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Experiment Station Work, XXI.

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THE DISK PLOW

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Director.

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CONTENTS OF THE SERIES OF FARMERS' BULLETINS ON EXPERIMENT STATION WORK.

EXPERIMENT STATION WORK.

Edited by W. H. Beal and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. True, Director, Office of Experiment Stations.

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ILLUSTRATIONS.

EXPERIMENT STATION WORK.

THE VALUE OF BARNYARD MANURE.

The Ohio Station has recently issued a bulletin dealing with the important question of the preservation and proper use of barnyard manure. The experiments on this subject were made on rotations of corn, oats, and wheat followed for two years by clover and timothy mixed, and on corn, oats, and wheat grown continuously. In these experiments manure "taken from flat, open yards, where it had accumulated for several months during the fall and winter, and had been subjected to the conditions which affect the ordinary open-yard manure of the average Ohio farm, conditions which involve very considerable losses," was compared with manure treated as follows:

A lot of manure, taken from an open yard, where it had accumulated during the winter from daily cleaning out of the stable behind a herd of dairy cows, which had been liberally fed on bran, gluten meal, corn meal, hay and silage, was divided in the spring into four parcels. On one parcel the finely ground phosphatic rock, from which acid phosphate is made by treating with sulphuric acid, and which, in its untreated condition, is known in the South as "floats" was dusted as the manure was thrown into a pile; on a second parcel acid phosphate was dusted; on another the crude potash salt known as kainit, and on another, land plaster, or gypsum, these materials all being used at the uniform rate of 2 pounds per 100 pounds of manure, or 40 pounds per ton. At the same time a lot of manure was taken from box stalls, where it had accumulated under the feet of animals which were kept continuously in their stalls, being given sufficient bedding to keep them clean without cleaning out the stalls, and similarly treated.

For corn and wheat the manure was applied as a top-dressing, being put on with a manure spreader at rates of 4 and 8 tons per acre on each crop in the rotation, and 2½ to 5 tons in the case of the continuous cropping. The results of the experiments, as measured by the crop yields, show—

That it will pay well to give more attention than is done on the average farm to the preservation of barnyard manure, first, by guarding it from the sources of loss which occur in the ordinary open barnyard, and, second, by treating it with materials calculated to reduce the losses from escaping ammonia on the one hand and to increase its content of phosphoric acid on the other.

To accomplish this purpose, acid phosphate appears to be the material producing the largest and most profitable immediate increase in effectiveness of the manure, but the experiments strongly suggest the possibility that the finely ground phosphatic rock from which acid phosphate is made may be found an economical substitute for the latter, by using it as an absorbent in the stables and thus securing an intimate mixture with the manure in its fresh condition.

The yields were uniformly larger and the increase due to the addition of the preservatives smaller in case of the stall manure than in case of the open-yard manure, thus showing that either with or without the addition of preservatives stall manure suffers less loss and is richer in fertilizing constituents than open-yard manure.

NITRATE OF SODA FOR MARKET GARDEN CROPS.

The results of experiments by the New Jersey Stations to test the value of several common forms of nitrogenous fertilizers for certain market garden crops have been summarized in an earlier number of this series.[a] In a recent bulletin of the stations Prof. E. B. Voorhees gives the results of further experiments along the same line. The purpose of the later experiments was to study the value of different amounts of nitrate of soda for several prominent market garden crops, and also the effect of applying the nitrate in two and three equal dressings, the first when the crops were planted, the others when the character of the season and the growth of the crops indicated.

The question of the proper use of nitrate of soda is of special importance because (1) it is an expensive fertilizer, (2) it furnishes only one element of plant food, namely, nitrogen, and (3) it furnishes nitrogen in a form which is highly soluble, and consequently is not only quickly absorbed by the plant roots but is also readily washed out of the soil and lost. In order, therefore, that this fertilizer may be most economically and profitably employed it is necessary not only to use it in proper amounts but to apply it in such a way that the nitrogen is used by the plant to the fullest possible extent.

If the quantity found to be necessary for a definite increase of crop, under average conditions, were all applied at once, say in the early spring, a greater opportunity would be offered for losses from leaching than would be the case if the material were given in successive dressings, so that the losses due to the escape of the nitrogen would be minimized; on the other hand, if no losses occurred, the plant might take up more than could be utilized in a normal development, thus defeating the purpose, because resulting in a product of less commercial value. This would apply, of course, only in the case of those crops that are injured by abnormal development in certain directions, as, for example, too large a proportion of straw in cereal grains, too large a root in sugar beets, etc. All these difficulties may be obviated by a fractional application, or, in other words, by supplying the nitrogen at the time and in the quantity best adapted for the plant and for the purpose in view in its growth.

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[a] U. S. Dept. Agr., Farmers' Bul. 124 (Experiment Station Work, XVII), p. 12.

The results from the use of nitrogen may also be unsatisfactory if nitrogen only of the essential elements is used. The best results from the use of nitrate can come only when there exist in the soil, or are applied with it, sufficient amounts of the mineral elements to enable the plant to obtain a food suited to its needs.

The experiments of the New Jersey Stations were planned to determine not only the best amounts of nitrate to use in case of various garden crops, but also the best method of application. The land used in the experiments was very fertile, but in order to insure an abundance of phosphoric acid and potash in the soil it was further enriched in every instance by applications of 350 pounds per acre of acid phosphate and 150 pounds of muriate of potash, as well as 450 pounds per acre of a fertilizer containing 3.69 per cent of nitrogen, 7.85 per cent of available phosphoric acid, and 6.39 per cent of potash. The results obtained with the different crops were briefly as follows:

Cabbage.—With this crop there was a yield of but 910 prime heads per acre when no nitrate of soda was used. When 300 pounds of the nitrate was applied per acre in two equal dressings the number of prime heads obtained was 3,260. When the same amount was applied in three equal dressings the yield of prime heads per acre was 5,390. On the plat which had received 400 pounds of nitrate of soda per acre in two equal dressings the yield was 4,160 prime heads per acre, and when this same amount was applied in three equal dressings 7,580 prime heads were obtained per acre. From these figures it will be seen that the use of the nitrate of soda greatly increased the yield of prime heads in every instance. It will further be noticed that when the nitrate was applied in three equal dressings the largest yields were obtained. Applying the nitrate in three dressings proved more effective in increasing the yield than increasing the amount 100 pounds. For example, 300 pounds in three equal dressings was more effective than 400 pounds in two equal dressings, and the best yield of all was obtained by applying 400 pounds of nitrate in three equal dressings. Not only was the yield much greater than on any other plat but the quality of the cabbage was much improved, the heads selling for 50 per cent more than those from any other plat.

Celery.—As with the cabbage crop noted above, 300 and 400 pounds per acre of nitrate of soda were used on different plats in two and three equal dressings. The average increased yield of all the plats, due to the use of the nitrate, was 17,810 pounds or 132 per cent. This was on good land previously well fertilized with 450 pounds of high-grade fertilizers. No marketable celery whatever was obtained when the nitrate was not used, and the use of the ground, expense of growing, etc., was a total loss. Where the nitrate was used the crop was worth on the average $378.10 per acre. The cost of the nitrate was but $7. This is equivalent to a gain of $54.01 for every $1 invested in the nitrate of soda. As to the influence of the amount applied the average increased gain due to the use of 400 pounds of nitrate was 255 marketable roots, worth $25.19. When the nitrate was applied in three equal dressings there was an increased gain on the average of 495 plants, worth $31.19 over the yield obtained when the application was made in two equal dressings. The gain from the third application was considerably larger when the 400 pounds of nitrate was applied than when 300 pounds was used, the value of the increased gain in the former case being $16 and in the latter $56.38. These results indicate the value of a liberal quantity of nitrate of soda for celery as well as a judicious distribution throughout the season.

Tomatoes.—With tomatoes the heaviest yields were obtained when 200 pounds of nitrate of soda was used per acre in three equal dressings. The increase in the yield in this case was 5,880 pounds. When the same amount of nitrate was used in two equal dressings the gain was but 3,220 pounds. When 300 pounds of nitrate of soda was used in two equal dressings the increased yield was 4,610 pounds. When the same amount was applied in three equal dressings the increased yield was but 3,540 pounds. The third application in this case caused a larger growth of vine and later maturing fruit, thus considerably reducing the yields.

Turnips.—This crop is often grown for early market. In the station experiments different plats were fertilized with nitrate of soda at the rate of 200 and 300 pounds per acre, respectively, in two and three equal dressings. Where no nitrate was used the yield was 8,230 pounds per acre; when 200 pounds was applied in two equal dressings the yield was increased to 12,740 pounds; and when in three equal dressings the yield was but 11,220 pounds. When 300 pounds was applied in two equal dressings the yield was 16,520 pounds, and when in three equal dressings the yield was but 13,360 pounds. These figures show that while there was a greatly increased yield in every instance due to the use of the nitrate of soda, the best yields were obtained when the nitrate was applied in two equal dressings rather than three. The late dressings seemed to induce growth of tops rather than of roots. The greatest increase in yield and the most profitable crop was obtained from the use of 300 pounds of nitrate of soda in two equal dressings.

Peppers.—The use of nitrate of soda considerably increased the yields in every instance with this crop. When 200 pounds were applied per acre in two equal dressings the increased cash value of the crop, due to the use of the nitrate, was $16.70. When this same amount was applied in three equal dressings the increased value of the crop was $25.90. When 300 pounds of the nitrate of soda were used in two applications the increased value of the crop was $30.20, and in three applications, $29.50.

The experiments with these various crops would seem to indicate that a good profit can be derived from using liberal amounts of nitrate of soda for market-garden crops, even when they are planted on land already rich and liberally fertilized with complete fertilizers. They also indicate that the nitrate should not be applied all at once, but in two or three applications throughout the growing season, depending on the nature of the crop, the character of the season, and the growth of the crop.

COOKING MEAT.

Most of the experiment stations have studied the relative value of different feeding stuffs and methods of feeding farm animals for market purposes. A smaller number have studied various problems relating to the important subject of meat and its place in the diet.

The Connecticut (Storrs) Station on the basis of a large number of American dietary studies, calculated that beef and veal together furnish 10.3 per cent of the total food, 24.6 per cent of the total protein, and 19.5 per cent of the total fat of the diet of the average American family, while meat, fish, and poultry together furnish 20.1 per cent of the total food, 43 per cent of the total protein, and 55.3 per cent of the total fat. The composition of meat of different kinds and cuts has been quite fully studied by a number of the stations and colleges and by this Department.

Although so much attention has been given to the production of beef and to studying its composition, little information has been available regarding the changes which take place when it is cooked. Doubtless all are familiar with the fact that a piece of roasted or fried meat weighs less than it did before cooking, but know little of the nature of the losses thus resulting. Prof. H. S. Grindley, of the University of Illinois, has recently reported the results of a considerable number of experiments on the character and extent of the losses sustained when meat is cooked in different ways. Generally speaking the tests were made with beef, although a few were made with mutton. The meat was either pan broiled—that is, fried in a medium hot frying pan without the addition of fat—or it was boiled or stewed—that is, cooked in hot water—the length of time the meat was cooked and the temperature of the water varying in different tests. In some cases the meat was plunged at once into boiling water; in others the water was cold at the start. The pan-broiled meat was weighed before and after cooking, the material which adhered to the frying pan being included with the cooked meat. Boiled and stewed meat and broth which contained the material extracted while cooking were also weighed and analyzed. In every case the composition of the cooked meat was compared with that of raw meat of a similar cut.

Among the conclusions reached as a result of these experiments are the following: The chief loss in weight during the cooking of beef, and doubtless of other meats also, is due to the driving off of water. When beef is pan broiled there appears to be no great loss of nutritive material, particularly if the material adhering to the pan is utilized in the preparation of gravy. When beef is cooked in water from 3 to 20 per cent of the total substance is extracted and found in the broth. The material thus removed from the meat is not an actual loss if the broth is utilized for soup or in other ways.

Beef which has been used for the preparation of beef tea or broth has on an average lost comparatively little nutritive material, though much of the flavoring material has been removed. The amount of fat found in the broth varies directly with the amount originally present in the meat, i. e., the fatter the meat the greater the quantity in the broth. The amount of water lost during cooking varies inversely as the fatness of the meat, i. e., the fatter the meat the less the shrinkage due to loss of water during cooking. In cooking in water the loss of constituents is inversely proportional to the size of the piece of meat. In other words, the smaller the piece the greater the percentage of loss. The loss appears to depend also upon the length of time cooking is continued.

When pieces of meat weighing from 1½ to 5 pounds are cooked in water having a temperature of 175° to 185° F. there appears to be little difference in the amount of material found in the broth, whether the meat was placed in cold water or in hot water at the start. The broths obtained when meat is cooked in water do not contain a high percentage of nutritive material, but they do contain much of the flavoring material ordinarily present in the meat.

FEEDING VALUE OF SUGAR-BEET PRODUCTS.

Both sugar beets and fodder beets have been fed to farm animals, and their fitness for this purpose has been tested at a number of the experiment stations.[a] In the manufacture of sugar from beets several by-products are obtained which are of more or less importance in animal production. These include such materials as leaves, tops, molasses, and pulp. The leaves and tops, the latter consisting of beet crowns and leaves, have been fed fresh and ensiled. Like all similar succulent feeds, they contain a high percentage of water in proportion to their bulk. The crowns have a fairly high ash content in comparison with the whole root. Beet molasses owes its feeding value chiefly to the sugar which it contains. When fed, it is usually mixed with some material which absorbs it so that it may be handled readily, a concentrated feed rich in protein being often used, with the object of

[a] For tests with sugar beets see U. S. Dept. Agr., Farmers' Bul. 84 (Experiment Station Work—VII) p. 15.

providing at the same time a well-balanced ration. The feeding value of molasses has been discussed in an earlier bulletin of this series.[a]

That portion of the beet root which remains after the sugar-bearing juice has been extracted is called beet pulp. According to analysis, fresh pulp contains some 90 per cent water, 6 per cent nitrogen-free extract (carbohydrates), and 2 per cent crude fiber, in addition to a small amount of protein, fat, and ash. Obviously the feeding value of this material is low in proportion to its bulk.

Sugar-beet pulp accumulates in large quantities at the sugar factories, and it is evident that an economical use of a material with so low a feeding value depends upon an inexpensive method of handling and storing it. Jaffa and Anderson, in a recent bulletin of the California

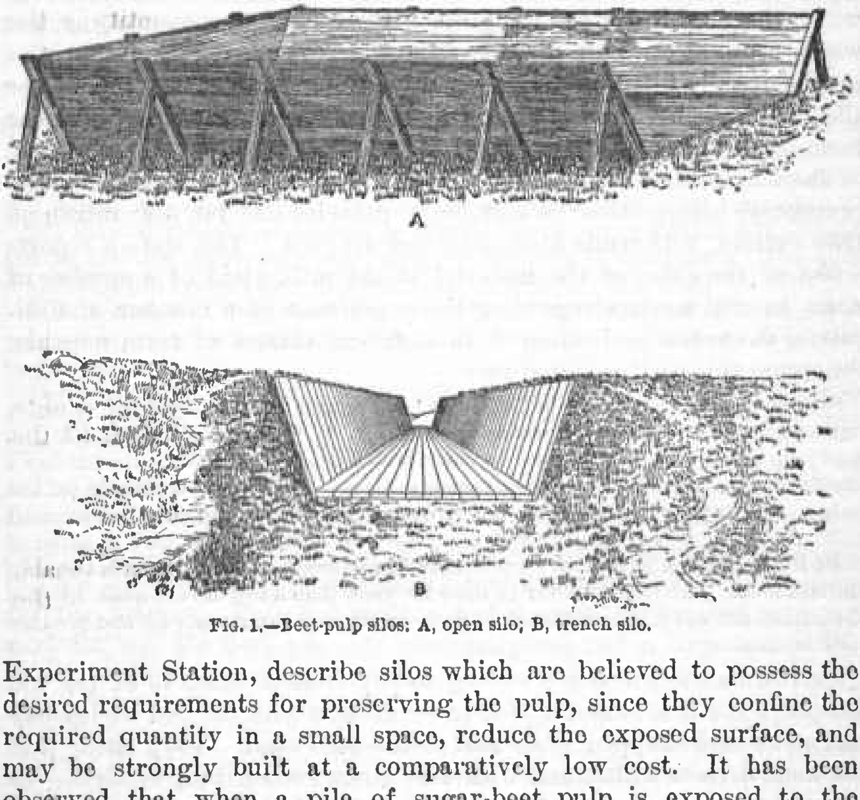

FIG. 1.—Beet-pulp silos: A, open silo; B, trench silo.

Experiment Station, describe silos which are believed to possess the desired requirements for preserving the pulp, since they confine the required quantity in a small space, reduce the exposed surface, and may be strongly built at a comparatively low cost. It has been observed that when a pile of sugar-beet pulp is exposed to the weather, the surface decays to a depth of 6 or 8 inches, forming a crust which protects the remainder. In the silos described this fact is taken advantage of. One form consists of a large open bin with sloping sides built on the surface of the ground; the other of a trench or excavation with sloping sides and a flat floor covered with plank. (See fig. 1.) The authors point out that silo A may be made

[a] U. S. Dept. Agr., Farmers' Bul. 107 (Experiment Station Work—XIII), p. 17.

of refuse lumber and of any size to suit the convenience of the feeder. That shown in the figure was 12 feet wide, 30 feet long, and 6 feet deep, and would hold about two carloads of pulp. The silo B is simple and inexpensive, and may be conveniently made by excavating a passage through or in the side of a hill. According to the authors, the bottom should always be planked and provided with means whereby the water may be easily and quickly drained from the pulp. The planks should be set up well from the ground and be far enough apart to leave a crack between them after they have swelled. The sides may or may not be planked, but less pulp is lost if they are covered with boards. A silo of this sort, with which the authors were familiar, was 600 feet long, 50 feet deep, 20 feet wide at the base, and 80 feet wide at the top. The bottom only was planked, and had a gutter under the floor which thoroughly drained the pulp. It was filled by means of carriers which brought the pulp directly from the sugar factory. Small silos can be readily filled by driving a wagon alongside of the top of the silo and shoveling the pulp into it. It is not necessary to cover either form of silo with a roof.

The California Station found that beet-pulp silage had the following percentage composition: Water, 88.9; protein, 1.5; fat, 0.2; nitrogen-free extract, 5.4; crude fiber, 3.6; and ash, 0.4. This station reports a test of the effect of the material on the milk yield of a number of cows, as well as data regarding the experience of a number of California stockmen in feeding it to different classes of farm animals. Summing this up it is stated that—

> Several years of experience in California have proven sugar-beet pulp of value for fattening cattle as well as for producing milk. * * * The larger portion of the beet pulp in the State is consumed by cattle which are being fitted for the butcher's block. It has been fed also to some extent to sheep. Both cattle and sheep eat the pulp so readily that there is scarcely any difficulty about getting them accustomed to it. So far as we are able to learn, all those who have fed beet pulp to either of these kinds of stock have been successful except where they tried to make the pulp the sole food. This should never be done for more than a few days at most, because the animal can not consume enough of such watery food to maintain life and produce milk or meat.

California stockmen are willing to pay from 25 cents to $1 per ton for pulp, and it is generally fed in connection with oat and barley hay and straw and chopped grain and cotton-seed meal. They claim that the meat dresses whiter and with less sinews when pulp is used. In the California experiments milch cows ate from 20 to 80 pounds of pulp per day in addition to 6 to 16 pounds of hay and 8 pounds of grain. The flow of milk was increased but the quality was not affected.

In experiments with milch cows at the New York Cornell Station it was found that—

> The cows, as a rule, ate beet pulp readily and consumed from 50 to 100 pounds per day, according to size, in addition to the usual feed of 8 pounds of grain and 6 to 12 pounds of hay.

The dry matter in beet pulp proved to be of equal value, pound for pound, with the dry matter in corn silage.

The milk-producing value of beet pulp as it comes from the beet-sugar factory is about one-half that of corn silage.

Beet pulp is especially valuable as a succulent food, and when no other such food is obtainable it may prove of greater comparative value than is given above.

In the dairy districts of New York and other States where factories have been established beet pulp is coming into great demand for cows.

The Michigan Station reports experiments which indicate that pulp may be profitably used to replace a considerable part of the roughage of fattening steers, and has a value for this purpose of from $2 to $3 per ton. Michigan stockmen who have used the material are of the opinion that it saves one-third of the coarse fodder. When fed with hay and grain to milch cows the flow of milk was increased somewhat, but the yield of butter fat was not affected.

In experiments at the Colorado Station—

Five cows fed 24 pounds of beet pulp for six weeks, in addition to grain and hay, made an average gain per week of 6.2 pounds. The same cows fed 12 pounds of beets per day for five weeks made an average gain per week of one-fifth pound.

The cows on the pulp ration gave an average weekly milk yield of 131.1 pounds, and on the beet ration they gave an average weekly milk yield of 127.4 pounds.

The cows on the pulp ration gave an average weekly butter yield of 6.76 pounds, and on the beet ration an average weekly butter yield of 6.90 pounds. The milk contained a little more butter fat when the cows were fed sugar beets.

A little more than three times as much profit resulted from feeding 24 pounds of pulp per day than was realized from 12 pounds of beets per day, at $1 and $4 per ton, respectively.

The total profits indicated a feeding value of the pulp for butter production of $2.61 per ton, and of the beets of $5.06 per ton when fed in small amounts, and when butter is worth 20 cents per pound.

The Colorado Station reports experiments with lambs which show that while beet pulp is a valuable food for lambs during the earlier part of the feeding period, it is of such a bulky character that lambs can not consume enough of it to produce sufficient fat to finish them for the market. Pulp-fed mutton had a good flavor, but was not very fat, and the flesh was soft when pulp was fed in large quantities. It was not found profitable to allow lambs to eat so much of the pulp during the finishing period that they could not consume good rations of hay and grain. Alfalfa and beet pulp gave good results during the earlier stages of the feeding. "When large quantities of pulp were fed to animals confined in small lots, the lots became very foul, much to the discomfort of the animals and loss to the feeder." In these experiments 1 pound of pulp was found to be equal to about 2 pounds of sugar beets.

In experiments with pigs at the same station it was found that sugar-beet pulp was about as valuable as sugar beets for feeding purposes, and the conclusion was reached that because of its cheapness and effect on growth pulp may be profitably fed to growing pigs in connection with a grain ration or during the first part of the fattening period. The beet pulp gave a return of $1.50 a ton when fed in combination with grain. It served the same purpose in the ration as sugar beets and at less expense. "It was necessary to mix beet pulp with grain in order to educate the pigs to eat it." It is not recommended to feed "more than 2 pounds of pulp to a pound of grain in a ration for pigs which are from 100 to 200 pounds in weight."

Practical experience favorable to the use of pulp for beef cattle, milch cows, and sheep is reported from various places in California, Colorado, Michigan, Nebraska, New Mexico, New York, and Utah, near beet-sugar factories, where the pulp is available in quantity.

Prof. B. C. Buffum sums up the question of the use of the pulp in a bulletin of the Colorado Station as follows:

It should be stated that the attempts to compute the cash value of pulp compared with other foods do not indicate its total value. It supplies a succulent food at a time when such food is either not available or is scarce, and its effect on stock seems to be much more favorable than either its chemical analysis or the return in increased meat or milk would indicate. To its actual nutritive effect as a food should be added its general effect on the quality of meat and milk and on the animal system. Pulp undoubtedly overcomes much of the injurious effects of dry and concentrated foods, puts the system in good sanitary condition, keeps off disease, and so aids the appetite and digestion and assimilation of food that there is less waste, both of food which is generally discarded in eating, and that which usually passes through the animal undigested.

There seems to be no difficulty in regard to keeping beet pulp. While there is some loss of material when placed in open piles, the fermentation which takes place seems to be beneficial rather than otherwise. Animals eat the sour pulp as well, and after a little time even better than they do the pulp fresh from the factory, and the dry beet chips on the surface of the piles are very palatable to sheep and cattle. Nebraska feeders claim that pulp which has been left in open piles for two or three years is as good as ever.

No injurious effects have been observed from feeding pulp, unless too large amounts are given before the animals become accustomed to it. * * *

The greatest difficulty with pulp feeding is that the large amount of water it contains makes it heavy and rather expensive to handle, and it is sometimes difficult to keep the animals dry and comfortable while feeding large amounts of it. The feeder who is near the factory and has the appliances so arranged that he can handle the pulp with the least expense, should make the greatest use of pulp and will gain the greatest profit from its use. If it can be placed before stock at a cost of not more than $1 per ton, we believe it will bring good returns for the investment, and in many instances it may be worth two or three times this amount. Whether fresh, fermented, or dry, beet pulp is a valuable stock food, and one of which our farmers should make the largest possible use.

As an example of how pulp may be combined with other foods in forming a ration, we give the following illustration:

Beet-pulp rations.

[For fattening cattle weighing 1,000 pounds.]

	Dry matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive ratio.
First period:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Standard ration	30.00	2.50	15.00	0.50	1:6.5
Alfalfa, 15 pounds	13.70	1.65	5.94	.18	
Beet pulp, 75 pounds	7.60	.45	5.47		
Cotton-seed meal, 2 pounds	1.80	.75	.30	.24	
	23.10	2.85	11.71	.42	1:4.4
Second period:					
Standard ration	30.00	3.00	14.50	.70	1:5.4
Alfalfa, 15 pounds	13.70	1.65	5.94	.18	
Beet pulp, 25 pounds	2.50	.15	1.80		
Cotton-seed meal, 2 pounds	1.80	.75	.30	.24	
Corn meal, 6 pounds	5.36	.46	4.00	.26	
	23.36	3.01	12.04	.68	1:4.5

SOME RECENT EXPERIMENTS IN HORSE FEEDING.

The feeding of cattle, sheep, and pigs for the production of meat, milk, and wool, as well as of domestic fowls for meat and eggs, has received a great deal of attention from scientific men, and the bulletins and reports of the experiment stations contain many accounts of investigations on this subject. The feeding of horses, however, for the production of power, although hardly less important, has received little attention and has been left until recent years largely as fixed by tradition, custom, or arbitrary rule. Successful horse breeders have undoubtedly developed excellent systems of handling, care, and feeding, as the results demonstrate, but their knowledge has not been carefully formulated on definite principles and made available for general use. It is encouraging to note, however, that a number of stations are now taking up this important subject with promise of valuable scientific results in formulating the principles involved and of very useful practical results in teaching more rational and economical methods of feeding horses. Accounts are given below of some recently reported work of this kind.

MAINTENANCE RATION FOR FARM AND DRIVING HORSES.

At the Wyoming Station the amount of alfalfa hay required to maintain farm horses performing little work and driving horses at light work was studied by F. E. Emery, the alfalfa being supplemented by some oat straw. The work horses were occasionally harnessed, but did not work much. They were fed alfalfa only in the stable, and ordinarily were allowed to run out of doors and have free access to water and a straw pile, but were given no grain. It was found that they maintained their weight on an average when eating 13.5 pounds of good alfalfa hay per day per 1,000 pounds, live weight, in addition to some straw. The amount of straw required to balance the alfalfa ration was next studied, and it was found that the daily ration eaten was 13.75 pounds alfalfa hay and 2.25 pounds oat straw per 1,000 pounds, live weight. A similar test was made with a driving horse required to perform a moderate amount of work. He was driven 6 miles a day at a pace which was nearly the limit of his road gait. It was found that his weight, 1,170 to 1,200 pounds, was maintained on a ration of 21.25 pounds alfalfa hay and 3.4 pounds oat straw, or 17.71 and 2.83 pounds, respectively, per 1,000 pounds, live weight. According to the author, there was every reason to believe that the ration was sufficient to maintain the horse although he did not gain in weight. These tests are especially interesting since they furnish experimental proof of the feeding value of alfalfa hay for horses.

ALFALFA AS A FEEDING STUFF FOR HORSES.

The alfalfa crop is of great importance in many regions of the United States and is depended upon as a standard feed for farm animals. Nevertheless, the statement is often made that it is not a good feed for horses, though excellent for other farm animals. The Utah Station believes that it is also suited for horses, and reports a number of experiments by L. A. Merrill which bear out this belief, and supplement the experience gained in using alfalfa as the principal coarse fodder of the station horses for a number of years.

In the first test, which began January 13, 1899, four of the station farm work horses were fed a ration consisting of 10 pounds of bran and shorts and 25 pounds hay, two being given alfalfa hay and two timothy. The average cost of the alfalfa ration was 9.9 cents per day and the timothy ration 12.3 cents. During the 95 days of the first period of the test the horses fed timothy lost 124 pounds; those fed alfalfa, 4 pounds. The rations were then reversed for 56 days. During this time the horses fed alfalfa hay gained 75 pounds; those fed timothy hay lost 60 pounds.

The second test began November 20 and the experimental conditions were practically the same as before, except that the grain ration was larger, averaging a little over 12 pounds per head daily. In 91 days the two horses fed the alfalfa ration gained 55 pounds, while those fed the timothy hay lost 41 pounds. The two rations cost 11 cents and 13 cents per head per day, respectively. For a period of 68 days the rations were reversed, the grain ration being increased to some 15 pounds per head per day. On alfalfa hay there was a total gain of 65 pounds, and on timothy hay a loss of 100 pounds.

The rations were also tested for 39 days with two driving horses used for light work. In addition to some 12 pounds of grain per day, one horse ate 8.3 pounds timothy hay, the other 16 pounds of alfalfa hay on an average. On the former ration there was a loss of 50 pounds, and on the latter a gain of 10 pounds; the cost of the two rations being 9.5 cents and 8.7 cents, respectively.

In the following November another test was begun, which included all the horses previously mentioned and two additional driving horses used for light work. The daily ration of the work horses consisted of 15 pounds of hay and 12 pounds of oats; that of the driving horses of 12 pounds of hay and 9 pounds of oats. In each case two horses were fed the timothy and two alfalfa hay. During the 180 days of the test the horses fed timothy lost 189 pounds, and those fed alfalfa made a total gain of 8 pounds. The average cost of the latter ration was 13 cents per head per day and the former ration 15 cents.

A test covering 60 days was made during the following winter with two of the work horses previously used, and, as before, the ration consisted of grain with alfalfa hay in one case and timothy hay in the other. The rations were, however, reversed every ten days.

> Although the horses were fed exactly the same amount of hay and grain, the two horses ate during the experiment 253 pounds more alfalfa than timothy during an equal number of days. [This] brings out very clearly the fact that individuality is an important factor in feeding.

Generally speaking, in these tests the amount of alfalfa uneaten was less than the amount of timothy; that is, the former ration was less wasteful. Of these experiments the author says further that—

> The results of the tests, under varying conditions of work, are so uniform that the value of alfalfa when fed to horses may be regarded as quite definitely established. It did not seem a difficult matter to maintain the weights of horses on alfalfa when given the same amount as was given to the timothy-fed horses. No ill effects on the general health of the horses were noted, and in appearance the alfalfa-fed horses certainly contrasted favorably with those which received timothy.
>
> It is folly to claim that a horse will not eat more than is necessary if allowed the liberty of the stack and the grain bin. The argument is sometimes made that a horse, under natural conditions, on pasture never eats more than is necessary, and that under these conditions he is never subject to digestive disorders. While this is undoubtedly true, it must be kept in mind that as soon as we stable the horse and require work of him we have taken him away from his natural condition and placed him under unnatural environments.

The comparative merits of bran and shorts, and oats, are discussed, and the conclusion drawn that bran and shorts may be substituted for oats in a ration containing either alfalfa or timothy hay, and that there is no reason for considering oats a necessary part of a ration.

Since on many Utah farms horses are maintained for a part of the year on alfalfa alone, its feeding value under such conditions was made the subject of a special study. In a 10 days' test, during the summer, two work horses weighing nearly 1,400 pounds each practically maintained their weight on an average daily ration of 19.8 pounds alfalfa hay per head. The horses were idle during the test. During the following winter the same horses were fed alfalfa hay without grain for 21 days, consuming on an average 32.6 pounds each daily. Excepting Sundays, 9 hours work was required of them per day. One horse lost 2 pounds and the other 76 pounds. When very severe work was required, 40 pounds of alfalfa hay (about the limit which could be eaten) was not an adequate ration.

[It is stated that] a great difference was noted by the teamster in the life of the team; upon grain they had always shown considerable spirit, but soon after they were deprived of the grain it was found necessary to urge them frequently to do even the slow work required of them at ordinary farm labor. This is easily accounted for from the fact that the digestive organs of the horses were taxed to their limit [by the bulky ration] and the energy of the horses was largely consumed in the process of digestion.

It is doubtful if there is any economy in feeding a horse 40 pounds of alfalfa per day. It is certain that better results can be secured by limiting the amount of hay to 20 pounds and substituting for the extra 20 pounds enough grain to make up the cost. This would secure at current prices [1902] 8 pounds of bran and shorts or 3.6 pounds of oats per day, and this amount with 20 pounds of alfalfa will make a better maintenance ration than 40 pounds of alfalfa. Aside from the financial consideration, it may be emphasized again that if digestive disorders are to be entirely avoided, concentrated foods must make up part of the diet of the horse. Our experience justifies the conclusion that even 12 to 15 pounds of hay per day is sufficient, and it would seem wise, both from a financial and physiological standpoint, to combine with this enough grain to enable the weights to be maintained.

Regarding the idea sometimes advanced that alfalfa hay exercises a harmful diuretic effect on horses, the statement is made that "alfalfa has formed the sole fodder rations of all the horses belonging to the experiment station from the beginning, twelve years ago, except when, for brief periods, they have been fed experimentally on other forage. The station has never lost a horse, either directly or indirectly, from alfalfa feeding. Neither has there ever been any inconveniences noted as a result of excessive urination." It was observed that horses on alfalfa excreted more urine than on other feeds, but not enough more to cause any inconvenience.

The matter was tested in an experiment with two of the horses, covering 60 days, divided into periods of 10 days each. The daily ration consisted of 25 pounds of hay and 15 pounds of oats per horse. As before, one horse was fed alfalfa hay and the other timothy, the rations being reversed in the last half of the test. The urine was collected and studied during part of the test. On the timothy hay ration the average amount of water drunk was 81.92 pounds per day, and the average amount of urine excreted daily 16.04 pounds. The corresponding values for the alfalfa ration were 90.76 pounds and 27.26 pounds. It has been suggested that the increased excretion of urine on an alfalfa ration is due to a larger amount of water in alfalfa hay.

Such was not the case in the present experiment, as the timothy hay contained 10.7 per cent water and the alfalfa hay from 9.64 to 10.53 per cent. It was found that the specific gravity of the urine of the alfalfa ration was greater than that of the timothy ration. More nitrogen was excreted when alfalfa hay was consumed, as would be expected, since this ration furnished more nitrogen than the timothy hay ration.

Some of the conclusions drawn from the experiments as a whole are as follows:

In comparing alfalfa and timothy as roughage for horses, the results of [the] tests, under varying conditions of work, show that it is not as difficult to maintain the weights of horses when fed alfalfa as when fed timothy. The cost of maintenance was greater in every case, except one, on timothy than on alfalfa. The appearance of the horses in every comparison of alfalfa and timothy was in favor of the alfalfa-fed horse. When alfalfa and timothy were fed ad libitum much greater quantities of alfalfa were consumed.

No ill results were noted on the health of the horses by long-continued alfalfa feeding. Attacks of colic and other digestive disorders can be prevented by a judicious system of feeding. The amount of hay fed on most Utah farms could be reduced at least one-half. It may be economical to reduce the amount of hay and increase the amount of grain fed to horses. Twenty pounds of alfalfa per day proved sufficient to maintain the weights of horses weighing nearly 1,400 pounds when at rest. When at heavy work, 32.62 pounds of alfalfa per day was barely sufficient to maintain the weights of the same horses.

It would seem from the experiments conducted on the amount of water consumed by horses that the amount varies with the amount eaten, though further evidence is required to make this conclusive. In the experiments conducted, the horses fed timothy ingested more water for each pound of dry matter eaten than the alfalfa-fed horses. The individuality of the animal is a potent factor, both in food and water consumption.

MIXED RATIONS FOR FARM HORSES.

Many horse feeders regard oats as almost necessary, and it is doubtless true that in large regions of the United States the most common ration for horses consists of oats and hay, with an occasional bran mash. In the South and West corn seems to be the most common feed, especially in rural districts. Many experiments have been reported which support the theory that horses may be satisfactorily fed any reasonable combination of wholesome materials which supplies the required nutrients in due proportion. In other words, protein and energy are required by the animal body rather than any special feed. Believing that more horses should be raised, and that an economic system of feeding would be an incentive to horse breeders, C. W. Burkett, of the New Hampshire Station, recently studied the comparative value of a number of mixed rations with the station farm horses during a period of two years. The rations were so planned that an abundance of nutritive material was supplied by grain mixtures which were cheaper than oats. Throughout the greater part of the experimental period hay was fed with the grain. During a part of the time corn fodder was used.

The comparative merits of the following five rations were studied in the first test: Hay 10 pounds, bran 2 pounds, corn 6 pounds, and gluten feed 6 pounds; hay 10, bran 2, corn 6, oats 8; hay 10, corn 8, and bran 7; hay 10, corn 8, linseed-oil meal 4; and hay 10, cotton-seed meal 1, bran 2, and corn 8. Each of the five horses included in the investigation received one of the rations for one month, the rations being rotated, so that during the five months of the test each horse was fed all the rations. Ration No. 1, consisting partly of gluten feed, cost on an average 19.3 cents per day, and was regarded as quite satisfactory. It was eaten with relish. One horse lost weight on it, while two gained somewhat and two neither gained nor lost. Ration No. 2, costing 22.5 cents per day, was the most expensive of those tested on account of the oats which it contained. Three of the horses lost in weight on it, one gained, and in one there was no change. The oats in the ration proved no more satisfactory than the other concentrated feeding stuffs, either in respect to the animal or the efficiency of the work. Had more been fed to keep the weight constant, it would have materially affected the price of the ration. Ration No. 3 was moderate in price, costing 20.4 cents per day, and was relished more than the others. Two of the horses gained, one lost, and two remained unchanged. In the author's opinion this ration was healthful, palatable, and at the same time moderate in cost. Ration No. 4, also moderate in price, cost 20 cents per day. On it two of the horses lost somewhat in weight. The others made slight gains or remained unchanged. Although the amount of oil meal fed per day was quite large, no bad effects were noticed. Ration No. 5 was the least expensive, costing 17.4 cents per day. It was also the least bulky of the rations tested. Four of the horses remained unchanged or made slight gains, while one lost a little in weight. The author regards this ration as the least satisfactory, since none of the animals relished it at first on account of the cotton-seed meal. In this series of tests the amount of work varied from 103 to 240 hours per month. When the rations were each fed to one horse during the same week in the autumn, all the horses gained in weight, showing that each ration under the same conditions of work and same season of the year furnished satsfactorily the proper nutrients for the work done.

To further test these rations under similar conditions of climate and work, each was fed to one horse for one month. The amount of work ranged from 209 to 314 hours. In every case there was a gain in weight, showing, the author believes, that all the rations were satisfactory and suited to the amount of work performed.

In the above tests the rations were changed with regularity. To learn whether abrupt changes have an influence, the investigation was continued as follows: After the close of the last period all the horses were fed the linseed-meal ration for some six weeks. For about nine weeks three of the horses were then fed rations Nos. 2, 3, and 5. During about two weeks the remaining two horses were fed rations Nos. 1 and 4. Their rations were then reversed until the end of the period. In every case the conditions of work were uniform. No marked variations in weight were observed. This, in the author's opinion, shows that abrupt changes in the ration may be made without bad effects, and that "there is no so-called single ration for horses." In this connection it should perhaps be said that a great number of experienced feeders believe that feeding oats induces superior mettle and on this account recommend them for race horses and other fine stock.

From January 26 to April 9, the author further studied the value of oats, corn, and bran, in different combinations and at the same time tested the comparative value of timothy hay and corn stover. The rations fed consisted of 12 pounds of hay or corn stover alone, or with 14 pounds of corn, oats, and bran in different mixtures, the most usual one being made up of equal parts of two of the grains. Four of the horses gained in weight and one remained practically unchanged. Although corn stover costs only one-third as much as timothy hay, the author believes that it "has a feeding value, when fed either with corn and oats or corn and bran in the proportions it has been here, equal to timothy hay, and also when corn stover or timothy hay furnish the roughage of a ration, oats and corn half and half, and bran and corn half and half, have, generally speaking, equivalent feeding values."

To learn whether it was possible to substitute other grains for oats during a long period in summer feeding, the horses were continued on the grain rations mentioned in the preceding paragraph until October 8, being fed in every case 12 pounds of timothy hay per head daily. Three of the horses remained practically unchanged as regards weight, while two gained somewhat. The results show, according to the author, that bran, which is much the cheaper of the two, may be substituted for oats. The horses were continued on the same ration until April 29 to test the comparative value of bran and oats for winter feeding. One horse lost a little; the other gained. "These long periods of both summer and winter feeding show the value of the corn and bran ration for horses. The results evident from these experiments are fully consistent with all that has preceded."

The amount of water consumed was recorded in all these tests. According to the author, both the ration consumed and the amount of work performed influence the quantity of water drunk by work horses, although the individuality of the horse has the most marked effect. In this investigation the quantity of water varied from 25,895 to 32,997 pounds per year.

Following are the principal conclusions drawn from the experiments as a whole:

Any food stuff or combination of food stuffs furnishing the desirable nutrient at least cost should be considered in preparing rations for horses. A mixture of bran and corn, half and half, is a good substitute for corn and oats for feeding work horses. Corn stover is a good substitute for timothy hay for winter feeding of horses because of its feeding value, the yield per acre, and commercial value. A change from a grain mixture, consisting partially of linseed-oil meal, slowly or abruptly, does not cause a decrease in weight in horses if a proper substitute ration is fed. The average total cost per year for actual food supply per horse was $74.32. The average cost for feed per hour's work done during two years was 3.4 cents.

POISONING OF HORSES BY THE FIELD HORSETAIL.

Recent observations and experiments at the Vermont Station indicate that a considerable number of horses are annually poisoned by eating a plant known as the field horsetail. This plant, also known by various other names, such as scouring rush, coltstail, jointed rush, sour rush, etc., is generally distributed throughout the northern half of the United States. The plant appears in two forms, the sterile stems being green and finely branched, while the fertile stems are pale yellow or brown, unbranched, and furnished with scales at each joint of the stem (fig. 2). The plant grows most abundantly on sandy or gravelly soil, especially where floods occur in the spring or where the soil is quite moist, at least during a portion of the year. Observations made at the Vermont Station indicate that the plant is poisonous when eaten in considerable quantities and for a long period. No evidence was obtained to show that the plant is poisonous in the fresh state. In the form of hay, however, the

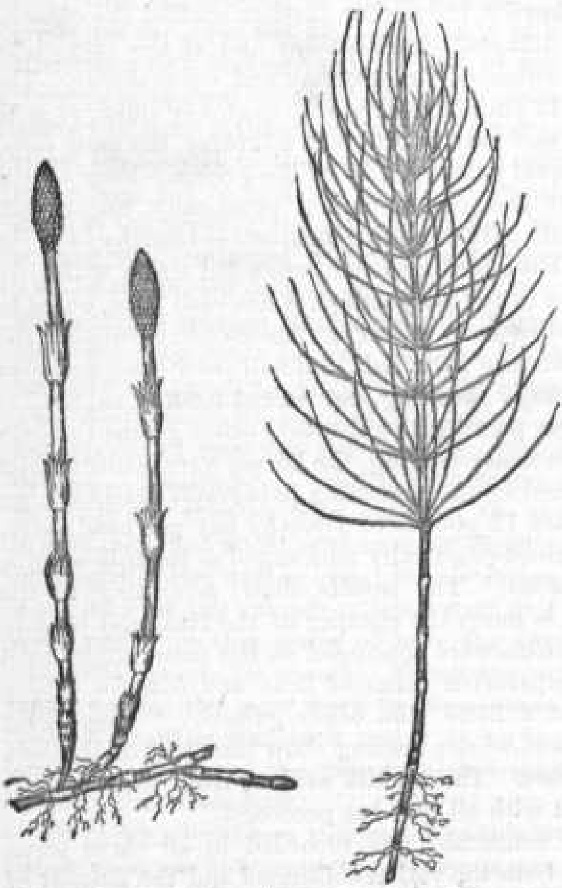

FIG. 2.—The common field horsetail (*Equisetum arvense*). The two upright stalks at the left represent the fruiting stems, which are pale yellowish in color and come up in early spring from the rooting branch below. On the right is one of the much-branched, many-jointed green shoots which arise later, and continue to grow all summer. It is these which cause the poisoning.

poisonous symptoms are produced within from a few days to four weeks, depending on the age and condition of the animal. Young animals are more susceptible than old horses and manifest the symptoms of poisoning more quickly. The first symptoms consist in unthriftiness and loss of flesh. Later the horse loses control of its muscles, staggers, and finally becomes unable to stand. Until the later stages appear, however, the appetite is good. It was observed that horses which were fed grain resisted the action of the plant much longer than those which did not receive grain. Apparently the animals acquire a depraved appetite for the plant after feeding upon it for some time. Treatment should be largely preventive. As soon as symptoms of poisoning are observed, the horsetail hay should be excluded from the ration and the animals may be given a purgative containing 1 ounce of Barbados aloes and 1 to 3 drams of ginger or a quart of raw linseed oil, after which it is advisable to give the animal a teaspoonful of powdered nux vomica, three times a day, until control of the muscles is restored.

Reports have been made in Europe concerning poisoning of cattle and horses from eating a related species of horsetail. This species also occurs in the United States, but according to the observations of German investigators it appears to be more poisonous to cattle than to horses.

FATTENING BEEF CATTLE FOR THE MARKET.

The Iowa Station has recently reported experiments made in cooperation with a large cattle feeder on large lots (11 lots of 20 animals each) of fair quality 3-year old Western cattle, in which 93 cents per bushel were realized for the corn consumed in case of the lot with which this was the sole food used, and "all the lots paid much higher prices for corn than could have been received for the same at any of the markets during the feeding period." The experiments as a whole show very strikingly the high value of corn and its by-products—gluten meal and feed—for fattening cattle for the market. The average net profit per steer from ninety-four days' feeding was, on corn alone, $14.49; corn and grass, $14.97; corn and dried blood, $15.36; corn and gluten feed, $17.60; and corn and gluten meal, $17.99. The lowest profits were realized when corn was used in connection with certain proprietary stock foods, due to the fact that the market price of the latter was very high as compared with the actual amounts of nutritive material which they contain.[a] It would appear that with corn at from 50 to 60 cents per bushel and fat steers bringing from $7 to $7.65 per hundredweight there is no more profitable use to be made of corn than to convert it into beef.

[a] U. S. Dept. Agr., Farmers' Bul. 73 (Experiment Station Work—IV), p. 25; 144 (Experiment Station Work—XIX), p. 22.

DIFFERENCE IN PROFIT FROM DAIRY COWS.

A good illustration of the difference in profit from dairy cows under like conditions is furnished by a recent bulletin of the Illinois Station.

Two grade cows of no known breeding, named Rose and Nora, and aged, respectively, 9 and 6 years, were treated as nearly alike in every respect as possible. The feeding stuffs used were clover hay, various green feeds, and a mixed grain ration. The experiment lasted one year. The food consumed and the milk and butter produced during this period are shown in the following table:

Food consumed and milk and butter produced during one year by two cows.

	Rose.	Nora.	Difference.
Food consumed:	*Pounds.*	*Pounds.*	*Pounds.*
Clover hay	3,873.10	3,547.50	325.60
Corn silage and green corn	8,107.50	8,082.00	25.50
Rape	2,482.00	2,482.00	....
Cowpeas	750.00	750.00	....
Corn meal	1,692.70	1,653.50	39.20
Wheat bran	1,256.50	1,158.00	98.50
Ground oats	670.10	567.60	102.50
Gluten meal	516.50	573.00	56.50
Old-process linseed meal	848.00	785.30	62.70
Total digestible dry matter consumed	6,477.92	6,189.06	288.86
Protein	1,117.02	1,067.24	49.78
Carbohydrates	4,982.09	4,755.43	226.66
Fat	378.81	366.39	12.42
Milk produced	11,329.00	7,759.40	3,569.60
Butter fat produced	564.82	298.64	266.18

The total food consumed by Rose was 20,196.4 pounds, by Nora 19,598.9 pounds, a difference of 597.5 pounds in favor of the former. As the object of the experiment was to compare the two cows on a like feed basis, it was estimated that Nora would have produced 8,121.6 pounds of milk and 312.53 pounds of butter fat had she eaten the same quantity of total digestible dry matter as Rose. Comparing the two cows, then, on this basis, there was a difference in their production of 3,207.4 pounds of milk and 252.27 pounds of butter fat, or, to express the comparison in a different way, for every 100 pounds of milk produced by Nora, Rose gave 139.5 pounds, and for every 100 pounds of butter fat produced by Nora, Rose gave 180.7 pounds. With butter at 16 cents per pound, the difference in the value of the butter produced by the two cows on the same feed basis was $47.09. Rose also made a greater gain in live weight than Nora.

These results go to show the very different returns dairy cows may make from the same kind and quantity of feed and also to emphasize the importance of testing dairy cows and of grading up a herd to a profitable standard of production, points which have been considered in an earlier number of this series.[a]

[a] U. S. Dept. Agr., Farmers' Bul. 114 (Experiment Station Work—XIV), p. 21.

EFFECT OF SHEARING ON THE GAINS MADE BY LAMBS.

In connection with a test of the comparative merits of spelt and barley for fattening lambs, Chilcott and Thornber, of the South Dakota Experiment Station, studied the effect of shearing on the profitable feeding of lambs already in condition to market. This was done because it is sometimes said that shearing a lamb which has been fed to the profitable limit for slaughtering purposes under ordinary conditions induces the animal to make still greater gains in weight. After a preliminary period of two weeks on brome grass, with all they would eat of a mixture of equal parts of spelt and barley, 24 lambs, each averaging 84 pounds in weight, were divided into two uniform lots of 12. Lot 1 was fed unground spelt, in addition to brome-grass hay, for fifteen weeks, the average gain per head per week being 1.67 pounds; the grain eaten per pound of gain, 7.47 pounds. Lot 2 was fed unground barley and brome-grass hay for the same length of time, gaining on an average 2.53 pounds per week and consuming 5.09 pounds of grain per pound of gain. The average weight of the lambs in the two lots at the close of this period was 109 and 122 pounds, respectively. Rating the lambs at 4 cents per pound, the authors calculate that they would have yielded a profit of 44 cents and 92 cents per head per lot, respectively, and it was believed that the lambs had reached the limit of profitable feeding. The rations previously fed were, however, continued for five weeks and the lambs shorn to learn whether this would induce further profitable gain. The total fleece from the two lots weighed, respectively, 79 and 80.5 pounds. The authors note that the amount of grain eaten steadily decreased during each succeeding week of the period. Lot 1 consumed only 77.25 pounds during the last week of the test, and lot 2 only 76.5 pounds. The decline was quite uniform and it is stated was not due to injudicious or careless feeding.

The lambs were not cloyed, but had simply reached the limit of their ability to profitably convert grain into mutton. The results of this part of the experiment are very conclusive and plain. Practically no returns whatever were obtained from the grain fed after the sheep were shorn, and consequently all the food, labor, and risk involved in keeping the sheep during this period was a total loss.

These sheep had undoubtedly been fed up to the limit before they were shorn, and the effect of the shearing * * * was entirely insufficient to materially affect their ability to lay on more flesh at a profit or, in some instances, to retain what they had already acquired. What the effect would have been had this shearing been done earlier, before they had reached the limit of profitable feeding, we can not, of course, determine from this experiment; nor can we say what the effect would have been had the grain ration been changed. Enough has been learned from this experiment to show that feeders should be very cautious about attempting to get profitable gains from sheep that have nearly reached the limit of profitable feeding, or are "finished," by simply taking their fleeces off, believing, as some feeders claim, that this will give them a new lease of life.

In this connection it is interesting to note that the Wisconsin, Michigan, and Ontario experiment stations have studied the effect of fall shearing on the gains made by lambs. The Wisconsin Station believed that, if done early, shearing hastened gains and made them slightly cheaper. The other two stations found no advantage in this practice, the Michigan Station regarding fall shearing as unfavorable.

SOFT PORK AND BACON.

It is a well-known fact that the material fed to pigs exercises a marked effect upon the carcass, especially the fat. For instance, the South Carolina and the Alabama experiment stations observed that the fat from pigs fed peanuts was oily and had a low melting point. According to the Alabama Station this was corrected in a measure by feeding corn before slaughter. The Canadian experiment stations for some years have studied the causes which produce soft pork.

G. E. Day, of the Ontario Agricultural College and Experimental Farms, tested the comparative value for fattening pigs of barley alone and in combination with corn, oats, or mangel-wurzels (raw and cooked), the special object being to determine the effect of the barley upon the firmness of bacon. The conclusion was reached that pigs having plenty of exercise and a mixed diet, or receiving a reasonable allowance of dairy by-products and mixed grain until they are over 100 pounds in weight, can be finished on corn without injuring the quality of the bacon. Close confinement in pens from birth to time of marketing tends to injure the quality of bacon, although the effect is not always well marked. The rational feeding of dairy products tends to produce excellent bacon and apparently compensates in a large measure for lack of exercise. The author observed a marked tendency to softness in the carcasses of unthrifty, unfinished pigs or those which had been kept on a maintenance ration to prevent their becoming too heavy while held for a rise in prices or other reason. Exclusive corn feeding during a somewhat extended period did not induce satisfactory gains, and the bacon produced was very soft and undesirable in quality. Feeding a mixture of two-thirds middlings and one-third corn at the beginning and one-third middlings and two-thirds corn at the end of the fattening period did not counteract the bad effects of the corn. Barley to the extent of one-half the ration appeared to mitigate the effect of the corn, but further investigations are regarded as necessary. Barley alone or in combination with oats and middlings produced bacon of first-class quality. As regards their effect on bacon, peas were similar to barley. So far as the experiments show, roots did not exercise an injurious effect upon the firmness of bacon.

Chemical studies of immature or unripe pork from pigs recently weaned were made by F. T. Shutt, of the Canada Central Experimental Farm. This pork contained a higher percentage of olein than firm pork. Apparently the fat of all young pigs contains a large amount of olein, and is consequently more or less soft. The investigations reported indicate that age and maturity or ripeness are factors of importance in producing firm fat. When the same ration was fed to mature and immature pigs, it was found that the fat of the latter invariably possessed a larger percentage of olein than that of the pigs on the same ration which were not slaughtered until they had reached a live weight of 180 to 200 pounds. It appears, therefore, that the olein content furnishes a reliable indication of relative firmness and may be safely used in the commercial rating of pork.

In the first series of experiments at this station with pigs fed corn, oats, barley, shorts, beans, peas, clover, and mangels, alone or in combination, the grains being fed whole or ground and the coarse fodders dry, soaked, or cooked, and with pigs pastured on clover, the pork rating highest was produced on a ration of equal parts of soaked oats, peas, and barley. Its olein content was 67.2 per cent and the melting point 35.6°. The pork rated lowest was produced on a soaked cornmeal ration, its olein content being 92.4 per cent and the melting point 27.7°.

In the second series of experiments, using the same feeds as in the first, with the addition of skim milk, rape, artichokes, and pumpkins, the pork rating the highest was produced on a ration of corn meal, oats, peas, and barley, skim milk, and sugar beets. Its olein content was 66.9 per cent and its melting point 32.3°. The least satisfactory pork was produced on beans, the olein content being 84.9 per cent and the melting point 29.5°.

From these results it appears that—

One great controlling factor in the quality of the pork of finished pigs lies in the character of the food employed. Indian corn and beans tend to softness, i. e., to increase the percentage of olein in the fat. If these grains are used, they must be fed judiciously if first-class, firm pork is to be produced. If fed in conjunction with skim milk, it has been shown that a considerable proportion of Indian corn may be used in the grain ration without injuring the quality of the pork.

A grain ration consisting of a mixture of oats, peas, and barley in equal parts gives a firm pork of excellent quality. Skim milk not only tends to thriftiness and rapid growth, but counteracts in a very marked manner any tendency to softness.

Rape, pumpkins, artichokes, sugar beets, turnips, and mangels can be fed in conjunction with a good ration without injuring the quality of the pork.

The fat of very young pigs and animals of unthrifty growth is softer than that of finished pigs that have increased steadily to the finishing weight.

PURIFYING MILK BY CENTRIFUGAL SEPARATION.

In spite of every effort at cleanliness, some impurities usually find their way into milk. These may be substances which are more or less soluble in milk and which no means can effectually remove. On the other hand, the impurities may be solids and in part or completely removable by straining, filtering, or centrifugal separation. The last-mentioned method is claimed by good authority to remove practically all solid impurities from milk. In this method the milk is run through the centrifugal separator in the usual way and the cream and skim milk are then mixed, the impurities being removed with the separator slime. This use of the centrifugal separator as a purifier of milk intended for retail trade has already reached some commercial importance. The disadvantages of the method, as pointed out by O. F. Hunziker in a recent bulletin of the New York Cornell Station, are the time and cost involved, and especially the fact that skim milk and cream when once separated do not mix well and when reunited the cream does not rise as abundantly as in fresh milk. "As the consumer judges the richness of milk largely by the amount of cream that rises on it, he naturally and unjustly regards centrifuged milk as an article poor in fat and is unwilling to pay the price it is really worth."

The effect of centrifugal separation upon the bacteria in milk has lately been studied at the Iowa Station. In seven experiments at different times during the year determinations were made of the number of bacteria present in whole milk and in the mixed skim milk and cream which had passed through the separator. The reduction in the number of bacteria in the different experiments due to centrifugal separation varied from 15 to 51 per cent. At the end of twenty-four hours milk which had been separated and afterwards mixed contained on an average considerably less acid than nonseparated milk. The keeping qualities of the milk, however, were considered as improved but little, if any, by separation. In eight other experiments at the same station it was found that the skim milk contained on an average about 29 per cent of the number of germs present in the whole milk, the cream 24 per cent, and the separator slime 47 per cent. The results of these experiments agree substantially with those obtained by other investigators. Centrifugal separation removes a good many germs from milk, but does not insure the complete removal of disease-producing bacteria, and it does not, according to the Iowa Station, improve to any great extent the keeping qualities of the milk. Its chief advantage lies in the removal of solid impurities.

CHEESE PRINTS.

As chemical analysis and the experience of users show, cheese is one of the most wholesome and nutritious of foods. The average composition of some of the more common cheeses is as follows:

Average composition of certain cheeses.

Kind of cheese.	Water.	Protein.	Fat.	Total carbohydrates.	Ash.	Fuel value per pound.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Cheddar	27.4	27.7	36.8	4.1	4	2,145
Full cream	34.2	25.9	33.7	2.4	3.8	1,950
Swiss	31.4	27.6	34.9	1.3	4.8	2,010
Skim milk	45.7	31.5	16.4	2.2	4.2	1,320
Cottage	72	20.9	1	4.3	1.8	510
Neufchatel	50	18.7	27.4	1.5	2.4	1,530

It will be seen that cheese contains large percentages of protein and fat, together with small amounts of carbohydrates and ash. In other words, it supplies fairly large amounts of both nitrogenous material and energy in proportion to its bulk. Notwithstanding its high food value, it is apparently eaten in much smaller amounts in this country than in some regions of Europe. According to the statistics gathered by the Connecticut (Storrs) Station, it furnishes only 0.4 per cent of the total food, 1.6 per cent of the total protein, and 1.6 per cent of the total fat in the average American diet. The cheese most commonly eaten is like the English Cheddar, and is known by that name.

The thoroughness with which this kind of cheese is digested by man was recently studied by H. Snyder at the Minnesota Station. He found that when a fairly large quantity was eaten with a ration of bread and milk 93 per cent of the protein and 95 per cent of the fat of the cheese was digested, the available energy being 93 per cent. Artificial digestion experiments showed that the pancreas ferment had much more effect on cheese than the peptic, indicating that it is digested in the intestines rather than in the stomach. According to Professor Snyder "this is probably the reason why cheese is characterized as a hearty food, and frequently causes digestive troubles when eaten. In such cases the amount of cheese consumed should be reduced to correspond with the digestive capacity of the individual."

In order to promote the manufacture of various kinds of cheese in this country, it is desirable to encourage greater consumption and thus increase the demand. Many believe that marketing cheese in more convenient and attractive forms would increase the consumption of this valuable food product. More attention is given to this matter in the case of butter than in the case of cheese. Some of the higher-priced sorts are marketed in small packages and jars, but the bulk of the cheese consumed is undoubtedly still marketed in large sizes, which are cut into slices and sold by the pound. Such slices do not keep well, since the freshly cut surface exposed to the air is large in proportion to the weight. E. H. Farrington, of the Wisconsin Station, has recently reported results of experiments on the manufacture of cheese in small sizes, the form chosen being suggested by the pound prints of butter which have proved so successful. The Cheddar cheese experimented with was made by the usual process, the only modification being in the pressing and in the "follower" used in the press. The curd was placed in a mold or hoop of rectangular shape, the bottom or "follower" of which was a carved board divided into a number of sections, each of which corresponded to a half-pound print of cheese. Two sections would of course represent a pound. The form of the prints is determined by the carving of the board, which may be of any size or design to suit any particular market. The sections can be readily cut apart when sold by the retailer. In the experiments at the University of Wisconsin the letters U W were stamped on each section of cheese. The thickness of the block of cheese is of course regulated by the amount of curd put into the mold each time. The cheeses shown in fig. 3 averaged very nearly 15 pounds in weight and were each divided into 15 prints. The dimensions of each block of cheese were 11.5 by 13.25 by 2.5 inches, each print being 2.5 by 2.5 by 4.25 inches. The cheese was pressed in an upright frame, the carved board placed at the bottom of the rectangular mold. The bandage cloth was large enough to cover the carved boards, the sides, and the bottom of the cheese. The ends were brought together on the smooth side of the cheese, the cloth being cut in such a way as to make smooth corners.

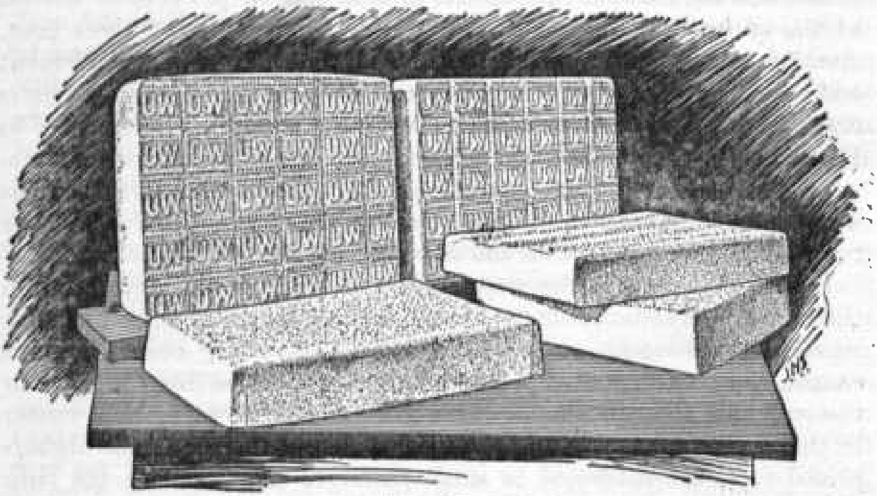

FIG. 3.—Cheese prints.

A metal hoop similar to the Cheddar cheese hoops, with fasteners, etc., it is believed can be made for this kind of cheese so that horizontal gang presses may be used and a number of cheeses put to press at the same time. By carving both sides of the board it can be used for molding two cheeses when the board is placed in the press between the cheeses.

At the Wisconsin Station no difficulty was experienced in curing these cheeses in the same way as Cheddar cheese is cured. The bottom and sides should be greased and the cheese turned occasionally, although it should not rest on the printed surface for a very long time. By exercising a little care in handling these cheeses during the curing process, according to Professor Farrington, they can be kept clean and attractive in appearance, and if well made from good milk will develop an acceptable flavor that, together with the trade-mark branded into each pound, will be helpful in protecting the reputation of a certain make of cheese. The Wisconsin Station print cheeses were cured in the regular Cheddar cheese-curing room at a temperature of 50° to 60° F. and a relative humidity of 60° to 70°. Professor Farrington thinks it very likely that print cheese may be satisfactorily cured in cold storage, and that the cheese so cured will possess a minimum of rind, with an excellent flavor and texture.

INFLUENCE OF THE HEIGHT OF WHEEL ON THE DRAFT OF FARM WAGONS.

This is a subject regarding which there is considerable difference of opinion. The Missouri Station has put the matter to practical test in a series of trials made on macadam, gravel, and dirt roads in all conditions, and on meadows, pastures, cultivated fields, stubble land, etc. With a net load of 2,000 pounds in all cases, three sets of wheels were tested, as follows: "Standard—front wheels, 44 inches; rear wheels, 55 inches. Medium—front wheels, 36 inches; rear wheels, 40 inches. Low—front wheels, 24 inches; rear wheels, 28 inches." The results obtained and conclusions reached were, in brief, as follows:

For the same load, wagons with wheels of standard height drew lighter than those with lower wheels. The difference in favor of the standard wheels was greater on road surfaces in bad condition than on good road surfaces. Low wheels cut deeper ruts than those of standard height. The vibration of the tongue is greater in wagons with low wheels. For most purposes wagons with low wheels are more convenient than those of standard height. Wagons with broad tires and wheels of standard height are cumbersome and require much room in turning. Diminishing the height of wheel to from 30 to 36 inches in front and 40 to 44 inches in the rear did not increase the draft in as great proportion as it increased the convenience of loading and unloading the ordinary farm freight. Diminishing the height of wheels below 30 inches front and 40 inches rear increased the draft in greater proportion than it gained in convenience. On good roads, increasing the length of rear axle, so that the front and rear wheels will run in different tracks to avoid cutting ruts, did not increase the draft. On sod, cultivated ground, and bad roads wagons with the rear axle longer than the front one drew heavier than one having both axles of the same length. Wagons with the rear axle longer than the front one require wider gateways and more careful drivers, and are, on the whole, very inconvenient and not to be recommended for farm use. The best form of farm wagon is one with axles of equal length, broad tires, and wheels 30 to 36 inches high in front and 40 to 44 inches behind.

THE DISK PLOW.

The disk plow, which is a comparatively recent invention, is beginning to attract considerable attention on account of the effective work it is capable of doing under certain conditions. The principal feature of this plow in its more perfect form is a tempered steel disk (sometimes arranged in gangs of two or more) 25 to 30 inches in diameter, and usually set at an angle to the furrow and to the surface so as to turn and pulverize the soil, being kept from clogging and assisted in pulverizing the soil by an adjustable scraper. The disk is carried by a steel framework mounted on wheels and provided with a seat for the driver and levers for control and adjustment of the plow.

The disk plow as put on the market by various manufacturers has been subjected to extended practical trial with results which encourage the belief that it is destined to prove a useful farm implement. In view of the importance of the matter the North Dakota Station has been carrying on for three years past a series of comparative trials of six different makes of the disk plow and of the ordinary moldboard plow. In summing up the results of these trials Professor Ten Eyck says:

I am not yet ready to recommend any disk plow as preferable to the best moldboard plow, for general use on North Dakota farms. If you have a very hard, gummy soil, in which it is almost impossible to keep the required depth with the moldboard plow, the disk plow may be used very advantageously. Every large farm in North Dakota might profitably use one or more disk plows, but it would not be practicable at the present time to wholly replace the moldboard plow by the disk plow upon any farm in North Dakota.

I do not advise farmers to purchase disk plows at the present time, except after a thorough trial on their own farms. I believe that ultimately, when the disk plow has been fully perfected, it will be a success. These plows should be tried in all parts of the State, but they should be introduced at the expense of the manufacturers and not at the expense of the farmers.

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