fourteen pounds of corn. With corn at a good price it is very often possible to grind it into corn-and-cob meal that is fine enough for cattle feeding and leave a small margin of profit. This is merely a question of price of grain and cost and availability of labor and machinery. In the case of hog feeding, however, tests with corn-and-cob meal have not been consistent. Some investigators prove that it is a good and economical feed; others demonstrate that it is decidedly not useful for hog feeding. There are several elements of difference between the feeding of corn-and-cob meal to hogs and cattle. It must be ground much finer for the hog than for the steer and this takes much more labor; also, the characteristics of corn-and-cob meal as regards bulk and palatability, militate against its usefulness for hog feeding. The feed is bulky and unpalatable if the percentage of corn cob is high. The results

favorable to the use of corn-and-cob meal for hogs must have been obtained with corn which shelled out a very low percentage of cob. With the steer there is not this great difference due to variety of corn, and he will chew down a considerable amount of cob with apparent satisfaction. In Missouri there are varieties of corn such as the Cartner which shell out only about six pounds of cobs per bushel and would make good corn-and-cob meal for pig feeding; there are others, such as the Big Collier, grown especially for large and woody cobs which shell out about twenty-five pounds of cobs to the bushel and if made into corn-and-cob meal would be only about as valuable as equal parts of corn meal and sawdust. There is great variability among common varieties of corn, as to the percentage of cob present but Missouri corn as it runs is not characterized by an especially light cob and it seems likely that it would not be especially palatable to hogs, if ground into corn-and-cob meal. Such value as results from the presence of the cob does not come from the small amounts of nutriment which it contains, but rather from the "lightening" or "extending" tendency which it has, allowing the meal to become more thoroughly impenetrated by the digestive fluids, and requiring longer mastication. Profit, however, requires that this lightening or extending of the ration be accomplished with the minimum amount of indigestible material. The idea has presented itself to the writer that if there is need of this mechanical improvement in the condition of corn meal, it may be attained at less expense by the addition of wheat bran than by the grinding of the corn cob. These experiments throw light upon this question.

Ration number 8, corn-and-cob meal, containing 14.3 pounds of cob per bushel, has nothing to commend it. There is much greater profit in the use of wheat bran with the corn, than the same proportion of corn cob.

Corn Meal.

Corn produces more pork if ground than if fed whole. There have been many comparisons of corn with corn meal, made at the Experiment Stations of the United

States, but as they vary widely in results obtained, it was deemed wise to subject the matter to further study.

Ration number 9, corn meal, produced ten pounds of pork per bushel of corn. Considering the poor quality of the pigs, the confinement and lack of mineral nutriment, this gain is consistent with what we have known of this feed. Much greater gain would probably have resulted from this ration had these pigs been allowed more freedom and earth to root in.

Whole Corn.

Soaked, whole corn in number 10 did only fairly well and hardly made ten pounds of pork per bushel. The pigs ate very little of any of the rations of corn alone. These were not fed under conditions favorable to their best use, and probably would have profited more by improvement of surroundings than would the supplemented rations; still they fairly represent results of feeding on a granitoid floor in small pens, and rank in order as they stand, corn meal, soaked corn, corn and bone meal, and whole dry corn.

The bone meal fed to lot 11 affected a marked saving of corn and if profit resulted from the feeding of whole shelled corn by itself, much greater profit would result from the feeding of bone meal with the corn. This appears to afford us satisfactory evidence of the fact that corn is deficient in ash, from the point of view of the growing and fattening hog. It seems more than doubtful, however, if bone meal could affect any saving of feed in a ration of mixed grains or one containing milk or roughage of any sort.

Gluten Feed.

Gluten feed is a very cheap source of protein but is not especially palatable to hogs and is too poor in mineral matter to be useful as a single supplement to corn. As the exact amount and nature of the mineral matter in the ration requisite to successful fattening has not been determined, it was thought advisable to try substituting gluten feed for half of the linseed oilmeal of the ration balanced by this feed, the idea being that there might still be enough min-

eral matter in the ration and that the cost of the total supplement might be slightly reduced.

Lot 18 furnishes us a basis for comparison of lot 19 with lots 1-12, since lot 18, receiving the same feed as lot 1, made almost exactly the same amount of pork per bushel of grain consumed. Ration 19 follows next after 1 and 18 and was more efficient than any ration containing middlings; it was appreciably less efficient, however, than rations 1 and 18, the gluten feed used in place of part of the oilmeal perceptibly lowering the value of the ration.

Summer Feeding in Dry Lot.

Lots 13-17 were fed in the dry lot in midsummer and had plenty of exercise, and shade, and earth to root in, but had no green feed. As a whole the gains were somewhat higher than in lots 1-12, fed in the winter and spring, but the grain requirement per pound of gain is decidedly greater though these pigs were fed only two-thirds as long as were lots 1-12 and were quite as thin to start with. As the feeding progressed, the hogs had every appearance of doing well; but the heat of summer, with only a shed for shade and no water to wallow in, probably accounts for the greater cost of the gains. The gains made are consistent, one lot with another, except that lot 13 falls somewhat below expectations. During the month of July, the first of the two during which the feeding lasted, these pigs led in gains and were the fattest pigs of all. The severely hot weather of August threw these pigs in this lot off feed, and for a considerable period they ate almost nothing. Still they made pork at the least expense in grain, and as to amount of gain, rank a close second to lot 14, where oilmeal was fed with corn, in proportion of one to ten. This last was a new proportion and it is not impossible that this was more palatable than number 13, for the pigs ate decidedly more of it. The fact that the fatter pigs in lot 13 were overcome by heat leaves this matter in doubt.

As indicating the difference in cost of making pork in spring and in summer, in the dry lot in both cases, these tests afford us data. The same kinds and proportions of feeds as used in rations 1, 2, 3 and 4 during the months of

March, April and May required in July and August, 26.6, 22.8, 32.5 and 30.1 per cent respectively, greater expenditure of grain for the production of 100 pounds of pork. In a general way, we should say that the surrounding conditions, aside from the temperature, were more favorable for cheap gains in weight with the pigs fed in summer than with those fed earlier in the year. It is true, however, that we did not have very exact data regarding the ages of these hogs.

The results of the feeding of lots 13-17 show greater advantages of the rations containing oilmeal over those containing middlings as a supplement to corn than those indicated by the results from lots 1-4. In the case of the lots fed in the summer, even the ration of one part oilmeal to twenty of corn excelled the rations supplemented by middlings, as regards the amount and economy of gains. Since twice as many pigs were fed in each lot during this second set of tests, as in the first, the later results afford us the more reliable data for comparisons.

FINANCIAL STATEMENT.

The financial results of farm operations, such as the production of pork, are under the control of a great complication of economic influences, kaleidoscopic in character, such that, in all probability, the same combination of factors will never occur but once. No single statement of expense of production will be likely ever again exactly to fit the controlling conditions. Still, we think in terms of dollars and cents, and not pounds of digestible nutriment; are obliged to do so, and must make the best compromise possible between accuracy and convenience of statement.

Each one of our grain feeds has a somewhat definite normal range of market value. Corn is usually worth as much as 30 cents per bushel and occasionally gets as high in price as 60 cents per bushel. The rise and fall in the price or corn affects the prices of other foodstuffs in the corn belt more powerfully than does variation in the price of any other single feed. Other feeds, in a very general way, under average normal conditions, rise and fall in price with corn.

True, there is often a marked failure for the various feeds to remain at the same level of value; one may soar to record-breaking heights, while another steadily falls in price, but such conditions are recognized as abnormal, and there certainly is a somewhat definite relationship of value between various feeds.

In computing the cost of pork we have valued corn at five cent intervals of price between 30 and 60 cents per bushel and have assumed a corresponding range of value of the other feeds used, after having made no little effort to ascertain from reliable sources, fair average values for

FINANCIAL TABLE

FEEDS					Values of
	$ per	$ per	$ per	$ per	$ per
Corn	.30 bu.	.536 cwt.	.35 bu.	.625 cwt.	.40 bu.
Wheat middlings	15.00 ton	.75 cwt.	15.83 ton	.791 cwt.	16.67 ton
Wheat bran	13.00 ton	.65 cwt.	13.83 ton	.691 cwt.	14.67 ton
Oats	.20 bu.	.625 cwt.	.23 bu.	.72 cwt.	.27 bu.
Gluten feed	19.00 ton	.85 cwt.	20.00 ton	1.00 cwt.	21.00 ton
Linseed oilmeal	24.00 ton	1.20 cwt.	25.00 ton	1.25 cwt.	26.00 ton
Ground bone	25.50 ton	1.27 cwt.	25.50 ton	1.27 cwt.	25.50 ton

No.	Ration			Cost of One Hundr
1	Corn meal 5 parts; linseed oilmeal 1 part.	$ 2.75	$ 3.06	$ 3.37
2	Corn meal 20 parts; linseed oilmeal 1 part.	2.853	3.23	3.60
3	Corn meal 2 parts; wheat middlings 1 part.	2.88	3.20	3.51
4	Corn meal 4 parts; wheat middlings 1 part.	3.03	3.396	3.76
5	Corn meal 2 parts; ground oats 1 part.	4.28	4.86	5.50
6	Corn meal 4 parts; ground oats 1 part.	4.06	4.62	5.22
7	Corn meal 4 parts; wheat bran 1 part.	3.14	3.53	3.93
8	Corn and cob meal.	4.81	5.48	6.16
9	Corn meal.	3.53	4.02	4.52
10	Soaked, whole, shelled corn.	3.10	3.61	4.13
11	Shelled corn; bone meal.**	3.55	4.14	4.72
12	Shelled corn.	3.71	4.33	4.95
18	Corn meal 5 parts; linseed oilmeal 1 part.	2.80	3.12	3.44
19	Corn meal 5 parts; { linseed oilmeal ½ part. gluten feed ½ part.	2.87	3.24	3.58

*Grinding is estimated to cost 10 cents per hundredweight; no account taken of cost o soaking.
**6.2 lbs. bone meal per head in 90 days.

TATEMENT
I.

Feeds								
per	$ per	$ per	$ per	$ per	$ per	$ per	$ per	$ per
14 cwt.	.45 bu.	.804 cwt.	.50 bu.	.893 cwt.	.55 bu.	.982 cwt.	.60 bu.	1.07 cwt.
33 cwt.	17.50 ton	.875 cwt.	18.33 ton	.916 cwt.	19.16 ton	.958 cwt.	20.00 ton	1.00 cwt.
33 cwt.	15.50 ton	.775 cwt.	16.33 ton	.816 cwt.	17.16 ton	.858 cwt.	18.00 ton	.90 cwt.
4 cwt.	.30 bu.	.94 cwt.	.33 bu	1.03 cwt.	.37 bu.	1.16 cwt.	.40 bu.	1.25 cwt.
5 cwt.	22.00 ton	1.10 cwt.	23.00 ton	1.15 cwt.	24.00 ton	1.20 cwt.	25.00 ton	1.25 cwt.
0 cwt.	27.00 ton	1.35 cwt.	28.00 ton	1.40 cwt.	29.00 ton	1.45 cwt.	30.00 ton	1.50 cwt.
7 cwt.	25.50 ton	1.27 cwt.	25.50 ton	1.27 cwt.	25.50 ton	1.27 cwt.	25.50 ton	1.27 cwt.

Pounds of Pork.*				
	$ 3.68	$ 3.996	$ 4.30	$ 4.61
	3.98	4.36	4.73	5.10
	3.83	4.14	4.45	4.76
	4.13	4.497	4.856	5.22
	6.10	6.67	7.33	7.91
	5.79	6.34	6.94	7.50
	4.32	4.71	5.10	5.49
	6.83	7.50	8.18	8.88
	5.02	5.51	5.99	6.49
	4.65	5.16	5.68	6.19
	5.31	5.89	6.48	7.06
	5.57	6.19	6.81	7.42
	3.76	4.07	4.39	4.70
	3.92	4.26	4.60	4.95

these feeds under Missouri conditions. While accuracy in the establishment of such a standard of valuation is entirely out of the question, still the conclusions arrived at are probably as nearly correct as any others obtainable, and are useful for the purposes which they are intended to serve.

The feeds are figured at the money value on the farm; that is, freight is included in the estimated cost of those ordinarily requiring shipment by rail. The prices are given by the ton or bushel as ordinarily bought, in the first column, and all by the hundredweight in the second column of each division of Table VI, pages 68, 69.

With corn valued at 30 cents per bushel and other feeds at corresponding valuations, the cheapest pork was made with rations numbers 1, 2, 3, and 4, in the order named, but all at somewhat nearly the same cost, the difference between the cost of pork with rations 1 and 4 being but 28 cents per hundredweight of pork. As feeds increase in value, however, the cost of pork is not so nearly at the same figure; that is, the prices spread apart, but remain in the same relative order except that pork made by ration number 3 becomes cheaper than that made by number 2 between the first and second intervals of price of grains. In the second series of tests, however, where ten pigs were fed in each lot,[15] the same ration as number 2 excelled the same as number 3, as regards both amount and economy of gains produced.

In comparison with number 2, number 1 becomes increasingly cheaper as grains increase in value; that is, the higher the prices of feeds, the larger the proportion of high priced supplements we can afford to feed with our corn.

The difference between numbers 1 and 3, the best rations of corn and oilmeal and of corn and middlings, remains about constant; that is, the comparison of value at thirty cents is just about the same as at 60 cents for corn. These two rations made pork more cheaply, even at the 30 cent level of value, than any preparation of corn alone, and the difference in favor of the supplemented rations in-

[15] See lots 15 and 16 in tables numbers IV and V pages 52 and 57.

creases rapidly with the increase in value of feeds; that is, oilmeal and middlings are profitable supplements when feed is cheap, and much more so when feed is expensive.

As feeds advance in value, rations 2 and 4, those containing the smaller amounts of these supplements, fall further and further behind 1 and 3, where larger proportions of the supplements are used. If there is any condition under which the smaller allowances of supplement would net the most profit, it would be when feeds are still cheaper than at the lowest level of value in this table. The substance of this matter is this: a well balanced ration is worth the cost.

Rations 5 and 6, in which oats are used, are unprofitable at any price of feeds; but more so compared with other rations, as feeds increase in value. The least profitable of the two oat rations is the one containing the most oats.

Number 7, the corn and bran ration, is very much cheaper than number 8, where the bran is replaced by corn cob, this difference increasing with the cost of feeds.

As compared with ration number 1, the cost of pork with number 7 is considerably greater even when grains are cheap, and increasingly so as they increase in cost.

Compared with number 9; when corn is valued at 30 cents per bushel, there is a difference of 39 cents per hundredweight of pork, in favor of the corn and bran ration. With corn at 60 cents per bushel, the advantage of the corn and bran ration increases to $1.00 per hundredweight of pork.

Compared with number 10; with corn at 30 cents per bushel, the soaked corn ration is slightly the cheaper; but with corn at 35 cents, the corn and bran ration is cheaper and this advantage increases to 70 cents per hundredweight of pork when corn reaches 60 cents.

Number 8, the corn-and-cob meal ration, has nothing to commend it.

Number 9, the corn meal ration, is expensive as compared with those in which the meal has been properly supplemented. It grows proportionately more expensive as grain increases in value.

In number 10 we see that soaked corn made cheaper pork than corn alone prepared in any other way; the reason why this ration made cheaper pork than number 9 being that we ignored the slight expense involved in soaking, while we assessed the corn meal with 5.6 cents per bushel for grinding. The meal made pork more economically of grain than did the soaked corn.

Comparing rations 11 and 12, we see that bone meal helped to take the curse off from the diet of corn alone, but it is so inadequate to the necessities of the case that there is no profit in stopping there. We should have a better supplement. If we have a better supplement, we do not need bone meal. Probably the only ration that bone meal or wood ashes will help is a ration such as one of corn alone in which there is a poverty of mineral matter. With any ordinary ration of mixed grain feeds it seems unlikely that we have need for these mineral supplements.

Ration 18, the same as number 1, produced practically the same result. Number 19 was not so profitable. The gluten feed was not as well worth the cost as oilmeal.

The reason why differences between these rations increase with the cost of grains, is that the added cost per bushel of grain as prices rise, is on a larger number of bushels in the less efficient ration. By way of illustration, let us compare rations 1 and 9. With ration number 1, one hundred pounds of pork represents 376.6 pounds of grain; with number 9, a hundred pounds of pork represents an expenditure of 555.6 pounds of grain. An increase of 30 cents per bushel on 555.6 pounds amounts to considerably more than on 376.6 pounds; so as grains rise in value, the differences increase between the cost of pork as made by the efficient and the less efficient rations. This advantage of the ration requiring the smallest number of pounds of grain per pound of increase, irrespective of the cost per pound of the ration, is a very great one and accounts for the increasing cheapness as compared with other rations with which we have been able to make pork from the more expensive feeds, as feeds rise in value.

VALUES OF SUPPLEMENTS.

In Table No. VII, p. 74, we have an exposition of what we may term the "replacement value" of the supplements used with lots 1-12, and also a comparison of the value of soaking and grinding as methods of preparation of corn. In order that these figures do not mislead, it must be borne in mind that these pigs were fed on a granitoid floor and that the values of these supplements, as here stated, apply only to pigs so fed, probably being somewhat in excess of their value as fed to hogs under more agreeable conditions of life. The greater range prevalent under ordinary methods of feeding and the chance to vary the ration with vegetation and other food of various sorts, found by rooting in the earth, constitute important items in the environment of the animal, such as can not fail to reflect their influence upon the results of feeding. Any shortcomings of the surrounding conditions tend to exaggerate the differences between good and poor rations, by the greater severity with which they are felt by pigs getting the poorer feed. Still, the results are at least suggestive, however one cares for his pigs, and apply with the full force of these figures under such conditions as obtained during these tests.

It must also be borne in mind that the replacement value of a feed is not a fair basis of estimate as to the cost of pork made by the ration containing the supplement in question, since this replacement value is merely the value of the corn saved by a given amount of the supplement and takes no consideration of the total amount of grain required to produce 100 pounds of pork. The cheapest pork may be made with rations containing other proportions of the supplements than those contained in rations where they save the most corn per pound of their own weight.

Under the conditions above noted, one ton of linseed oilmeal when fed with five times its weight of corn meal, saved 7710 pounds of corn. This figure we get by comparison of ration number 1 with number 9, corn meal alone.

VALUES OF SUPPLEMENTS.—TABLE VII.

No.	Rations	Amount and Value of Corn Meal *Replaced by One Ton of Supplement						
		30 cts. ***	35 cts.	40 cts.	45 cts.	50 cts.	55 cts.	60 cts.
1	Corn meal 5 parts; linseed oilmeal 1 part.	7710 lbs. $49.01	7710 lbs. $55.89	7710 lbs $62.78	7710 lbs. $69.66	7710 lbs $76.55	7710 lbs $83.43	7710 lbs $90.31
2	Corn meal 20 parts; linseed oilmeal 1 part.	14224 lbs. $90.42	14224 lbs $103.12	14224 lbs $115.82	14224 lbs $128.52	14224 lbs $141.22	14224 lbs $153.92	14224 lbs $166.62
3	Corn meal 2 parts; Wheat middlings 1 part.	3792 lbs $24.10	3792 lbs $27.49	3792 lbs $30.88	3792 lbs $34.26	3792 lbs $37.65	3792 lbs $41.03	3792 lbs $44.42
4	Corn meal 4 parts; Wheat middlings 1 part.	4066 lbs. $25.85	4066 lbs $29.48	4066 lbs $33.11	4066 lbs $36.74	4066 lbs $40.37	4066 lbs $44.00	4066 lbs $47.63
5	Corn meal 2 parts; ground oats 1 part.	1186 lbs. $7.54	1186 lbs $8.60	1186 lbs $9.66	1186 lbs $10.72	1186 lbs $11.78	1186 lbs $12.84	1186 lbs $13.89
6	Corn meal 4 parts; ground oats 1 part.	938 lbs $5.96	938 lbs $6.80	938 lbs $7.64	938 lbs $8.48	938 lbs $9.31	938 lbs $10.15	938 lbs $10.99
7	Corn meal 4 parts; wheat bran 1 part.	3290 lbs $20.92	3290 lbs $23.85	3290 lbs $26.79	3290 lbs $29.73	3290 lbs $32.67	3290 lbs $35.60	3290 lbs $38.54
9	Corn meal	2000 lbs $12.71	2000 lbs $14.50	2000 lbs $16.28	2000 lbs $18.07	2000 lbs $19.85	2000 lbs $21.64	2000 lbs $23.43
	Amount and Value of Shelled Corn Replaced by One Ton of Following Rations.							
8	Corn and cob meal	1472 lbs $7.89	1472 lbs $9.20	1472 lbs $10.51	1472 lbs $11.83	1472 lbs $13.14	1472 lbs $14.46	1472 lbs $15.77
9	Corn meal	2495.4 lbs $13.37	2495.4 lbs $15.59	2495.4 lbs $17.82	2495.4 lbs $20.05	2495.4 lbs $22.27	2495.4 lbs $24.50	2495.4 lbs $26.73
10	Soaked whole shelled corn.	2400 lbs $12.86	2400 lbs $15.00	2400 lbs $17.14	2400 lbs $19.28	2400 lbs $21.43	2400 lbs $23.57	2400 lbs $25.71
11	Shelled corn; bone meal ad libitum.**	2066.8 lbs $11.07	2066.8 lbs $12.92	2066.8 lbs $14.76	2066.8 lbs $16.61	2066.8 lbs $18.45	2066.8 lbs $20.30	2066.8 lbs $22.14
12	Shelled corn	2000 lbs $10.71	2000 lbs $12.50	2000 lbs $14.28	2000 lbs $16.07	2000 lbs $17.86	2000 lbs $19.64	2000 lbs $21.44

*Cost of grinding in all cases 10 cents per cwt. No account taken of cost of soaking.
**6.2 pounds bone meal per head in 90 days.
*** Values per bushel of corn.

These 7710 pounds of corn meal were worth $49.01 when corn was worth 30 cents per bushel, and $90.31 when corn was worth 60 cents per bushel. This valuation for oilmeal is very high but is indicated by the small amount of grain, 376.6 pounds, required in the making of 100 pounds of pork. It would seem that oilmeal has an unsuspected value as a supplement to corn, when fed in small quantity, this beneficial effect being largely due to the great increase in the amount of food consumed when oilmeal is fed.

Lot 2, however, would seem to indicate the value of oilmeal to be even greater when fed in very small quantities. In this lot a ton of oilmeal was fed with twenty times it weight of corn meal and saved 14224 pounds of corn, giving the oilmeal a value of $90.42 a ton when corn is worth 30 cents per bushel, and $166.62 when corn is worth 60 cents per bushel. The smaller the proportion of the supplement fed, the greater was its value per pound, by virtue of corn saved. This fact is also evident when we compare lots 3 and 4, 13 and 14, 14 and 15, and 16 and 17. It does not appear to be true, however, regarding lots 5 and 6, but here the use of an unpalatable feed of such composition as to make it an actual disadvantage to the pig eating it, introduces a different problem. In all the cases above noted where the smaller amount of supplement was most effective per pound of its own weight, the supplement increased the palatability of the ration, even where it added to its bulk and also to the amount of crude fiber present. From these data we can understand that extremely expensive feeds might be fed with actual profit if used with the corn in small enough proportion.

The greater profit, however, is not made from the ration where the supplement has its highest replacement value. Pork is made more cheaply where the larger amount of the supplement is fed. The smaller allowance of oilmeal saved more pounds of corn per pound of its own weight, but there were not pounds enough of it to make pork as cheaply as it was made where more oilmeal was fed, at a lower replacement value. This fact of the higher replacement value of supplements fed in smaller proportion than that necessary to balance the ration, is doubtless one of general applicability.

It is not to be supposed that the very small amount of oilmeal fed to lot 2, produced this remarkable saving of corn, solely or even principally by virtue of the nutriment contained. That would be an impossibility. We would have one pound of oilmeal making 1.27 pounds of pork. The principal value of this small allowance of oilmeal when fed with the corn must be that it increases the palatability, and hence the digestibility, of the ration; it increases the amount of feed eaten so that a smaller part of the nutriment is used for maintenance; it adds small amounts of much needed protein and mineral matter to the corn ration; and further, because of its "medicinal" value as indicated on page 55, probably had a usefulness in the ration other than as a nutrient, in the ordinary sense of that term.

The practical bearing of this is that a limited amount of high priced supplement will "go further," in the sense of saving more corn per pound of its own weight, if fed in small rather than in large proportion, and that this particular supplement, linseed oilmeal, has a value, when used in small proportion with corn alone, so entirely beyond the usefulness indicated by its chemical composition, that its effect may be said to be not only that of a food in the ordinary sense but also that of a medicine, the medicinal value being most apparent when it is used in very small proportion to other nutrients.

Turning to Table VI, pp. 68, 69, it will be seen that with corn at thirty cents per bushel and oilmeal at $24.00 per ton, pork costs $2.75 per hundredweight with ration number 1, and $2.85 with ration number 2, where the replacement value of oilmeal was almost double that in ration number 1. The explanation of this seemingly contradictory state of affairs lies in the fact that though the oilmeal in ration number 2 saved more pounds of corn per pound of oilmeal, than was saved by the oilmeal in ration number 1, there were not pounds enough of the oilmeal to lessen the cost as much as did a larger amount in ration number 1. It is as though "a stitch in time saved nine." Under certain conditions of stress of circumstance the one stitch comes to have an exaggerated value because taken in a place of grievous need.

In ration number 3, the wheat middlings have a value of $24.10 a ton when corn is worth 30 cents per bushel, and $44.42 a ton with corn at 60 cents. In ration number 4, the replacement value of the middlings ranged from $25.85 to $47.63 per ton, as corn increased in price from 30 to 60 cents per bushel. From these figures it is apparent that either oilmeal or middlings is worth more than the usual market price, when fed as in these experiments.

It will be noted that as corn doubles in value, from 30 to 60 cents per bushel, the supplement does not double in value in any one of lots 1-4. It is true, however, that the difference in value per ton of corn and supplement, increases with the price of corn. To illustrate this point; corn at 30 cents per bushel is worth $10.71 per ton. At this price of corn, the oilmeal in lot 1 has a feeding value of $49.01, a difference of $38.30 per ton in favor of the oilmeal. When corn is worth sixty cents per bushel or $21.44 per ton, oilmeal has a feeding value of $90.31 per ton, a difference of $68.87 in favor of oilmeal; that is, while there was a difference in value per ton of $38.30 between corn and oilmeal with corn at 30 cents per bushel, there was a difference of $68.87 between the value of corn and oilmeal with corn at 60 cents per bushel. This excess of $30.57 in the difference between the values per ton of corn and oilmeal at 60 cents per bushel over the difference when corn is worth 30 cents per bushel, indicates that unless oilmeal increases in value to the extent of $30.57 per ton as corn increases in value from 30 to 60 cents per bushel, there will be more profit in the use of oilmeal with high priced corn than when corn is lower, and we would expect to find that the difference in the cost of 100 pounds of pork made with corn alone and with corn and oilmeal, would be greater as these feeds increase in value.

Turning to Table VI, pp. 68, 69, and comparing the cost of pork at varying costs of rations 1 and 9, we see that our reasoning is borne out by the facts of the case. With corn worth 30 cents per bushel and oilmeal worth $24.00 per ton, it costs $0.78 more per hundredweight, to make pork

from corn meal alone as in lot 9, than to make it from corn and oilmeal as in lot 1. With corn at 60 cents per bushel and oilmeal at $30 per ton, pork costs $1.88 more per hundredweight made with corn meal alone than with the supplemented ration.

The conclusion is as follows: Oilmeal as a supplement is worth the cost, at ordinary market values of feed, but the profit from its use increases with the price of corn; that is, the supplement does not increase in cost at the same rate as does corn. It is cheaper at the higher levels of value of feeds. This fact holds good with middlings as well as oilmeal as is shown by a comparison of lots 3 and 4.

From the results of the feeding of lots 5 and 6, we see that the replacement value of oats of the quality used gave them a valuation much lower than that of the corn.

In lot 5, one pound of oats was worth .6 of a pound of corn. In lot 6, one pound of oats was worth only .47 of a pound of corn. From the facts that the amount of feed eaten and the amount of pork produced per pound of digestible nutriment, were both less with lots 5 and 6, than with lot 9, where the pigs received corn meal alone; that less feed was eaten where the larger amount of oats were fed, but that pork was made a little more economically of nutriment in this lot, we must conclude that oats detracted from the palatability of the ration because of the hull, that the pigs receiving oats ate less feed, both because of its bulk and its unpalatability, but that the nutriment contained in the oats of ration number 5 more nearly offset the disadvantage occasioned by their presence than did the smaller amount of nutriment contained in the oats of lot 6.

Bran, in the proportion of one part to four of corn, added somewhat to the palatability of the ration, produced gains in weight at less cost in digestible nutriment than did corn meal alone, is a profitable feed at usual prices of grain, but not as good an investment as middlings used in the same proportion with corn. It is a good food to use with brood sows and is exceedingly useful to keep them from getting too fat. The author has been more successful in keeping brood sows in desirable condition by use of

bran than with any other feed, though clover and alfalfa hay are also good for this purpose. It contains considerable protein and a great deal of mineral matter, more than any other common grain food. Hence it is especially valuable as a bone food and as a fertilizer.

Corn-and-cob meal under the conditions of this experiment was not a useful feed. The author does not see any place for this feed in pork production. To give an unpromising feed a fair chance we reckoned the grinding of corn-and-cob meal at 10 cents per hundredweight as with corn meal, considering that with a grinder especially adapted to the handling of ear corn, the cost might not be appreciably more than with shelled corn; but, as a matter of fact, with the best grinders available, it was necessary to grind this corn-and-cob meal three times before it was fine enough to feed to a hog. Even then it should have been finer. If one wants to lighten up the meal ration it is vastly cheaper to buy bran to mix with it than to grind the cob into it.

Comparing rations 9 and 12 in the lower part of Table VII, p. 74, we see that as a means of preparation, grinding costing $2 per ton was worth the price even with corn at 30 cents per bushel. This, however, is due to the very poor showing made by the shelled corn. It is interesting, however, to note that soaking was worth 15 cents per ton more than the cost of grinding at $2.00 per ton, though soaked corn was somewhat less efficient than ground corn.

Bone meal has some value as a supplement, but the addition of this feed did not improve the shelled corn ration nearly as much as did either soaking or grinding.

As the cost of preparation does not vary with the cost of corn, it is clear that preparation is increasingly valuable as corn rises in price. Soaking and grinding were both profitable under the conditions of this experiment, even when corn cost 30 cents per bushel, though as a general proposition, the increase in efficiency due to grinding and soaking is considered to be only about 10 per cent, in which case these methods of preparation cannot be profitably practiced unless at an expense of less than one tenth the value of corn.

This method of computation credits all of the improvement of the ration supplemented to the feed used as an amendment. It is in common use and has impressiveness in its favor, but is apt to be misleading and is hardly fair to the corn, which furnishes most of the nutriment of the rations and is the feed in whose usefulness the feeder is most especially interested.

VALUES OF CORN.

Table No. VIII, page 81, places the credit for the improvement of the supplemented rations all upon the corn. Like the above, this method of statement of such cases is in common use but the differences between the two plans seem not to be so generally appreciated.

In this case we compute separately the cost of the corn and the accompanying supplement necessary to make one hundred pounds of pork. The value of the supplement is then substracted from the cost of the corn alone necessary to make the same weight of pork. The amount by which the remaining sum exceeds the cost of the corn accompanying the supplement in the mixed ration is considered to be the cash saving occasioned by the presence of the supplement. This gives us a basis for computation of the added value of the corn in the supplemented ration.

With corn worth 30 cents per bushel, corn meal costs 35.6 cents, if we allow 10 cents per hundredweight for grinding. With this value as a base, corn meal in ration number 1 is worth 49.6 cents per bushel. As corn increases in value to 60 cents per bushel, corn meal in ration number 1 becomes worth 91.4 cents per bushel. All of the supplements except oats added to the value of the corn.

The various preparations of corn are compared with whole corn in the lower division of the table. The preparations with the exception of corn-and-cob meal were all an improvement over whole corn. The bone meal added 1.7 cents per bushel to the value of the thirty-cent corn fed with it.

The business of hog feeding differs considerably, as regards the financial principles involved, from the business of steer feeding. These differences are due to the facts

VALUES OF CORN. LOTS 1-12
TABLE VIII.

FEEDS	Varying Values of Feeds													
	$ per	$ per	$ per	$ per	$ per	$ per	$ per	$ per	$ per	$ per.	$ per	$ per	$ per	$ per.
Corn	.30 bu.	.536 cwt.	.35 bu.	.625 cwt.	.40 bu.	.714 cwt.	.45 bu.	.804 cwt.	.50 bu.	.893 cwt.	.55 bu.	.982 cwt.	.60 bu.	1.071 cwt.
Wheat middlings	15.00 ton	.75 cwt.	15.83 ton	.791 cwt.	16.67 ton	8.33 cwt.	17.50 ton	.875 cwt.	18.33 ton	.916 cwt.	19.16 ton	.958 cwt.	20.00 ton	1.00 cwt.
Wheat bran	13.00 ton	.65 cwt.	13.83 ton	.691 cwt.	14.67 ton	.733 cwt.	15.50 ton	.775 cwt.	16.33 ton	.816 cwt.	17.16 ton	.858 cwt.	18.00 ton	.90 cwt.
Oats	.20 bu.	.625 cwt.	.23 bu.	.72 cwt.	.27 bu.	.84 cwt.	.30 bu.	.90 cwt.	.33 bu.	1.03 cwt.	.37 bu.	1.16 cwt.	.40 bu.	1.25 cwt.
Linseed oilmeal	24.00 ton	1.20 cwt.	25.00 ton	1.25 cwt.	26.00 ton	1.30 cwt.	27.00 ton	1.35 cwt.	28.00 ton	1.40 cwt.	29.00 ton	1.45 cwt.	30.00 ton	1.50 cwt.
Ground bone	25.50 ton	1.27 cwt.	25.50 ton	1.27 cwt.	25.50 ton	1.27 cwt.	25.50 ton	1.27 cwt.	25.50 ton	1.27 cwt.	25.50 ton	1.27 cwt.	25.50 ton	1.27 cwt.
Grinding	.10 cwt.	.10 cwt.	.10 cwt.	.10 cwt.	.10 cwt.	.10 cwt.	.10 cwt.	.10 cwt.	.10 cwt.	.10 cwt.	.10 .cwt	.10 cwt.	.10 cwt.	.10 cwt.

No.	Rations	Values per Bushel of Corn Meal on Basis of Lot 9.						
1	Corn meal 5 parts; linseed oilmeal 1 part.	.496	.566	.635	.705	.775	.844	.914
2	Corn meal 20 parts; linseed oilmeal 1 part.	.448	.511	.574	.637	.699	.762	.825
3	Corn meal 2 parts; wheat middlings 1 part.	.484	.552	.620	.688	.756	.824	.892
4	Corn meal 4 parts; wheat middlings 1 part.	.432	.493	.553	.614	.675	.735	.796
5	Corn meal 2 parts; ground oats 1 part.	.258	.294	.330	.367	.403	.439	.476
6	Corn meal 4 parts; ground oats 1 part.	.296	.338	.379	.421	.463	.504	.546
7	Corn meal 4 parts; wheat bran 1 part.	.412	.469	.527	.585	.643	.700	.758
9	Corn meal.	.356	.406	.456	.506	.556	.606	.656
		Values per Bushel of Corn on Basis of Lot 12.						
8	Corn and cob meal.	.276	.322	.367	.413	.459	.505	.551
9	Corn meal.	.374	.437	.499	.562	.624	.686	.749
10	Soaked corn.	.360	.420	.480	.540	.601	.661	.721
11	Shelled corn; bone meal*	.317	.370	.422	.475	.528	.581	.634
12	Shelled corn.	.30	.35	.40	.45	.50	.55	.60

*6.2 lbs. bone meal per pig during the 90 days.

that the feeder of a hog is usually its breeder, while in steer feeding the animal is not usually fed by the first owner; and that the cost of making a pound of pork is usually less than the selling price; while in steer feeding, as usually practiced, the cost of making a pound of meat is almost always much more than the selling price per pound.

The steer feeder, however, often buys stock hogs. From the feeding of hogs along with steers there is almost always a profit when stock hogs cost the same per pound as they bring when fat, even figuring the waste grain consumed, at the market price. We often do even better; the profit on each pound of pork often makes it possible for us to pay more per pound for the stock hog than the fat hog will bring, especially if the stock hog be light in weight. The younger a hog is, the more economically will he convert grain into pork. Other things than age being equal, the greater profit is always with the feeding of the younger hog.

In steer feeding, profit requires a margin of increase in value per pound during fattening. In hog feeding this is almost never so. In case, however, it be impossible to make a profit on hogs, by straight grain feeding, they may often be held over until another season with profit, on a partial grain ration with clover or alfalfa hay or on pasture. Comparatively slow gains on pasture with a partial grain feed, may be made much more economically than larger gains on full feed either with or without pasture.

The steer feeder desires so to increase the value per pound of his animal that the margin of selling price over cost per pound, will help to pay for the gains, which usually cost more per pound than the fat steer brings. He wants to get this margin with as few and as cheap pounds of gain as possible, put onto as heavy and high priced a steer as he can get, in as short a time as is possible.

The hog feeder's problem is more simple. Added weight and age so rapidly increase the cost of gains and the initial weight of the stocker is so small that the only margin which concerns the hog feeder, be he buyer or breeder, is the excess of market value over cost per pound of making pork. He wants to make as many pounds of increase in as short a time as possible at the lowest possible cost per pound.

SHIPPING, SALE AND SLAUGHTER RECORDS. LOTS 1—12.
TABLE IX.

Lot No.	Rations	Average shipping weight. Pounds.	Average dressed weight[1]. Pounds.	Per cent dressed to live weight[2].	Average net weight[3]. Pounds.	Per cent net to dressed weight.	Average wt. heads, leaf and facings. Pounds.	Per cent heads, leaf and facings to dressed weight.	Selling price per cwt. Dollars.	Cost per cwt. dressed. Dollars.	Margin cost per cwt. dressed over cost alive. Dollars.	Cost per cwt. net. Dollars.	Margin, cost per cwt. net over cost alive. Dollars.
1	Corn meal 5 parts; linseed oilmeal 1 part.	251	198	78.88	180.4	91.12	17.6	8.88	5.00	6.34	1.34	6.96	1.96
2	Corn meal 20 parts; linseed oilmeal 1 part.	217	168.5	77.65	153.75	91.25	14.75	8.75	4.94	6.36	1.42	6.97	2.03
3	Corn meal 2 parts; wheat middlings 1 part.	238	185.5	77.94	169	91.11	16.5	8.89	5.00	6.44	1.44	7.04	2.04
4	Corn meal 4 parts; wheat middlings 1 part.	220	170.8	77.64	155	90.75	15.8	9.25	4.92	6.34	1.42	6.98	2.03
5	Corn meal 2 parts; ground oats 1 part.	178	136.4	76.63	121.6	89.15	14.8	10.85	4.85	6.41	1.56	7.10	2.25
6	Corn meal 4 parts; ground oats 1 part.	170	132.5	77.94	118	89.06	14.5	10.94	4.92	6.31	1.39	7.09	2.17
7	Corn meal 4 parts; wheat bran 1 part.	196.5	150.25	76.46	135.25	90.02	15	9.98	4.92	6.43	1.51	7.15	2.23
8	Corn and cob meal.	139.5	107	76.70	94.25	88.81	12.75	11 19	4.75	6.19	1.44	7.03	2.28
9	Corn meal.	189	149	78.36	132.4	88.99	16.04	11.01	4.88	6.19	1.31	6.97	2.09
10	Soaked whole corn.	166	140	84.34	125.6	89.61	14.04	10.39	4.75	5.63	.88	6.27	1.52
11	Whole corn; bone meal.	155.4	124	79.79	110.4	89.21	13.4	10.79	4.72	5.91	1.19	6.64	1.92
12	Shelled corn	153	124	81.05	109.75	88.51	14.25	11.49	4.70	5.80	1.10	6.55	1.85

1. Including heads, leaf and facings.
2. On basis of shipping weight; market scales not sensitive for small weights.
3. Sides as to cooler, without heads, leaf and facings.

The dressed weight of the different lots varied considerably and in accord with the ration fed. We may study these figures most handily in groups of four. Rations 1-4 were in every way the best and most profitable to the producer. Computing the dressed weight of the four as one, we find that they dressed out 78.08 per cent of carcass to live weight in the feed lot.

The second group, Nos. 5-8, happen to be the four bulky rations of the twelve. These dressed 76.92 per cent of carcass to live weight, a very marked decrease from the first group. In general, animals dress out according to fatness, though the thickness of the muscle, the weight of the bones, and the development of the viscera and the amount of food eaten, are also important factors. This group dressed lower than the first probably because of lower condition, thinner muscular development, and bulky feed.

The third group, lots 9-12, dressed out 80.95 per cent of carcass to live weight. These pigs were the ones which received corn alone in various forms and dressed much higher than either of the other lots. They had gained less than either group but outdressed even the first. The viscera were lighter since the pigs dressed off less in killing; this was probably due both to the fact that there was less feed in them for they ate less, and also that the visceral organs and the blood actually weighed less. The percentage of net weight to dressed weight was, in a general way, according to fatness; though the weight of the head, leaf and facings increases with the fatness of the animal, the percentage of their weight to the total weight decreases. There was a smaller percentage of head, leaf and facings when the pigs were well fattened, and the highest percentage was with lots that had gained the least.

As heavy hogs were at a premium at the time lots 1-12 were sold, the well-fattened lots brought the highest price per pound. By having the buyer estimate the value of each pig separately, it was possible, by use of these estimates and the individual weight of each pig, to arrive at a very accurate figure, representing the market value of the lot. The closeness with which these figures follow the condition of the

pigs as shown by their gains in weight during fattening, shows that the buyer's opinion was a most accurate judgment of condition, but the margins of cost per hundredweight dressed over cost per hundredweight alive show that the buyer's estimate was a much more accurate judgment of condition than of per cent of shrinkage in killing. One is not exactly the reciprocal of the other.

On the basis of these estimated values per pound we have calculated the cost per hundred pounds of dressed carcass. In general, the pigs which had received supplemented rations were much the most expensive in the carcass. Either they were worth more per pound or were not bought so well worth the money as the straight corn lots. The cheapest hogs to the packer were those that had received soaked whole corn; the most expensive were those receiving bulky rations and those for which high prices had been paid because they were well fattened.

The margin of cost per hundredweight of dressed carcass over cost alive, shows that the corn lots cost less dressed, in excess of the cost alive, than the lots fed on supplemented rations. Ration number 1, however, the best ration of corn and oilmeal, follows closely after the corn lots and was much better than the bulky rations, probably because the oilmeal hogs were not only better fattened, but also because their muscular development was stronger, as evidenced by their great growth during feeding. The advantage which the corn hogs had over the others, in the matter of dressed weights, is here increased by the fact that the advance in cost per pound dressed, over cost per pound alive, is a matter of percentage of a smaller figure, since the cost per pound alive was much less with the corn hogs. This, however, is an abnormal condition, for the corn-fed hogs would have brought as much per pound as the others, had they been as well fattened.

The cost per hundredweight net somewhat decreases the advantage of the corn-fed hogs over the others because there was a higher percentage of head, leaf and facings, with the corn-fed hogs. Lot 1 follows very closely after the corn-fed lots and was quite possibly better worth the cost to the packer than even the corn-fed hogs, because they

must have been much better carcasses for many uses.

The oilmeal hogs cost a little less as sent to the cooler than the hogs fed on middlings. The oats, bran and corn-and-cob-meal-fed hogs were finally the most expensive to the packer, and less valuable surely than the oilmeal- and middling-fed hogs, while in the final statement the hogs getting whole corn in lots 10, 11 and 12, cost decidedly less per pound in the cooler than any others.

The fact that the amount of feed eaten has a marked influence upon dressed weight, is shown by a comparison of lot 9, receiving corn meal, with lots 10, 11 and 12, receiving whole corn. The latter dressed considerably higher though not nearly so fat, this because they ate less feed, and probably had smaller visceral organs. The cost per pound to the packer both with heads, leaf and facings on, and as sent to the cooler, was considerably more for the hogs receiving corn meal than those fed on whole corn.

Lot 1 outdressed lot 3 by nearly one per cent. They had eaten a greater weight of feed but it was less bulky than the ration fed to lot 3. The hogs in lot 1 were not as fat as those in lot 3, but had grown more during fattening. They dressed higher than the pigs in lot 3, probably because of smaller digestive organs, due to less bulky feed, and to the greater thickness of their muscular development.

In Table X, page 87, we have the shipping, sale and slaughter weights of lots 13-17. We note that the percentage of heads, leaf and facings with lot 13, was lower than with the other lots, and consequently the percentage of net to dressed weight was higher.

The cost per pound of net dressed weight shows that the higher the proportion of corn in the ration, the cheaper will be the cost per pound of net weight to the packer.

These hogs were all estimated at the same value per pound on the market and were bought at the same price, it being considered that such advantage as the fatter lots had over the leaner ones, was offset by the fact that they were of less desirable weights, since light hogs were preferred.

The fact that lots 13, 14 and 15 were fatter than lots 16 and 17 was very easily noticeable and was commented

SHIPPING, SALE AND SLAUGHTER RECORDS. LOTS 13—17.
TABLE X.

Lot No.	Ration.	Average shipping weight.	Average market weight.	Per cent shrinkage in shipping.	Average dressed weight,	Per cent dressed to live weight.	Average weight heads.	Per cent of heads to dressed weight.	Average weight, leaf and facings.	Per cent of leaf and facings to dressed weight.	Average net weight.	Per cent net to dressed weight.	Cost to packer per pound dressed weight.*	Cost to packer per pound net weight.**	Per cent dressed to live weight in feed lot.
13	Corn meal 5 parts; linseed oilmeal 1 part.....	223	213	4.5	174.2	81.78	9.6	5.51	8.00	4.59	156.6	89.90	7.09	7.89	78.12
14	Corn meal 10 parts; linseed oilmeal 1 part.....	231	216.5	3.9	177.9	82.33	10.25	5.76	8.75	4.92	158.9	89.32	7.04	7.88	77.01
15	Corn meal 20 parts; linseed oilmeal 1 part..... ...	218.4	210	3.8	171.4	81.64	9.89	5.77	8.44	4.93	153.1	89.31	7.10	7.94	78.48
16	Corn meal 2 parts; wheat middlings 1 part.....	210.9	201	4.7	167.7	83.43	9.5	5.66	7.8	4.65	150.4	89.68	6.95	7.75	79.52
17	Corn meal 4 parts; wheat middlings 1 part	213.6	204	4.5	169	82.84	9.7	5.73	7.7	4.56	151.4	89.58	7.00	7.81	79.12

*Shipment delayed by wreck; forty-eight hours on road.
**On basis of $5.80 per cwt. alive. All sold at this figure.

upon by the buyer; still the thinner hogs, which had received the largest proportion of corn, had eaten the least and had gained the least, dressed the highest and, bought at the same price per pound, cost the packer less per pound in the cooler, than those hogs which had been more rationally fed and which had done much better for the producer.

If hogs which have consumed large amounts of feed of any sort, are as well worth the same cost per pound alive to the packer, as those which have consumed less feed or more concentrated feed, the former must be such as are useful for more purposes, or such as produce higher grades of products, for they do not dress out as high a percentage of carcass to live weight and also cost more per pound as sent to the cooler, than do the latter.

Conclusion.

It is of great importance that the nutrients be present in the food in that proportion of greatest efficiency, known as the balanced ration; and when corn is as low in value as 30 cents per bushel, with other feeds at corresponding prices, the balanced ration of corn and linseed oilmeal was more profitable for dry-lot feeding than any other ration tested. In addition to being a balanced ration, it is also of prime importance that the feed be palatable, high in percentage of digestibility, rich in digestible mineral matter, varied in constituents, and characterized by beneficial effect upon the life activities of the animal.

The nutritive ratio alone does not determine the economy with which the nutrients will be used. A ration which is poor in protein but is palatable, digestible and concentrated may be greatly more efficient and profitable than a balanced ration not possessing these characteristics. Palatability may in a measure compensate for a lack of protein.

Hogs fed on corn and linseed oilmeal ate more feed, made greater increase in weight, with a smaller amount both of food and of digestible nutriment and at less expense than with any other grain ration tested in these dry-lot feeding experiments. The quality of the pork produced was unsurpassed and the tendency of these feeds to make real growth as well as fat was greater than that of any other ration tested.

Wheat middlings makes a profitable supplement to corn and at those prices for which feeds sell in quantity in Missouri, middlings ranked a close second to oilmeal, as to profit resulting from use with corn for hogs. The gains in weight produced with corn and middlings were considerably less, however, than those made with corn and oilmeal.

Oilmeal as fed in these experiments is a more efficient supplement than middlings as here used, both pound for pound and dollar's worth for dollar's worth. With it a larger proportion and value of corn may be fed and less cash outlay is required.

Considering that the money paid out for the purchased supplement comes from the sale of corn, if we feed oilmeal rather than middlings, we have a smaller proportion of the corn crop to market as grain, a larger proportion to market concentrated into pork, a smaller weight of supplement to haul back to the farm, greater manurial value of the feed purchased and less cash outlay involved in the enterprise.

Gluten feed, substituted for half of the oilmeal of the balanced ration, reduced the efficiency of the ration and the profit from its feeding. Being itself a corn product, it is not naturally adapted to supplement corn, since other feeds will add more mineral matter, in which all corn products are deficient, and for hog feeding add greater variety and palatability to the ration. The protein contained can be bought cheaply along with much more mineral matter in linseed oilmeal.

Oats of the grade used, make an unprofitable supplement to corn for hog feeding. They were not relished and made poor gains, at great expense, both in feed and in dollars.

Bran, as here fed was a useful supplement but was less efficient and less profitable than the same proportion of middlings. If the hog needs the cornmeal ration extended or lightened by the addition of such a feed as bran, this need must be very slight and not to be compared with the necessity for protein or mineral supplement or palatability.

Corn-and-cob meal contains too much indigestible and unpalatable fiber and costs too much in the preparation to

be the best feed for any purpose, for swine. It is the last food we would choose to use for hog feeding.

The addition of bone meal to the corn ration is of theoretic interest because it shows by the added efficiency of the supplemented ration, that corn lacks mineral nutriment, but practically, there is no use in stopping with such a poor supplement while there are within easy reach so many better ones, serving at once the same purpose and still more important ones.

Corn alone, however prepared, even when as cheap as 30 cents per bushel, is a very expensive feed for dry-lot pork production.

Under the conditions of this experiment, grinding is more efficient than soaking as a means of preparation of corn; soaking, however, costs much less and is nearly as valuable; both methods of preparation are very useful and well worth the cost in these experiments, even when corn costs as little as thirty cents per bushel.

Summer feeding in Missouri in the dry lot seems to require very much more grain per pound of gain than is required in spring and fall. The roughage picked up by the pig on pasture is a very important part of the ration.

The higher grains are in cost, the greater is the profit from the use of supplements with corn, though oilmeal, middlings and bran were well worth the cost, for dry-lot feeding, even when corn was as low in value as thirty cents per bushel. That is, the supplements do not double in cost as corn doubles in selling price.

The higher grains are in cost, the greater is the financial advantage of the balanced ration over one containing less protein.

The smaller the proportion in which a palatable supplement is fed, the greater is the amount of corn which each pound of supplement saves; but the larger the proportion of a palatable supplement fed, until a balanced ration is reached, the lower is the cost of making pork in the dry-lot, both in pounds of grain, and, at usual prices of grain feeds, also in dollars and cents.

Supplements costing far too much to allow of profit from their use in balancing a ration might still be fed with

profit if used in small enough proportion with the corn.

The value per ton of a palatable supplement, by virtue of corn saved through its use, is greatest when the proportion in which it is fed is lowest, hence one dollar invested in supplements will save more dollars worth of corn if the supplement be fed in small proportion, but at usual prices of feeds in Missouri pork is made more cheaply and the total profit is greater when more cash is involved and enough proteid supplement provided to balance the ration.

The fattest hog need not dress out the highest per cent of carcass to live weight. Hogs of the same quality fed on corn alone outdressed other much fatter hogs fed on balanced rations.

The fatter the hog, the lower will be the per cent of head, leaf and facings in the dressed carcass, and consequently, aside from dressed weight, which of course is *usually* greater, the less expensive to the packer are the sides of pork as sent to the cooler.

Straight corn feeding does not support normal growth, nor produce rapid gains; the rations in which liberal amounts of protein were fed, produced marketable hogs in much less time than did corn alone. The hogs ate very much more of the supplemented rations and made larger and cheaper gains.

Among the hogs produced by the supplemented rations, the most profitable ones to the packer were those which had received concentrated rations. Bulk in the ration is prejudicial to the packer's interest.

The hog which shrinks the least in killing is the corn-fed hog. Bought at the same price and the products sold at the same prices, the hog which has been fed on whole corn without supplements, is the most profitable to the packer. This is the least profitable hog to the farmer.

The higher the proportion of corn that is in the ration and the less feed the hog has been in the habit of eating, the cheaper is the cost per pound, net dressed weight, to the packer.

The hog with which the farmer has made the cheapest pork has probably been raised on grass or has received milk or nitrogenous grain supplements along with its corn. This

method of feeding produces a "shrinky" or "grossy" hog.

The interests of the farmer and the packer do not indicate exactly the same method of feeding.

It is most largely the bulky character and amount of feed eaten that make one hog dress out a lower per cent of carcass to live weight than another equally fat hog. Milk, or grass, or water mixed with the feed, tend to produce a shrinky hog; so does indigestible substances like the fiber of bran and corn cob.

The packer can afford to pay more for a hog that has had a concentrated grain ration during finishing, than for a hog that has had bulkier rations from whatever cause.

The general method of feeding of a hog is at once apparent to any careful or experienced person at the market and does not fail to influence prices. The straight bellied sort is quickly noted and meets with much more favor than the grassy or slop-fed hog.

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