

Oregon Agricultural College
Experiment Station

Department of Animal Husbandry

Finishing Pigs for Market

(Revised Edition)

By

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and

E. L. POTTER



CORVALLIS, OREGON

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SUMMARY TABLE

Ground barley is the principal hog feed for Oregon, and therefore the other feeds are compared with it. Shorts, for example, is given the value of 90, which means that 100 pounds of shorts has the same feeding value as 90 pounds of barley.

GRAIN AND MILL FEEDS

Feed	Relative value	How used. (The relative values given apply only when feeds are used as indicated)
Barley—ground	100	As the chief grain ration
Barley—whole	88	As the chief grain ration
Wheat—ground	100	As the chief grain ration
Wheat—whole	88	As the chief grain ration
Corn—ground	100	As the chief grain ration
Corn—whole	95	As the chief grain ration
Oats—ground	90	Not over 1/3 of grain ration
Oats—whole	...	Not advisable
Middlings	105	For sows and young pigs
Middlings	100	For fattening hogs (not over 1/3 of ration)
Shorts	95	For sows and young pigs
Shorts	90	For older hogs (not over 1/3 of ration)
Mill-run	...	Varies greatly
Bran	75	For maintenance only (contains too much fiber for fattening)
Cocoanut meal	100	Not over 1/4 of the ration

SUPPLEMENTAL FEEDS

Skim milk or buttermilk	33	Not more than 3 lbs. of milk with 1 lb. of grain
Skim milk or buttermilk	12	In unlimited amounts (not advisable)
Tankage (60 percent)	300	5 to 10 percent to balance the ration
Oil meal	150	10 to 20 percent to balance the ration
Soy bean meal	190	8 to 15 percent to balance the ration
Cottonseed meal	...	Dangerous for pigs

SUCCULENT FEEDS

Potatoes raw	17	Not over 2 lbs. to 1 lb. grain
*Potatoes cooked	25	Not over 4 lbs. to 1 lb. grain
Mangels or turnips	12	Not over 3 lbs. to 1 lb. grain
Rutabagas	15	Not over 3 lbs. to 1 lb. grain
Sugar beets	20	Not over 4 lbs. to 1 lb. grain
Silage	...	Not suitable to pig feeding

ROUGHAGE

Alfalfa hay, chopped alfalfa, †or alfalfa meal	75	Not over 10 percent of ration
Oat hulls	...	Not suitable for pigs. Often used to adulterate prepared pig feeds
**Garbage	20	For fattening hogs (entire ration)

*Feed value is on basis of weight before cooking.

†Compared on basis of amount actually eaten, chopping or grinding saves some waste, especially in wet weather.

**Should not be fed to pigs under 75 pounds of weight and only in limited amounts to brood sows.

Finishing Pigs for Market

By

A. W. OLIVER and E. L. POTTER

This bulletin is prepared and revised with a view to putting before the stockmen of the state the results of experimental work in pig feeding that has been conducted through a series of years by the Oregon Experiment Station at Corvallis and at the Eastern Oregon Branch Experiment Station at Union. We have made no attempt to include all the data involved in these experiments but on the contrary have tried to state only the results that are immediately applicable to pig feeding in Oregon. We have made reference to the work of stations outside of Oregon wherever it has bearing on the question under discussion.

All of the data upon which this bulletin is based are on file, and full details of any of the tests can be furnished on request. No positive statements are made which have not been thoroughly proved by repeated tests.

As the title indicates, this bulletin deals with finishing pigs for market rather than with growing younger pigs or feeding brood sows. These latter subjects are reserved for later publications.

The larger number of the pigs marketed in Oregon are of light weight, ranging from 175 pounds to 225 pounds. The pigs are growing, therefore, as well as laying on fat during the finishing period, and in order to secure the very best results considerable attention must be given the question of balancing the ration so that sufficient protein and mineral matter will be given to develop muscle and bone. The finishing period need not exceed sixty days unless a rising market warrants longer feeding.

The finishing period should begin when the pig is about 100 pounds in weight regardless of age. As a rule, however, the pig that reaches 100 pounds in weight when about five months old is more economical to feed for market than one that reaches this weight at an earlier or a later age.

PREPARATION OF FEEDS AND METHODS OF FEEDING

A good many tests have been made concerning the various methods of preparing and feeding the common feed stuffs. It may be said, in general, that preparation and methods of feeding are less important than many believe, provided the feed is palatable and fed regularly. It must be remembered that no method of treatment can change the composition of the feed. Particularly is it true that no grinding, soaking, or cooking can lessen the percentage of crude fiber. Digestibility and palatability may, however, be changed to a small degree and thus affect the rate of gain and the amount of feed to the 100 pounds gain, as is indicated in the summary of results following.

GRINDING AND SOAKING

Grains. Averages of all tests conducted at Corvallis and Union on the value of grinding small grains show a saving of 10 percent over feeding whole grains. According to a compilation of Experiment Station

results by G. M. Rommel (Bulletin 47, United States Department of Agriculture), the average saving resulting from grinding small grains is 12 percent. This percentage is figured on the amounts of feed necessary to produce 100 pounds gain. The saving effected by grinding corn is less than with wheat or barley. An average of 18 trials at Wisconsin showed a saving of 6 percent in favor of ground over shelled corn, where the corn was hard and dry. Iowa reports a saving of from 4 to 6 percent. So small a saving will not usually pay for the expense of grinding, but on the other hand the advantage of grinding small grains is enough ordinarily to pay the expense of grinding.

Recent experiments at Corvallis involving sixty animals indicate rather conclusively that in respect to rate of gains, economy of gains, and daily feed consumption, there is practically no difference between the lots fed finely ground, coarse ground, or steamed rolled barley. There may be, however, a big difference in cost. Where grain is ground very fine, say to the consistency of shorts, big mills are required which cost several hundred dollars. Such mills are beyond the reach of the average stockman. The farm mills regularly on the market whether of the roller or burr type will not do very fine grinding although satisfactory for coarse grinding. The simple roller mill does very good work and does a great amount of grinding in proportion to the power used. Dry grain, especially barley, breaks up in rolling, and the product resembles that from the burr mills. Where the grain is steamed, or dampened, before rolling, the kernel does not break up but mashes out flat like oatmeal. Steaming or dampening requires additional work and equipment as compared with dry rolling or grinding and adds some moisture which may sometimes cause the grain to heat if stored in large quantities. The fact that fresh steamed rolled barley contains quite a little moisture should be given consideration in buying feed. From the standpoint of cheapness, dry rolling is therefore the best method of preparation, with coarse grinding in a burr mill next in order.

Soaking of whole grains is a partial substitute for grinding and seems advisable where grinding is unusually expensive, though further data are necessary before positive conclusions can be drawn. In soaking, care must be taken to prevent feeding too much water as gains will be retarded if the animals are forced to consume more water than they naturally require.

The soaking of grains that have been ground is of very little advantage as shown by tests at Corvallis and Union. There was no material difference between soaked and unsoaked ground grain, either as to rate of gain, feed consumed, or feed required to produce 100 pounds gain; consequently the trouble of soaking would be largely wasted. Wetting ground feed, however, may save waste when fed out of doors in dry, windy weather.

Alfalfa Hay. Alfalfa hay may be fed long, cut into short lengths, or ground into meal. Results at Union indicate that alfalfa hay fed long in racks as a grain supplement induced larger daily consumption with larger and cheaper gains than when fed either as a meal or cut. The cost of 100 pounds gain in the lot fed long hay was 42c less than where alfalfa meal was used, and 53c less than where cut alfalfa was used. These figures take into account the rapidity and economy of gains, as well as cost of preparation. Kansas reports no greater gains where alfalfa hay was ground than where fed long. Nebraska reports results

of five years' experimentation, indicating clearly that the best way to feed alfalfa for fattening pigs is to feed it long and in racks. The poor showing for chopped or ground alfalfa is in all probability due to the forced consumption of stems, which contain much crude fiber. In other words, it is only the leaves and finer portion that are of value for pigs, while the coarser portions may be a detriment. The leaves and blossoms are sometimes separated from the stems and fed to pigs while the coarser portions are fed to cattle. This is a desirable practice wherever it can be done without too great expense.

Roots. Roots should always be chopped before being fed to fattening hogs. When fed in troughs separate from the grain ration, two or three inches square is a desirable size, but results at Corvallis show very clearly that much greater root consumption can be induced where the roots are finely chopped and mixed with the grain.

COOKING

Grains. Extensive experiments have shown conclusively that the cooking of grains is not only of no value but has a decidedly detrimental effect upon the feed. Corvallis experiments give uncooked grains a preference of 9.8 percent over cooked. Numerous experiments elsewhere confirm these results. Cooking seems to lessen the digestibility of protein and mineral matter but may have some slight beneficial effect on the starches.

Potatoes. Potatoes being a very starchy feed must be cooked before feeding in order to obtain the best results. In an experiment at Union, it took 556 pounds of raw potatoes to replace 100 pounds of barley while it only required 385 pounds of cooked potatoes to accomplish the same result. Experiments elsewhere confirm these results.

The degree to which potatoes are cooked is important. Tests at Corvallis have shown definitely that potatoes are more palatable when cooked until they are about to drop to pieces and form a meal. Cooking until potatoes are desirable for table use is not sufficient to make them palatable for fattening hogs.

The moisture content must be guarded, as hogs forced to consume too much water do not make the most economical use of their feed. If steamed no water need be added. If boiled the water in which they are boiled must be poured off.

Roots. Cooking does not improve roots for hog feeding purposes. This is true also of squashes, pumpkins, melons, and practically all feeds except potatoes and possibly beans.

Alfalfa Hay. Results secured at Union on the increased value of steamed alfalfa hay are not extensive enough to warrant definite conclusions. A slight advantage for steamed alfalfa is indicated, but not sufficient to justify the expense of the steaming process. Steaming alfalfa or clover for hogs at Corvallis has not proved profitable.

METHODS OF FEEDING

Hand Feeding. This method consists in giving the pigs at each feeding time the amount of feed they will require to meet their needs until the next feeding time. Under this system feed is given two or three times daily.

Self Feeding. This system consists in having a quantity of feed before the pigs at all times and in such form that it will not be trampled under foot and wasted. Results of seven tests conducted at Corvallis and Union show a saving of 38 pounds of grain to the 100 pounds gain in favor of self feeding over hand feeding. The average daily food consumption was greater and consequently the daily gain more rapid. Similar results have been obtained at other stations. The use of a self feeder reduces the feeding labor to some extent though attention must be given to the feeder once or twice a day to prevent clogging. Some care must be exercised in getting the animals on full feed.

Free Choice. Under this plan several self feeders are employed, each containing a different feed, thus allowing the pigs to balance their own ration. Iowa reports excellent results following this system. The plan involves less work than mixing the feed and putting it all in one feeder, but can not be used where it is desired to introduce some less palatable food to lessen the cost of the ration.

Hogging Down. Under this plan such crops as peas, horse beans, wheat, corn, and root crops are grown to maturity, and the pigs are then allowed to do the harvesting. Waste of feed from tramping into the ground is offset by the saving in the expense of harvesting. This is often the best method, especially where cost of harvesting is high as is the case with peas or corn or with very light crops of wheat or barley.

FEEDING STUFFS

This section of the bulletin discusses the different feeds that are generally used in the Northwest for pig-fattening purposes. The results of experiments conducted in Oregon are given to substantiate statements made, and results from other states are cited when of sufficient pertinence.

CONCENTRATES

Barley. Barley is the basis of all pig-feeding operations in the Northwest and thus has the same position in this section that corn holds in the Middle West. The barley fed is of three kinds: common feed barley, bald barley, and hull-less barley. The common feed barley is much more generally used than either of the other varieties.

A great number of experiments have been conducted at Corvallis and Union as to the value of common feed barley, and the results can be taken as conclusive. In the case of bald barley and hull-less barley fewer experiments have been conducted and definite conclusions can not be drawn. An average of twelve tests shows that it requires 438 pounds of common feed barley, ground and without supplement, to produce 100 pounds of gain. This is for barley weighing 41 to 46 pounds to the bushel. It required 404 pounds of bald barley or 475 pounds hull-less barley, both ground, to produce 100 pounds gain.

Wheat. This grain is used extensively in Oregon for fattening pigs and is commonly thought to be superior to barley, but in numerous experiments wheat has not given results quite equal to barley. The difference is very slight, however, and generally they may be considered of equal value. An average of fourteen tests shows that to produce 100 pounds gain requires 463 pounds of wheat if fed alone.

Corn. For fattening purposes corn is approximately equal pound for pound to barley or wheat. The following table indicates the results obtained at Ohio and Missouri stations:

Station	Feed	Daily gain	Feed to produce 100 pounds gain
Ohio	Ground corn 9, tankage 1	lbs. 1.59	lbs. 366
	Ground wheat 9, tankage 1	1.59	383
Missouri	Ground corn 10, tankage 1	1.51	480
	Ground wheat 10, tankage 1	1.60	469

The results at these stations show a slight advantage for corn in Ohio and wheat in Missouri. In general feeding operations the relative prices of corn, wheat, and barley should determine the grain the producer should feed since their value, ton for ton, is practically equal.

Wheat By-products. Middlings and shorts can be used as a partial substitute for barley whenever prices justify. Experiments at Corvallis indicate that a combination of one-third middlings or shorts and two-thirds barley will give just as good returns as barley alone, but middlings or shorts fed alone as a fattening ration have not been satisfactory, gains being very slow and amount of feed necessary to produce 100 pounds gain being excessive. These feeds are not palatable when fed in large quantities and contain too much crude fiber. Bran is too bulky for a satisfactory fattening feed and can seldom be used economically.

Oats. Owing to the bulkiness (high percentage of fiber) of this feed it should not constitute the sole grain for fattening purposes. Experiments at Corvallis in which one-third of the ration consisted of oats and two-thirds of barley gave results approximating very closely those given by barley alone. Results at the Wisconsin Station in which one-third of a corn ration was replaced by ground oats indicate approximately the same relative values.

Ohio reports indicate a slightly smaller feeding value for oats than for corn. The difference is not great, however, and the feeder is fairly safe in making one-third of the ration oats providing the price of oats justifies the substitution. When fed in larger amounts than one-third of the ration, however, oats have not proved satisfactory.

Rye. Rye as a sole feed for fattening purposes is not palatable and does not give as good returns as other grains. Not only does it require more feed to produce 100 pounds gain, but gains are made less rapidly, as it seems impossible to induce the animals to eat sufficient quantities to make production satisfactory. Rye-fed pigs were lacking very much in finish as compared with the other lots.

The following table gives results of rye feeding:

Station	Feed	Daily gain	Feed to produce 100 pounds gain
Oregon	Rye, ground	lbs. 1.09	lbs. 440
	Wheat, ground	1.6	423
Nebraska	Rye, soaked	.88	546
	Wheat, soaked	1.05	504
Ohio	Rye 9, tankage 1	1.00	441
	Corn 9, tankage 1	1.09	399

If a small proportion of rye is mixed with a larger proportion of other feed the pigs will eat it satisfactorily and make good gains.

Peas. Because of the prevailing high prices for peas they are not generally used for hog-feeding purposes. They contain about two times as much crude protein as the cereals and are high in phosphorus and potash. Peas are more efficient when fed in combination with some carbonaceous feed, such as wheat, barley, corn, etc.

The most general method of feeding peas is the hogging-down system. The peas are allowed to get ripe, and the pigs are then turned into the field to do the harvesting. This system at Union gave an average daily gain of 1.52 pounds with an average production of 397 pounds of pork to the acre. The Idaho Station reports slightly greater returns. The amount of pork produced to the acre is very largely determined by the yield of the peas. The returns are generally satisfactory considering the fact that the peas are essentially a rotation crop and that the pigs under this system do their own harvesting.

The following table indicates the value of threshed peas compared with other grain:

Station	Feed	Daily gain		Feed to produce 100 pounds gain	
		lbs.		lbs.	
Oregon (Union)	Peas	1.76		353	
Oregon	Wheat	1.60		423	
Oregon	Barley	1.54		438	

From the foregoing tables it is clear that peas rank first of the grains in efficiency of pork production. The economy, however, will depend upon the relative prices and supply of these feeds.

SUPPLEMENTAL FEEDS

Supplemental feeds are feeds used as supplements to the grains such as wheat, barley, or corn, so as to make a better balanced or more palatable ration. Most cereals and cereal products are deficient in protein and the protein contained is incomplete, that is, lacking in certain compounds essential to the most rapid gains. Animal proteins, on the other hand, and to a lesser extent leguminous proteins, contain these desired compounds. But relatively small amounts of supplement are necessary to give satisfactory results. Very large amounts of supplement may greatly increase the cost and lower the rapidity of gains, since their high value lies more largely in their influence upon the utilization of the other feeds used than upon their own independent nutritive value.

Skim Milk. This is not only the very best supplement for growing pigs, but is almost of equal value for fattening purposes. Though very low in dry-matter content, milk furnishes a complete protein, which fact accounts in a large measure for the excellent returns. Milk renders the ration more palatable, inducing greater consumption and consequently greater daily gains.

The following tables give comparative results of feeding milk as supplement to grain:

BARLEY AND SKIM MILK

Station	Ration	No. of tests	Average daily gain	Feed to produce 100 pounds gain
Oregon	Barley	12	lbs. 1.54	lbs. Barley 438
Oregon	Barley and milk	4	1.57	Barley 322 Milk 319

WHEAT AND SKIM MILK

Oregon	Wheat	14	1.12	Wheat 463
Oregon	Wheat and milk	4	2.06	Wheat 292 Milk 330

Tests elsewhere indicate that where three or four pounds of milk are fed to each pound of grain it will require 400 pounds of milk to replace 100 pounds of grain and where milk is fed alone, gains will be quite slow, and it will require 1000 to 1500 pounds of milk to replace 100 pounds of grain.

Buttermilk. This supplement when free from wash water, is equal in feeding value pound for pound to skim milk. As in the case of skim milk it should be fed at not over 3 pounds of buttermilk to 1 pound grain in order to attain the greatest efficiency. Before paying prices equal to quotations on skim milk the purchaser of buttermilk should be sure that the product is not diluted. It is a very easy matter to dilute buttermilk with water. This dilution is also very difficult to detect unless a moisture determination is made. In order to avoid the spreading of tuberculosis buttermilk should be heated to 180° temperature if the cream has not been pasteurized before churning.

Whey. While whey is a dairy by-product and usually thought of in connection with skim milk or buttermilk, it is very low in its protein content and can not be used as a supplemental feed. It is therefore discussed further on under the head of miscellaneous feeds.

Tankage. Tankage, often called meat meal, is a by-product of the meatpacking industry. Waste meat, scraps, blood, and fat trimmings are subjected to a very high steam pressure and thoroughly cooked. The fat is then drawn off, and the residue dried, finely ground, and placed on the market under the name of Digester Tankage. There are different grades of the product, containing from 40 percent to about 60 percent protein. It is always advisable to use the grade containing the highest percentage of protein, as the value of tankage is mainly in its protein content. In general there is no advantage in using tankage in combination with skim milk or other protein supplements. Tankage added to alfalfa pasture does not seem to justify its extensive use for this purpose although the evidence on this point is not absolutely conclusive.

The following tables give value of tankage as a protein supplement.

BARLEY AND TANKAGE

Station	Ration	No. of tests	Average daily gain	Feed to produce 100 pounds gain
Oregon	Barley	12	lbs. 1.54	lbs. Barley 438
Oregon	Barley and tankage	5	1.61	Barley 340 Tankage 36

WHEAT AND TANKAGE

Station	Ration	No. of tests	Average daily gain	Feed to produce 100 pounds gain
Oregon	Wheat	14	1.21	Wheat 463
Oregon	Wheat and tankage	2	1.42	Wheat 330 Tankage 41
Ohio	Wheat and tankage	1	1.59	Wheat 345 Tankage 38

These tables show that 100 pounds of 60 percent tankage replaced nearly 300 pounds of grain.

Besides the foregoing results eight tests conducted at Union show that 100 pounds of 60 percent protein tankage replaced 327 pounds of grain.

These results indicate clearly the value of tankage as a protein supplement to the grains. One pound of tankage fed in amounts of from 5 to 7 percent of the ration will in general replace 3 pounds of grain. Results of two tests at Corvallis show that a ration containing 7 percent tankage gives just as good results as a ration with 17 percent; that is, the gains were as good and the total amount of feed to the 100 pounds gain no higher, thus showing that 5 to 7 percent was enough to balance the ration.

Fishmeal. Fishmeal is a protein supplement prepared from fish scraps and fish unsuited for human food. The fish and scraps are cooked, then pressed to extract the oil, after which the residue is dried and ground.

Fishmeal generally contains from 2 to 10 percent less protein than does tankage, but it contains more mineral matter, especially more calcium and phosphorus, bone-building compounds, which are important in hog feeding.

The following table gives the results of tests of tankage versus fishmeal.

Station	No. of tests	Ration	Daily gain	Average amount of feed to produce 100 lbs.
Oregon	2	Barley 93%	lbs. 1.32	lbs. Barley 402
Oregon	2	Fishmeal 7%		Fishmeal 30
		Barley 93%		Barley 441
		Tankage 7%	1.08	Tankage 83
United States	1	Corn 90%		Corn 354
		Fishmeal 10%	2.16	Fishmeal 89
United States	1	Corn 90%		Corn 416
		Tankage 10%	2.00	Tankage 46

From the table it will be observed that fishmeal is more efficient than tankage as a protein supplement. The average saving in feeding fish-

meal in preference to tankage is 9 percent. The relative price of tankage and fishmeal will determine which feed should be fed. Fishmeal containing less than 45 percent protein can not be expected to be as efficient as the high grade tankage.

Cocoanut Meal. Cocoanut meal is the product resulting after the oil has been extracted from the copra, or meat of the cocoanut. There are two kinds of cocoanut meal, the domestic and the Oriental. The domestic meal is made in America from copra imported from the Orient. The Oriental meal is made in the Orient, and due to the crude method of manufacturing it still contains 30 to 40 percent fat. Most of the cocoanut meal on the American market is of domestic manufacture. The use of cocoanut products is being encouraged by commercial shipping interests of the Northwest to furnish return cargo for ships that have gone to the Orient with flour and lumber.

Cocoanut meal tends to become rancid if stored for a long period, especially when it contains much moisture. Cocoanut meal varies as to palatability, as occasionally there will be a quantity that the pigs will not eat readily, probably because the fat has become rancid, although we can not be quite sure on this point.

In one test at Corvallis, growing pigs refused to eat cocoanut meal when fed as 21 percent of the ration, but in other tests they have readily eaten up to 50 percent cocoanut meal. In two tests cocoanut meal containing 43 percent fat was fed in the proportions of 25 percent and 50 percent of the total ration. In both cases the 25 percent ration proved the more satisfactory. The 50 percent had a laxative effect causing the pigs to scour. The standard domestic cocoanut meal was fed in two other tests, and each time a ration containing 25 percent cocoanut meal and 75 percent barley or wheat was the most satisfactory. In a ration of 25 percent cocoanut meal, the remainder being barley, wheat or corn, cocoanut meal is equal to any of the common grains.

Linseed Oil Meal. Linseed oil meal is the product remaining after the linseed oil has been extracted from the flax seed. It is very palatable, uniform in quality, keeps well, and is in all cases a very safe feed. It gives results similar to tankage but must be fed in double the amount as approximately two pounds of linseed oil meal is required to furnish the same protein as one pound of tankage. Tankage is for this reason usually the more economical at the usual market prices. The term "oil meal" is generally used to mean linseed oil meal, but is sometimes applied to other products resulting from the extraction of various vegetable oils.

Soy Bean Meal. Soy bean meal is the product remaining after the oil is extracted from the soy bean. It is similar to linseed oil meal in feeding value but has about 20 percent more protein and consequently a higher value. In the South the term "soy bean meal" is used to indicate the entire soy bean ground fine, without the oil having been extracted. This product, however, is not on the market in the Northwest. The soy bean meal on the market here is imported from the Orient and has had the oil extracted.

Cottonseed Meal. Because of certain poisonous properties cottonseed meal should not be used as a pig feed although it is very desirable for cattle and sheep.

Alfalfa Hay. Alfalfa hay is in some respects a desirable supplement. It contains the compounds which are lacking in the cereals, and where grown in abundance has the advantage of being relatively cheap. It is, however, so bulky that the pigs do not readily consume enough of it to balance the ration without cutting down the total amount of feed consumed. Pigs will not consume a normal amount of any ration containing more than 10 percent alfalfa hay, and this amount of hay does not contain enough protein properly to supplement the grain ration, though it is a little better than grain alone. When added to a ration already balanced, alfalfa hay is of little or no value. For these reasons alfalfa hay is not recommended for fattening pigs although it may be used for growing shoats or brood sows. (See Alfalfa Pasture.)

SUCCULENTS

These foods have a very beneficial effect upon the digestive system and produce unusually good returns in proportion to nutrients contained, but on account of their large water content they can supply only a small part of the total nutrients required. Their use, therefore, does not lessen to any large extent the amount of grain needed. When cheap, feeders are often tempted to feed succulents to excess with the result that the pigs make poor gains and do not get fat.

Potatoes. Cooked potatoes are possibly the best succulent for fattening purposes, but because of their high water content pigs will not consume a full ration if the proportion of potatoes is greater than four pounds of potatoes to one of grain. If a larger proportion of potatoes is used the pigs will gain more slowly and will put on but little finish. On potatoes alone pigs will make a very small gain in weight but will not fatten.

In several tests at Corvallis and Union with a ration consisting of four parts by weight of cooked potatoes to one part of grain, an average of 238 pounds of barley and 845 pounds of potatoes were necessary to produce 100 pounds gain. On this basis it required 422 pounds of cooked potatoes to replace 100 pounds of barley. Wisconsin reports that 442 pounds of cooked potatoes replaced 100 pounds of corn-meal. Denmark reports that 400 pounds cooked potatoes saved 100 pounds of mixed grain. These results indicate that 400 to 425 pounds of cooked potatoes will replace 100 pounds of grain (barley, wheat, corn, or mixed grains), if fed in proportions not to exceed four parts cooked potatoes to one part grain.

Roots. Roots, including sugar-beets, mangels, carrots, rutabagas, etc., are valuable when fed in limited amounts. It is not advisable to feed a ration consisting of more than three-fourths roots to one-fourth grain. On the basis of palatability the roots rank as follows: sugar-beets, mangels, carrots, rutabagas.

By actual test animals weighing 150 pounds receiving ground barley in a self feeder could be induced to eat in addition to the barley not to

exceed three pounds of mangels each in a day. In a recent experiment conducted at Corvallis, however, finely chopped mangels mixed with grain in proportion of one pound of grain to four pounds of mangels were fed successfully in self feeders. The lot consisted of fifteen head, having an average initial weight of 183 pounds. The average daily gain was 1.64, and the daily feed consumption 4.66 pounds of barley and 20.8 pounds of mangels. It required 1,261 pounds of mangels and 283 pounds of barley to produce 100 pounds gain. The heavy consumption of mangels is due to mixing the grain and finely chopped mangels before feeding.

We are safe in concluding that 600 pounds of mangels will replace 100 pounds of barley if fed in proper proportions. Carrots and turnips are slightly more valuable than mangels, though not as palatable. Results from other stations show that 400 pounds of sugar beets are necessary to replace 100 pounds of grain. The difference in efficiency of the various root crops, except sugar beets, is so slight that the determining factor should be the comparative yield and cost of producing the crops. Such differences as there are seem to depend upon the dry-matter content.

Artichokes. As reported in Station Bulletin 54 one-eighth acre of artichokes supplemented with 736 pounds of mixed grain produced 244 pounds of pork. Allowing 450 pounds of mixed grain for 100 pounds gain, an acre of artichokes was worth 2,896 pounds of grain. Missouri Bulletin 29 reports artichokes practically equal to potatoes for pig feeding. Henry states the following regarding artichokes: "Although long grown in a small way and often extolled, no extended feeding trials have yet been made with artichokes, nor does their use by feeders seem to increase." Artichokes are grown to some extent on the richer bottom soils of the coast counties of Oregon but are almost unknown in the other parts of the state.

Silage. Corn silage is practically of no value in a fattening ration. Tests at Corvallis show a smaller daily gain and a greater amount of grain requirement to the pound of gain when silage constituted part of the ration than when the same ration was fed without silage. Results at the other stations confirm these conclusions. This is probably due to the large amount of fiber contained in the silage.

Silage made from the ear corn without the stalks is a very satisfactory pig feed, but the pigs leave the cobs and husks and eat only the kernels. There seems to be no advantage in putting ear corn in the silo instead of putting it in the crib.

MISCELLANEOUS FEEDS

Molasses. Cane molasses can be used to advantage in combination with other feeds. Tests at Corvallis show that one lot of fifteen pigs receiving four parts mill-run and one part molasses consumed as much mill-run as similar lots receiving mill-run alone. The gains were proportionally better, thus making cane molasses more efficient than mill-run and at the same time inducing greater consumption and greater gains.

In another test recently conducted at Corvallis fifteen pigs having an average initial weight of 183 pounds, consumed daily 10.7 pounds of a

mixture of ground barley 72 percent, tankage 8 percent, and molasses 20 percent. They made a daily gain for 50 days of 2.11 pounds. In this test molasses proved practically equal pound for pound to ground barley.

In a test at Corvallis, one lot of pigs were fed as high a proportion of molasses as was possible, to determine how much they could consume without any detrimental effects. The pigs were started on a 30-percent ration and gradually increased until they were receiving 43 percent of the ration molasses. Molasses has a laxative effect and causes the pigs to scour.

Molasses is especially good to mix with other feeds of an unpalatable nature. It is a valuable feed when it does not cost more than barley, wheat, or corn. Molasses is used chiefly, however, by feed manufacturers in the preparation of mixed feeds. These dealers get molasses in tank cars and at a much cheaper rate than farmers who have to buy it in barrels and in small lots. Barreling adds approximately 50 percent to the cost of molasses. Farmers usually dislike molasses because it is unpleasant to handle.

Whey. Whey contains a small amount of carbohydrate material and is valuable to this extent, but should be fed in combination with grain and a protein supplement. Fed as indicated, whey has a feeding value equal to about one-sixteenth or one-twelfth that of grain. These results are determined from the use of ordinary whole whey, which according to Day is worth 25 percent more than separated whey. Hogs can not be fed entirely on whey because it contains too much water.

Garbage. Garbage can be utilized as a hog feed without any detrimental effects on the pork produced although popular opinion is to the contrary. The only effect garbage has on the hogs is that it makes them rather "paunchy" and in that way lowers their dressing percentage.

In several tests at Corvallis, with garbage from the dormitories, it required from 1500 pounds to 2000 pounds to produce 100 pounds of gain. As high as 1.5 pounds gain per day has been made by pigs fed on garbage alone. Restaurant and hotel garbage has a higher feed value than family garbage. It is not necessary to cook garbage, in fact it is an additional expense and does not increase the feed value unless the garbage is nearly all potato peelings. Cooking does not control the spread of disease and it is always necessary to vaccinate the hogs in case cholera is prevalent. Some feeders cook garbage in order to remove the grease, which they sell as soap grease, but the grease ordinarily does not pay the expense of cooking. In order to skim the grease off it is necessary to add enough water to cover the garbage, which increases the bulk and reduces the feed value. In addition the grease has a feed value to the pigs of about two times the value of grain.

Since the supply of garbage always varies from day to day it is a good plan to have pigs enough to eat up all the garbage at all times and then when there is not enough garbage, make up the deficiency with grain. Garbage should always be fed fresh as there is no very satisfactory way of storing it.

Hogs that are fed garbage from a city should be vaccinated for hog cholera.

When grain is fed to reduce the pig's "paunchiness" we should feed only grains that have a small amount of crude fiber such as barley, wheat, or corn. Such feeds as mill-run or oats are too bulky and cause the same "paunchy" condition as garbage.

In tests at Corvallis, it was proved that garbage does not need a protein supplement such as tankage or fishmeal, as there seems to be sufficient protein in the garbage to balance the ration.

Beans. Cooked cull beans, according to the Michigan Station, fed with equal parts of corn made 1.5 pounds gain per day and require 406 pounds of feed to produce 100 pounds gain. When a straight ration of cooked beans was fed, the daily gains were not as much and it required more feed per 100 pounds gain. A ration composed more than one-half of cooked beans causes soft pork.

PASTURE CROPS

Alfalfa Pasture. There is considerable question in the minds of farmers as to the advisability of allowing fattening pigs pasturage in combination with their grain ration. Results at Union show that it is advisable providing the animals are marketed under 200 pounds. Under these conditions alfalfa pasture made a saving of 88.61 pounds barley to the 100 pounds gain.

Following is a table of results obtained at Wichita Union Stock Yards:

Feed	Daily gain	Feed to produce 100 lbs. gain	
		lbs.	lbs.
Corn	.77	Corn 560	
Corn and alfalfa pasture	1.63	Corn 393	
Corn and meat meal	1.47	Corn 409, Meat meal 19	
Corn, meat meal, and alfalfa pasture	1.48	Corn 390, Meat meal 17	

This table shows a great advantage for alfalfa pasture and corn as compared to corn alone. The average initial weight of the hogs used was approximately 120 pounds; thus they were growing during the fattening period. These results indicate the inadvisability of using corn alone as a ration for growing pigs. In the corn and meat-meal ration alfalfa pasture effected a saving of 19 pounds of corn and 2 pounds of meat-meal to the 100 pounds gain.

In general, light-weight hogs can utilize pasture to the best advantage. Pasture for fattening pigs must be good in all cases and the grain not limited.

Clover Pasture. Clover pasture and rape pasture are of about equal value for hogs. They will not yield as much as alfalfa but will grow in localities where alfalfa will not grow and are especially suited to the Willamette Valley. Clover will furnish pasture earlier in the season than will rape, while rape is at its best during the summer when clover is getting woody. Clipping clover when it is getting stemmy or woody will induce a new growth and greatly improve the pasture. Red clover is the most satisfactory variety for hog pastures. It is seeded at the rate of 8 to 10 pounds per acre.

Rape Pasture. Rape can be sown either in rows or broadcasted. Sowing in double rows so it can be cultivated is generally more satisfactory for pasture in dry weather. It may be sown with a grain drill leaving the first two holes open and plugging the next three holes, then leave two holes open, and so on across the drill. Rape should not be sown until the weather and the ground are warm, and it should be cultivated after each rain to keep down weeds and conserve moisture.

Rape should not be pastured until it is about ten or twelve inches high. After rape has been grazed down to four or five leaves to the plant, the hogs should be changed to another pasture and the rape cultivated. Then after a short time it can be pastured again.

Seed rape at about 5 pounds per acre in rows and about 8 pounds when broadcasted. It is probably our best pasture in Western Oregon.

Winter Wheat. Winter wheat planted in the spring makes a good hog pasture for Western Oregon. It yields only about two-thirds as much as rape or clover but it is better suited to poor undrained soil. It is necessary to keep the wheat grazed to about three or four inches high or the wheat will head and stop growing. Winter wheat may often be grazed the second season. Seed about two bushels per acre.

Vetch and Oats. Vetch and oats are not as satisfactory as the foregoing crops. They do not stand the grazing as well and do not grow well after being once eaten off.

IMPORTANT CONSIDERATIONS IN BALANCING RATIONS

Crude Fiber. An important factor, and one that frequently receives little consideration in balancing rations for fattening pigs is crude fiber. This comprises the woody portion of the feeding stuffs and consists mainly of cellulose, which is much less digestible than other constituents of the feed. It is a high content of crude fiber that makes a ration "bulky."

The cow, the sheep, and the horse have special digestive arrangements, whereby crude fiber may be digested in large quantities. Fiber is in fact necessary for the well-being of these animals. The hog, however, is not so constituted. He is especially fitted for consumption of large quantities of concentrates which he converts into edible product much more efficiently than any other meat-producing animal, but he can digest crude fiber to but a limited extent, if at all. Large quantities of fiber have a detrimental effect and some authorities consider any crude fiber detrimental.

If the fiber content of the ration exceeds 5.5 percent, it is impossible to make good gains in fattening hogs. Small quantities of crude fiber in a fattening ration do little harm, but the limit is easily reached and is too often passed. Canadian laws on feed regulations stipulate that feeds being placed on the market for pig feeding purposes must not contain to exceed 6 percent crude fiber.

A few examples will make this conclusion evident. Experiments have shown that alfalfa hay, though containing a high quality of protein and other digestible nutriment, will barely maintain hogs if fed as a sole feed in a ration. The feed contains 28 percent crude fiber. To make satisfactory gains a 200-pound fattening hog would have to consume

daily 15 to 20 pounds of alfalfa hay. The consumption of this amount is a physical impossibility.

Such feeds as wheat bran, containing fiber 10.2 percent; wheat shorts, containing fiber 7 percent; barley shorts, containing fiber 10.1 percent; oats bran, containing fiber 18.3 percent; barley bran, containing fiber 19.3 percent; oat hulls, containing fiber 29.2 percent; oats, containing fiber 10.9 percent, are all too high in crude fiber content when fed as a sole feed in a fattening ration. Numerous experiments have clearly shown that they do not give satisfactory gains unless fed with other feeds, low enough in fiber so that the fiber content of the mixture is less than 5.5 percent.

Experiments at Corvallis have shown that a ration consisting of two-thirds barley, one-third shorts, is equal to barley. This combination gives a crude fiber content of 5.4 percent, just under our limit. Experiments at Corvallis and other places have shown, likewise, that a ration consisting of one-half shorts and the other half barley is not equal to barley alone. This combination gives a fiber content of 5.9 percent, which is above our standard. Similar experiments have shown that two-thirds corn and one-third oats equals corn alone. The fiber content in such a ration equals 5 percent. A ration two-thirds barley and one-third oats is barely equal to barley. The fiber content is approximately 6 percent. Many more experiments are available and could be cited to support the principle that the crude fiber content of the ration should not exceed 5.5 percent.

A great number of commercial hog feeds are advertised with emphasis on their protein and carbohydrate content. These nutrients, though very important, are of little value in the presence of too much fiber. Alfalfa hay, for example, contains a high percentage of protein and a fair amount of carbohydrates, but, as stated above, it would be impossible to fatten hogs on alfalfa hay alone. If the purchaser of feeds will pay more attention to fiber content he will obtain much greater returns.

In selecting feeds the purchaser may be guided by the following principles: Feeds containing 2 percent to 5.5 percent fiber are concentrates ordinarily suitable to pig fattening. Feeds containing 10 percent to 15 percent fiber are bulky concentrates satisfactory for horses and cattle but not for hogs unless mixed with large quantities of more concentrated feeds. Feeds containing 20 percent to 30 percent fiber are roughage and must be fed as such, no matter how finely they may be ground. Feeds containing over 30 percent fiber must be classed with the straws and are not ordinarily worth buying.

Protein. The protein question is always important in pig feeding as nearly all the common grains are deficient in protein. Some of the cereal by-products contain enough protein but it is not of the proper quality. It becomes necessary, therefore, to supply this lack with some feed that contains a high percentage of protein and in which the protein is the proper kind. Such feeds are tankage, the oil meals, skim milk, butter-milk, and within certain limits alfalfa. The pig seems to require animal or legume protein, but when once the protein requirements of the animal are met it is of no advantage to add more; in fact, it may be a disadvantage. The high values often obtained from tankage or skim milk are not to be obtained when these feeds are given in larger quantities than enough

to furnish the necessary protein. The optimum amount of digestible animal or legume protein for a fattening pig is about one-fourth pound a day.

Minerals. Our definite information on the value of minerals for hogs is limited. It is known, however, that the hog should be given some minerals to supplement the grain rations since the grains in these climates are deficient, especially in calcium, or lime.

Hogs that are not receiving enough minerals will generally become lame and sometimes paralyzed in the hind quarters. Purdue University in a recent experiment found that a mineral mixture of wood ashes, acid phosphate, and salt increased the daily gains and made the gains more economical with a ration of soy beans and corn.

The following mineral mixture can be fed either by adding about one-tenth pound per day per hog to the ration or by keeping it before them at all times in a self feeder.

Slacked coal	100 pounds
Stock salt	8 pounds
Ground bone (fine).....	4 pounds
Ground sulfur	1 pound
Air-slacked lime	2 pounds
Glauber's salt	2 pounds
Potassium iodine	0.4 pound

Thoroughly mix all the ingredients except coal together before mixing with the slacked coal.

Water. The pig needs good, clean water accessible at all times. Water in the feed and water in the trough are the same to the pig providing there is not too much in the feed so that he has to consume too much water in order to get enough feed. While our information on this subject is not as definite as we should like, it seems that the entire ration for a fattening pig should not contain more than 60 percent water and that if it does contain more than 60 percent the pigs will not consume enough feed and will make slower gains and take on less finish.