

UNIVERSITY OF MINNESOTA
AGRICULTURAL EXPERIMENT STATION

SELECTION AND
PURCHASE OF FEEDERS AND
RATIONS FOR FATTENING BEEF CATTLE

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SELECTION AND PURCHASE OF FEEDERS AND RATIONS FOR FATTENING BEEF CATTLE

W. H. PETERS

INTRODUCTION

In the last fifteen years experiments to determine the most profitable methods of fattening beef cattle have been made by the Division of Animal Husbandry, of the University of Minnesota Agricultural Experiment Station. Results were reported in mimeographed form at the close of each trial. Several bulletins summarizing a part of the trials have been published. The supply of reports and bulletins previously published having been exhausted and a demand for the information contained in them still continuing, it seems desirable to summarize and publish a condensed report of all of the trials.

Most of the trials were made at University Farm, St. Paul, tho some were made at the Northwest Branch Experiment Station, at Crookston. Credit for gathering the data is due O. M. Kiser, H. W. Vaughan, L. M. Winters, A. L. Harvey, N. K. Carnes, Louis Vinke, S. G. Denner, George Wight, C. W. Means, R. Ramsey, and H. McMahon, all of whom served in carrying out one or more of the trials.

METHOD OF PROCEDURE

In most of the trials feeder calves were fattened, tho in some yearling and two-year-old steers were used and a few groups of heifers were fed. In some years the thin feeder animals were purchased for delivery direct from a ranch in the west; in some, the animals were purchased from Minnesota farmers, and in some years they were purchased at the South St. Paul market. In all trials the cattle to be fattened were purchased just prior to putting them on feed.

Dehorning and castrating.—In each trial the cattle were rested for from one to three weeks after arriving at the feeding sheds. During this period each year any cattle having horns were dehorned by the clipper method and bull calves were castrated, generally by the use of a knife, tho in the last four years with an emasculator.

Starting on feed.—During this rest period the thin cattle were accustomed to grain by feeding a mixture of about 60 per cent shelled corn or ground shelled corn and 40 per cent whole oats or ground oats, if corn was to be the principal grain fed in the trial; or a mixture of 50 per cent ground barley and 50 per cent ground oats, if barley was to be the principal grain fed. Thin calves, not accustomed to grain, were started on about 2 pounds of grain per head per day and yearlings and two-year-olds on 4 pounds of grain. The grain was increased at the

rate of a pound per head every other day. One feed of alfalfa hay and one of prairie or timothy hay per day were fed. Handled in this way the thin cattle were well accustomed to grain, tho generally not yet on full feed, when the initial weights were taken and the experimental rations begun. The inclusion of a rather high percentage of oats in the grain ration is believed to be especially beneficial to avoid scouring and digestive disturbances while starting thin cattle on feed. This is especially true with calves six to nine months old. Likewise, beginning with one feed of prairie or timothy hay and one feed of alfalfa per day is much more satisfactory than beginning with alfalfa as the only roughage.

Shipping fever.—Just what this disease is no one seems to know. Early symptoms are a tendency to scour, a lack of appetite, coughing, and a high fever. The behavior of cattle affected with shipping fever closely resembles that of hogs affected with swine influenza. It is not uncommon for as many as half of a shipment of thin feeder cattle, particularly if they are calves, to develop symptoms of shipping fever at any time during the first ten days after arrival. Generally, most of the cattle recover in about a week, but often a few severe cases of pneumonia will develop, and there may be a death loss as high as 6 per cent. In the purchase of approximately one thousand thin feeder cattle that have been used in the feeding trials reported in this bulletin, there have been opportunities to watch several groups of cattle pass through the shipping fever sickness. About one-third of all of the groups purchased showed some infection. In some years there was no infection, but in two years, the infection was severe. Of the 1,000 head of cattle purchased over a period of fifteen years, there was a death loss of 10 head, or one per cent, from shipping fever; or, putting it more correctly, from pneumonia following shipping fever symptoms. Some of the groups of cattle purchased were vaccinated for the prevention of the disease. The experience with these groups leads to the conclusion that vaccination can not be depended upon to prevent the disease. The best precautions that can be taken against it may be listed as follows:

Reject any animals that appear sick or are scouring.

Avoid purchasing cattle that are "yard stale," that is, cattle that have been held at the market three or four days or more, waiting for a buyer.

Provide a well ventilated shed with a good roof and a dry, well bedded floor, into which the cattle can go in cold or wet weather. This is about the best preventive measure the cattle feeder can take to avoid the development of pneumonia following shipping fever symptoms.

Allotment of calves.—In all trials, lots to be compared were made as nearly uniform as possible in size, form, quality, thrift, condition, color, and any other points that might influence results. In most of the trials 10 cattle per lot were fed, tho in a few lots 8 head, and in one trial 12 head, were fed.

Shelter.—The different lots of cattle occupied similar quarters, consisting of a section of the feeding shed 24 x 24 feet and a small outdoor exercising lot. A hayrack, feed bunk, salt box, and water tank were all inside the shed. The clay floor of the shed was bedded with straw as needed, and the sheds were cleaned at intervals of 2 to 4 weeks.

Weights and feed records.—All weights and feed records were taken and kept according to standard methods used by experiment stations in lot feeding experiments.

Valuation of cattle.—Initial costs were always figured as the actual cost of the cattle delivered to the feed lot at the beginning of the trial. Selling prices at the close of the trial were estimated selling prices based on the South St. Paul market and were supplied by commission salesmen and packing house buyers. In every trial except one, actual selling prices a few days to several weeks after the close of the trial were a trifle higher than the estimated selling prices. In that trial, the cattle were held several weeks and during this period a declining market prevailed.

Duration of the trials.—The length of the feeding period each year was determined by the length of time required to put a majority of the animals in a suitable condition for slaughter. This varied from 112 days for two-year-old steers to 224 days for calves.

Feed prices charged.—The prices charged for the various feeds in each trial were determined by the prevailing market prices in the locality during the period covered by the trial. The trials were usually begun in October or November and closed the following May or June.

Hogs following the cattle.—Four or five feeder pigs were nearly always placed with each lot of cattle. Twice daily the hogs were hand-fed enough feed to enable all lots to make uniform gains of a pound or a little more than a pound per day. Complete records were kept of all feeds fed to hogs and of all gains in weight. When the hogs reached an average weight of 200 to 225 pounds, they were marketed and were replaced by new lots of feeder pigs weighing about 100 pounds per head. Generally, two or three lots of hogs were fattened with each lot of cattle.

Hog gains credited to cattle.—Each lot of cattle was credited with the pounds of pork produced by the pigs from feed that passed through the cattle undigested or was thrown out of the feed bunks. The amount of pork credited to each lot of cattle was the difference between the total hog gains and the gains produced by the additional feeds fed to the hogs. This deduction was determined from the records of a check lot of similar pigs full fed on grain. The figure "hog gains credited to cattle," cannot be considered 100 per cent accurate, but is reasonably accurate; as accurate as such a figure could be unless the pigs were getting all of their feed from the waste of the cattle, and that has not proved an economical method. The hogs should always have some feed in addition to what they salvage from the cattle.

PURCHASING FEEDER CATTLE

The results obtained in all feeding trials reported in this bulletin, in which the object was a comparison of different rations, will apply whether the feeder has raised his own animals or purchased them. Many cattle fatteners purchase all or part of the thin animals to be fattened. To these feeders, the item of purchasing the thin cattle is an all important one.

Thin cattle of many sorts of breeding, of several market classifications, and of several market grades within each class are to be had. In some localities, feeder cattle may be purchased from neighboring farms; at a large central market, or through commission agents, or from the owner for shipment from a ranch direct to the farm of the feeder.

When, where, and how to buy, and what breeding, market class and grade, sex, and age, to buy are questions confronting the cattle fattener. Such questions must be studied and decided for each enterprise.

Every fall there is a low time in the feeder cattle market. No one knows just when until after it has passed. It does not occur at the same time each year. No one can advise the cattle fattener just when is the best time to buy. It is better to buy when he is ready to start his cattle on feed, and when he can get the kind of cattle he wants. If suitable cattle can be purchased locally, at prevailing market prices, and driven to the farm of the feeder, it is generally best to do that. The place to buy depends on the location of the farm of the feeder and where the feeder cattle can be obtained.

How to buy will depend on the ability of the feeder to interpret market quotations and to judge accurately the market class and grade of the animals. If the feeder is expert enough as a buyer, he may depend on his own judgment and buy on his own account. The majority of feeders can profit by using the services of a co-operative livestock marketing association or some other reliable marketing agency, whether the feeders are purchased for delivery directly from a ranch or purchased from a large livestock market.

Several trials directed toward the obtaining of information that would help to answer questions concerning the influence of breeding, market class and grade, sex, and age, have been made and are reported.

Fattening Purebred, Grade, and Common Steer Calves

Ten purebred Hereford steer calves, 10 grade Hereford steer calves, and 10 common or "scrub" steer calves showing traces of Hereford breeding were fed the same feeds for 196 days. The ration consisted of shelled corn, ground oats, linseed meal, and alfalfa hay. The results are given in Table 1.

At the beginning of the trial the purebred calves averaged 487.6 pounds in weight, the grade calves 479.9 pounds, and the common calves 334 pounds. The purebreds and the grades both cost \$8.07 per hundredweight at the beginning; the common calves, \$4.14 per hundredweight. On this basis the breeders of the purebred calves received

\$39.35 per head for them, those of the grades \$38.73, and those of common calves only \$13.83. The common calves were approximately as old as the others. Unquestionably, the common calves were produced at considerable loss to the men who raised them and sold them as feeder calves.

Table 1
Fattening Purebred, Grade, and Common Calves for Market
December 15, 1921 to June 29, 1922—196 Days

Lot No.	1	2	3
No. of steers per lot	10	10	10
Description of feeders	Purebred	Grade	Common
Ration	All lots fed the same feeds.		
Initial weight, lb.	487.60	479.90	334.00
Final weight, lb.	923.16	916.98	796.82
Average gain per steer, lb.	435.56	437.08	462.82
Average daily gain per steer, lb.	2.22	2.23	2.36
Average daily feed:			
Shelled corn, lb.	8.46	8.50	7.74
Ground oats, lb.	3.34	3.35	3.02
Linseed meal, lb.	1.31	1.31	1.19
Alfalfa hay, lb.	5.33	5.47	5.19
Feed per 100 lb. gain:			
Shelled corn, lb.	380.70	381.16	327.90
Ground oats, lb.	150.07	150.17	127.80
Linseed meal, lb.	58.95	58.98	50.40
Alfalfa hay, lb.	239.85	245.29	219.80
Feed cost per 100 lb. gain*	\$7.06	\$7.09	\$6.14
Initial cost per 100 lb.			
Initial cost per head	8.07	8.07	4.14
Total cost of feeds	39.35	38.73	13.83
Final cost per head	30.75	30.99	28.44
Selling price, South St. Paul			
Selling price, Univ. Farm	9.40	9.10	7.05
Value per head, Univ. Farm	9.00	8.70	6.65
	\$83.08	\$79.78	\$52.99
Pork credit per steer, lb.			
Pork credit at \$10 per cwt.	31.70	26.00	28.10
Margin per steer over feed cost, excluding hogs	\$3.17	\$2.60	\$2.81
Margin per steer over feed cost, including hog gains	12.98	10.06	10.72
	16.15	12.66	13.33

* Feed prices charged: Shelled corn 42 cents per bu., ground oats 28 cents per bu., linseed meal \$45 per ton, alfalfa hay \$13 per ton.

The common calves were much thinner than the others at the beginning of the trial, hence they made more rapid gains and required less feed per pound of gain than did the purebred or grade calves.

When finished, the purebred calves were valued at \$9.00 per hundredweight, the grade calves at \$8.70, and the common calves at \$6.65. Even with this low valuation, the common calves returned more margin over feed cost during the fattening period than did the purebred or the grade calves. The common calves proved more profitable to the feeder because some one raised and sold them as feeders at a price considerably below cost of production. The breeder's loss was the feeder's gain.

Fattening Good, Medium, and Common Yearling Steers

Ten yearling steers graded by market experts as "Good," 10 graded as "Medium," and 10 graded as "Common," all showing some trace of Shorthorn breeding and all red or roan in color, were fed the same feeds for 189 days. The ration was a mixture of ground barley 85

per cent, ground oats 15 per cent, for the first 84 days, then shelled corn for the rest of the period. Throughout the trial, all lots were fed 1.5 pounds per steer per day of a protein supplement composed of one-third linseed meal, one-third cottonseed meal, and one-third corn gluten meal. Alfalfa hay was fed as the roughage. Pigs were placed with the cattle only when the cattle were getting shelled corn. The results are given in Table 2.

Table 2
Fattening Yearling Feeder Steers, Grading "Good," "Medium," and "Common"
December 12, 1930 to June 19, 1931—189 days

Lot No.	1	2	3
No. of steers per lot	10	10	10
Market grade of feeder steers	Good	Medium	Common
Ration	All lots fed the same feeds.		
Initial weight, lb.	765.2	594.5	515.1
Final weight, lb.	1,202.8	999.4	981.7
Average gain per steer, lb.	437.6	404.9	466.6
Average daily gain per steer, lb.	2.32	2.14	2.47
Average daily feed:			
Grain, lb.	16.43	13.80	14.13
Protein supplement, lb.	1.50	1.50	1.50
Alfalfa hay, lb.	7.01	5.86	5.89
Feed per 100 lb. gain:			
Grain, lb.	708.75	644.18	572.33
Protein supplement, lb.	64.61	69.83	60.60
Alfalfa hay, lb.	302.90	273.64	238.64
Feed cost per 100 lb. gain*	\$10.03	\$9.32	\$8.22
Initial cost per 100 lb.			
Initial cost per head	8.25	7.25	6.25
Total cost of feeds	63.13	43.10	32.19
Final cost per head	43.87	37.74	38.37
Final cost per head	107.00	80.84	70.56
Selling price, So. St. Paul			
Selling price, Univ. Farm	7.00	6.50	6.50
Value per head, Univ. Farm	6.50	6.00	6.00
Value per head, Univ. Farm	\$78.18	\$59.96	\$58.90
Pork credit per steer, lb.			
Pork credit at \$6.00 per cwt.	19.58	15.84	12.40
Margin per steer over feed cost, excluding hogs	\$1.18	\$0.95	\$0.75
Margin per steer over feed cost, including hogs	-28.82	-20.88	-11.66
Margin per steer over feed cost, including hogs	-27.64	-19.93	-10.91

* Feed prices charged: Shelled corn 53 cents per bu., ground oats 28 cents per bu., ground barley 42 cents per bu., protein supplement \$38 per ton, alfalfa hay \$15 per ton.

At the beginning of this trial the yearling feeders grading good averaged 765.2 pounds in weight; the medium, 594.5 pounds; and the common, 515.1 pounds. Those grading good cost \$8.25 per 100 pounds; the medium, \$7.25, and the common, \$6.25. The difference in weight of the feeder animals, as the grade was lowered, came largely from the fact that the medium and common calves, respectively, were longer legged, shallower bodied, inferior in shape, lacked natural fleshing, and were thinner than those grading good. These differences in desirability of the animals account for the lower costs as feeders.

The results of special interest in this trial are: (1) Both medium and common feeders made 100 pounds of gain on less feed than was required by those grading good, and the common feeders gained in weight more rapidly than the good ones. (2) When fat, the good feeders sold for \$7.00 per 100 pounds or \$1.25 less than they cost as feeders; the medium sold for \$6.50 per 100 pounds, or 75 cents less than they

cost; and the common sold for \$6.50 per 100 pounds, or 25 cents more than they cost. The low selling price and the high cost price on all groups was the result of a declining market throughout the period during which the cattle were being fattened. The result was a much smaller financial loss on the common cattle than on the medium and a smaller loss on the medium than on the good ones. What the result would have been if all lots had shown a profit instead of a loss is demonstrated in the next trial.

Fattening Good, Medium, and Common Feeder Calves

Twelve steer calves, graded by market experts as "Good"; 12 graded as "Medium," and 12 graded as "Common," all showing some trace of Hereford breeding, were fed the same ration for 224 days. The ration was shelled corn from the beginning of the trial on November 6 to April 1, and ground shelled corn from April 1 to the close of the trial, June 17. Linseed meal was fed, beginning with one-half pound per calf per day, and gradually increased to one and one-half pounds by the time the calves had reached a full feed of grain. Through most of the trial one feed of alfalfa and one of prairie hay per day were given. For the rest of the time, alfalfa hay was the only roughage fed. Because of the low prices of hogs prevailing at the time this trial was conducted, pigs were not placed with the cattle. Results are reported in Table 3.

Table 3
Fattening Feeder Steer Calves Grading "Good," "Medium," and "Common"
November 6, 1931 to June 17, 1932—224 days

Lot No. No. of steers per lot Market grade of feeder calves Ration	1	2	3
	12 Good All lots	12 Medium fed corn, linseed meal, alfalfa hay, and prairie hay.	12 Common
Initial weight, lb.	409.3	326.8	262.7
Final weight, lb.	899.4	843.9	759.6
Average gain per calf, lb.	490.1	517.1	496.9
Average daily gain per calf, lb.	2.18	2.30	2.21
Average daily feed:			
Shelled corn, lb.	11.14	10.22	8.97
Linseed meal, lb.	1.18	1.16	1.14
Alfalfa hay, lb.	3.02	2.79	2.73
Prairie hay, lb.	2.12	2.05	2.00
Feed per 100 lb. gain:			
Shelled corn, lb.	509.36	442.80	404.52
Linseed meal, lb.	54.31	50.36	51.62
Alfalfa hay, lb.	138.24	121.07	123.05
Prairie hay, lb.	98.90	89.10	90.38
Feed cost per 100 lb. gain*	\$5.86	\$5.16	\$4.93
Initial cost per 100 lb.			
Initial cost per head	7.25	5.50	4.00
Total cost of feed per head	29.67	17.97	10.51
Final cost per head	28.75	26.71	24.50
Final cost per head	58.42	44.68	35.01
Selling price, So. St. Paul			
Selling price, Univ. Farm	7.50	6.50	6.00
Value per head, Univ. Farm	7.00	6.00	5.50
Margin per head, over feed cost	62.95	50.63	41.78
Margin per head, over feed cost	4.53	5.95	6.77

* Feed prices charged: Shelled and ground shelled corn, 40 cents per bu., linseed meal \$30 per ton, alfalfa hay \$14 per ton, prairie hay \$9.00 per ton.

At the beginning of the trial the feeder calves grading "good" averaged 409.3 pounds in weight; the medium, 326.8 pounds, and the common, 262.7 pounds. Those grading good cost \$7.25 per 100 pounds, the medium, \$5.50, and the common, \$4.00. Just as with the yearlings reported in the previous trial, the difference in weight of the feeder animals as the grade was lowered was largely from the fact that the medium and common calves were longer legged, shallower bodied, inferior in shape, lacked natural fleshing, and were thinner than those grading good. These differences again account for the lower cost prices.

The results of this trial check very closely with the results in the trial reported just previously. (1) The medium and common feeder calves both made 100 pounds of gain on less feed than was required by those grading good, and the mediums actually gained in weight more rapidly than the good ones. (2) When fat, the good calves sold for \$7.50 per 100 pounds, or 25 cents more than they cost as feeders; the medium sold for \$6.50 per 100 pounds, or \$1.00 more than they cost, and the common ones sold for \$6.00 per 100 pounds, or \$2.00 more than they cost. The result was a larger profit on the common calves than on the medium and a larger profit on the medium than on the good feeders.

Interpretation of Results

Neither the cattle breeder nor the cattle fatterer should allow himself to become confused by the results of the three feeding trials in which cattle of different breeding and market grade were fed. It must not be concluded from them that it does not pay to raise good cattle. In each of the three trials, the cattle of better breeding and higher market grade had much higher values as feeders and as fat cattle than did the scrubs of low market grade. From the standpoint of the breeder and the cattle raiser, it is the total selling price of the animal as a feeder or a fat animal that largely determines the profit. From the standpoint of the cattle fatterer who purchases thin cattle and fattens them, it is the difference or margin between cost price of the feeder and the selling price of the fat animal that largely determines the profit. A low cost price of the feeder, therefore, may become just as important a factor in determining profit as a high selling price of the fat animal. If one farmer buys a feeder animal at a low price, that simply means that some other farmer has sold the animal at a low price; and while cheap, low-grade animals may mean profit to the fatterer; they can mean only loss to the man who raised them.

Several observations on the purchase and fattening of feeder animals of poor breeding and low market grade are of interest and importance. (1) When animals of low market grade are purchased to fatten they must be given even better care during the early part of the feeding period than better cattle because they are invariably more susceptible to physical ailments, generally because of the poor care they have had. (2) Once they get started on feed, animals of low market grade make

more efficient use of their feed than animals of higher market grade simply because they have been stunted and are thin. Such animals always show a rapid response to good feed. (3) Cattle of the lower feeder grades sell so much lower than cattle of the higher grades largely because everybody would rather fatten good cattle than poor ones. (4) The selling price per pound for feeder cattle of the lower grades when fat generally shows a wider margin over cost price than with the higher grades, because the addition of the proper amount of fat to the animal of low feeder grade actually does raise the carcass value of the animal more than it does the good feeder. The good feeder animal already has a large part of his carcass value when purchased as a feeder and the feeder buyer must pay for it, while the common animal has very little of his carcass value when purchased as a feeder, and, as a result, can be purchased at a relatively low price. (5) Only experienced cattle feeders should undertake the fattening of low-grade feeders, as such feeders must be selected more carefully and fed more carefully at the beginning than cattle of the higher grades. If a profit is to be made from the fattening of low-grade cattle, the animals must be fed good feeds and kept on feed long enough to put them in good market condition before they are sent to market.

Comparison of Steer and Heifer Calves

How do steer calves and heifer calves compare in rate of gain, cost of gain, time required to fatten, selling price, and profit? Does the feeding of steers and heifers together in the same lot decrease the rate of gain and increase the cost of gain, as compared with separating the steers and heifers and feeding them in different lots?

To answer these questions, a 217-day trial was carried out, with three lots of purebred and grade Hereford calves. The first lot contained 10 steer calves, the second 5 steers and 5 heifers, and the third 10 heifers. Purebreds and grades were distributed evenly in the three lots. All three lots were fed a ration of shelled corn, linseed meal, corn silage, and alfalfa hay. The results are given in Table 4.

The 10 steer calves and 10 heifer calves were each fed an average of 12.14 pounds of shelled corn and 2 pounds of linseed meal per head daily, and all the corn silage and alfalfa hay they would clean up twice a day for 217 days. The cost of feeding the heifers was \$1.40 per head higher because they ate more silage and alfalfa than the steers. Altho the heifers ate more feed, they made less gain. However, the hogs following the heifers made larger gains from wasted feed than did those following the steers.

Altho the heifers did not gain as fast as the steers, they were fatter at the finish, because the heifers did not grow so much as the steers. The gains of the heifers were more in fat and less in growth than those of the steers.

Table 4
Fattening Steer and Heifer Calves
November 13, 1925 to June 18, 1926—217 days

Lot No. No. of animals per lot	1	2	3
	10 Steers	5 Steers 5 Heifers	10 Heifers
Ration	All lots shelled corn, linseed meal, corn silage, alfalfa hay.		
Initial weight, lb.	451.00	449.20	449.03
Final weight, lb.	960.85	940.00	941.70
Average gain per calf, lb.	509.85	490.80	492.67
Average daily gain per calf, lb.	2.35	2.26	2.27
Average daily feed:			
Shelled corn, lb.	12.14	12.14	12.14
Linseed meal, lb.	2.00	2.00	2.00
Corn silage, lb.	7.57	7.30	8.87
Alfalfa hay, lb.	1.61	1.59	2.10
Feed for 100 lb. gain:			
Shelled corn, lb.	516.60	537.17	534.80
Linseed meal, lb.	85.10	88.49	88.10
Corn silage, lb.	322.12	323.00	390.75
Alfalfa hay, lb.	68.51	70.31	92.51
Feed cost per 100 lb. gain*	\$8.98	\$9.29	\$9.58
Initial cost per 100 lb.	8.00	8.00	8.00
Initial cost per head	36.08	35.94	35.92
Total cost of feeds	45.77	45.61	47.17
Final cost per head	81.85	81.55	83.09
Selling price, So. St. Paul	10.00	9.95	9.60
Selling price, Univ. Farm	9.50	9.45	9.10
Value per head, Univ. Farm	\$91.28	\$88.83	\$85.69
Pork credit per calf, lb.	36.60	38.18	59.65
Pork credit at \$11 per 100 lb.	\$4.03	\$4.20	\$6.56
Margin per calf over feed cost, excluding hogs	9.43	7.28	2.60
Margin per calf over feed cost, including hog gains	13.46	11.48	9.16

* Feed prices charged: Shelled corn 62 cents per bu., linseed meal \$48 per ton, corn silage \$4.50 per ton, alfalfa hay \$14.25 per ton.

In every respect the heifers indicated a greater degree of maturity and earlier maturity than the steers. This was shown in their greater feed consumption, slower gains, quicker finish, and larger pork credit. They were somewhat patchy at the tailhead and heavy in the brisket at the end of 217 days. However, even if the steers and heifers had been sold at the end of 140 or 168 days, the heifers would not have equaled the steers in price and profit. This is shown in Table 5.

Table 5
Fattening Steer and Heifer Calves
November 13, 1925 to June 18, 1926—217 days

	Steer calves	Steers and heifers	Heifer calves
Selling price, Univ. Farm			
April 2—140 days	\$8.30	\$8.25	\$8.15
April 30—168 days	8.85	8.85	8.65
June 18—217 days	9.50	9.45	9.10
Margin per head over feed cost			
April 2—140 days	\$4.48	\$2.71	\$2.80
April 30—168 days	7.64	6.73	5.98
June 18—217 days	13.46	11.48	9.16

The lot containing 5 steers and 5 open heifers was fed exactly the same amount of shelled corn and linseed meal as the lot of steers and the lot of heifers. The mixed lot consumed about the same amount of silage and alfalfa as the steer lot, but made less gain. The pork credit was about the same as in the steer lot. The heifers in the mixed lot fattened to a greater degree than the steers in the same lot. At the finish the heifers in the mixed lot showed more smoothness and quality than those in the heifer lot, which explains why the value of the mixed lot was nearly as high as that of the steer lot.

The 5 steers in the mixed lot made an average daily gain of 2.34 pounds, and the 10 steers in the steer lot averaged 2.35 pounds, or practically the same. The 5 heifers in the mixed lot made an average daily gain of 2.18 pounds, as compared to 2.27 pounds for the 10 heifers in the heifer lot. Therefore, it appears that if the heat periods lessened the gains in the mixed lot, it was not caused by a lessening of the steers' gains, but by a lessening of the heifers' gains only. It is doubtful whether the slower gains of the heifers in the mixed lot can be accounted for by the presence of steers in the same lot. There is little or no evidence in this trial that the feeding of mixed lots of steers and open heifers is objectionable. All the calves in the mixed lot were well finished at the close of the trial.

The following conclusions may be drawn from this trial: (1) Steer calves make larger and more economical daily gains than heifer calves, but the heifers fatten in less time. (2) When steer calves and heifer calves of the same breeding are purchased for feeding at the same price per pound, the steers sell at higher prices when finished and return a larger profit. In this trial, in order to have equaled the steers in profit the heifers should have been purchased at \$7.05 per 100 pounds, or 95 cents per 100 pounds cheaper than the steers. (3) There was little or no evidence that feeding steers and heifers in mixed lots is less profitable than feeding them separately.

Fattening Steers of Different Ages

One trial was carried out to secure data on the differences that prevail in the purchase and fattening of feeder cattle of different ages, such as the comparative cost of the thin cattle, length of time required to fatten, daily rate of gain, feed required per 100 pounds gain, and final selling price. Three lots of cattle were fed: Lot 1 consisted of 10 two-year-old grade Shorthorn steers; Lot 2, 10 yearling grade Shorthorn steers, and Lot 3, 10 grade Shorthorn steer calves.

Every effort was made to obtain steers for the different lots as nearly alike in breeding, quality, condition of flesh and thrift as possible. All lots were fed the same feed and each lot was allowed to eat what grain and hay would be eaten without waste. The ration was a mixture of ground barley, 85 per cent, and ground oats, 15 per cent, for the first 84 days of the feeding period. Then the barley and oats mixture was re-

placed with shelled corn. All lots were fed a protein supplement composed of one-third linseed meal, one-third cottonseed meal, and one-third corn gluten meal. Alfalfa hay was the roughage. The two-year-old steers were fed one pound of the protein supplement per head per day throughout the feeding period, the yearlings $1\frac{1}{2}$ pounds, and the calves one pound per head per day at the beginning. This was increased to $1\frac{1}{2}$ pounds after 84 days on feed, then to 2 pounds for the last two months. Pigs were placed with the cattle only when the cattle were getting shelled corn. Results are reported in Table 6.

Table 6
Fattening Two-Year-Old Feeder Steers, One-Year-Old Feeder Steers, and
Feeder Steer Calves
December 12, 1930 to June 19, 1931—189 days

Lot No.	1	2	3
Age of steers at beginning	Two years	One year	Calves
Length of feeding period	147 days	189 days	189 days
No. of steers per lot	10	10	10
Ration	All lots fed the same feeds.		
Initial weight, lb.	983.5	765.2	399.9
Final weight, lb.	1,378.4	1,202.8	856.8
Average gain per steer, lb.	394.9	437.6	456.9
Average daily gain per steer, lb.	2.69	2.32	2.42
Average daily feed:			
Grain, lb.	18.80	16.43	11.52
Protein supplement, lb.	1.02	1.50	1.40
Alfalfa hay, lb.	10.18	7.01	5.00
Feed per 100 lb. gain:			
Grain, lb.	700.00	708.75	476.34
Protein supplement, lb.	38.11	64.61	58.04
Alfalfa hay, lb.	378.83	302.90	206.50
Feed cost per 100 lb. gain*	\$9.95	\$10.03	\$7.05
Initial cost per 100 lb.	8.50	8.25	10.00
Initial cost per head	83.60	63.13	39.99
Total cost of feeds	39.28	43.87	32.23
Final cost per head	122.88	107.00	72.22
Selling price, So. St. Paul	8.00	7.00	7.50
Selling price, Univ. Farm	7.50	6.50	7.00
Value per head, Univ. Farm	\$103.38	\$78.18	\$59.98
Pork credit per steer, lb.	18.36	19.58	18.08
Pork credit at \$6.00 per cwt.	\$1.10	\$1.18	\$1.08
Margin per steer over feed cost, excluding hogs	-19.50	-28.82	-12.24
Margin per steer over feed cost, including hog gains	-18.40	-27.64	-11.16

* Feed prices charged: Shelled corn 53 cents per bu., ground oats 28 cents per bu., ground barley 42 cents per bu., protein supplement \$38 per ton, alfalfa hay \$15 per ton.

The respective costs of the cattle of the three different ages at the beginning of the feeding trial were: For the two-year-olds, \$8.50; for the yearlings, \$8.25; and for the calves, \$10 per 100 pounds. When fattened, the two-year-olds sold at \$8.00; the yearlings at \$7.00; and the calves at \$7.50 per 100 pounds. Because the general price trend was rather rapidly downward when this group of cattle was fed, a loss was experienced on all groups. The two-year-olds were ready for market some weeks ahead of the yearlings and calves, and for that reason sold to better advantage so far as selling price per pound is concerned as compared to cost price per pound. The calves could hardly be considered quite fat enough when they were sold and this affected their selling price

a little. For these reasons very little emphasis should be placed on the difference between the losses experienced on the three lots of the three different ages.

Several conclusions of importance can, however, be drawn from the results secured:

1. It required 125 days of feeding to put the two-year-old steers in proper condition for slaughter, 170 days for the yearlings, and the calves at 189 days were not quite fat enough. All lots were in good grass condition at the beginning of the trial.

2. The two-year-olds ate the largest amount of grain per head daily, 18.8 pounds; the yearlings ate 16.43 pounds, and the calves 11.52 pounds. The difference in daily consumption of hay per head was more pronounced, the two-year-olds eating 10.18 pounds, the yearlings, 7.01 pounds, and the calves, only 5 pounds.

3. When it comes to the feed required per 100 pounds of gain, the two-year-olds took 700 pounds of grain plus 38.11 pounds of protein supplement, and the yearlings 708.75 pounds of grain plus 64.67 pounds of protein supplement, to make 100 pounds of gain. The calves required a great deal less feed to make 100 pounds of gain, using only 476.34 pounds of grain and 58.04 pounds of protein supplement. The effect of this difference on the cost of gains resulted in a cost per 100 pounds gain of \$9.95 for the two-year-olds; \$10.03 for the yearlings, and \$7.05 for the calves.

4. It is safe to conclude from this trial that it takes more feed per 100 pounds gain to fatten yearling and two-year-old steers than it does to fatten calves. It is also safe to conclude that, generally, cost of gains per 100 pounds will be considerably higher for yearlings and two-year-olds than for calves. Profit or loss will, however, be determined more by the comparative cost price and selling price per 100 pounds. While the calves had a decided advantage in this trial because of their lower initial weight and consequent smaller loss because of the declining market, on a steady market or a rising market this factor would favor the heavier cattle.

STANDARD CORN-BELT RATIONS FOR FATTENING CATTLE

Corn and a Legume Hay

As long as 60 to 70 years ago beef cattle were being fattened extensively in the great corn-growing area of the United States by feeding, generally, ear corn, prairie hay, salt, and water. The first step in the improvement of this ration was the feeding of shelled corn rather than ear corn. The second step was the feeding of clover hay rather than prairie hay. Then for a considerable time shelled corn, clover hay, salt, and water remained the standard ration. Then came the silo and the addition of corn silage to the corn and clover hay, and then the use of high-protein, supplemental feed, added either to the corn and clover

or to the corn, clover, and silage ration. In this period alfalfa came into use on many farms in place of clover. A comparison of these old standards or "standard rations" is of interest.

Corn, a Legume Hay, and Corn Silage

On corn-belt farms on which silage is available, it is common practice to add silage to the corn and clover or corn and alfalfa ration. It has been demonstrated by many experiments at several different experiment stations that the addition of silage only to a ration of corn and clover hay or corn and alfalfa hay is of doubtful value. One trial conducted at this station bears out the conclusion. In this trial one lot of 10 purebred and grade Aberdeen-Angus calves was fed for 224 days on a ration of shelled corn and alfalfa hay; a second lot of 10 similar calves was fed shelled corn, alfalfa hay, and corn silage. Results of the trial are given in Table 7.

Table 7
Adding Corn Silage to a Shelled Corn-Alfalfa Ration
November 2, 1923 to June 13, 1924—224 days

Lot No. No. of calves per lot Ration	1 Shelled corn Alfalfa hay Silage	2 Shelled corn Alfalfa hay
Initial weight, lb.	445.03	446.64
Final weight, lb.	898.43	915.63
Average gain per calf, lb.	453.40	468.99
Average daily gain per calf, lb.	2.02	2.09
Average daily feed:		
Shelled corn, lb.	13.34	13.25
Corn silage, lb.	4.34	
Alfalfa hay, lb.	1.83	3.45
Feed per 100 lb. gain:		
Shelled corn, lb.	603.96	634.00
Corn silage, lb.	214.85	
Alfalfa hay, lb.	90.59	165.07
Feed cost per 100 lb. gain*	\$8.95	\$8.75
Initial cost per cwt.	7.00	7.00
Initial cost per head	31.15	31.26
Total cost of feeds	40.59	41.02
Final cost per head	71.74	72.28
Selling price, So. St. Paul	9.45	9.70
Selling price, Univ. Farm	8.95	9.20
Value per head, Univ. Farm	\$80.41	\$84.24
Pork credit per calf, lb.	32.51	30.18
Pork credit at \$6.30 per cwt.	\$2.05	\$1.90
Margin per calf over feed cost, excluding hogs	8.67	11.96
Margin per calf over feed cost, including hog gains	10.72	13.86

* Feed prices charged: Shelled corn 65 cents per bu., corn silage \$5.00 per ton, alfalfa hay \$17 per ton.

While the addition of corn silage to the corn-alfalfa ration produced no great effect, it did lower the rate of gain a little, increased the cost of gain, lowered the degree of finish and the selling price a little, and decreased the profits by \$3.14 per head. It seems that the addition of silage only to the corn-alfalfa ration is of doubtful value.

Corn, a Legume Hay, and a Protein Supplement

For the last twenty-five or thirty years, it has been the practice on many cattle-feeding farms to add from one to two pounds per head per day of a high-protein supplemental feed to the ration of corn and a legume hay. Linseed meal, cottonseed meal, corn gluten meal, and soybean oilmeal are all used for this purpose. Because it is produced within the state and the others are not, linseed meal has been used for this purpose in Minnesota to a much larger extent than any of the others. Comparisons at many experiment stations have shown linseed meal to be at least equal to any of the others as a protein supplemental feed for fattening cattle. The addition of a high-protein supplemental feed to the ration of corn and a legume hay can generally be depended upon to increase the rate of gain, improve the finish, and slightly increase the selling price of the cattle. Whether it pays to add such a high-protein supplement to the corn and legume hay ration depends more upon the comparative cost of corn and the protein supplement, but nine times out of ten this price relationship is such that it does pay. One trial was made to get a comparison between a ration composed of shelled corn and alfalfa to one composed of shelled corn, alfalfa, and linseed meal. The trial was conducted with two lots of 10 high-grade Hereford calves each and is reported in Table 8. In this trial, with all feeds at very low prices, adding the linseed meal to the corn-alfalfa ration proved desirable.

Table 8
Adding Linseed Meal to the Shelled Corn—Alfalfa Ration
December 6, 1932 to June 6, 1933—182 days

Lot No. No. of steers per lot Ration	1	2
	Shelled corn Alfalfa hay	Shelled corn Linseed meal Alfalfa hay
Initial weight, lb.	493.0	494.0
Final weight, lb.	886.5	932.8
Average gain per steer, lb.	393.5	438.8
Average daily gain per steer, lb.	2.16	2.41
Average daily feed:		
Shelled corn, lb.	12.40	12.88
Linseed meal, lb.		1.50
Alfalfa hay, lb.	3.87	3.84
Salt and mineral, lb.	0.09	0.07
Feed for 100 lb. gain:		
Shelled corn, lb.	573.95	534.41
Linseed meal, lb.		61.20
Alfalfa hay, lb.	179.41	159.64
Salt and mineral, lb.	3.45	3.09
Feed cost per 100 lb. gain*	\$3.30	\$3.77
Initial cost per 100 lb.	7.00	7.00
Initial cost per head	34.51	34.58
Total cost of feed per head	12.98	16.54
Final cost per head	47.49	51.12
Selling price per 100 lb., So. St. Paul	6.25	7.00
Selling price per 100 lb., Univ. Farm	5.75	6.50
Value per head, Univ. Farm	\$50.97	\$60.63
Pork credit per steer, lb.	21.23	33.80
Pork credit at \$4 per cwt.	\$0.85	\$1.35
Margin per steer over feed cost, excluding hog gains	3.48	9.51
Margin per steer over feed cost, including hog gains	4.33	10.86

* Feed prices charged: Shelled corn 25 cents per bu., linseed meal \$23.50 per ton, alfalfa hay \$8.00 per ton, salt and mineral \$17.50 per ton.

Corn, Legume Hay, Corn Silage, and Protein Supplement

As pointed out in the preceding discussion, a ration composed of corn, a legume hay, and corn silage is not particularly satisfactory for fattening beef cattle. This is largely because cattle receiving this ration do not eat enough legume hay to satisfy their need for protein.

Several trials were made to determine the effect of correcting this deficiency by adding a protein supplement to the corn-legume hay-silage ration. In the first trial, the grain fed was a mixture of ground shelled corn and ground oats and the hay was red clover. In the second trial, shelled corn was the grain and the hay was alfalfa. Corn silage was fed to both lots in each trial and linseed meal was fed to one lot and none to the other in each trial. Results of the two trials are given in Table 9.

Table 9

Adding Linseed Meal to a Ration of Grain, a Legume Hay, and Silage

First trial—November 21, 1922 to June 26, 1923—217 days

Second trial—November 2, 1923 to June 13, 1924—224 days

Lot No. No. of calves per lot Ration	First trial		Second trial	
	1 10	2 10	1 10	2 10
	Grain Linseed meal Legume hay Corn silage	Grain Legume hay Corn silage	Grain Linseed meal Legume hay Corn silage	Grain Legume hay Corn silage
Initial weight, lb.	485.30	496.70	447.37	445.03
Final weight, lb.	986.02	956.50	966.60	898.43
Average gain per calf, lb.	500.72	459.80	519.23	453.40
Average daily gain per calf, lb.	2.31	2.12	2.32	2.02
Average daily feed:				
Grain, lb.	13.92	14.52	13.45	13.34
Linseed meal, lb.	1.55		1.85	
Corn silage, lb.	12.29	10.88	4.34	4.34
Legume hay, lb.	2.17	2.50	1.33	1.83
Feed per 100 lb. gain:				
Grain, lb.	602.60	684.90	580.00	660.40
Linseed meal, lb.	67.10		79.74	
Corn silage, lb.	532.03	513.20	187.07	214.85
Legume hay, lb.	94.00	117.92	57.32	90.59
Feed cost per 100 lb. gain*	\$10.20	\$9.59	\$9.61	\$8.95
Initial cost per cwt.	7.17	7.17	7.00	7.00
Initial cost per head	34.80	35.61	31.32	31.15
Total cost of feeds	51.07	44.11	49.88	40.59
Final cost per head	85.87	79.72	81.20	71.74
Selling price, So. St. Paul	10.50	10.00	10.10	9.45
Selling price, Univ. Farm	10.00	9.50	9.60	8.95
Value per head, Univ. Farm	\$98.60	\$90.87	\$92.79	\$80.41
Pork credit per calf, lb.	51.48	39.01	28.14	32.51
Pork credit at \$6.30 per cwt.	\$3.24	\$2.46	\$1.77	\$2.05
Margin per calf over feed cost, excluding hogs	12.73	11.15	11.59	8.67
Margin per calf over feed cost, including hog gains	15.97	13.61	13.36	10.72

* Feed prices charged: (First trial) Shelled corn 59 cents per bu., oats 34 cents per bu., linseed meal \$49 per ton, corn silage \$4.25 per ton, clover hay \$12.11 per ton. (Second trial) Shelled corn 65 cents per bu., linseed meal \$48 per ton, corn silage \$5.00 per ton, alfalfa hay \$17 per ton.

In both trials the cattle receiving linseed meal in addition to grain, a legume hay, and corn silage made more rapid daily gains than did those not receiving linseed meal but the feed cost was slightly higher per 100

pounds gain. Those receiving linseed meal sold at a higher price per pound and returned the larger margin over feed costs.

In a third trial—to test the value of the complete ration of grain, a legume hay, corn silage, and a protein supplement—three lots, each containing 10 purebred Hereford steer calves, were fed for 196 days. For the first 136 days the grain mixture consisted of 60 per cent shelled corn, 30 per cent ground oats, and 10 per cent linseed meal; for the other 60 days, a mixture of 75 per cent shelled corn, 15 per cent ground oats, and 10 per cent linseed meal. All lots were given as much alfalfa hay as the calves would eat. Lot 1 was given all the corn silage the calves would eat; Lot 2, one-half as much silage as the amount consumed by Lot 1, and Lot 3 was given no silage. The results are given in Table 10.

Table 10
Fattening Calves With and Without Corn Silage in the Ration When
Shelled Corn Was the Grain Used
December 15, 1921 to June 29, 1922—196 days

Lot No. No. of calves per lot Ration	1 10 Full feed silage	2 10 Half feed silage	3 10 No silage
Initial weight, lb.	493.40	481.50	487.60
Final weight, lb.	955.30	938.76	923.16
Average gain per calf, lb.	461.90	457.26	435.56
Average daily gain per calf, lb.	2.36	2.33	2.22
Average daily feed:			
Shelled corn, lb.	7.78	8.35	8.46
Ground oats, lb.	3.09	3.23	3.34
Linseed meal, lb.	1.21	1.27	1.31
Corn silage, lb.	11.98	6.02	.....
Alfalfa hay, lb.	4.25	4.86	5.33
Feed per 100 lb. gain:			
Shelled corn, lb.	329.70	358.37	381.08
Ground oats, lb.	130.93	138.63	150.45
Linseed meal, lb.	51.27	54.50	59.00
Corn silage, lb.	507.63	258.37	.....
Alfalfa hay, lb.	180.08	208.58	240.09
Feed cost per 100 lb. gain*	\$6.72	\$6.85	\$7.06
Initial cost per cwt.			
Initial cost per head	8.07	8.07	8.07
Total cost of feeds	39.81	38.86	39.35
Final cost per head	31.02	31.34	30.75
Final cost per head	70.83	70.20	70.10
Selling price, So. St. Paul			
Selling price, Univ. Farm	9.30	9.30	9.40
Value per head, Univ. Farm	8.90	8.90	9.00
Value per head, Univ. Farm	\$85.02	\$83.55	\$83.08
Pork credit per calf, lb.			
Pork credit at \$10 per cwt.	37.10	34.30	31.70
Margin per calf over feed cost, excluding hogs	\$ 3.71	\$ 3.43	\$ 3.17
Margin per calf over feed cost, including hog gains	14.19	13.35	12.98
Margin per calf over feed cost, including hog gains	17.90	16.78	16.15

* Feed prices charged: Shelled corn 42 cents per bu., ground oats 28 cents per bu., linseed meal \$45 per ton, alfalfa hay \$13 per ton.

The principal advantage from the silage in this ration was that the calves receiving silage in addition to grain, a legume hay, and linseed meal, remained on feed a little more regularly than those receiving no silage. It was true that the silage-fed calves ate a little less grain and gained a little faster, but they sold 10 cents per 100 pounds lower than the calves fed no silage. The difference in margin over feed cost for

the three lots was small, but again the ration of grain, a legume hay, corn silage, and a protein supplement proved slightly more desirable than the same ration without the silage.

While in the three trials, the addition of linseed meal to a ration of grain, a legume hay, and corn silage increased slightly the daily feed consumption and cost of gains, it also increased the rate of gain, produced a higher finish and a higher selling price. The lots fed linseed meal in addition to corn, a legume hay, and corn silage returned the largest profit.

A study of Tables 8, 9, and 10 brings out the conclusions that a ration of corn alone and a legume hay proved fairly satisfactory for fattening cattle. The addition of silage only to this ration was detrimental rather than beneficial, but the addition of a protein supplement rather decidedly improved the ration of corn, a legume hay, and silage. It may be concluded that if silage is added to a ration of corn and a legume hay, a protein supplement should also be added.

Several Standard Cornbelt Rations Compared

There are four standard or commonly used cornbelt rations for fattening cattle. While all are satisfactory, they will generally be found profitable in the following order :

1. Shelled corn, a legume hay, corn silage, and a protein supplement.
2. Shelled corn, a legume hay, and a protein supplement.
3. Shelled corn and a legume hay.
4. Shelled corn, a legume hay, and corn silage.

BARLEY AS A GRAIN FOR FATTENING CATTLE

Ground Barley Compared with Shelled Corn

Cattle-fattening trials have been made by the Minnesota Experiment Station to determine the value of barley as a grain feed. Five trials have been conducted in which ground barley has been compared with shelled corn.

In the first trial, covering 196 days, Lot 1, 10 purebred Hereford steer calves, for 136 days was fed a mixture of 60 per cent shelled corn, 30 per cent ground oats, and 10 per cent linseed meal, together with as much alfalfa hay as the cattle would eat. For the other 60 days, the mixture was shelled corn, 75 per cent; ground oats, 15 per cent, and linseed meal, 10 per cent. Lot 2 was fed the same except that ground barley was substituted for the shelled corn. The results are given in Table 11.

The corn-fed calves made somewhat more rapid gains; their gains cost \$1.07 per hundredweight less than those of the barley-fed calves; the pigs following the corn-fed lot made twice as much gain from waste, and the corn-fed calves sold at a higher price when finished. For the

barley-fed calves the margin of profit over feed cost was \$6.91 per head. The margin on the corn-fed calves was \$16.15 per head, or \$9.24 per head more.

If the profits made in this trial are applied to the corn and barley consumed, then the corn lot returned 96 cents per bushel for shelled corn and the lot receiving ground barley returned 63 cents per bushel for whole barley.

Table 11
Ground Barley vs. Shelled Corn for Fattening Calves
December 15, 1921 to June 29, 1922—196 days

Lot No. No. of calves per lot Ration	1 10 Corn lot	2 10 Barley lot
Initial weight, lb.	487.60	494.30
Final weight, lb.	923.16	907.92
Average gain per calf, lb.	435.56	413.62
Average daily gain per calf, lb.	2.22	2.11
Average daily feed:		
Shelled corn, lb.	8.46	.....
Ground barley, lb. ....	.....	8.40
Ground oats, lb.	3.34	3.34
Linseed meal, lb.	1.31	1.30
Alfalfa hay, lb.	5.33	5.82
Feed per 100 lb. gain:		
Shelled corn, lb.	381.08	.....
Ground barley, lb. ....	.....	398.10
Ground oats, lb.	150.45	158.29
Linseed meal, lb.	59.00	61.61
Alfalfa hay, lb.	240.09	275.83
Feed cost per 100 lb. gain*	\$ 7.06	\$ 8.13
Initial cost per cwt.		
.....	8.07	8.07
Initial cost per head		
.....	39.35	39.89
Total cost of feeds		
.....	30.75	33.64
Final cost per head		
.....	70.10	73.53
Selling price, So. St. Paul		
.....	9.40	9.10
Selling price, Univ. Farm		
.....	9.00	8.70
Value per head, Univ. Farm		
.....	\$83.08	\$78.99
Pork credit per calf, lb.		
.....	31.70	14.50
Pork credit at \$10 per cwt.		
.....	3.17	1.45
Margin per calf over feed cost, excluding hogs		
.....	12.98	5.46
Margin per calf over feed cost, including hog gains		
.....	16.15	6.91

* Feed prices charged: Shelled corn 42 cents per bu., ground barley 43 cents per bu., ground oats 28 cents per bu., linseed meal \$45 per ton, alfalfa hay \$13 per ton.

The second trial, comparing ground barley with shelled corn, was made at the Northwest Branch Experiment Station, at Crookston. In this trial, Lot 1, composed of 8 high-grade Hereford steer and heifer calves, was fed shelled corn, linseed meal, corn silage, and alfalfa hay; Lot 2 received ground barley, linseed meal, corn silage, and alfalfa hay. The results are given in Table 12.

In this trial the barley-fed cattle compared quite favorably with the corn-fed cattle in every respect. Charging other feeds at cost and applying the rest of the selling price to the grain, shelled corn returned 95.8 cents for each bushel of corn fed and barley returned 77.6 cents for each bushel of barley.

Table 12
Ground Barley vs. Shelled Corn for Fattening Calves
November 9, 1926 to June 14, 1927—217 days

Lot No. No. of calves per lot Ration	1 10		2 10	
	Shelled corn Linseed meal Corn silage Alfalfa hay		Ground barley Linseed meal Corn silage Alfalfa hay	
Initial weight, lb.	374.99		372.49	
Final weight, lb.	883.99		853.37	
Average gain per calf, lb.	509.00		480.88	
Average daily gain per calf, lb.	2.34		2.21	
Average daily feed:				
Barley, lb.			10.53	
Corn, lb.	11.16			
Linseed meal, lb.	1.50		1.50	
Corn silage, lb.	9.71		9.55	
Alfalfa hay, lb.	2.78		2.53	
Feed per 100 lb. gain:				
Barley, lb.			475.59	
Corn, lb.	475.78			
Linseed meal, lb.	63.87		67.61	
Corn silage, lb.	414.04		431.14	
Alfalfa hay, lb.	118.90		114.32	
Feed cost per 100 lb. gain*	\$10.29		\$ 9.45	
Initial cost per cwt.				
	8.50		8.50	
Initial cost per head				
	31.87		31.67	
Total cost of feeds				
	52.37		45.44	
Final cost per head				
	84.24		77.10	
Selling price, So. St. Paul				
	11.25		11.00	
Selling price, Crookston				
	10.55		10.30	
Value per head, Crookston				
	93.26		87.89	
Margin per head over feed cost				
	9.92		10.79	

* Feed prices charged: Barley 55 cents per bu., corn 75 cents per bu., linseed meal \$47 per ton, corn silage \$5.00 per ton, alfalfa hay \$17 per ton. Cost of grinding grain, 8 cents per cwt.

The third trial, for a comparison of ground barley with shelled corn, was made at University Farm. Two lots containing 10 head each of high-grade Hereford yearling steers were fed for 175 days. Lot 1 was fed shelled corn, linseed meal, alfalfa hay, and corn silage. Lot 2 received ground barley, linseed meal, alfalfa hay, and corn silage. Results are given in Table 13.

In this trial, results were similar to those in the two preceding trials. Charging other feeds at cost, these steers returned \$1.24 per bushel for corn as contrasted with 94 cents per bushel for barley.

In the fourth trial, for a comparison of ground barley with shelled corn, two lots of high-grade Shorthorn yearling steers were fed for 161 days. Lot 1 received a ration of shelled corn, linseed meal, molasses, and alfalfa hay; Lot 2, a ration of ground barley, linseed meal, molasses, and alfalfa hay. Results are given in Table 14.

The results of this trial again check closely with those of the comparisons of ground barley and shelled corn already reported. In fact, a close study of Table 14 reveals the fact that the barley-fed cattle in this trial more nearly duplicated the performance of the corn-fed cattle than in the preceding trials; yet they did not quite equal the corn-fed cattle in final profit. The corn-fed cattle returned \$1.17 per bushel for shelled corn and the barley-fed cattle 83 cents per bushel for barley.

Table 13

A Comparison of Ground Barley and Shelled Corn as the Grain for Fattening Yearling Steers

November 4, 1927 to April 27, 1928—175 days

Lot No. No. of steers per lot Ration	1	2
	10 Shelled corn Linseed meal Alfalfa hay Corn silage	10 Ground barley Linseed meal Alfalfa hay Corn silage
Initial weight, lb.	681.30	687.20
Final weight, lb.	1,116.30	1,081.50
Average gain per steer, lb.	435.00	394.30
Average daily gain per steer, lb.	2.49	2.25
Average daily feed:		
Ground barley, lb.		12.48
Shelled corn, lb.	14.34	
Linseed meal, lb.	1.97	1.97
Alfalfa hay, lb.	4.30	4.29
Corn silage, lb.	12.71	12.20
Feed per 100 lb. gain:		
Ground barley, lb.		553.75
Shelled corn, lb.	576.97	
Linseed meal, lb.	79.14	87.30
Alfalfa hay, lb.	173.11	187.63
Corn silage, lb.	511.32	541.54
Feed cost per 100 lb. gain*	\$12.54	\$13.89
Initial cost per 100 lb.		
Initial cost per head	11.00	11.00
Total cost of feeds	74.94	75.59
Final cost per head	54.57	54.79
	129.51	130.38
Selling price, So. St. Paul		
Selling price, Univ. Farm	13.50	13.20
Value per head, Univ. Farm	13.00	12.70
	\$145.12	\$137.35
Pork credit per steer, lb.		
Pork credit at \$8.40 per cwt.	43.10	7.60
Margin per steer over feed cost, excluding hogs	\$3.62	\$0.64
Margin per steer over feed cost, including hog gains	15.61	6.97
	19.23	7.61

* Feed prices charged: Shelled corn 80 cents per bu., whole barley 76 cents per bu., linseed meal \$48 per ton, alfalfa hay \$13 per ton, corn silage \$5.00 per ton. Charge for grinding grain, 8 cents per cwt.

A fifth trial similar to the fourth was a comparison of shelled corn and ground barley in every way except that high-grade Hereford steer calves were fed instead of yearling steers as reported in Table 15.

In this trial, the calves receiving shelled corn returned 33 cents per bushel of corn and those receiving ground barley returned 18 cents per bushel of barley. The barley-fed calves gained a trifle more rapidly than the corn-fed calves. The results in these trials indicate that cane molasses gives a little better account of itself for producing gains when fed with barley than when fed with corn, principally by stimulating a larger consumption of barley.

A summary of the five trials comparing ground barley with shelled corn shows that 48 fattening cattle receiving shelled corn as their principal grain gained an average of 2.35 pounds per day through the fattening period, while the 48 receiving ground barley gained 2.28 pounds. The average selling price at the market per 100 pounds for the 48 corn-fed cattle was \$11.75, and for those receiving ground barley \$11.47. Pigs following the corn-fed cattle made an average of 41.92 pounds of

pork per steer; those following the ground-barley cattle made only 9.07 pounds. This indicates that it is of doubtful value to allow pigs to follow cattle receiving ground barley. The 48 fattening cattle receiving shelled corn returned an average price of 93 cents per bushel of shelled corn; the 48 head fed ground barley returned 67 cents per bushel of whole barley. These prices give shelled corn a value of \$1.66 per 100 pounds as contrasted with \$1.39 per 100 pounds of whole barley. Expressed in percentages, whole barley was worth 84 per cent as much per 100 pounds as shelled corn. As corn is sold at 56 pounds to the bushel and barley at 48 pounds, a bushel of barley is worth only 77 per cent as much as a bushel of corn for fattening cattle.

There are four reasons why whole barley is not worth so much, pound for pound, as shelled corn for fattening cattle: (1) A little more barley than corn is required to make 100 pounds of gain. (2) Shelled

Table 14
A Comparison of Ground Barley and Shelled Corn for Fattening
Yearling Steers
November 23, 1928 to May 3, 1929—161 days

Lot No. No. of steers per lot Ration	1 10	2 10
	Shelled corn Linseed meal Molasses Alfalfa hay	Ground barley Linseed meal Molasses Alfalfa hay
Initial weight, lb.	718.00	722.00
Final weight, lb.	1,104.00	1,118.00
Average gain per steer, lb.	386.00	396.00
Average daily gain per steer, lb.	2.40	2.46
Average daily feed:		
Shelled corn, lb.	13.90	.....
Ground barley, lb. ....	.....	14.18
Linseed meal, lb.	1.53	1.53
Molasses, lb.	2.53	2.53
Alfalfa hay, lb.	7.30	6.18
Feed per 100 lb. gain:		
Shelled corn, lb.	580.30	.....
Ground barley, lb. ....	.....	576.40
Linseed meal, lb.	63.80	62.20
Molasses, lb.	105.60	102.90
Alfalfa hay, lb.	304.60	251.10
Salt, lb.	1.06	1.14
Bonemeal, lb.	2.93	3.61
Feed cost per 100 lb. gain*	\$ 14.98	\$ 13.99
Initial cost per 100 lb.	11.25	11.25
Initial cost per head	80.77	81.22
Total cost of feeds	57.82	45.40
Final cost per head	138.59	136.62
Selling price, So. St. Paul	14.10	13.80
Selling price, Univ. Farm	13.35	13.05
Value per head, Univ. Farm	\$147.38	\$145.90
Pork credit per steer, lb.	45.30	0.00
Pork credit at \$10 per cwt.	\$ 4.53	\$ 0.00
Margin per steer over feed cost, excluding hogs	8.79	9.28
Margin per steer over feed cost, including hog gains	13.32	9.28

* Feed prices charged: Shelled corn 85 cents per bu., whole barley 64 cents per bu., pea-sized linseed meal \$62 per ton, powdered linseed meal \$61 per ton, molasses \$38 per ton, alfalfa hay \$15 per ton, salt \$30 per ton, bonemeal \$60 per ton. Charge for grinding grain, 8 cents per cwt.

Table 15

A Comparison of Ground Barley and Shelled Corn for Fattening Steer Calves
December 13, 1929 to June 20, 1930—189 days

Lot No. No. of steers per lot Ration	1	2
	10 Shelled corn Cane molasses Linseed meal Alfalfa hay	10 Ground barley Cane molasses Linseed meal Alfalfa hay
Initial weight, lb.	453.30	450.00
Final weight, lb.	887.30	900.00
Average gain per steer, lb.	434.00	450.00
Average daily gain, lb.	2.30	2.38
Average daily feed:		
Shelled corn, lb.	10.90	.....
Ground barley, lb. ....	.....	12.19
Molasses, lb.	1.91	1.91
Linseed meal, lb.	1.47	1.47
Alfalfa hay, lb.	3.60	3.28
Feed per 100 lb. gain:		
Shelled corn, lb.	474.70	.....
Ground barley, lb. ....	.....	512.04
Molasses, lb.	83.02	80.06
Linseed meal, lb.	63.86	61.59
Alfalfa hay, lb.	157.40	137.86
Feed cost per 100 lb. gain*	\$10.89	\$9.95
Initial cost per 100 lb.		
Shelled corn, lb.	13.50	13.50
Initial cost per 100 head	61.20	60.75
Total cost of feeds	47.26	44.77
Final cost per head	108.46	105.52
Selling price, So. St. Paul		
.....	10.60	10.25
Selling price, Univ. Farm		
.....	9.85	9.50
Value per head, Univ. Farm		
.....	\$87.40	\$85.50
Pork credit per steer, lb.		
.....	49.38	14.20
Pork credit at \$9.25 per cwt.		
.....	\$4.57	\$1.31
Margin per steer over feed cost, excluding hogs		
.....	-21.06	-20.02
Margin per steer over feed cost, including hog gains		
.....	-16.49	-18.71

* Feed prices charged: Shelled corn 78 cents per bu., whole barley 55 cents per bu., pea-size linseed meal \$56 per ton, cane molasses \$30 per ton, alfalfa hay \$15 per ton. Charge for grinding barley, 8 cents per cwt.

corn can be fed whole, while barley must be ground before feeding. (3) Pigs following cattle receiving shelled corn can salvage an appreciable amount of feed, while pigs following cattle receiving ground barley can salvage very little. (4) Cattle fattened on shelled corn sell at a slightly higher price per pound than cattle fattened on ground barley. This is because the corn-fed cattle show more bloom when finished for market and, while the beef may be no better or the dressing percentage be no higher for the corn-fed cattle, the salesman just can not overcome the argument of the buyer that barley-fed cattle do not quite measure up to corn-fed cattle in appearance.

The fact that the selling price of the animals need not be considered in many kinds of feeding indicates that barley might have a slightly higher feeding value for animals not being fattened than it has for fattening cattle. Even with a value for barley equal to only 84 per cent of that of corn, pound for pound, barley is not much inferior to corn as a fattening grain, especially in localities where corn is not grown or where barley might be produced at a lower cost per 100 pounds than corn.

PROTEIN SUPPLEMENT WITH CORN SILAGE, GROUND BARLEY, AND LEGUME HAY

It was demonstrated by two trials already reported (page 18) that when a ration of shelled corn, corn silage, and legume hay was fed to fattening cattle, a worth-while advantage was gained by the addition of from 1½ to 2 pounds of linseed meal per head per day. It was similarly demonstrated in two trials conducted at the Northwest Branch Station, at Crookston, that with a ration of ground barley, corn silage, and alfalfa hay, a protein supplement should also be fed. The two trials are reported in Table 16.

Table 16
Adding Linseed Meal to a Barley, Silage, and Alfalfa Ration
First trial—November 10, 1925 to June 8, 1926—210 days
Second trial—November 9, 1926 to June 14, 1927—217 days

Lot No. No. of calves per lot Ration	First trial		Second trial		Average of two trials	
	1 10	2 10	1 10	2 10	1 20	2 20
	Ground barley Linseed meal Alfalfa Corn silage	Ground barley Alfalfa Corn silage	Ground barley Linseed meal Alfalfa Corn silage	Ground barley Alfalfa Corn silage	Linseed meal	No linseed meal
Initial weight, lb.	465.71	479.99	372.49	375.20	419.10	425.59
Final weight, lb.	883.09	833.45	853.37	789.95	868.23	811.70
Average gain per calf, lb.	417.38	353.46	480.88	414.75	449.13	386.11
Average daily gain per calf, lb. ...	1.98	1.68	2.21	1.91	2.09	1.79
Average daily feed:						
Barley, lb.	10.40	10.52	10.53	10.22	10.47	10.37
Linseed meal, lb.	1.97	.....	1.50	.....	1.73	.....
Corn silage, lb.	10.32	10.12	9.55	9.52	10.48	9.82
Alfalfa hay, lb.	2.79	2.56	2.53	3.22	2.66	2.89
Feed per 100 lb. gain:						
Barley, lb.	523.40	625.53	475.59	534.80	499.49	580.66
Linseed meal, lb.	99.46	.....	67.61	.....	83.53	.....
Corn silage, lb.	512.29	601.55	431.14	498.13	475.22	549.84
Alfalfa hay, lb.	140.57	152.21	114.32	168.59	127.45	160.45
Feed cost per 100 lb. gain*	\$10.56	\$ 9.00	\$ 9.45	\$ 9.23	\$10.01	\$ 9.12
Initial cost per cwt.	7.35	7.25	8.50	8.50	7.93	7.93
Initial cost per head	34.22	35.28	31.66	31.89	32.94	33.58
Total cost of feeds	44.07	31.81	45.44	38.28	44.75	35.05
Total cost per head	78.29	67.09	77.10	70.17	77.69	68.63
Selling price, So. St. Paul	9.65	8.80	11.00	10.60	10.33	9.70
Selling price, Crookston	8.95	8.10	10.30	9.90	9.63	9.00
Value per head, Crookston	79.03	67.51	87.89	78.20	83.46	72.86
Margin per head over feed cost ...	0.74	0.42	10.79	8.03	5.77	4.23

* Feed prices charged: (First trial) Barley 45 cents per bu., linseed meal \$58 per ton, corn silage \$5.00 per ton, alfalfa hay \$15 per ton. (Second trial) Barley 55 cents per bu., linseed meal \$47 per ton, corn silage \$5 per ton, alfalfa hay \$17 per ton. Cost of grinding grain, both trials, 8 cents per cwt.

In the first trial, one lot of 8 high-grade Aberdeen-Angus steer and heifer calves was fed ground barley, corn silage, alfalfa hay, and 2 pounds of linseed meal per head per day. A second lot was fed the same ration without the linseed meal.

In the second trial, one lot of 8 high-grade Hereford steer and heifer calves was fed ground barley, corn silage, alfalfa hay, and 1½ pounds of linseed meal per head daily. A second lot was fed the same ration without the linseed meal.

In each trial the calves receiving linseed meal gained more rapidly and were valued at a higher price per pound at the close of the feeding period. In appearance, they were fatter and showed more bloom. Counterbalancing these advantages, however, calves receiving linseed meal in each trial showed a higher feed cost per 100 pounds of gain.

The final profit in each trial favored the calves fed linseed meal over those not receiving it, by a small margin. It may be concluded from the results of these two trials that it is advisable to add 1½ to 2 pounds of linseed meal per head per day to a ration of ground barley, corn silage, and alfalfa hay for fattening beef calves.

OATS AND SHELLED CORN FOR FATTENING CATTLE

Altho oats are known to be highly satisfactory as a part of the grain ration in starting cattle on feed, one trial showed that oats can not be used to advantage in the ration of shelled corn, linseed meal, corn silage, and alfalfa hay, once the cattle have been brought up to a full-feed of grain.

In this trial, one lot of 10 purebred and grade Aberdeen-Angus steer calves was fed a ration of shelled corn, linseed meal, corn silage, and alfalfa hay and a similar lot was fed the same ration with 20 per cent of the shelled corn by weight replaced with whole oats. Results are given in Table 17.

Table 17
Corn vs. Corn and Oats for Fattening Calves
November 2, 1923 to June 13, 1924—224 days

Lot No.	1	2
No. of calves per lot	10	10
Ration	No oats	Oats
Initial weight, lb.	447.37	446.80
Final weight, lb.	966.60	936.77
Average gain per calf	519.23	489.97
Average daily gain per calf, lb.	2.32	2.19
Average daily feed:		
Shelled corn, lb.	13.44	10.55
Whole oats, lb. ....	.....	2.64
Linseed meal, lb.	1.85	1.85
Corn silage, lb.	4.34	4.40
Alfalfa hay, lb.	1.33	1.33
Feed per 100 lb. gain:		
Shelled corn, lb.	579.74	481.73
Whole oats, lb. ....	.....	120.55
Linseed meal, lb.	79.74	84.47
Corn silage, lb.	187.07	200.90
Alfalfa hay, lb.	57.33	60.73
Feed cost per 100 lb. gain*	\$ 9.61	\$10.01
Initial cost per 100 lb.	7.00	7.00
Initial cost per head	31.32	31.28
Total cost of feeds	49.88	49.05
Final cost per head	81.20	80.33
Selling price, So. St. Paul	10.10	9.90
Selling price, Univ. Farm	9.60	9.40
Value per head, Univ. Farm	\$92.79	\$88.06
Pork credit per calf, lb.	28.14	33.75
Pork credit at \$6.30 per cwt.	\$ 1.77	\$ 2.13
Margin per calf over feed cost, excluding hogs	11.59	7.73
Margin per calf over feed cost, including hog gains	13.36	9.86

* Feed prices charged: Shelled corn 65 cents per bu., oats 36 cents per bu., linseed meal \$48 per ton, corn silage \$5.00 per ton, alfalfa hay \$17 per ton.

As shown in the table, the addition of oats to the ration lessened the rate of gain, increased the cost of gain, gave less finish, and resulted in a slightly lower selling price per 100 pounds. When oats were omitted from the ration, the margin of profit per calf was \$3.50 higher than when oats were fed.

Grinding Shelled Corn and Oats

As shown by another trial, grinding the shelled corn and oats reduced the profit still more, so that one could not hope to increase the profit of corn and oats, in comparison with shelled corn, by grinding them. The effect of grinding the corn and oats ration is shown in Table 18.

Table 18
Grinding Shelled Corn and Oats for Fattening Calves
November 21, 1922 to June 26, 1923—217 days

Lot No. No. of calves per lot Ration	1 10 Whole grain	2 10 Ground grain
Initial weight, lb.	483.50	483.30
Final weight, lb.	958.58	986.02
Average gain per calf	475.08	502.72
Average daily gain per calf, lb.	2.19	2.31
Average daily feed:		
Shelled corn, lb.	9.37	9.97
Oats, lb.	3.81	3.95
Linseed meal, lb.	1.47	1.55
Corn silage, lb.	10.44	12.29
Clover hay, lb.	2.26	2.17
Feed per 100 lb. gain:		
Shelled corn, lb.	427.85	431.60
Oats, lb.	173.97	127.60
Linseed meal, lb.	67.12	67.10
Corn silage, lb.	476.71	532.03
Clover hay, lb.	103.20	93.94
Feed cost per 100 lb. gain*	\$ 9.64	\$10.20
Initial cost per 100 lb.	7.17	7.17
Initial cost per head	34.67	34.80
Total cost of feeds	45.79	51.07
Final cost per head	80.46	85.87
Selling price, So. St. Paul	10.50	10.50
Selling price, Univ. Farm	10.00	10.00
Value per head, Univ. Farm	\$95.86	\$98.60
Pork credit per calf, lb.	55.92	51.48
Pork credit at \$6.30 per cwt.	\$ 3.52	\$ 3.24
Margin per calf over feed cost, excluding hogs	15.40	12.73
Margin per calf over feed cost, including hog gains	18.92	15.97

* Feed prices charged: Shelled corn 59 cents per bu., oats 34 cents per bu., linseed meal \$49 per ton, corn silage \$4.25 per ton, clover hay \$12.11 per ton. Cost of grinding grain, 8 cents per cwt.

In this trial the calves fed ground grain consumed more feed and made somewhat larger gains. The two lots sold at the same price per 100 pounds. The calves fed whole grain made somewhat cheaper gains, and the pigs following them made slightly more pork from wasted feed, so that the calves fed the whole grain made a profit of \$2.95 more per head than those fed the ground grain.

Oats and Ground Barley for Fattening Cattle

It is a common practice among feeders of all types of livestock to include some oats with the barley, when barley is being fed as the principal grain. Cattle fatteners have taken no exception to this established custom. Two reasons are generally given why some oats should be included, especially for calves. (1) Oats are known as a growth-producing feed and fattening calves need to grow as well as fatten. (2) It is common opinion that barley fed as the only grain to fattening cattle is likely to produce digestive disturbances, such as bloat and scouring. It is common opinion that replacing from one-fourth to one-half of the barley with oats will correct this undesirable characteristic of barley.

In two trials at the Northwest Branch Station, at Crookston, varying proportions of ground barley and ground oats were fed to fattening calves. In the first trial, four lots of 8 each of high-grade Hereford calves, mixed steers and heifers, were fed for 224 days. Lot 1 received ground barley, linseed meal, corn silage, and alfalfa hay; Lot 2, ground barley two-thirds, oats one-third, linseed meal, corn silage, and alfalfa hay; Lot 3, ground barley one-third, ground oats two-thirds, linseed meal, corn silage, and alfalfa hay; and Lot 4, ground oats, linseed meal, corn silage, and alfalfa hay. Results are given in Table 19.

Table 19
Ground Oats as a Substitute for Ground Barley for Fattening Calves
November 1, 1927 to June 12, 1928—224 days

Lot No. No. of calves per lot Ration	1 8	2 8	3 8	4 8
	Ground barley Linseed meal Corn silage Alfalfa hay	Ground barley, $\frac{2}{3}$ Ground oats, $\frac{1}{3}$ Linseed meal Corn silage Alfalfa hay	Ground barley, $\frac{1}{3}$ Ground oats, $\frac{2}{3}$ Linseed meal Corn silage Alfalfa hay	Ground oats Linseed meal Corn silage Alfalfa hay
Initial weight, lb.	395.23	378.95	380.23	379.03
Final weight, lb.	897.61	862.49	838.80	848.33
Average gain per calf, lb.	502.38	483.54	458.57	469.30
Average daily gain per calf, lb.	2.24	2.15	2.05	2.09
Average daily feed:				
Ground barley, lb.	10.72	7.00	3.49	.....
Ground oats, lb. ....	.....	3.50	6.98	10.24
Linseed meal, lb.	1.45	1.45	1.45	1.45
Corn silage, lb.	7.92	7.09	7.80	7.20
Alfalfa hay, lb.	2.47	2.11	2.37	2.13
Feed per 100 lb. gain:				
Ground barley, lb.	478.35	324.51	170.46	.....
Ground oats, lb. ....	.....	162.21	340.87	488.90
Linseed meal, lb.	64.94	67.16	70.65	69.20
Corn silage, lb.	353.57	328.48	381.21	343.78
Alfalfa hay, lb.	110.50	97.89	115.82	101.93
Feed cost per 100 lb. gain*	\$10.60	\$10.68	\$11.37	\$10.82
Initial cost per cwt.	11.60	11.60	11.60	11.60
Initial cost per head	45.84	43.96	44.10	43.96
Total cost of feed	53.25	51.64	52.13	50.77
Final cost per head	99.09	95.60	96.23	94.73
Selling price, So. St. Paul	13.75	13.50	13.20	12.75
Selling price, Crookston	13.00	12.75	12.45	12.00
Value per head, Crookston	116.68	109.97	104.40	101.80
Margin per head over feed cost	17.59	14.37	8.20	7.07

* Feed prices charged: Barley 72 cents per bu., oats 48 cents per bu., linseed meal \$50 per ton, corn silage \$5.00 per ton, alfalfa hay \$10 per ton. Cost of grinding grain, 8 cents per cwt.

It is seen from Table 19 that the calves fed ground barley as the only grain made slightly larger daily gains than those fed one-third oats, two-thirds oats, or oats alone, as the grain. A slightly smaller amount of barley was required to make 100 pounds gain than when the ration contained part oats or all oats. As barley and oats were charged at the same price per pound, this resulted in cheaper gains for the calves fed ground barley alone. After 224 days on feed, the barley-fed calves showed quite a desirable market finish; calves fed oats only as the grain were still under-finished from the market buyer's viewpoint. This difference in finish was so marked that the barley-fed calves sold a full dollar per 100 pounds higher than those fed oats as the only grain. This resulted in a larger margin over feed cost of \$10.52 per head for the barley-fed calves as against that of the oats-fed calves. This striking difference should lead the feeder of baby beef calves to consider carefully the extent to which oats should be used in preference to barley in the fattening ration. In this trial each of the four lots of calves remained on feed equally well, and the oats could be given no value as a stabilizing or conditioning agent in the ration. It seems that calves receive sufficient growth-producing feed when barley is fed as the only grain in a ration supplemented by a sufficient amount of high protein feed, together with a legume hay and corn silage, while the addition of oats retards the fattening process in proportion to the percentage of oats fed. Substituting oats for one-third of the barley gave results closely approaching the barley-alone ration, while substituting oats for two-thirds of the barley brought the margin over feed cost down almost as low as oats alone. The barley and oats used in this trial were of similar market grade. If barley of poor quality and oats of good quality are available, results would, no doubt, be more favorable to the use of oats.

In the second trial, in which oats were substituted for part of the barley in the ration for fattening calves, three lots each containing 8 high-grade Shorthorn steers were fed for 196 days. Lot 1 received ground barley, linseed meal, corn silage, and alfalfa hay; Lot 2, ground barley two-thirds, ground oats one-third, linseed meal, corn silage, and alfalfa hay; Lot 3 received ground oats alone during approximately the first half of the feeding period and ground barley alone during the last half, with linseed meal, corn silage, and alfalfa hay. The results of this trial are reported in Table 20.

In this trial, results for the three lots were so similar in daily rate of gain that no one of the three rations can be said to have had an advantage over the others in producing gains. There was a slight difference in finish in favor of the calves fed barley alone, resulting in a small advantage in selling price. All lots remained on feed equally well. Again it must be concluded that the substitution of oats for a part of the barley in the ration for fattening the baby beef calf has no definite advantage, and, with the two grains at approximately the same price per pound, barley alone is preferable. Substituting oats for a large percentage of the

barley would prove most detrimental in a short feeding period of less than 200 days, while it would prove least detrimental in a long feeding period of considerably more than 200 days. If a good quality of feed oats is underselling barley, pound for pound, by an appreciable difference, it would be desirable to replace any amount up to 50 per cent of the barley with oats.

Table 20
Oats as a Substitute for Barley for Fattening Calves
November 27, 1928 to June 11, 1929—196 days

Lot No. No. of calves per lot Ration	1 8 Barley Linseed meal Corn silage Alfalfa	2 8 Ground barley $\frac{2}{3}$ Ground oats $\frac{1}{3}$ Linseed meal Corn silage Alfalfa	3 8 Ground oats, 1st half Ground barley, 2nd half Linseed meal Corn silage Alfalfa
Initial weight, lb.	463.12	463.95	467.64
Final weight, lb.	917.29	920.83	930.20
Total gain, lb.	454.17	456.88	462.56
Average daily gain per calf, lb.	2.31	2.33	2.36
Average daily feed:			
Ground barley, lb.	12.70	8.59	14.41†
Ground oats, lb.		4.29	11.66†
Linseed meal, lb.	1.41	1.41	1.41
Corn silage, lb.	6.02	6.05	6.17
Alfalfa hay, lb.	2.73	2.66	2.66
Feed per 100 lb. gain:			
Ground barley, lb.	548.14	368.80	306.17
Ground oats, lb.		184.40	247.80
Linseed meal, lb.	61.26	60.90	60.29
Corn silage, lb.	260.06	259.83	262.37
Alfalfa hay, lb.	118.10	114.41	112.98
Feed cost per 100 lb. gain*	\$ 9.76	\$ 9.95	\$10.00
Initial cost per 100 lb.			
Initial cost per head	12.25	12.25	12.25
Total cost of feeds	56.73	56.83	57.28
Final cost per head	44.33	45.46	46.25
Final cost per head	101.06	102.29	103.53
Selling price, So. St. Paul			
Selling price, Crookston	14.15	14.00	13.90
Value per head, Crookston	13.45	13.30	13.20
Value per head, Crookston	123.37	122.47	122.78
Margin per head over feed cost	22.31	20.18	19.25

* Feed prices charged: Barley 52 cents per bu., oats 38 cents per bu., linseed meal \$60 per ton, corn silage \$5.00 per ton, alfalfa hay \$15 per ton. Cost of grinding grain, 8 cents per cwt. † For a period of 98 days.

WHOLE BARLEY FOR FATTENING CATTLE

While it is generally believed that barley must be ground to give satisfactory results in feeding any kind of livestock, there seemed a possibility that whole barley might be fed to fattening cattle with success similar to that attending the feeding of shelled corn or ear corn, when hogs are provided to salvage the feed wasted by the cattle. Two trials were made to compare whole barley with ground barley for fattening cattle, one at the Northwest Branch Station, at Crookston, in which two-year-old steers were fattened through a period of 112 days, and one at University Farm, in which yearling steers were fattened through a period of 175 days.

In the first trial, Lot 1, composed of 8 two-year-old grade Shorthorn steers, was fed whole barley, linseed meal, corn silage, and alfalfa hay; Lot 2 received ground barley, linseed meal, corn silage, and alfalfa hay. One pig to each two steers was placed with each lot in order that the extent of salvage from the whole barley ration might be determined. Results of the trial are given in Table 21.

Table 21
Whole Barley or Ground Barley for Fattening Two-Year-Old Steers
October 15, 1924 to February 3, 1925—112 days

Lot No. No. of steers per lot Ration	1	2
	8 Ground barley Linseed meal Corn silage Alfalfa hay	8 Whole barley Linseed meal Corn silage Alfalfa hay
Initial weight, lb.	1,113.38	1,116.66
Final weight, lb.	1,458.88	1,355.27
Total gain, lb.	345.50	238.61
Average daily gain per steer, lb.	3.08	2.13
Average daily feed:		
Ground barley, lb.	15.05	.....
Whole barley, lb. ....	.....	17.45
Linseed meal, lb.	1.67	1.82
Alfalfa hay, lb.	8.67	8.29
Corn silage, lb.	28.62	28.38
Feed per 100 lb. gain:		
Ground barley, lb.	488.34	.....
Whole barley, lb. ....	.....	765.56
Linseed meal, lb.	54.25	85.06
Corn silage, lb.	927.25	1,332.02
Alfalfa hay, lb.	281.33	389.26
Feed cost per 100 lb. gain*	\$13.79	\$20.19
Initial cost per 100 lb. 6.50 6.50		
Initial cost per head 72.39 72.58		
Total cost of feeds 47.64 48.17		
Final cost per head 120.03 120.75		
Selling price, So. St. Paul 8.90 8.60		
Selling price, Crookston 8.20 7.90		
Value per head, Crookston \$119.62 \$107.06		
Pork credit per steer, lb. 12.00 59.80		
Pork credit per steer at \$9.75 per cwt. \$ 1.17 \$ 5.83		
Margin per steer over feed cost, excluding hogs -0.41 -13.65		
Margin per steer over feed cost, including hog gains 0.76 -7.82		

* Feed prices charged: Barley 72 cents per bu., linseed meal \$50.50 per ton, alfalfa hay \$17 per ton, corn silage \$5.00 per ton. Cost of grinding grain, 8 cents per cwt.

In the second trial, comparing whole barley with ground barley, conducted at University Farm, two lots of high-grade yearling Hereford steers were fed. Lot 1 received ground barley, linseed meal, corn silage, and alfalfa hay; Lot 2 received whole barley, linseed meal, corn silage, and alfalfa hay. Results of this trial are given in Table 22.

It is seen from Tables 21 and 22 that both the two-year-old and the yearling steers receiving whole barley ate several pounds more barley each per day than those receiving ground barley, yet gained a good deal less in weight. The cattle fed ground barley were fatter at the close of each trial and sold at a slightly higher price per pound. While the hogs following the cattle fed whole barley did a fair job of salvaging feed, they

did not make anything like enough gains from the salvaged feed to make up for the higher feed consumption, slower gains, and lower selling price of the cattle fed whole barley, as compared to those fed ground barley. One unexpected result was that cattle fed whole barley ate much more barley per day than those fed ground barley. One would expect that whole barley being a hard grain, small in size, and covered with a fibrous hull would not be palatable. However, in both trials, the cattle eating whole barley ate their grain quickly and greedily, always seeming to be more hungry at feeding time than those receiving ground barley. The steers eating whole barley remained healthy throughout the trials and were not troubled with digestive disorders of any kind. They apparently swallowed a large part of the barley whole, and it passed through the digestive tract without being digested. The result was a low daily gain, a high feed cost per 100 pounds gain, a poor finish, a low selling price, and a loss per head instead of a profit.

It is doubtful whether it would pay to feed barley to fattening cattle without grinding it, even tho it was very low in price.

Table 22
A Comparison of Ground Barley and Whole Barley for Fattening
Yearling Steers
November 4, 1927 to April 27, 1928—175 days

Lot No. No. of steers per lot Ration	1 10	2 10
	Ground barley Linseed meal Alfalfa hay Corn silage	Whole barley Linseed meal Alfalfa hay Corn silage
Initial weight, lb.	687.20	692.70
Final weight, lb.	1,081.50	1,063.60
Average gain per steer	334.30	370.90
Average daily gain per steer, lb.	2.25	2.12
Average daily feed:		
Ground barley, lb.	12.48	.....
Whole barley, lb. ....	.....	14.84
Linseed meal, lb.	1.97	1.97
Alfalfa hay, lb.	4.29	4.30
Corn silage, lb.	12.20	14.76
Feed per 100 lb. gain:		
Ground barley, lb.	553.75	.....
Whole barley, lb. ....	.....	700.12
Linseed meal, lb.	87.30	92.82
Alfalfa hay, lb.	187.63	202.88
Corn silage, lb.	541.54	696.67
Feed cost per 100 lb. gain*	\$13.89	\$16.37
Initial cost per 100 lb.		
Initial cost per head	11.00	11.00
Total cost of feeds	75.59	76.01
Final cost per head	54.79	60.73
Final cost per head	130.38	136.74
Selling price, So. St. Paul		
Selling price, Univ. Farm	13.20	12.95
Value per head, Univ. Farm	12.70	12.45
Value per head, Univ. Farm	\$137.35	\$132.41
Pork credit per steer, lb.		
Pork credit at \$8.40 per cwt.	7.60	33.80
Margin per steer over feed cost, excluding hogs	\$ 0.64	\$ 2.84
Margin per steer over feed cost, including hog gains	6.97	-4.33
Margin per steer over feed cost, including hog gains	7.61	-1.49

* Feed prices charged: Shelled corn 80 cents per bu., whole barley 76 cents per bu., linseed meal \$48 per ton, alfalfa hay \$13 per ton, corn silage, \$5.00 per ton. Charge for grinding grain, 8 cents per cwt.

PREPARATION AND AMOUNT OF CORN FOR FATTENING CALVES

Corn may be fed to fattening cattle in any one of several ways. The cattle may be turned into a field of standing corn and allowed to harvest it themselves; the corn may be cut and cured as fodder and fed in the bundle; the corn may be husked and fed as ear corn; the ear corn may be cut into short lengths or ground and the ground ear corn fed; the ear corn may be shelled, the cobs discarded and the shelled corn fed, or the shelled corn may be ground and fed as ground shelled corn. Often corn will be fed to the same group of cattle in three forms, all at the same time, as when corn silage, corn fodder, and corn grain in some form are fed.

It has been demonstrated by many feeding trials at several experiment stations, and by practice of commercial cattle fatteners, that when pigs are provided to follow fattening cattle that are being fed corn as grain, it makes no very great difference whether the corn is fed as ear corn, cut ear corn, ground ear corn, shelled corn, or ground shelled corn. If it is fed as ear corn or shelled corn, the cattle will not gain quite so much, but the hogs will gain more than when it is fed as ground ear corn or as ground shelled corn.

Results of comparisons of methods of preparation and amount of corn fed, made at the Minnesota Station, however, bring out the fact that the feeding of corn-and-cob meal is an excellent method of limiting the consumption of corn to an amount that will give best results in keeping cattle on feed regularly and in producing gains at low cost. The following series of trials develop much useful information relative to the methods of feeding corn to fattening cattle.

Shelled Corn, Broken Ear Corn, or Corn-and-Cob Meal

In a trial to determine the comparative merits of shelled corn, broken ear corn, and corn-and-cob meal for fattening beef calves, three lots of 10 high-grade Hereford steer calves each were fed through a fattening period of 182 days. Each lot of calves received alfalfa hay and $1\frac{1}{2}$ pounds of linseed meal per head per day. Lot 1 then received a full feed of shelled corn, Lot 2 a full feed of broken ear corn, and Lot 3 a full feed of corn-and-cob meal. Results of the trial are given in Table 23.

In Lots 1 and 2, Lot 1 receiving shelled corn, and Lot 2 broken ear corn, both lots receiving linseed meal, the daily gains were practically identical. Lot 2, receiving broken ear corn, ate quite a little more corn-and-cob meal per day than Lot 1 did of shelled corn, but Lot 2 ate less hay than Lot 1. When the broken ear corn is separated into corn-and-cob by figuring 80 per cent shelled corn and 20 per cent cob, it is found that Lot 2 ate less corn than Lot 1. In other words, 2.84 pounds of corncob replaced 1.49 pounds of corn and 0.84 pounds of hay per steer per day. The replacement of shelled corn and hay by

corn cob in this lot would have been a little greater except for the fact that after a time the steers in this lot learned that they could shell off the corn and leave the cob and as a result 40 per cent of all the cob fed for the entire trial was not eaten. This was determined by weighing the cobs left in the feed trough each day. The total weigh-back of cobs not eaten for the 10 steers for the 182 days on feed was 2,120 pounds. The feed cost per 100 pounds gain was 43 cents less for Lot 2 receiving broken ear corn than for Lot 1 receiving shelled corn. The selling price for the steers in Lot 2, however, was 50 cents per 100 pounds less. Lot 2 ate 37 bushels of corn per steer and paid 46 cents per bushel for it, while Lot 1 ate 42 bushels and paid 51 cents for it.

Table 23
Methods of Feeding Corn to Fattening Steer Calves
December 6, 1932 to June 6, 1933—182 days

Lot No. No. of steers per lot Ration	1	2	3
	10 Shelled corn Linseed meal Alfalfa hay	10 Broken ear corn Linseed meal Alfalfa hay	10 Corn-and-Cob meal Linseed meal Alfalfa hay
Initial weight, lb.	494.0	490.6	491.0
Final weight, lb.	932.8	930.8	942.6
Average gain per steer, lb.	438.8	440.2	451.6
Average daily gain per steer, lb.	2.41	2.42	2.48
Average daily feed:			
Shelled corn, lb.	12.88	(11.39)*	(11.86)*
Broken ear corn, lb.		14.24	
Corn-and-cob meal, lb.			14.83
Linseed meal, lb.	1.50	1.50	1.50
Alfalfa hay, lb.	3.84	3.00	2.99
Salt and mineral, lb.	0.0744	0.0670	0.0827
Feed per 100 lb. gain:			
Shelled corn, lb.	534.41	(471.15)*	(478.12)*
Broken ear corn, lb.		588.94	
Corn-and-cob meal, lb.			597.76
Linseed meal, lb.	61.20	61.67	60.00
Alfalfa hay, lb.	159.64	123.70	120.46
Salt and mineral, lb.	3.09	2.79	3.33
Feed cost per 100 lb. gain†	\$ 3.77	\$ 3.34	\$ 3.60
Initial cost per 100 lb.			
Shelled corn, lb.	7.00	7.00	7.00
Initial cost per head	34.58	34.34	34.37
Total cost of feed per head	16.54	14.70	16.26
Final cost per head	51.12	49.04	50.63
Selling price, So. St. Paul			
Shelled corn, lb.	7.00	6.50	6.75
Selling price, Univ. Farm	6.50	6.00	6.25
Value per head, Univ. Farm	\$60.63	\$55.85	\$58.91
Pork credit per steer, lb.			
Shelled corn, lb.	33.80	23.96	22.10
Pork credit at \$4.00 per cwt.	\$1.35	\$0.96	\$0.88
Margin per steer over feed cost, excluding hogs	9.51	6.81	8.28
Margin per steer over feed cost, including hog gains	10.86	7.77	9.16

* Shelled corn equivalent.

† Feed prices charged: Shelled corn 25 cents per bu., broken ear corn 25 cents per bu., corn-and-cob meal 28 cents per bu., linseed meal \$23.50 per ton, alfalfa hay \$8.00 per ton, salt and mineral \$17.50 per ton.

There was practically no bloating of steers in Lot 2 at any time throughout the feeding period; while there was considerable bloating of those in Lot 1, especially toward the close of the period.

Lot 3 was fed in the same manner as Lot 1, except that whole ear corn coarsely ground replaced the shelled corn. The steers in Lot 3 out-gained those in Lot 1 by almost 15 pounds per steer. When the corn-and-cob meal is separated into corn and cob by figuring 80 per cent shelled corn and 20 per cent cob, it is found that Lot 3 ate 2.97 pounds of cob per steer per day and this 2.97 pounds of cob replaced 1.02 pounds of shelled corn and 0.85 pounds of hay. The steers in Lot 3 ate all of the cob fed to them, and ate a little more total feed, by weight, each day than those receiving shelled corn. This was probably because the digestive systems of the steers on corn-and-cob meal remained in better condition throughout the feeding period than those on shelled corn, and it was possible to feed them more heavily without the risk of bloating or scouring. There was not a single case of bloat in the corn-and-cob meal lot throughout the feeding period. When it came to selling price, the steers in Lot 3 were valued 25 cents per 100 pounds lower than those in Lot 1. This was due to less uniformity, less bloom, and a slightly more paunchy shape observed in Lot 3 as contrasted to Lot 1. The steers in Lot 3, receiving corn-and-cob meal, consumed 38.6 bushels of corn each and paid 49 cents per bushel, plus 3 cents per bushel for grinding it; while those in Lot 1 ate 42 bushels of corn and paid 51 cents per bushel for it.

Corn-and-Cob Meal in a Ration with Silage

Two trials were made to determine whether it is advisable to limit to some degree the amount of corn-and-cob meal consumed by fattening calves, provided the calves also receive corn silage as a part of their ration.

In the first trial, lasting 210 days, one lot of 10 grade Aberdeen-Angus steer calves was fed twice daily all the corn-and-cob meal, all the corn silage, and all the alfalfa hay the animals would eat. This lot was also fed linseed meal throughout the trial, at the rate of 2 pounds per head daily, after the calves had been brought up to a full feed of concentrates.

A second and similar lot was fed in the same manner, except that the allowance of both corn-and-cob meal and linseed meal was limited to 85 per cent of the amount consumed by the first lot. In other words, Lot 2 was fed 85 pounds of corn-and-cob meal for every 100 pounds of the meal consumed by Lot 1. Lot 2 also received 1.7 pounds of linseed meal per head daily in place of the 2 pounds given to Lot 1. Each lot was fed as much corn silage and alfalfa hay as the calves would eat.

A third and similar lot was fed in the same manner but was limited to 70 per cent of the full allowance of corn-and-cob meal and linseed meal given to Lot 1.

A fourth and similar lot of calves was limited to 60 per cent of a full allowance of concentrates for the first 56 days of the trial. This

allowance was increased every 56 days, first to 70 per cent, then to 85 per cent, and finally to 100 per cent. The calves received 100 per cent for the last 42 days of the trial. The results at the end of 210 days are given in Table 24.

Table 24
Comparison of Full and Limited Allowances of Corn-and-Cob Meal
November 21, 1924 to June 19, 1925—210 days

Lot No.	1	2	3	4
No. of steers per lot	10	10	10	10
Ration	Full fed	85%	70%	60-100%
Initial weight, lb.	419.57	419.00	420.13	417.67
Final weight, lb.	882.57	891.07	854.83	856.73
Average gain per steer, lb.	463.00	472.07	434.70	439.06
Average daily gain per steer, lb.	2.20	2.25	2.07	2.09
Average daily feed:				
Corn-and-cob meal, lb.	14.14	11.97	9.97	11.34
Linseed meal, lb.	1.88	1.59	1.33	1.48
Corn silage, lb.	4.01	7.62	10.13	8.43
Alfalfa hay, lb.	1.81	2.70	3.14	2.76
Feed per 100 lb. gain:				
Corn-and-cob meal, lb.	642.73	532.44	481.64	542.60
Linseed meal, lb.	85.45	70.66	64.25	70.81
Corn silage, lb.	182.27	338.66	490.00	403.35
Alfalfa hay, lb.	82.27	120.00	151.20	132.06
Feed cost per 100 lb. gain*	\$12.88	\$11.68	\$11.46	\$12.10
Initial cost per cwt.	7.75	7.75	7.75	7.75
Initial cost per head	32.52	32.47	32.56	32.37
Total cost of feeds	59.63	55.12	49.80	53.18
Final cost per head	92.15	87.59	82.36	85.55
Selling price, So. St. Paul	11.05	10.85	10.00	10.45
Selling price, Univ. Farm	10.55	10.35	9.50	9.95
Value per head, Univ. Farm	\$93.11	\$92.23	\$81.21	\$85.24
Pork credit per steer, lb.	41.82	25.88	16.58	25.62
Pork credit, at \$11 per cwt.	\$4.60	\$2.85	\$1.82	\$2.82
Margin per steer over feed cost, excluding hogs	0.96	4.64	-1.15	-0.31
Margin per steer over feed cost, including hog gains	5.56	7.49	0.67	2.51

* Feed prices charged: Ear corn \$1.00 per bu., linseed meal \$47 per ton, corn silage \$6.00 per ton, alfalfa hay \$16 per ton. Cost of grinding ear corn, 8 cents per cwt.

When the allowance of corn-and-cob meal and linseed meal was limited to 85 per cent of a full feed, the consumption of corn silage and alfalfa hay was increased considerably and the pork credit was reduced more than one-third. Nevertheless, the feed cost per 100 pounds of gain was reduced \$1.20, the rate of gain in the 85 per cent lot was slightly greater than in the full-fed lot, the degree of finish was fully equal to the full-fed lot, the selling price was nearly as high, and the 85 per cent lot returned the greater profit. Therefore, with silage and a legume hay in the ration, it proved profitable to limit the amount of concentrated feeds to 85 per cent of a full feed.

When the allowance of concentrates was limited to 70 per cent of a full feed, the daily gains were so much decreased that at the end of 210 days the steers were not only lighter in weight but decidedly lacking in the finish necessary to command a satisfactory price. Tho the cost of their feed was almost \$10 per head less than in the full-fed lot, they

were worth almost \$12 per head less at the finish and the pigs following them made \$2.78 less in pork per steer, so that the 70 per cent calves showed practically no margin over feed cost. They ate more pounds of feed than any other lot, but the quality of their ration was not good enough to produce the rate of gain and the finish needed in order to sell to advantage. They made the least profit of any of the four lots.

When the allowance of concentrates was limited to 60 per cent of a full feed at the start, and then increased every 56 days, first to 70 per cent, then to 85 per cent, and finally to 100 per cent, the results were better than in the 70 per cent lot, but were not equal to the 85 per cent and full-fed lots.

With higher prices for concentrates or lower prices for silage and hay, the lots fed the more limited grain rations would have made relatively better showings. However, if the charge for silage had been reduced from \$6.00 to \$2.00 per ton, and the charge for alfalfa hay from \$16 to \$8.00 per ton, the full-fed lot and the 85 per cent lot would still have surpassed in profit the 70 per cent lot and the 60-100 per cent lot. If the more limited lots had been carried longer on feed in order to give them a good finish, they would have been carried into hot weather and fly time, and it is doubtful whether they could have equaled the other lots in profit.

After the close of the trial, the four lots were carried for 10 days on the same rations fed during the trial. They were shipped by rail to the South St. Paul market on the tenth day, were sold on the eleventh day, and were slaughtered on the twelfth day. The average dressing percentages based on chilled carcass weights were as follows:

	Dressing percentage
Full-fed lot	60.42
85 per cent lot	61.11
70 per cent lot	58.94
60-100 per cent lot	59.14

The results of this trial indicate that baby heaves require nearly a full feed of corn-and-cob meal in order to yield the greatest profit on a ration composed of corn-and-cob meal, linseed meal, corn silage, and alfalfa hay.

A second trial, using purebred and grade Hereford steer calves, 10 calves per lot, was made in order to verify the results obtained in the first trial with the full-fed and 85 per cent lots. The results of the second trial, compared with the results of the first, are given in Table 25.

The second trial verified the results of the first. It again proved economical and profitable to limit the allowance of corn-and-cob meal and linseed meal to 85 per cent of a full feed. In the second trial, the rate of gain, selling price, and production of pork in the two lots were nearly the same, but the cost of feed was \$3.70 per head less in the 85

per cent lot than in the full-fed lot. Therefore the 85 per cent lot returned the most profit.

In the first trial, after the calves had been brought up to a full feed the full-fed lot consumed an average of about 2.23 pounds of corn-and-cob meal per 100 pounds live weight, and the 85 per cent lot consumed an average of about 1.94 pounds. In the second trial the full-fed calves consumed an average of about 2.35 pounds of corn-and-cob meal per 100 pounds of live weight after getting on full feed, and the 85 per cent lot consumed an average of about 2 pounds.

The conclusion to be drawn from the two trials is that, with a full feed of corn silage and alfalfa hay in the ration, it is profitable to limit the allowance of corn-and-cob meal to about 2 pounds per 100 pounds live weight, and to limit the linseed meal to 1.7 pounds per head daily.

Table 25
Comparison of Full and Limited Allowances of Corn-and-Cob Meal
First trial—November 21, 1924 to June 19, 1925—210 days
Second trial—November 13, 1925 to June 18, 1926—217 days

Lot No. No. of calves per lot Ration	First trial		Second trial		Av. of two trials	
	1 10	2 10	1 10	2 10	1 20	2 20
	Corn-and-cob meal full fed	Corn-and-cob meal 85%	Corn-and-cob meal full fed	Corn-and-cob meal 85%	Corn-and-cob meal full fed	Corn-and-cob meal 85%
	Linseed meal, corn silage, alfalfa hay fed to all lots					
Initial weight, lb.	419.57	419.00	450.17	449.97	434.87	434.49
Final weight, lb.	882.57	891.07	964.93	955.34	923.75	923.21
Average gain per steer, lb.	463.00	472.07	514.76	505.37	488.88	488.72
Average daily gain per steer, lb.	2.20	2.25	2.37	2.33	2.29	2.29
Average daily feed:						
Corn-and-cob meal, lb.	14.14	11.97	15.18	12.90	14.66	12.44
Linseed meal, lb.	1.88	1.59	2.00	1.70	1.94	1.65
Corn silage, lb.	4.01	7.62	4.49	8.32	4.25	7.97
Alfalfa hay, lb.	1.81	2.70	1.37	1.79	1.59	2.25
Feed per 100 lb. gain:						
Corn-and-cob meal, lb.	642.73	532.44	640.50	553.65	644.54	543.04
Linseed meal, lb.	85.45	70.66	84.39	72.00	84.72	71.33
Corn silage, lb.	182.27	338.66	189.45	357.08	185.60	347.87
Alfalfa hay, lb.	82.27	120.00	57.80	76.82	70.03	98.41
Feed cost per 100 lb. gain*	\$12.88	\$11.68	\$ 8.86	\$ 8.29	\$10.87	\$ 9.99
Initial cost per cwt.	7.75	7.75	8.00	8.00	7.88	7.88
Initial cost per head	32.52	32.47	36.01	36.00	34.27	34.24
Total cost of feeds	59.63	55.12	45.61	41.91	52.62	48.52
Final cost per head	92.15	87.59	81.62	77.91	86.89	82.75
Selling price, So. St. Paul	11.05	10.85	9.95	9.90	10.50	10.38
Selling price, Univ. Farm	10.55	10.35	9.45	9.40	10.00	9.88
Value per head, Univ. Farm	\$93.11	\$92.23	\$91.19	\$89.80	\$92.15	\$91.02
Pork credit per steer, lb.	41.82	25.88	13.56	13.43	27.69	19.66
Pork credit at \$11 per cwt.	\$ 4.60	\$ 2.85	\$ 1.49	\$ 1.48	\$ 3.05	\$ 2.17
Margin per steer over feed cost, excluding hogs	0.96	4.64	9.57	11.89	5.26	8.29
Margin per steer over feed cost, including hog gains	5.56	7.49	11.06	13.37	8.31	10.43

* Feed prices charged: (First trial) Ear corn \$1.00 per bu., linseed meal \$47 per ton, corn silage \$6.00 per ton, alfalfa hay \$16 per ton. Cost of grinding ear corn, 8 cents per cwt. (Second trial) Ear corn 60 cents per bu., linseed meal \$48 per ton, corn silage \$4.50 per ton, alfalfa hay \$14.25 per ton. Cost of grinding ear corn, 8 cents per cwt.

Shelled Corn vs. Corn-and-Cob Meal, Full Fed

In the foregoing pages it is seen: (1) That a mixture of shelled corn and whole oats proved superior to a mixture of ground shelled corn and ground oats for fattening baby beeves. (2) That shelled corn surpassed a mixture of shelled corn and whole oats. (3) That corn-and-cob meal also surpassed a mixture of shelled corn and whole oats. The next step is to compare shelled corn and corn-and-cob meal as grain feeds for fattening baby beeves.

What happens when two lots of calves are fed linseed meal, corn silage, and alfalfa hay, one lot receiving a full feed of shelled corn and the other a full feed of corn-and-cob meal? Two trials have been made to obtain this information. Purebred and high-grade Aberdeen-Angus steer calves were used, 10 calves per lot. The results are given in Table 26.

Table 26
Shelled Corn vs. Corn-and-Cob Meal, When Both are Full Fed
First Trial—November 2, 1923 to June 13, 1924—224 days
Second Trial—November 21, 1924 to June 19, 1925—210 days

Lot No. No. of calves per lot Ration	First trial		Second trial		Av. of two trials	
	1 10 C. and c. meal	2 10 Shelled corn	1 10 C. and c. meal	2 10 Shelled corn	1 20 C. and c. meal	2 20 Shelled corn
Linseed meal, corn silage, alfalfa hay fed to all lots						
Initial weight, lb.	445.07	447.37	419.57	418.33	432.32	432.85
Final weight, lb.	951.00	966.60	882.57	904.83	916.79	935.72
Average gain per steer, lb.	505.93	519.23	463.00	486.50	484.47	502.87
Average daily gain per steer, lb.	2.26	2.32	2.20	2.32	2.23	2.32
Average daily feed:						
Corn-and-cob meal, lb.	15.08	.....	14.14	.....	14.61	.....
Shelled corn, lb. ....	.....	13.45	.....	13.09	.....	13.27
Linseed meal, lb.	1.85	1.85	1.88	1.88	1.87	1.87
Corn silage, lb.	4.14	4.34	4.01	4.01	4.08	4.18
Alfalfa hay, lb.	1.33	1.33	1.81	1.84	1.57	1.59
Feed per 100 lb. gain:						
Corn-and-cob meal, lb.	667.25	.....	642.73	.....	654.99	.....
Shelled corn, lb. ....	.....	580.00	.....	564.22	.....	572.11
Linseed meal, lb.	81.86	80.00	85.45	81.03	83.65	80.51
Corn silage, lb.	183.19	187.07	182.27	172.41	182.73	179.74
Alfalfa hay, lb.	58.85	57.32	82.27	79.31	70.56	68.31
Feed cost per 100 lb. gain*	\$ 9.47	\$ 9.61	\$12.88	\$13.35	\$11.17	\$11.48
Initial cost per cwt.	7.00	7.09	7.75	7.75	7.38	7.38
Initial cost per head	31.15	31.32	32.52	32.42	31.84	31.87
Total cost of feeds	47.91	49.88	59.63	64.96	53.77	57.42
Final cost per head	79.06	81.20	92.15	97.38	83.61	89.29
Selling price, So. St. Paul	10.40	10.10	11.05	11.20	10.73	10.65
Selling price, Univ. Farm	9.90	9.60	10.55	10.70	10.23	10.15
Value per head, Univ.						
Farm	\$94.15	\$92.79	\$93.11	\$96.82	\$93.63	\$94.81
Pork credit per calf, lb.	30.70	28.14	41.82	56.17	36.26	42.16
Pork credit, at \$6.30 per cwt.	\$ 1.93	\$ 1.77	\$ 4.60	\$ 6.18	\$ 2.30	\$ 0.89
Pork credit, at \$11 per cwt.	.....	.....	.....	.....	.....	.....
Margin per calf over feed cost, excluding hogs	15.09	11.59	0.96	-0.57	8.02	5.51
Margin per calf over feed cost, including hog gains	17.02	13.36	5.56	5.61	11.29	9.49

* Feed prices charged: (First trial) Ear corn 63 cents per bu., shelled corn 65 cents per bu., linseed meal \$48 per ton, corn silage \$5.00 per ton, alfalfa hay \$17 per ton. Cost of grinding ear corn, 8 cents per cwt. (Second trial) Ear corn \$1.00 per bu., shelled corn \$1.02 per bu., linseed meal \$47 per ton, corn silage \$6.00 per ton, alfalfa hay \$16 per ton. Cost of grinding ear corn, 8 cents per cwt.

Both corn-and-cob meal and shelled corn gave good results when full fed in combination with linseed meal, corn silage, and alfalfa hay. However, certain differences in results were noticeable. In both trials, the shelled-corn lot made somewhat larger gains, but the corn-and-cob meal lot made their gains at lower cost and their gains were also rapid enough to produce a good finish and make possible a satisfactory selling price. The average of the two trials shows a somewhat larger pork credit for the shelled-corn lot.

In each of the two trials a larger return was obtained per bushel of ear corn when the ear corn was fed as corn-and-cob meal than when the corn was shelled, the cobs thrown away, and the corn fed as shelled corn. The corn-and-cob meal ration also proved excellent for starting the calves on feed and had a slight advantage in keeping them steadily on feed throughout the fattening period.

Why the Larger Profit for Corn-and-Cob Meal?

It has been seen that in one trial a full feed of corn-and-cob meal was more profitable than a full feed of shelled corn and oats, and in two trials a full feed of the meal gave a larger return per bushel than did a full feed of shelled corn, when used in a ration which also included a protein supplement, corn silage, and legume hay. When corn-and-cob meal surpasses shelled corn under these conditions, it must be for one or more of the following reasons:

1. It is possible that the presence of the bulky ground cob in the corn-and-cob meal makes the ground corn more completely digestible than it would be if the ground cob were not mixed with it. To determine this, 5 calves were fed the usual full-fed corn-and-cob meal ration, except that the ground corn was fed by itself and the ground cob was fed mixed with the silage. The 5 calves made slightly larger gains per head than a lot of 10 similar calves fed corn-and-cob meal, thus apparently eliminating this possible advantage of corn-and-cob meal from further consideration.

2. The kernels of corn in corn-and-cob meal are in a cracked or ground condition, and it is a well known fact that cattle digest ground grain somewhat more completely than whole grain. In one trial, calves fed ground shelled corn and ground oats made more rapid gains than calves fed the whole grain, but they did not show so much profit after charging them with the cost of grinding the grain. This agrees with the majority of similar trials with fattening cattle at other stations. Further consideration of this second possible advantage of corn-and-cob meal may, therefore, be eliminated.

3. Corn cobs probably have some feeding value. One of our trials indicated that ground corn cobs have more feeding value than ground wheat straw. Ground corn cobs probably have a nutritive value no greater than oat straw, pound for pound, but they are less bulky than oat straw. If a bushel of ear corn can be shelled at a cost of 2 cents or ground at a cost of 6 cents, the grinding costs 4 cents more than shelling

but produces 14 pounds of ground cobs which the cattle are compelled to eat. At this rate, a ton of ground cobs may be said to cost \$5.72 and the grinding of the four tons of kernels which were on the cobs would cost nothing. The feeding of corn cobs to fattening calves may be profitable under certain conditions, especially when feeds are high in price.

4. Still another reason why a full feed of corn-and-cob meal fed to baby beeves gives a larger profit than a full feed of shelled corn may be the following: Corn-and-cob meal is approximately twice as bulky as the same weight of shelled corn, and cattle given a full feed of the meal do not consume as many bushels of corn as do those full fed on shelled corn. Probably some of the advantage of corn-and-cob meal over shelled corn, when both are full fed, is due to the fact that the cob limits the consumption of corn, thereby lessening the daily feed cost and the cost per pound of gain. In two trials, the shelled-corn calves consumed an average of 113.5 bushels of corn for every 100 bushels consumed by the meal-fed calves.

What would happen if two lots of calves were fed exactly the same number of bushels of corn, one lot receiving shelled corn and the other lot corn-and-cob meal? With this question in mind, another trial was made.

Shelled Corn vs. Corn-and-Cob Meal, Fed Bushel for Bushel

This trial was planned to answer the following question: If two lots of beef calves are to be fed the same number of bushels of ear corn daily in a ration that includes silage, shall we grind the ear corn and feed it as corn-and-cob meal, or shall we shell the corn, throw the cobs away, and feed the shelled corn only?

Each of four lots of purebred and grade Hereford steer calves, 10 calves per lot, were fed twice daily all of the corn silage and alfalfa hay the calves would clean up, in addition to the following concentrates, which were also fed twice daily:

- Lot 1. Corn-and-cob meal, full fed; linseed meal 2 pounds per head daily.
- Lot 2. 85 per cent of the corn-and-cob meal and the linseed meal fed to Lot 1.
- Lot 3. Shelled corn and linseed meal in amounts exactly equal to these feeds in the ration of Lot 1.
- Lot 4. Shelled corn and linseed meal in amounts exactly equal to these feeds in the ration of Lot 2.

A bushel of ear corn weighs 70 pounds and contains, on the average, 56 pounds of shelled corn and 14 pounds of cobs. In other words, ear corn averages 80 per cent shelled corn and 20 per cent cobs. Therefore, the calves in Lots 3 and 4 were fed 80 pounds of shelled corn for every 100 pounds of corn-and-cob meal consumed by Lots 1 and 2.

The average of a number of shelling tests, which were made from time to time during the trial, indicated that the ear corn used in this

trial contained approximately 80 per cent of grain and 20 per cent of cobs.

Lot 1 was the "pace-maker" in this trial. For every 100 pounds of corn-and-cob meal fed to Lot 1, Lot 2 received 85 pounds of corn-and-cob meal, Lot 3 received 80 pounds of shelled corn, and Lot 4 received 68 pounds of shelled corn.

Lots 1 and 3 received 2 pounds of linseed meal per head daily, and Lots 2 and 4 received 85 per cent as much, or 1.7 pounds of linseed meal per head daily.

All lots received as much corn silage and alfalfa hay as they would eat, in addition to their concentrates. The results are given in Table 27.

Table 27
Shelled Corn vs. Corn-and-Cob Meal, Fed Bushel for Bushel
November 13, 1925 to June 18, 1926—217 days

Lot No. No. of calves per lot	1		2		3		4	
	10		10		10		10	
Grain	Corn-and-cob meal				Shelled corn			
Concentrate allowance	Full fed		85%		Equal Lot 1		Equal Lot 2	
Initial weight, lb.	450.17	449.97	451.00	449.80	451.00	449.80	451.00	449.80
Final weight, lb.	964.93	955.34	960.85	958.27	960.85	958.27	960.85	958.27
Average gain per calf, lb.	514.76	505.37	509.85	508.47	509.85	508.47	509.85	508.47
Average daily gain per calf, lb.	2.37	2.33	2.35	2.34	2.35	2.34	2.35	2.34
Average daily feed:								
Corn-and-cob meal, lb.	15.18	12.90	.....	.....	.....	.....	.....	.....
Shelled corn, lb. ....	.....	.....	12.14	10.33	12.14	10.33	12.14	10.33
Linseed meal, lb.	2.00	1.70	2.00	1.70	2.00	1.70	2.00	1.70
Corn silage, lb.	4.49	8.32	7.57	15.06	7.57	15.06	7.57	15.06
Alfalfa hay, lb.	1.37	1.79	1.61	2.21	1.61	2.21	1.61	2.21
Feed per 100 lb. gain:								
Corn-and-cob meal, lb.	640.50	553.65	.....	.....	.....	.....	.....	.....
Shelled corn, lb. ....	.....	.....	516.60	441.45	516.60	441.45	516.60	441.45
Linseed meal, lb.	84.39	73.00	85.11	72.60	85.11	72.60	85.11	72.60
Corn silage, lb.	189.88	357.08	322.13	643.59	322.13	643.59	322.13	643.59
Alfalfa hay, lb.	58.00	76.82	68.51	94.44	68.51	94.44	68.51	94.44
Feed cost per 100 lb. gain*	\$ 8.86	\$ 8.29	\$ 8.98	\$ 8.74	\$ 8.98	\$ 8.74	\$ 8.98	\$ 8.74
Initial cost per cwt.								
.....	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Initial cost per head								
.....	36.01	36.00	36.08	35.98	36.08	35.98	36.08	35.98
Total cost of feeds								
.....	45.61	41.91	45.77	44.45	45.77	44.45	45.77	44.45
Final cost per head								
.....	81.62	77.91	81.85	80.43	81.85	80.43	81.85	80.43
Selling price, So. St. Paul								
.....	\$ 9.95	\$ 9.90	\$10.00	\$ 9.75	\$10.00	\$ 9.75	\$10.00	\$ 9.75
Selling price, Univ. Farm								
.....	9.45	9.40	9.50	9.25	9.50	9.25	9.50	9.25
Value per head, Univ. Farm								
.....	\$91.19	\$89.80	\$91.28	\$88.64	\$91.28	\$88.64	\$91.28	\$88.64
Pork credit per calf, lb.								
.....	13.56	13.43	36.60	60.02	36.60	60.02	36.60	60.02
Pork credit, at \$11 per cwt.								
.....	\$ 1.49	\$ 1.48	\$ 4.03	\$ 6.60	\$ 4.03	\$ 6.60	\$ 4.03	\$ 6.60
Margin per calf over feed cost, excluding hogs								
.....	9.57	11.89	9.43	8.21	9.43	8.21	9.43	8.21
Margin per calf over feed cost, including hog gains								
.....	11.06	13.37	13.46	14.81	13.46	14.81	13.46	14.81

* Feed prices charged: Ear corn 60 cents per bu., shelled corn 62 cents per bu., linseed meal \$48 per ton, corn silage \$4.50 per ton, alfalfa hay \$14.25 per ton. Cost of grinding ear corn, 8 cents per cwt.

The results with Lots 1 and 3 show that when shelled corn was fed in an amount exactly equal to the corn contained in a full feed of corn-and-cob meal, the shelled corn produced about 5 pounds less beef and 23 pounds more pork per calf. The cost of feed was practically the same in

the two lots. The shelled-corn lot made the greater profit, owing chiefly, to the larger pork credit.

The largest item in the feed bill for each of these lots was the charge for corn. If the profits in feeding these calves are applied to the corn which they consumed, Lot 1 returned 84 cents per bushel of ear corn, while Lot 3 returned 89 cents, or 5 cents per bushel more. Both lots also returned \$48 per ton for linseed meal, \$4.50 for silage, and \$14.25 for alfalfa hay. Lot 1 also paid 8 cents per hundredweight for grinding ear corn, and Lot 3 paid 2 cents per bushel for shelling.

A comparison of Lots 2 and 4 shows that shelled corn again excelled corn-and-cob meal, fed bushel for bushel. In this instance the feeding of shelled corn produced about 3 pounds more beef and 47 pounds more pork per calf than did the feeding of corn-and-cob meal. However, the shelled-corn calves ate much more silage and somewhat more hay, so that their feed bill was larger than that of the meal-fed calves. Furthermore, the shelled-corn calves were valued slightly lower. But in spite of these handicaps they surpassed the meal-fed calves in profit, because of the much greater production of pork from waste in the shelled-corn lot.

The deciding factor in this trial, and the factor which enabled shelled corn to surpass corn-and-cob meal in profit, was the larger pork credits in the two lots in which the calves were fed shelled corn. If the hog gains had been reduced in value from \$11 to \$8 per hundredweight, the shelled-corn lots still would have surpassed the corn-and-cob meal lots in profit.

If the hogs following cattle are not properly managed, shelled corn may not produce as much profit as corn-and-cob meal. Thrifty shoats weighing about 100 pounds are best for following cattle, and they should be given enough additional feed to make rapid gains. Slow gains by fattening hogs mean less efficient use of feed, higher cost per pound of pork, and a smaller pork credit per calf. In feeding hogs as in feeding cattle, rapid gains are necessary for greatest economy and profit. During a seven months' feeding period at least two lots of shoats should be finished, one following the other.

Shelled Corn Full Fed or Limited, in a Ration with Silage

As shown in Table 27 baby beeves (Lot 4) limited to a daily average of 10.33 pounds of shelled corn and 1.7 pounds of linseed meal per head, and given daily all the corn silage (15.06 pounds) and alfalfa hay (2.21 pounds) they would eat, made very satisfactory gains and returned more profit than another lot (Lot 3) which was fed daily an average of 12.14 pounds of shelled corn and 2 pounds of linseed meal, plus corn silage and alfalfa hay.

In two previous trials (Table 26), beef calves given a full feed of shelled corn consumed an average of 13.27 pounds of shelled corn per head daily; in a ration which included 1.87 pounds of linseed meal and all the corn silage and alfalfa hay the calves would eat.

On the basis of the foregoing figures, it appears that Lot 4, in Table 27, received about 78 per cent of a full feed of shelled corn, and Lot 3 received about 91 per cent. The 78 per cent allowance gave a larger profit than the 91 per cent allowance. Both the 78 and 91 per cent allowances resulted in a larger margin of profit than was obtained in Lot 1, which was given a full feed of corn-and-cob meal. In two previous trials (Table 26) a full feed of corn-and-cob meal surpassed a full feed of shelled corn in profit.

The foregoing facts seem to justify the statement that if silage is fed it is ordinarily most profitable to limit the allowance of shelled corn to about 78 per cent of a full feed. This allowance amounts to about 1.6 pounds of shelled corn daily per 100 pounds live weight.

The following conclusions may be drawn (Tables 23-27) for those who desire to fatten beef calves on a ration of corn, linseed meal, corn silage, and a legume hay, and with feed prices such as prevailed in Minnesota in the course of these trials:

1. Baby calves can be fattened most profitably by limiting the allowance of concentrates somewhat below a full feed.

2. A full feed of corn-and-cob meal surpassed a full feed of shelled corn because the cob limited the consumption of grain.

3. A full feed of corn-and-cob meal still provided too generous an allowance of grain for best results. Eighty-five per cent of a full feed of corn-and-cob meal proved more profitable. An allowance of 2 pounds of corn-and-cob meal per 100 pounds live weight of calves per day is equivalent to 85 per cent of a full feed.

4. Corn-and-cob meal as a grain for fattening calves may be excelled in profit by shelled corn only through greater gains made by hogs following.

5. With pigs following the cattle and with the pigs so managed as to obtain rapid gains, best results of all were obtained by feeding baby calves shelled corn limited to about 1.6 pounds daily per 100 pounds live weight. No doubt this allowance should be varied in accordance with the amount of grain in the silage. The silage used in the trials contained almost no grain. Compensation may be made for varying amounts of grain in the silage by feeding as follows: At feeding time, first feed a generous allowance of shelled corn, yet limited in amount to just such an extent that, when the grain is fed, all the calves come up to the feed bunk immediately and remain there until all the grain is eaten. Feed with the corn 1.7 pounds of linseed meal per head daily. After the concentrates are eaten, feed all the corn silage and alfalfa hay the calves will clean up.

FEEDING MOLASSES TO FATTENING CATTLE

Two feeding trials have been made at this Experiment Station to test the importance and value of cane molasses in a ration for fattening cattle. In the first, yearling steers were fed, and in the second, steer calves.

First Trial

In the first trial, 60 grade Shorthorn yearling steers, purchased on the market at South St. Paul, were fattened in six lots of 10 steers each. They were fed the following rations:

- Lot 1. Shelled corn, linseed meal $1\frac{1}{2}$ pounds per head daily, alfalfa hay full fed.
- Lot 2. Shelled corn, Durham cane molasses $2\frac{1}{2}$ pounds per head daily, alfalfa hay full fed.
- Lot 3. Shelled corn, linseed meal $1\frac{1}{2}$ pounds per head daily, Durham cane molasses $2\frac{1}{2}$ pounds per head daily, alfalfa hay full fed.
- Lot 4. Shelled corn, linseed meal $1\frac{1}{2}$ pounds per head daily, Durham cane molasses full fed, alfalfa hay full fed.
- Lot 5. Ground shelled corn, linseed meal $1\frac{1}{2}$ pounds per head daily, Durham cane molasses $2\frac{1}{2}$ pounds per head daily, ground alfalfa hay. (All feeds mixed together.)
- Lot 6. Ground barley, linseed meal $1\frac{1}{2}$ pounds per head daily, Durham cane molasses $2\frac{1}{2}$ pounds per head daily. Alfalfa hay full fed.

Number 3 yellow corn and a medium quality of feed barley were used. The corn contained an average of 17.5 per cent moisture and the barley 11.25 per cent. The alfalfa hay was about on the line between the standard grade and No. 2. The molasses was Durham cane and contained 50 per cent combined sugars, 19.78 per cent organic non-sugars, 7.97 per cent ash, and 22.25 per cent moisture. Pea-size linseed meal was fed with the shelled corn and powdered linseed meal with the ground grain. Table 28 gives the results.

That molasses is not a successful substitute for linseed meal to supplement a ration of corn and alfalfa hay is clearly shown by the results with Lots 1 and 2. Lot 1, the one receiving shelled corn, alfalfa hay, and $1\frac{1}{2}$ pounds linseed meal, made larger daily gains, required less feed per 100 pounds gain, made gains at a lower cost per 100 pounds, showed a higher finish, a trifle higher selling price, and a greater profit per head by \$7.30 than Lot 2, which received shelled corn, alfalfa hay, and $2\frac{1}{2}$ pounds of molasses. We may give credit to the molasses for stimulating a trifle greater feed consumption in this lot, but neither the molasses itself nor the small increase in the amount of corn and hay consumed contained sufficient nutritive value to balance the nutritive value of the $1\frac{1}{2}$ pounds of linseed meal fed in Lot 1. Neither of the two lots had any advantage over the other so far as the condition of the digestive systems of the animals was concerned. No steer in either lot missed a single feed during the entire feeding period.

In this trial, as in a number of other cattle-fattening trials that have been carried out by this and other experiment stations, the ration of corn, alfalfa hay, and linseed meal has always given a very good account

of itself and has come to be considered a good standard ration for fattening cattle. By comparing the figures for Lots 1 and 3, it will be seen that adding molasses at the rate of $2\frac{1}{2}$ pounds per day per steer did not improve the results in any way, but rather seemed to reduce the effectiveness of the standard ration.

Table 28
A Comparison of Several Rations in a Study of Feeding Cane Molasses
to Fattening Yearling Steers
November 23, 1928 to May 3, 1929—161 days

Lot No. No. of steers per lot Ration	1 10 Corn Linseed meal Alfalfa hay	2 10 Corn Molasses Alfalfa hay	3 10 Corn Linseed meal Molasses Alfalfa hay	4 10 Corn Linseed meal Molasses (self-fed) Alfalfa hay	5 10 Ground corn meal Linseed meal Molasses Ground alfalfa hay (fed mixed)	6 10 Ground barley meal Linseed meal Molasses Alfalfa hay
Initial weight, lb.	718.00	722.00	718.00	715.00	722.00	722.00
Final weight, lb.	1,127.00	1,088.00	1,104.00	1,127.00	1,153.00	1,118.00
Average gain per steer, lb.	409.00	366.00	386.00	412.00	431.00	396.00
Average daily gain per steer, lb.	2.54	2.27	2.40	2.56	2.61	2.46
Average daily feed:						
Shelled corn, lb.	14.18	14.74	13.90	13.88	13.82	.....
Ground shelled corn, lb. ....	.....	.....	.....	.....	.....	.....
Ground barley, lb. ....	.....	.....	.....	.....	.....	14.18
Linseed meal, lb.	1.53	.....	1.53	1.53	1.53	1.53
Molasses, lb. ....	.....	2.53	2.53	4.36	2.37	2.53
Alfalfa hay, lb.	7.24	7.30	7.30	7.07	.....	6.18
Ground alfalfa hay, lb. ....	.....	.....	.....	.....	6.06	.....
Feed per 100 lb. gain:						
Shelled corn, lb.	560.50	548.50	580.30	542.60	.....	.....
Ground shelled corn, lb. ....	.....	.....	.....	.....	516.10	.....
Ground barley, lb. ....	.....	.....	.....	.....	.....	576.40
Linseed meal, lb.	60.30	.....	63.80	59.80	57.20	62.20
Molasses, lb. ....	.....	111.30	105.60	170.40	88.60	102.90
Alfalfa hay, lb.	284.80	321.20	304.60	276.30	.....	251.10
Ground alfalfa hay, lb. ....	.....	.....	.....	.....	226.30	.....
Salt, lb.	1.54	1.58	1.06	1.07	1.16	1.14
Bonemeal, lb.	3.50	3.90	2.93	1.53	3.55	3.61
Feed cost per 100 lb. gain*	\$12.65	\$14.52	\$14.98	\$15.78	\$13.76	\$13.99
Initial cost per 100 lb.	11.25	11.25	11.25	11.25	11.25	11.25
Initial cost per head	80.77	81.22	80.77	80.44	81.22	81.22
Total cost of feeds	51.74	53.14	57.82	64.19	59.30	45.40
Final cost per head	132.51	134.36	138.59	144.63	140.52	136.62
Selling price, So. St. Paul	14.10	14.00	14.10	14.05	14.10	13.80
Selling price, Univ. Farm	13.35	13.25	13.35	13.30	13.35	13.05
Value per head, Univ. Farm	\$150.45	\$144.16	\$147.38	\$149.89	\$153.92	\$145.90
Pork credit per steer, lb.	28.60	37.00	45.30	28.10	2.50	0.00
Pork credit at \$10 per cwt.	\$ 2.86	\$ 3.70	\$ 4.53	\$ 2.81	\$ 0.25	\$ 0.00
Margin per steer over feed cost, excluding hogs	17.94	9.80	8.79	5.26	13.40	9.28
Margin per steer over feed cost, including hog gains	20.80	13.50	13.32	8.07	13.65	9.28

* Feed prices charged: Shelled corn 85 cents per bu., whole barley 64 cents per bu., pea-size linseed meal \$62 per ton, powdered linseed meal \$61 per ton, molasses \$38 per ton, alfalfa hay \$15 per ton, salt \$30 per ton, bonemeal \$60 per ton. Charge for grinding grain, 8 cents per cwt. Charge for grinding hay, \$2.30 per ton.

Molasses might have had a fairer chance to make a showing in this ration if the amount of corn had been limited to $2\frac{1}{2}$ pounds per head per day less than the amount eaten by Lot 1 and if the $2\frac{1}{2}$ pounds of

molasses had been used to replace $2\frac{1}{2}$ pounds of corn. One of the valuable qualities of molasses, however, is considered to be its appetizing effect, inducing cattle to eat more of the other feeds. As the cattle in Lot 3 seemed to take about the same amount of corn as those in Lot 1 without being crowded, they were allowed to have all of the corn and hay they would eat to find out whether or not this appetizing quality of molasses was of real value when good corn and alfalfa hay were fed. In this case the increased feed consumption was not beneficial in any way. The ration of corn, alfalfa, linseed meal, plus molasses, was less profitable than the same ration minus the molasses.

One of the questions always asked by the beginner in molasses feeding is "How do you feed it?" or "How do you handle it?"

Self-feeding molasses by building a feed bunk just a little larger than a molasses barrel, setting the barrel on end in the bunk, taking out the small plug in a metal barrel or boring a three-quarter or one-inch hole in a wooden barrel, and letting the molasses run out, has been recommended as a method that greatly simplifies feeding it. The molasses will automatically stop running when the amount in the bunk gets deep enough to rise above the hole in the barrel. If allowed to take care of itself in this way, there will always be molasses in the bunk and the cattle can eat all they want of it.

Lot 4, in this trial, was self-fed molasses by this method, after having been accustomed to it by feeding gradually increasing amounts during the first four weeks, until they were up to about a full feed of grain and were eating 5 pounds of molasses each per day. When the self-feeding of molasses was begun, the steers were receiving 14 pounds of shelled corn, $1\frac{1}{2}$ pounds of linseed meal, 5 pounds of molasses, and 6 pounds of hay per day. They immediately went up to a consumption of 9 pounds of molasses per head per day in addition to the other feeds, except that they ate a little less hay. The digestive systems became quite laxative, but no steer in the lot lost his appetite or could be considered off feed during the entire period. After about a month of this heavy consumption of molasses, the steers gradually dropped back until they were eating less than 3 pounds per head per day. In the meantime, the corn had been increased some, and was kept about on a level with the amount of corn eaten by Lot 3. About four weeks before the close of the trial, and after the consumption of molasses had dropped down to less than 3 pounds per head per day, it was thought that possibly the cattle did not like to eat molasses that had remained in the bunk several days and been licked over, so the bunk was taken out and a clean metal trough put in and just enough molasses to last a day at a time was placed in the trough. The consumption of molasses was increased somewhat after this change was made, but not much. It seems, therefore, that cattle will tire of molasses in time. A good gain and a good finish were secured on the cattle in this lot, but these advantages did not make up for the higher cost of the ration, and the profit was lower than with the standard ration

(Lot 1) or the standard ration plus molasses limited to $2\frac{1}{2}$ pounds per day (Lot 3).

The ration fed to Lot 5 might be called a home-made mixed ration and was kept as nearly as possible equal in amount of feed with Lot 3, the difference being that in Lot 3 the shelled corn and alfalfa hay were fed whole, while in Lot 5 both were ground and all feeds mixed together. The cattle in Lot 5 had three months of large gains, the first, fourth, and fifth, and two months of low gains, the second and third. In the second month, 3 steers in Lot 5 developed a condition of chronic bloating and after about four weeks were removed and replaced with three others as nearly like them as could be obtained. How or why three steers in this lot became chronic bloaters we are unable to explain, but we do not believe it was due, particularly, to the grinding or mixing of the feeds, because this is the only experience of bloating we have had in feeding ground mixed feeds in trials for several years. Neither do we believe that the substitution of the three steers influenced the results materially, either favorably or unfavorably. The daily gains for Lot 5 were larger and the feed requirement per 100 pounds gain was lower than in Lot 3, fed whole corn and whole hay, but the selling price per pound was the same and the cost of grinding the feeds, together with the low gains made by the pigs following, prevented any appreciable increase in profit as a result of the grinding and mixing of the corn and hay. The ground and mixed feed has to its credit 33 cents per steer more than the feeds fed whole.

Lots 6 and 3 were fed the same ration, except that in Lot 6 ground barley replaced shelled corn. The figures for Lot 6 and Lot 3 show that the barley-fed cattle, receiving molasses plus linseed meal and alfalfa hay, actually outgained the corn-fed cattle receiving molasses plus linseed meal and alfalfa hay. The two lots ate almost the same number of pounds of feed, tho the barley-fed cattle ate a trifle more grain and a little less hay than the corn-fed cattle. Charging shelled corn at 85 cents a bushel and whole barley at 64 cents, however, the corn-fed cattle showed the larger profit by \$4.04 per head. This was due, principally, to the higher finish and higher selling price of the corn-fed cattle. The cost of grinding the barley and failure of the hogs following the barley cattle to make any gain from salvaged feed helped to lower the profit from the barley-fed group.

One problem in fattening cattle on barley is that, after 75 to 90 days on feed, the cattle tire of the grain and do not eat well. From the results with Lot 6, it is possible that the appetizing quality of the molasses may have some value when used with barley.

Second Trial

The second trial in the feeding of cane molasses was carried out during the winter of 1929-30. In this trial 60 grade Hereford steer calves were purchased on the market at South St. Paul late in Novem-

ber and fattened in six lots of 10 calves each. The six lots of calves were fed the following rations:

- Lot 1. Shelled corn full fed, linseed meal $1\frac{1}{2}$ pounds per head daily, alfalfa hay full fed.
- Lot 2. Shelled corn plus 2 pounds cane molasses, total equal to amount of shelled corn consumed by Lot 1, linseed meal $1\frac{1}{2}$ pounds per head daily, alfalfa hay equal to the amount consumed by Lot 1.
- Lot 3. Ground shelled corn equal to amount consumed by Lot 1, linseed meal $1\frac{1}{2}$ pounds per head daily, ground alfalfa hay equal to amount consumed by Lot 1. (All feeds mixed.)
- Lot 4. Ground shelled corn plus 2 pounds cane molasses, total equal to amount of shelled corn consumed by Lot 1, linseed meal $1\frac{1}{2}$ pounds per head daily, ground alfalfa hay equal to amount consumed by Lot 1. (All feeds mixed.)
- Lot 5. Ground barley full fed, linseed meal $1\frac{1}{2}$ pounds per head daily, alfalfa hay full fed.
- Lot 6. Ground barley full fed, cane molasses 2 pounds per head daily, linseed meal $1\frac{1}{2}$ pounds per head daily, alfalfa hay full fed.

Number 3 yellow corn and a good quality of feed barley were fed. The corn contained an average of 17.5 per cent moisture and the barley 11.5 per cent. The alfalfa was about on the line between standard and No. 2. The molasses was Durham cane and contained 50 per cent combined sugars, 19.78 per cent organic non-sugars, 7.97 per cent ash, and 22.25 per cent moisture. Pea-size linseed meal was fed with the shelled corn and powdered linseed meal with the ground grain. The results are presented in Tables 29 and 30.

It should be kept in mind that in feeding Lots 1 and 2, Lot 1 was full fed shelled corn, $1\frac{1}{2}$ pounds linseed meal per head per day, and alfalfa hay full fed. Lot 2 was fed exactly the same amounts and the same feeds, except that 2 pounds of molasses per steer per day replaced 2 pounds of shelled corn. By feeding in this way, molasses was robbed of its appetizing effect and made to show its value pound for pound as compared with corn. That molasses does have an appetizing effect was clearly demonstrated in the feeding of these two lots of cattle. Lot 2 would have consumed a little more feed at every feeding throughout the entire trial, while Lot 1 had all the feed it would clean up. The question will at once be asked, "What would have happened had Lot 2 been allowed all the corn and hay the cattle would eat in addition to the 2 pounds of molasses per head per day?" This question is answered by Lots 1 and 3 in the first trial, reported in Table 28, in which for Lot 3 the molasses was allowed to exert its appetizing effect and the cattle were fed all the corn and hay they would eat. In that trial the result was similar in all respects to that in this trial. Table 29 shows that

Lot 1 fed corn, linseed meal, and alfalfa gained one-fourth pound per day more, required less feed per 100 pounds gain, made 100 pounds gain at a lower cost by \$1.19, sold for 55 cents per 100 pounds more, and made a smaller loss by \$9.01 per steer than Lot 2, fed molasses.

Table 29

A Comparison of Several Rations in a Study of Feeding Cane Molasses and Grinding and Mixing Feeds for Fattening Steer Calves
December 13, 1929 to June 20, 1930—189 days

Lot No. No. of steers Ration	1 10 Shelled corn Linseed meal Alfalfa hay	2 10 Shelled corn Molasses Linseed meal Alfalfa hay	3 10 Ground shelled corn Linseed meal Ground alfalfa hay (mixed)	4 8* Ground shelled corn Molasses Linseed meal Ground alfalfa hay (mixed)
Initial weight, lb.	450.50	453.30	450.00	444.90
Final weight, lb.	933.70	887.30	909.90	913.90
Average gain per steer, lb.	483.20	434.00	459.90	469.00
Average daily gain per steer, lb.	2.56	2.30	2.43	2.48
Average daily feed:				
Shelled corn, lb.	12.81	10.90	.....	.....
Ground shelled corn, lb. ....	.....	.....	12.38	10.88
Linseed meal, lb.	1.47	1.47	1.47	1.47
Molasses, lb. ....	.....	1.91	.....	1.91
Alfalfa hay, lb.	3.60	3.60	.....	.....
Ground alfalfa hay, lb. ....	.....	.....	3.44	3.36
Salt, lb.	0.023	0.020	0.027	0.023
Bonemeal, lb.	0.020	0.015	0.017	0.020
Feed per 100 lb. gain:				
Shelled corn, lb.	500.94	474.70	.....	.....
Ground shelled corn, lb. ....	.....	.....	508.90	439.02
Linseed meal, lb.	57.35	63.86	60.10	59.09
Molasses, lb. ....	.....	83.02	.....	76.80
Alfalfa hay, lb.	141.02	157.40	.....	.....
Ground alfalfa hay, lb. ....	.....	.....	141.35	148.00
Salt, lb.	0.009	0.008	0.011	0.009
Bonemeal, lb.	0.007	0.006	0.007	0.008
Feed cost per 100 lb. gain†	\$ 9.70	\$10.89	\$10.47	\$10.61
Initial cost per 100 lb.	13.50	13.50	13.50	13.50
Initial cost per head	60.81	61.20	60.75	60.06
Total cost for feeds	46.87	47.26	48.15	49.76
Final cost per head	107.68	108.46	108.90	109.82
Selling price, So. St. Paul	11.15	10.60	10.50	10.75
Selling price, Univ. Farm	10.40	9.85	9.75	10.00
Value per head, Univ. Farm	\$97.10	\$87.40	\$88.72	\$91.39
Pork credit per steer, lb.	33.47	49.38	16.80	5.42
Pork credit at \$9.25 per cwt.	\$ 3.10	\$ 4.57	\$ 1.55	\$ 0.50
Margin per steer over feed cost, exclud- ing hogs	-10.58	-21.06	-20.18	-18.43
Margin per steer over feed cost, includ- ing hog gains	-7.48	-16.49	-18.63	-17.93

* Two steers died during progress of trial.

† Feed prices charged: Shelled corn 78 cents per bu., pea-size linseed meal \$56 per ton, molasses \$30 per ton, alfalfa hay \$15 per ton, salt \$1.50 per cwt., bonemeal \$3.25 per cwt. Charge for grinding grain, 8 cents per cwt. Charge for grinding hay, \$2.30 per ton.

Lot 3 was fed exactly the same amounts as Lot 1, except on a few occasions when Lot 3 would not eat so much feed as Lot 1. The shelled corn and alfalfa were fed whole to Lot 1 and were fed ground and mixed to Lot 3. The cattle in Lot 1 gained 0.13 pound per day more. re-

quired less feed per 100 pounds gain, made their gains at a lower cost by 77 cents per 100 pounds, sold for 65 cents per 100 pounds more, and made a smaller loss by \$11.15 per steer than Lot 3, fed the ground mixed ration.

Table 30

A Comparison of Several Rations in a Study of Feeding Cane Molasses with Barley to Fattening Steer Calves
December 13, 1929 to June 20, 1930—189 days

Lot No. No. of steers Ration	1	2	3
	10 Shelled corn Linseed meal Alfalfa hay	10 Ground barley Linseed meal Alfalfa hay	10 Ground barley Linseed meal Molasses Alfalfa hay
Initial weight, lb.	450.50	449.80	450.00
Final weight, lb.	933.70	897.20	900.00
Average gain per steer, lb.	483.20	447.40	450.00
Average daily gain per steer, lb.	2.50	2.37	2.38
Average daily feed:			
Shelled corn, lb.	12.81	.....	.....
Ground barley, lb. ....	.....	12.66	12.19
Linseed meal, lb.	1.47	1.47	1.47
Molasses, lb. ....	.....	.....	1.91
Alfalfa hay, lb.	3.60	3.82	3.28
Salt, lb.	0.023	0.026	0.016
Bonemeal, lb.	0.020	0.014	0.011
Feed per 100 lb. gain:			
Shelled corn, lb.	500.94	.....	.....
Ground barley, lb. ....	.....	534.89	512.04
Linseed meal, lb.	57.35	61.95	61.59
Molasses, lb. ....	.....	.....	80.06
Alfalfa hay, lb.	141.02	161.45	137.86
Salt, lb.	0.009	0.011	0.006
Bonemeal, lb.	0.007	0.006	0.005
Feed cost per 100 lb. gain*	\$ 9.70	\$ 9.54	\$ 9.95
Initial cost per 100 lb.			
.....	13.50	13.50	13.50
Initial cost per head			
.....	60.81	60.72	60.75
Total cost of feeds			
.....	46.87	42.68	44.77
Final cost per head			
.....	107.68	103.40	105.52
Selling price, So. St. Paul			
.....	11.15	11.00	10.25
Selling price, Univ. Farm			
.....	10.40	10.25	9.50
Value per head, Univ. Farm			
.....	\$97.10	\$91.96	\$85.50
Pork credit per steer, lb.			
.....	33.47	10.60	14.20
Pork credit at \$9.25 per cwt.			
.....	\$ 3.10	\$ 0.98	\$ 1.31
Margin per steer over feed cost, excluding hogs			
.....	-10.58	-11.44	-20.02
Margin per steer over feed cost, including hog gains			
.....	-7.48	-10.46	-18.71

* Feed prices charged: Shelled corn 78 cents per bu., whole barley 55 cents per bu., pea-size linseed meal \$56 per ton, molasses \$30 per ton, alfalfa hay \$15 per ton, salt \$1.50 per cwt., bonemeal \$3.25 per cwt. Charge for grinding grain, 8 cents per cwt.

Lots 3 and 4 were fed exactly the same amounts, except occasionally when Lot 3 failed to eat quite as much feed as Lot 4. For both lots all feeds were ground and mixed. For Lot 4, 2 pounds of ground shelled corn were replaced by 2 pounds of molasses per steer per day. Two steers in Lot 4 died during the progress of the trial, one on January 30, and one on April 19. Both were figured out of the trial by eliminating them from the weight records and deducting the average amount of feed consumed per steer during the time they were in the trial. Both steers died suddenly, having eaten as usual at the last feeding time. Post-mortem examinations failed to show the exact cause. Death in

each case was probably caused by acute bloat. Neither steer had been a chronic bloater. Lots 3 and 4 were similar in all respects, except that a slightly higher feed cost per 100 pounds gain for Lot 4 was a little more than made up for by a selling price of 25 cents per 100 pounds higher for Lot 4 than Lot 3.

Lots 1 and 5 were each allowed to eat as much grain and hay as they cared for. Lot 1 received shelled corn, alfalfa hay, and linseed meal; Lot 5, ground barley, alfalfa hay, and linseed meal. While the larger gain and slightly higher selling price of Lot 1 over Lot 5 gave a slight advantage, the lot of barley-fed cattle made a very creditable showing.

Cattle fed ground barley often lose their appetites and consume less barley after having been on feed for 75 to 100 days. In adding molasses to the ground-barley ration in Lot 6, the barley was full fed and 2 pounds of molasses per steer per day was added (Table 30). In other words, the molasses in the ration for Lot 6 was allowed to exert its appetizing effect in the hope that it would keep up the consumption of barley and result in larger gains and a higher finish and higher selling price at the close of the trial. The figures in the table show that the molasses did exert an appetizing effect, because the cattle in this lot ate almost as much barley as those in Lot 5, and the 2 pounds of molasses besides. The additional consumption of feed, however, failed to produce a larger gain or a higher finish, and we find that Lot 5 fed barley without molasses required less feed per 100 pounds gain, made 100 pounds gain at a lower feed cost by 41 cents, sold for 75 cents per 100 pounds more, and made a smaller loss by \$8.25 per steer than Lot 6, fed barley plus 2 pounds of molasses per head per day.

GRINDING SHELLED CORN AND ALFALFA HAY

First Trial

The first trial to determine the effect of grinding shelled corn and alfalfa hay was with a group of 30 high-grade Hereford yearling feeder steers. In this trial, lasting 180 days, corn and alfalfa hay were the only feeds used, the aim being to fatten the cattle.

The cattle were divided into three lots of 10 each. Lot 1 received a ration of whole shelled corn, full fed, whole alfalfa hay, full fed; Lot 2 ground shelled corn, full fed, whole alfalfa hay, full fed; and Lot 3, ground shelled corn and ground alfalfa hay fed in about the proportion of the two feeds eaten by Lot 1. The simple ration of corn and alfalfa was used because it would give the grinding of the corn and hay the best chance to show its effects. Results are given in Table 31.

Grinding the shelled corn increased the daily feed consumption, increased the daily gain, and lessened very slightly the amounts of corn and alfalfa required to produce a pound of gain. The steers in Lot 2 were somewhat fatter at the end of the trial and were valued 15 cents per hundredweight higher than those in Lot 1. However, in the

ground-corn lot, the cost of gain was higher and the pork credit was much lower than in the shelled-corn lot. The ground-corn lot did not quite equal the shelled-corn lot in profit.

Table 31
Grinding Shelled Corn and Alfalfa Hay for Fattening Yearling Steers
November 19, 1926 to May 18, 1927—180 days

Lot No. Steers per lot Ration	1	2	3
	Shelled corn Alfalfa hay	Ground shelled corn Ground alfalfa hay	Shelled corn and alfalfa hay ground and mixed
Initial weight, lb.	688.83	688.47	689.33
Final weight, lb.	1,105.00	1,136.27	1,142.17
Average gain per steer, lb.	416.17	447.80	452.84
Average daily gain per steer, lb.	2.31	2.49	2.52
Average daily feed:			
Shelled corn, lb.	15.86	.....	.....
Ground shelled corn, lb. ....	.....	16.97	17.20
Alfalfa hay, lb.	6.59	6.95	.....
Ground alfalfa hay, lb. ....	.....	.....	6.44
Feed per 100 lb. gain:			
Shelled corn, lb.	685.80	.....	.....
Ground shelled corn, lb. ....	.....	681.96	683.53
Alfalfa hay, lb.	285.20	279.32	.....
Ground alfalfa hay, lb. ....	.....	.....	255.93
Feed cost for 100 lb. gain*	\$10.08	\$10.52	\$10.48
Initial cost per cwt.	8.00	8.00	8.00
Initial cost per head	55.11	55.08	55.15
Total cost of feeds	41.94	47.13	47.46
Final cost per head	97.05	102.21	102.61
Selling price, So. St. Paul	11.85	12.00	12.00
Selling price, Univ. Farm	11.35	11.50	11.50
Value per head, Univ. Farm	\$125.42	\$130.67	\$131.35
Pork credit per steer, lb.	34.11	16.35	16.31
Pork credit at \$10 per cwt.	\$ 3.41	\$ 1.64	\$ 1.63
Margin per steer over feed cost, excluding hogs	28.37	28.46	28.74
Margin per steer over feed cost, including hog gains	31.78	30.10	30.37

* Feed prices charged: Shelled corn 59 cents per bu., alfalfa hay \$20 per ton. Cost of grinding shelled corn, 8 cents per cwt. Cost of grinding alfalfa hay, \$1.35 per ton.

Grinding and mixing the shelled corn and alfalfa hay increased the daily feed consumption, increased the daily gain, and slightly lessened the amounts of corn and alfalfa required to produce a pound of gain. The steers in Lot 3 were somewhat fatter at the end of the trial, but they were also a little more paunchy. Lot 3 was valued 15 cents per hundredweight higher than Lot 1. However, in Lot 3 the cost of gain was higher and the pork credit was much lower than in Lot 1. Lot 3 did not quite equal Lot 1 in profit.

Lot 2 was fed underground alfalfa hay, whereas for Lot 3 the alfalfa was ground and fed mixed with the ground corn. The two lots consumed about the same amounts of feed and made practically the same gain in weight, with about the same cost per gain. Lot 3 was a little fatter and slightly more paunchy at the finish than Lot 2. Both lots were given the same final valuation per hundredweight.

The hogs following Lots 2 and 3 made almost identical gains from waste. This indicates that grinding the alfalfa hay and mixing it with

the ground corn did not improve the digestibility of the feeds fed to these steers.

Lot 3 returned 27 cents per head more profit over cost of feed than Lot 2, but no charge was made against Lot 3 for the time required to mix the feed. Lot 3 did not surpass Lot 2 in return per bushel of corn. The results show that it was not profitable to grind the alfalfa hay and mix it with the corn.

Second Trial

The second trial, to determine the effect of grinding shelled corn and alfalfa hay, was with a group of 20 high-grade Hereford yearling feeder steers. In this trial, lasting 175 days, a fairly complete ration was fed, including shelled corn, linseed meal, and alfalfa hay, corn fodder being substituted for the alfalfa hay during the first 56 days. The results of this comparison are given in Table 32.

Table 32
Grinding All Feeds, Including Roughage, for Fattening Yearling Steers
November 4, 1927 to April 27, 1928—175 days

Lot No. No. of animals Ration	1	2
	10 Whole shelled corn Linseed meal Whole corn fodder (56 days) Whole alfalfa hay (119 days)	10 Ground shelled corn Linseed meal Ground corn fodder (56 days) Ground alfalfa hay (119 days)
Initial weight, lb.	683.20	683.80
Final weight, lb.	1,080.20	1,085.60
Average gain per steer, lb.	397.00	401.80
Average daily gain, lb.	2.27	2.30
Average daily feed:		
Ground shelled corn, lb.		13.52
Whole shelled corn, lb.	13.52	
Linseed meal, lb.	1.97	1.97
Ground corn fodder, lb.		14.08 (56 days)
Whole corn fodder, lb.	13.76 (56 days)	
Ground alfalfa hay, lb.		5.87 (119 days)
Whole alfalfa hay, lb.	5.87 (119 days)	
Feed per 100 lb. gain:		
Ground shelled corn, lb.		589.09
Whole shelled corn, lb.	594.58	
Linseed meal, lb.	86.72	85.68
Ground corn fodder, lb.		534.50 (56 days)
Whole corn fodder, lb.	565.20 (56 days)	
Ground alfalfa hay, lb.		274.98 (119 days)
Whole alfalfa hay, lb.	268.22 (119 days)	
Feed cost per 100 lb. gain*	\$12.68	\$13.44
Initial cost per 100 lb.		
Initial cost per head	11.00	11.00
Total cost of feeds	75.15	75.21
Final cost per head	50.37	54.04
Selling price, So. St. Paul		
Selling price, Univ. Farm	13.25	13.20
Value per head, Univ. Farm	12.75	12.70
	\$137.72	\$137.87
Pork credit per steer, lb.		
Pork credit at \$8.40 per cwt.	27.30	16.60
Margin per steer over feed cost, excluding hogs	\$ 2.30	\$ 1.40
Margin per steer over feed cost, including hog gains	12.20	8.62
	14.50	10.02

* Feed prices charged: Shelled corn 80 cents per bu., linseed meal \$48 per ton, alfalfa hay \$13 per ton, corn fodder \$10 per ton. Charge for grinding corn, 8 cents per cwt. Cost of grinding roughage, alfalfa hay \$2.30 per ton, corn fodder \$2.00 per ton.

In planning the feeding of the two lots, the proportion of ground roughage to ground corn fed Lot 2 was based on the proportionate amount of each that fattening cattle consumed on the average in trials at this and other experiment stations in which whole shelled corn and whole corn fodder or whole alfalfa hay were fed. In working up to a full feed, a mixture of 75 per cent ground corn fodder and 25 per cent ground shelled corn with one pound of linseed meal per head per day was fed at the beginning, the aim being to feed enough to satisfy the appetites of the cattle, the proportion of corn to corn fodder being increased as the amount of feed was increased and the amount of linseed meal increased until the cattle were getting all the feed they would clean up in two feeds a day. The mixture by that time was composed of 2 pounds linseed meal, 12 pounds ground shelled corn, and 8 pounds ground corn fodder per steer per day. At each feeding time, the same amounts of whole shelled corn, whole corn fodder, linseed meal, and alfalfa hay were fed Lot 1 as were contained in the ground mixture fed Lot 2. A ration of corn, alfalfa hay, and linseed meal will often cause a tendency to scour during the early part of the feeding period, especially if an attempt is made to bring the cattle up to a full feed of grain in as short a period as three to four weeks. Corn fodder was fed in place of alfalfa hay in the early part of this trial, in an effort to alleviate this difficulty, also to demonstrate whether or not farmers could use some corn fodder to advantage in this way, thus saving alfalfa. Throughout the trial, the cattle in Lot 1, receiving unground feeds fed separately, were given exactly the same amounts of each feed at each feeding time as contained in the mixture fed Lot 2. The only exception to this was for about ten days in the early part of the trial, when the cattle in Lot 1 were unable to eat quite as much whole corn fodder as the amount included in the ration and consumed by Lot 2 as ground corn fodder.

It will be noticed from Table 32 that differences in all the figures are very small, except that the cost of feed is a little higher for Lot 2 than for Lot 1, and the pork credit is noticeably lower for Lot 2 than for Lot 1, leaving a difference of \$4.48 per steer in margin over feed cost in favor of Lot 1, the lot fed whole feeds. At the close of the trial, the steers in Lot 1 were given a valuation 5 cents per 100 pounds higher than that given those in Lot 2. The reason for this slight difference given by the salesman and buyer was that the steers in Lot 2, fed ground feeds, were noticeably more paunchy than those in Lot 1, fed whole feeds.

It was found in this trial that ground corn fodder could not be kept in any considerable bulk for more than two days, even in the coldest weather, without heating and molding. This is because of the high moisture content of corn fodder—in this instance, 35 per cent. Ground alfalfa will keep indefinitely but the job of grinding it is dusty and unpleasant under farm conditions. Once the roughage is ground, it is convenient and pleasant to handle.

The substitution of corn fodder for alfalfa hay in starting the cattle in this trial showed no particular advantage over previous experiments in which alfalfa hay was used from the beginning.

WHEAT AND RYE AS GRAINS FOR FATTENING CATTLE

Normally, wheat and rye are given little consideration as grains for fattening cattle, because of the higher value of the two as bread grains. Occasionally, in times of low prices and a surplus of the grains, it is desirable to feed some wheat or some rye to livestock to use up the surplus. In two trials at the Northwest Branch Experiment Station, at Crookston, wheat was fed to fattening calves and in one rye was fed. In the first trial, four lots, each containing 8 high-grade Hereford steer calves, were fed for 224 days. Lot 1 received ground barley, linseed meal, and sweet clover hay; Lot 2, ground wheat, linseed meal, and sweet clover hay; Lot 3, ground barley 50 per cent, ground wheat 50 per cent, linseed meal, and sweet clover hay. The quality of the three grains was as similar as could be obtained and all were of No. 2 grade, the wheat being dark Northern Spring. Results are given in Table 33.

Table 33
Ground Wheat for Fattening Steer Calves
October 29, 1930 to June 10, 1931—224 days

Lot No. No. of animals per lot Ration	1 8 Ground barley Linseed meal Sweet clover hay	2 8 Ground wheat Linseed meal Sweet clover hay	3 8 Ground wheat Ground barley Linseed meal Sweet clover hay	4 8 Ground wheat Ground oats Linseed meal Sweet clover hay
Initial weight, lb.	424.3	424.2	424.1	424.3
Final weight, lb.	898.6	905.9	860.7	930.6
Total gain, lb.	474.3	481.7	436.6	506.3
Average daily gain per steer, lb.	2.12	2.15	1.95	2.26
Average daily feed:				
Ground barley, lb.	11.32	.....	5.24	.....
Ground wheat, lb. ....	.....	10.49	5.24	5.69
Ground oats, lb. ....	.....	.....	.....	5.69
Linseed meal, lb.	1.5	1.5	1.5	1.5
Sweet clover hay, ton	2.63	2.54	2.38	2.52
Feed per 100 lb. gain:				
Ground barley, lb.	534.42	.....	268.98	.....
Ground wheat, lb. ....	.....	487.85	268.98	252.02
Ground oats, lb. ....	.....	.....	.....	252.02
Linseed meal, lb.	70.84	69.75	76.98	66.36
Sweet clover hay, lb.	124.10	118.25	122.28	111.47
Feed cost per 100 lb. gain*	\$ 6.38	\$ 7.47	\$ 7.51	\$ 7.20
Initial cost per cwt.				
Initial cost per head	9.60	9.60	9.60	9.60
Total cost of feed	40.73	40.72	40.71	40.73
Value per head, Crookston	30.25	34.87	32.81	36.47
Final cost per head	70.98	75.59	73.52	77.20
Selling price, So. St. Paul				
Selling price, Crookston	7.50	7.75	7.25	7.65
Value per head, Crookston	6.75	7.00	6.50	6.90
Margin per head over feed cost	60.66	63.41	55.95	64.21
Margin per head over feed cost	-10.32	-12.18	-17.57	-12.99

* Feed prices charged: Barley 33 cents per bu., wheat 63 cents per bu., oats 26 cents per bu., pea-size linseed meal \$45 per ton, sweet clover hay \$11 per ton. Charge for grinding grain, 8 cents per cwt.

It was noticeable, as the feeding period progressed, that the calves eating ground barley alone and those eating ground wheat 50 per cent, ground oats 50 per cent, remained on feed quite a little more regularly and consumed a little more grain daily than those receiving ground wheat alone or those receiving ground wheat 50 per cent, ground barley 50 per cent.

Altho eating a trifle less grain, the calves receiving ground wheat gained a trifle faster than those receiving ground barley, while the combination of ground wheat 50 per cent, ground oats 50 per cent proved especially efficient in producing rapid gains. The lot of cattle in this trial receiving ground wheat 50 per cent, ground barley 50 per cent did not make a highly creditable showing but a lot of cattle fed this combination in the second trial did make a much better showing.

In the second trial, four lots of high-grade Hereford steer calves, each lot containing 8 calves, were fed for 196 days. Lot 1 received ground wheat, linseed meal, and sweet clover hay; Lot 2, ground wheat 50 per cent, ground barley 50 per cent, linseed meal, and sweet clover hay; Lot 3, ground rye, linseed meal, and sweet clover hay; and Lot 4, ground rye 50 per cent, ground barley 50 per cent, linseed meal, and sweet clover hay. Results are reported in Table 34.

Table 34
Ground Wheat and Ground Rye for Fattening Steer Calves
November 24, 1931 to June 7, 1932—196 days

Lot No. No. of animals per lot Ration	1	2	3	4
	Ground wheat Linseed meal Sweet clover hay	Ground wheat Ground barley Linseed meal Sweet clover hay	Ground rye Linseed meal Sweet clover hay	Ground rye Ground barley Linseed meal Sweet clover hay
Initial weight, lb.	385.62	384.06	396.07	376.35
Final weight, lb.	792.91	793.95	724.99	761.66
Total gain, lb.	407.29	409.09	328.97	385.31
Average daily gain, lb.	2.08	2.09	1.67	1.96
Average daily feed:				
Ground wheat, lb.	9.48	4.91	.....	.....
Ground rye, lb. ....	.....	.....	7.96	4.72
Ground barley, lb. ....	.....	4.91	.....	4.72
Linseed meal, lb.	1.34	1.34	1.34	1.34
Sweet clover hay, lb.	2.29	2.22	2.36	2.25
Feed per 100 lb. gain:				
Ground wheat, lb.	456.03	234.95	.....	.....
Ground rye, lb. ....	.....	.....	474.44	245.85
Ground barley, lb. ....	.....	234.95	.....	345.85
Linseed meal, lb.	64.63	64.21	80.06	69.97
Sweet clover hay, lb.	110.45	106.41	140.86	123.09
Feed cost per 100 lb. gain*	\$ 5.75	\$ 5.22	\$ 4.98	\$ 4.86
Initial cost per cwt.	7.75	7.75	7.75	7.75
Initial cost per head	29.88	29.76	30.69	29.17
Total cost of feed	23.42	21.35	16.38	18.72
Final cost per head	53.30	51.11	47.07	47.89
Selling price, So. St. Paul	6.85	6.90	5.75	6.15
Selling price, Crookston	6.10	6.15	5.00	5.40
Value per head, Crookston	48.37	48.83	36.24	41.12
Margin per head over feed cost	-4.93	-2.28	-10.83	-6.77

* Feed prices charged: Wheat 50 cents per bu., barley 27 cents per bu., rye 31 cents per bu., pea-size linseed meal \$39 per ton, sweet clover hay \$6.00 per ton. Charge for grinding grain, 8 cents per cwt.

In this trial, because of sickness, one calf had to be removed from each of Lots 3 and 4, early in the progress of the trial. It is noticed from the table that both the lot receiving ground wheat as the only grain and the lot receiving wheat 50 per cent, ground barley 50 per cent, made a creditable showing and a very similar showing from the standpoint of daily rate of gain, feed consumed per 100 pounds gain, and selling price. Because of the slightly higher price of the wheat-alone ration per 100 pounds, as compared with the wheat and barley combination, the latter gave slightly the more favorable financial return. If a lot of calves receiving barley alone as the grain, had been fed in this trial, it would probably have had a still larger advantage in financial return than the wheat-alone lot, the larger difference being due to the higher cost of the wheat.

The lot of cattle fed ground rye alone as the grain made a very poor showing. The ground rye, even tho of very good quality, was decidedly unpalatable, the calves eating only an average of 7.96 pounds per day, while those receiving ground barley ate 9.48 pounds of that feed per day. The feeding of the ground rye resulted in lower daily gains, an unthrifty appearance, unfinished condition, and much lower selling price than was the case with calves receiving barley or the barley and wheat combination. Replacing one-half of the ground rye with ground barley as in Lot 4 improved the results materially in every way, yet the calves fed ground rye 50 per cent, ground barley 50 per cent, failed to measure up at all closely to those fed ground barley alone.

It may be concluded from these trials that wheat may be used quite satisfactorily as the grain for fattening cattle, fed alone, ground, or fed in combination with ground barley or ground oats. Whether or not wheat can be fed to advantage depends more on its cost per 100 pounds as compared to the cost of barley than upon any other factor. Using Lots 1 and 2 of the first trial (Table 33) as a basis for making the determination, it is found that 100 pounds of barley was worth 70 per cent as much as 100 pounds of wheat, or a bushel of barley was worth 54 per cent as much as a bushel of wheat when each was fed as the only grain along with a protein supplement and legume hay.

The one trial in which rye was fed can hardly be considered sufficient evidence on which to base any definite conclusion as to the value of rye. That the results in this one trial were so pronounced, however, justifies a statement that rye is not a highly satisfactory grain for fattening cattle and should be used only to form a small part of the grain ration, if it is used at all.

CUT SWEET CLOVER HAY AS A ROUGHAGE FOR FATTENING CATTLE

During recent years there has been a great deal of interest on the part of cattle feeders in the use of sweet clover hay as the roughage for fattening cattle. It is known that sweet clover hay has about the same

chemical composition as alfalfa hay, and when a good quality of leafy, fine-stemmed sweet clover hay is available, a ration of grain and sweet clover hay will give fully as satisfactory results as a ration of grain and alfalfa hay. Many feeders have not used sweet clover hay because so often it is hard to get it cured, and it is coarse and off color and cattle do not eat the coarse stems readily. Even sweet clover hay that is quite coarse generally has a chemical composition equal to alfalfa, and it would seem that if it could be ground or cut economically so that cattle would eat it more readily, it would make a good feed.

Feeders and experiment stations have tried grinding coarse roughages quite fine but have found that this is quite expensive, and cattle do not eat the extremely finely ground roughage any too readily. It is much less expensive to run such a coarse feed through a silage cutter than it is to run it through a feed grinder.

Table 35
Cut Sweet Clover and Prairie Hay for Fattening Steer Calves
November 17, 1933 to June 1, 1934—196 days

Lot No. No. of steers per lot Ration	1	2
	12 Shelled corn Linseed meal Prairie hay Salt and limestone	12 Shelled corn Linseed meal Cut sweet clover hay Salt and limestone
Initial weight, lb.	458	455
Final weight, lb.	916	940
Average gain per steer, lb.	458	485
Average daily gain per steer, lb.	2.34	2.47
Average daily feed:		
Shelled corn, lb.	12.07	12.21
Linseed meal, lb.	1.42	1.42
Prairie hay, lb.	4.80	.....
Cut sweet clover hay .....	.....	4.65
Salt and limestone, lb.	0.023	0.024
Feed per 100 lb. gain:		
Shelled corn, lb.	516.46	493.25
Linseed meal, lb.	61.00	57.60
Prairie hay, lb.	205.55	.....
Cut sweet clover hay, lb. ....	.....	187.73
Salt and limestone, lb.	1.00	1.05
Feed cost per 100 lb. gain	\$6.47	\$6.12
Initial cost per 100 lb.	\$5.60	\$5.60
Initial cost per head	25.65	25.48
Total cost of feed per head	29.63	29.63
Final cost per head	55.28	55.11
Selling price, So. St. Paul	\$7.25	\$7.50
Selling price, Univ. Farm	6.75	7.00
Value per head, Univ. Farm	61.83	65.80
Pork credit per steer, lb.	19.00	18.00
Pork credit at \$3 per cwt.	\$0.57	\$0.54
Margin per steer over feed cost excluding hogs	6.55	10.69
Margin per steer over feed cost including hog gains	7.12	11.23
Bushels of corn consumed per steer	42.25	42.75
Price returned per bushel of corn	\$0.62	\$0.71

Feed prices charged: Shelled corn 45 cents per bu., linseed meal \$35 per ton, prairie hay \$12 per ton, sweet clover hay \$10 per ton, salt and limestone \$1.50 per 100 pounds, cost of cutting sweet clover hay \$2 per ton.

The trial reported in Table 35 is a comparison of prairie hay fed whole with a medium quality of sweet clover hay run through a silage cutter before feeding. The particular comparison of prairie hay with cut sweet clover was made to determine whether a good-quality, non-leguminous roughage such as prairie hay would prove more profitable than a medium-quality, coarse legume hay such as sweet clover cut before feeding it.

In determining the comparative cost of the two hays, it is easy to establish a price for prairie hay because it is offered in considerable quantity on the market. Sweet clover hay is seldom offered on the market, and it is more difficult to establish a price to charge for it. The price charged for the sweet clover hay was arbitrarily set at \$10 per ton, with a charge of \$2 per ton for putting it through the silage cutter. It is certain that \$2 per ton will cover the cost of cutting the sweet clover hay under conditions that are at all favorable for the work.

The results secured and observation during the feeding period show that the cattle ate the cut sweet clover hay very readily and that it proved a decidedly more satisfactory roughage for fattening cattle than did the upland prairie hay. The margin over feed cost was \$7.12 per head for the calves fed shelled corn, linseed meal, and prairie hay, and \$11.23 per head for those fed shelled corn, linseed meal, and cut sweet clover hay. Putting the results another way, charging all other feeds at cost and crediting the profit to the corn, the calves fed prairie hay returned 62 cents per bushel for the corn they ate, while those fed cut sweet clover hay returned 71 cents per bushel for corn.

TANKAGE AS A PROTEIN SUPPLEMENT FOR FATTENING CATTLE

First Trial

Because of the prevailing low price during the year 1934 for tankage, a standard protein supplemental feed for hogs and poultry, its use as a protein supplement for cattle was suggested and tried. There are three kinds of meat products available as protein supplemental feeds: Sixty per cent protein steam-rendered tankage, 60 per cent protein dry-rendered tankage, and 50 per cent protein dry-rendered meat scraps. In the production of steam-rendered tankage, the cooking is done with steam applied directly to the offal, while in the dry-rendering process, the cooking is done by means of a steam-jacketed vat. The dry-rendered product is lighter in color and has much less odor than steam-rendered tankage. Meat and bone scrap is ground dry-rendered cracklings, with enough bonemeal added to bring the protein content down to 50 per cent. Because it was known that dry-rendered tankage was more palatable to hogs than the steam rendered, it was thought that dry-rendered tankage would also be more palatable to cattle. The 60 per cent protein dry-rendered tankage was, therefore, used in the two trials.

In the first trial, extending from June 26 to September 11, 1934, 27 head of short yearling grade Hereford heifers purchased on the market at South St. Paul were fed in three lots of 9 heifers each. The concentrates for Lot 1 consisted of shelled corn and linseed meal mixed in such proportions as to provide approximately 1½ pounds of linseed meal daily as an average for the feeding period. Lot 2 received shelled corn and an amount of tankage which furnished the same quantity of protein as provided by the linseed meal in Lot 1. Lot 3 received shelled corn and a mixture of tankage and linseed meal so that each feed provided an equal amount of protein and the same total amount as provided by the supplements in each of the other rations. The roughage consisted of alfalfa and prairie hay of which one feed of each was given daily. Each lot had access to bonemeal and salt.

Table 36
Tankage and Linseed Meal as Protein Supplements for Fattening Cattle
First trial
June 26 to September 11, 1934—77 days

Lot No.	1	2	3
No. of heifers per lot	9	9	9
Ration	Shelled corn Linseed meal Alfalfa hay Prairie hay Salt Bonemeal	Shelled corn Tankage Alfalfa hay Prairie hay Salt Bonemeal	Shelled corn Linseed meal Tankage Alfalfa hay Prairie hay Salt Bonemeal
Initial weight, lb.	464.59	456.17	464.44
Final weight, lb.	681.26	673.08	675.41
Average gain per heifer, lb.	216.67	216.91	210.97
Average daily gain per heifer, lb.	2.81	2.82	2.74
Average daily feed:			
Shelled corn, lb.	11.50	12.41	11.87
Linseed meal, lb.	1.47	.....	0.74
Tankage, lb. ....	.....	0.93	0.45
Alfalfa hay, lb.	4.24	4.19	4.17
Prairie hay, lb.	2.66	2.59	2.61
Salt, lb.	0.05	0.04	0.04
Bonemeal, lb.	0.03	0.03	0.03
Feed per 100 lb. gain:			
Shelled corn, lb.	408.69	440.68	433.35
Linseed meal, lb.	52.08	.....	27.08
Tankage, lb. ....	.....	33.17	16.60
Alfalfa hay, lb.	150.54	148.82	152.29
Prairie hay, lb.	94.46	91.84	95.42
Salt, lb.	1.70	1.44	1.58
Bonemeal, lb.	1.18	0.89	1.26
Feed cost per 100 lb. gain*	\$ 8.53	\$ 8.42	\$ 8.66
Initial cost per cwt.			
.....	4.50	4.50	4.50
Initial cost per head			
.....	20.91	20.53	20.90
Total cost of feeds			
.....	18.48	18.26	18.27
Total cost per head			
.....	39.39	38.79	39.17
Selling price, Univ. Farm			
.....	8.00	8.00	8.00
Value per head, Univ. Farm			
.....	54.50	53.85	54.03
Margin per heifer over feed cost			
.....	15.11	15.06	14.86
Price returned per bu. of corn			
.....	1.61	1.53	1.56

* Feed prices charged: Shelled corn 65 cents per bu., linseed meal \$45 per ton, tankage \$45 per ton, alfalfa hay \$23 per ton, prairie hay \$18 per ton, salt \$1 per cwt., bonemeal \$1.50 per cwt.

When the cattle were first placed on feed, close observations were made to determine whether the lots receiving tankage would eat their feed. At first, the cattle showed a marked dislike for the corn containing the tankage. By the end of a week, however, they were eating as readily as those receiving linseed meal. As shown in Table 36, the average daily gains are practically the same for the three lots and rather high for all lots. This trial demonstrates that tankage can be used as the protein supplement for cattle and that there is no advantage in mixing linseed meal with the tankage.

Second Trial

In the second experiment, extending from December 11, 1934 to May 28, 1935, 36 head of high-grade Hereford heifers were purchased at the South St. Paul market and divided equally into four lots. In this experiment it was desired to compare again linseed meal and tankage when fed in similar amounts as fed in the first experiment, namely 1.5 pounds of linseed meal and 0.90 pound of tankage, and likewise to observe the effect upon the rate of gain and economy of gain of feeding one-half this amount of these supplements to two other lots. The rations fed to the four lots are as follows: Lot 1, shelled corn and linseed meal mixed in such proportions as to provide approximately $1\frac{1}{2}$ pounds of linseed meal as an average for the feeding period; Lot 2, shelled corn and an amount of tankage so as to provide the same quantity of tankage as furnished by the linseed meal in Lot 1; Lot 3, shelled corn and one-half the amount of linseed meal as given to Lot 1; and Lot 4, shelled corn and one-half the amount of tankage as given to Lot 2. Altho the rations for Lots 3 and 4 did not contain as much protein as the rations for Lots 1 and 2, nevertheless the four rations contained the same total quantity of nutrients per 100 pounds.

As in the first experiment, the cattle at first objected to the tankage, but after about nine days they were eating as readily of the corn and tankage as were those receiving corn and linseed meal. It was also observed that as the feed for the various lots was increased from time to time, it was more difficult to keep the lots receiving corn and tankage on a high feed intake than was the case with the lots receiving corn and linseed. It would seem that this difficulty would be experienced only under conditions of heavy feeding, as was the case in this experiment. The results of this experiment are shown in Table 37. It will be observed that Lots 1 and 2 did essentially the same. This would be expected from the results of the first experiment. That the smaller quantities of protein supplements, as given to Lots 3 and 4 were not sufficient for maximum gains is evidenced by the daily gains of these two lots. At the start of the experiment, no attempt was made to keep the intake of feed for the four lots the same for it was desired to observe the palatability of the rations containing the tankage. After the cattle became accustomed to the tankage, the feed for all lots was increased as rapidly

Table 37
Tankage and Linseed Meal as Protein Supplements for Fattening Cattle
Second Trial

December 11, 1934 to May 28, 1935—168 days

Lot No. No. of heifers per lot Ration	1	2	3	4
	9	9	9	9
	Shelled corn Linseed meal	Shelled corn Tankage	Shelled corn Linseed meal	Shelled corn Tankage
	Alfalfa hay	Alfalfa hay	Alfalfa hay	Alfalfa hay
	Prairie hay	Prairie hay	Prairie hay	Prairie hay
	Salt	Salt	Salt	Salt
	Bonemeal	Bonemeal	Bonemeal	Bonemeal
Initial weight, lb.	457.41	454.59	456.19	454.48
Final weight, lb.	859.85	856.52	823.04	797.11
Average gain per heifer, lb.	402.44	401.93	366.85	342.63
Average daily gain per heifer, lb.	2.40	2.39	2.18	2.04
Average daily feed:				
Shelled corn, lb.	12.55	12.69	12.55	12.46
Linseed meal, lb.	1.46	.....	0.69	.....
Tankage .....	.....	0.93	.....	0.44
Alfalfa hay, lb.	2.68	2.65	2.60	2.60
Prairie hay, lb.	2.68	2.68	2.65	2.65
Salt	0.05	0.04	0.04	0.04
Bonemeal	0.03	0.02	0.02	0.02
Feed per 100 lb. gain:				
Shelled corn, lb.	523.85	530.42	574.85	610.97
Linseed meal, lb.	61.12	.....	31.82	.....
Tankage, lb. ....	.....	38.85	.....	21.70
Alfalfa hay, lb.	111.82	110.82	119.18	127.46
Prairie hay, lb.	111.76	112.21	121.31	130.05
Salt, lb.	2.10	1.62	1.67	1.75
Bonemeal, lb.	1.22	0.69	1.04	0.97
Feed cost per 100 lb. gain*	\$12.14	\$11.70	\$12.46	\$12.98
Initial cost per cwt.				
Initial cost per head	3.75	3.75	3.75	3.75
Total cost of feeds	17.15	17.05	17.11	17.04
Final cost per head	48.86	47.03	45.71	44.47
Final cost per head	66.01	64.08	62.82	61.51
Selling price, Univ. Farm				
Value per head, Univ. Farm	10.50	10.50	9.50	9.50
Margin per head over feed cost	90.28	89.93	78.19	75.73
Price returned per bu. of corn	24.27	25.85	15.37	14.22
Price returned per bu. of corn	1.54	1.58	1.31	1.28

* Feed prices charged: Shelled corn 90 cents per bu., linseed meal \$45 per ton, tankage \$45 per ton, alfalfa hay \$23 per ton, prairie hay \$18 per ton, salt \$1 per cwt., bonemeal \$1.50 per cwt.

as possible. When the cattle had been on full feed for about two months, Lots 3 and 4 began to show the effect of the smaller amounts of the protein supplements. They were not growing as fast, and it was not possible to get them to eat as much feed as Lots 1 and 2. In fact, Lots 3 and 4 ate three-fourths of a pound less concentrates daily than Lots 1 and 2, respectively. This resulted in less condition at the end of the feeding period, which in turn caused them to be valued at one dollar per hundred pounds under the other two lots. An expenditure of \$5.55 per head for linseed meal in Lot 1 as compared to \$2.64 for Lot 3 resulted in a profit of \$8.90 for Lot 1 over Lot 3. Just what amount of protein supplement to feed depends not only upon the price of the supplement but also upon the price of grain. During the progress of this trial corn was higher priced as compared to protein supplements than is ordinarily the case. If the corn in this experiment had been charged

at 60 cents per bushel, then the cost of feed for each 100 pounds of gain would have been approximately the same for Lots 1 and 3. Nevertheless, Lot 1, even had they been valued the same as Lot 3, would still have shown more profit for they were heavier at the end of the trial.

It can be seen in Table 37 that Lot 4 did not gain as rapidly as Lot 3. An explanation for this is that one heifer in this lot seemed to be in poor health and did rather poorly throughout the feeding period. This cannot be attributed to the tankage for all of the cattle in Lot 2, getting twice the tankage given to Lot 4, did uniformly well.

Results of these two feeding trials indicate that sixty per cent protein dry-rendered tankage is a suitable substitute for linseed meal for the growing and fattening of cattle. After a little more than a week the cattle become accustomed to the tankage and no difficulty is then experienced in getting them to eat the grain containing the tankage. There is no advantage in feeding both tankage and linseed meal, for either supplement fed alone is as suitable as a mixture of the two. There is no advantage in feeding tankage to fattening cattle except when a pound of protein can be obtained more cheaply in tankage than in other protein supplements. With normal prices between protein supplements and grain for 450-pound cattle, 1.50 pounds of linseed meal or 0.90 pound of tankage are more suitable than one-half these amounts because of the larger daily gains and increased selling price per pound of the cattle receiving the larger quantities of supplements.

THE FEEDING VALUE OF CORN SILAGE TREATED WITH PHOSPHORIC ACID WHEN FED TO FATTENING CATTLE

The preservation of feeds in such a manner as to conserve in a digestible condition the highest possible percentage of total digestible nutrients contained in such feeds at time of harvesting of the crop is an important item in livestock production. Many practices that have been developed by experiment stations for the better preservation of feeds are now in general use.

The preservation of the corn plant as silage has been in practice for many years. It has been demonstrated by experiment stations many times that an acre of corn will produce more pounds of beef or of milk preserved as silage than by any other means of curing and storing the corn. Even so, it is known that some of the feed value of the corn plant is lost in the processes of fermentation that take place in silage.

It has been found that green crops of any kind can be preserved without deterioration by first treating them with any one of several chemical compounds and then storing in an air-tight container such as an ordinary silo. One of the chemical compounds that has been found especially successful for this purpose is phosphoric acid. It is also one of the less

costly compounds that may be used, and it is possible that in case of a deficiency of phosphorus in the ration, it might serve also as a phosphorus supplement.

Since corn is the crop commonly used for silage in Minnesota, it seemed desirable that an experiment be conducted to learn if the treating of corn silage with phosphoric acid at the time of filling the silo would increase the feeding value of the silage.

Table 38

A Comparison of the Feeding Value of Phosphoric-Acid-Treated Silage and Natural Silage when Fed in the Ration to Fattening Steers November 12, 1935 to April 17, 1936—157 days

Lot No. No. of steers per lot Ration	1 9	2 9	3 9	4 9	5 9
	Shelled corn Linseed meal Natural silage Alfalfa hay Salt	Shelled corn Linseed meal Phosphoric acid silage Alfalfa hay Salt	Shelled corn Linseed meal Natural silage Alfalfa hay Bonemeal Salt	Shelled corn Linseed meal Natural silage Alfalfa hay Salt	Shelled corn Linseed meal Phosphoric acid silage Alfalfa hay Salt
Initial weight, lb.	648.00	656.00	653.00	654.00	649.00
Final weight, lb.	962.00	941.00	952.00	979.00	937.00
Total gain per steer, lb.	314.00	285.00	299.00	325.00	288.00
Average daily gain per steer, lb.	2.00	1.82	1.90	2.07	1.83
Average daily feed:					
Shelled corn, lb.	12.18	12.18	12.18	12.77	12.64
Linseed meal, lb.	1.00	1.00	1.00	1.00	1.00
Natural silage, lb.	13.35	.....	13.17	13.93	.....
Phosphoric-acid-treated silage, lb. ....	.....	13.18	.....	.....	13.00
Alfalfa hay, lb.	1.94	1.95	1.84	3.03	2.98
Bonemeal, lb. ....	.....	.....	0.0107	.....	.....
Salt	0.03	0.03	0.03	0.03	0.03
Feed per 100 lb. gain:					
Shelled corn, lb.	609.00	669.23	641.05	616.91	690.71
Linseed meal, lb.	50.00	54.95	52.63	48.31	54.64
Natural silage, lb.	667.50	.....	693.16	672.44	.....
Phosphoric-acid-treated silage, lb. ....	.....	724.17	.....	.....	710.38
Alfalfa hay, lb.	97.00	107.14	96.84	146.38	162.84
Bonemeal, lb. ....	.....	.....	0.363	.....	.....
Salt, lb.	1.50	1.65	1.58	1.45	1.64
Feed cost per 100 lb. gain*	\$ 8.59	\$ 9.68	\$ 9.02	\$ 8.84	\$10.09
Initial cost per cwt.	8.75	8.75	8.75	8.75	8.75
Initial cost per steer	56.70	57.40	57.14	57.22	56.78
Feed cost per steer	26.97	27.59	26.97	28.73	29.05
Total cost per steer	83.67	84.99	84.11	85.95	85.83
Selling price, So. St. Paul	8.35	8.35	8.35	8.35	8.35
Selling price, Univ. Farm	7.85	7.85	7.85	7.85	7.85
Selling price per steer	75.52	73.87	74.73	76.85	73.55
Loss per steer over feed cost	-8.15	-11.12	-9.38	-9.10	-12.28

* Feed prices charged: Shelled corn 56 cents per bu., linseed meal \$30 per ton, alfalfa hay \$8 per ton, natural silage \$4 per ton, phosphoric-acid-treated silage \$4.75 per ton, bonemeal \$30 per ton, salt \$20 per ton.

In order to make possible a fair comparison of natural, fermented silage with the phosphoric-acid-treated silage, two silos were filled during the fall of 1935 from the same field of corn and both during the same week. Both silos were filled in the usual way under conditions as nearly

identical as possible except that as the second silo was filled, an amount of dilute phosphoric acid calculated to be enough to dampen thoroly and coat over all particles of silage was run into the blower of the silo filler. This was accomplished by placing an ordinary wooden barrel on a stand and connecting it with the blower by means of a rubber hose and stop-cock. While the silo filler was operating, two attendants mixed and added the diluted phosphoric acid to the barrel, thus keeping the supply constant. About 7 gallons of the dilute mixture containing 10 pounds of phosphoric acid were added per ton of green corn. The cost of the acid plus the labor of adding it to the silage was 75 cents per ton of silage.

In conducting the feeding trial to test the feeding value of the two kinds of silage, 45 high-grade Hereford yearling steers purchased at the market at South St. Paul were fed in 5 lots of 9 steers each. Lots 1, 2, and 3 were fed as nearly as possible exactly the same amounts of each feed per day. The feeding plan followed was an attempt to feed Lot 1 proportionate amounts of each feed known to have given economical results in former feeding trials where the same four feeds, shelled corn, linseed meal, alfalfa hay, and corn silage, were fed. Then when the cattle reached about a full feed, the amounts were determined for all three lots by that lot which ate the least feed each day. This necessitated some weigh-back of silage and alfalfa, but never was the shelled corn fed heavy enough so there would be any left by any of the three lots. The aim was to encourage as large a consumption of silage as possible by holding back a little on both grain and hay. Generally, Lot 2 was the lot that determined the amount to be fed the next day, but part of the time it was Lot 3. Throughout the trial the steers in Lot 1 would have eaten a little more feed had it been given to them.

It was quite clearly demonstrated by these three lots that the cattle relished the taste of the fermented silage a little more than they did the phosphoric-acid-treated silage. The phosphoric-acid-treated silage was a dark green in color and practically without the characteristic silage odor, while the fermented silage was a more typical brown in color and had a strong, characteristic, natural silage odor.

The fact that Lot 2 made a noticeably smaller daily gain per steer than Lot 1 would indicate that at least the phosphoric acid treatment of this silage did not increase its feeding value but rather seemed to decrease it a little.

The fact that Lot 3 did not do any better than Lot 1—in fact, not quite so well—would indicate that addition of bonemeal to the ration fed Lots 1 and 3 was unnecessary. Apparently neither phosphorus nor calcium is needed to supplement Ration 1. The steers in Lot 3 ate very little bonemeal, which would again indicate that they did not need it. The results in Lot 1 and Lot 3 compared to Lot 2 indicate that neither the preservative quality nor the phosphorus contained in the phosphoric acid added to the feeding value of the silage. There is no explanation

why Lot 3 did not do just the same as Lot 1, except that even tho every effort was made to get a balance of quality in the cattle in the three lots at the beginning of the trial, there may have been a little difference in the feeding quality between the three lots, sufficient to account for the difference in gains.

Lots 4 and 5 were fed the same feeds as Lots 1 and 2, but in quite a different way. An attempt was made in these two lots to self-feed all feeds except the linseed meal. At intervals of six weeks the cattle in these lots were weighed and reversed so that half of the time Lot 4 was receiving natural silage and half of the time, phosphoric-acid-treated silage, the same being true of Lot 5. In making up the table for Lots 4 and 5, the figures do not represent individual steers but the totals for two steers, each of which ate phosphoric-acid-treated silage one-half of the feeding period and natural silage the other half. The results of this feeding plan demonstrated again that the cattle did not relish the taste of the treated silage as much as the natural product. Even tho the cattle were alternated from one type of silage to the other at six-week intervals during each period, the group receiving natural silage did better than the group receiving the treated silage.

GENERAL OBSERVATIONS ON CATTLE FATTENING

In the 15 years of experimental cattle fattening at University Farm 800 cattle were fed, and in the eight years of work at Crookston 256 head, a total of 1,056 cattle, were fattened. This has afforded an opportunity to make many general observations of factors that affect success and profit from cattle fattening, not directly brought out in the data on the individual trials. In 11 of the 15 years of feeding at University Farm, an average of all lots showed a margin over feed cost of \$13.68 per head. In four years, a loss margin below feed cost of \$16.85 per head resulted. The four years in which losses resulted were the winters of 1920-21, 1929-30, 1930-31, and 1935-36. The year of heaviest loss was 1920-21, when an average loss of \$26.28 per head was experienced on 48 two-year-old steers. This was probably the most disastrous year ever experienced by cattle fatteners. The year of the largest profit was the winter of 1926-27, when an average margin over feed cost of \$26.27 per head was made on 60 calves.

For the eight years of feeding at Crookston, a loss averaging \$9.73 per head was experienced in two years, and a gain over feed cost averaging \$7.28 per head was made for the other six years. The years of losses at Crookston were the winters of 1930-31 and 1931-32. At both University Farm and Crookston, the cattle-fattening enterprise proved profitable 75 per cent of the time, regardless of the ration fed, and unprofitable 25 per cent of the time.

The average content and desirability of all rations used would ap-

proximate closely those commonly used by cattle fatteners in practice on farms. What, then, are the more important factors that influence profits from cattle fattening?

Price Trends

The most important factor affecting profits from cattle fattening is undoubtedly the prevailing price trend. It is next to impossible to make a profit from fattening cattle when the market is on a rapidly declining trend. On such a market the cattle fattener buys thin feeder animals, say at 6 cents a pound, expecting that he will sell them 4 to 8 months later when they are fat for not less than 8 cents per pound because their actual value will be raised at least 2 cents a pound by the fattening process. Then if a decline in all cattle prices takes place while the cattle are on feed, the price of 8 cents per pound will not be realized, but a lower price, and the smallness of the profit or size of the loss will be determined by the extent of the decline.

Generally, if feeder cattle can be sold when fat at the same price they cost per pound when thin, the feeder will get market price for his feeds, and just about break even. Whenever, as fat cattle, they must be sold at a lower price per pound than they cost when thin, there will be a loss. If cattle prices could be stabilized to such an extent that the fattener who did a good job of fattening his cattle and got them to market in a desirable condition for slaughter could always secure a price 2 cents per pound higher than the cost price, it would be easy to plan and carry on cattle fattening with satisfactory profit.

Naturally, when an advancing cattle market prevails and a margin of more than 2 cents per pound in selling price over cost price is obtained, profits are increased. If price trends that have prevailed in the cattle market during the last 15 years are taken as a criterion, it is found that during the period the cattle were on feed, the market was steady to slowly rising or slowly declining 50 per cent of the time, rapidly rising 25 per cent of the time, and rapidly declining 25 per cent of the time.

Under such market behavior averaged over the 15-year period, the cattle-fattening enterprise has been modestly profitable. It would have been much more so if the four "loss" years had been eliminated.

Will it be possible to eliminate loss years, because of fast declining market price trends in the future? Probably not entirely, because the loss years are produced largely by factors not under the control of the cattle feeder or possible of accurate prediction in advance by anyone. The cattle fattener can protect himself from serious loss years to some extent by becoming a student of market reports and guarding intelligently and carefully against losses from other causes that do come under his control. Then he must arrive at the conclusion that specialized cattle fattening is best taken up as a long-time enterprise, to be made a part of a general farm management plan to be continued over a period of years. In that way, probably there will still be some loss years, but

their effect on the farm income will be minimized, and in the long run the well managed fattening of thin cattle will be a reasonably profitable enterprise.

Selection of Feeds

Next in importance to general price trends as a factor affecting profits from cattle fattening is the ration used. This includes the selection of feeds, the preparation given the feeds, and the amount of feed given. In the 15 years of trials at University Farm, the largest difference in the margin over feed cost due to a difference in the rations fed any two lots of cattle the same year was \$17.44 per steer. A similar figure for the trials conducted at Crookston was \$17.85 per steer. The average difference for the 15 years at University Farm was \$9.98 per steer, while the average difference for the 8 trials at Crookston was \$7.91 per steer.

This means that if all the cattle fattened at University Farm each year had been fed the same ration as the lot that made the largest margin over feed cost for that year, the profit would have been \$9.98 per steer larger than if all had been fed the ration fed to the lot making the poorest showing. The similar figure for the Crookston trials was \$7.91 per steer. It does, therefore, make a big difference what feeds are used, how they are prepared, and in what amounts they are fed. The many feeding trials reported in this bulletin should prove a valuable guide to the cattle feeder in selecting the rations that will prove most profitable on his farm.

Overhead Expense and Manure Value

Under "overhead expense affecting profits from cattle fattening" must be included interest on investment; interest, upkeep, and depreciation on equipment; cost of bedding, water supply, salt, and labor, together with any other incidental expense incurred. The above elements of cost all grouped together do not make a large item in the average cattle-fattening enterprise. Because it was practically impossible to get an accurate evaluation of these items under experimental conditions when animals were being fed in small groups and all feeds were weighed, this item of overhead expense was balanced against the value of the manure produced and both were omitted from the records. Whether the cattle feeder, in practice, can balance the two items in the same way depends on how his cattle-fattening enterprise has been planned and developed. If he has been conservative in the construction of his equipment and so arranged it as to allow a reasonable labor requirement and is fattening cattle as one feature of a well managed farm enterprise, he need not look to the value of the manure produced as an item to balance overhead costs only, but will find the manure a source of additional profit from increased crop yields from his farm in future years.

Death Loss

Fortunately, loss of animals by death is not a serious factor affecting profits from cattle fattening. In the 15 years of cattle-fattening experimental work reported in this bulletin, in which 1,056 animals were fed, the death loss totaled 16 head. Ten of these animals died from pneumonia, following shipping fever symptoms before the trials started and soon after the cattle arrived. Of the rest, 4 died of bloat and 2 from unknown causes. For a period of years, it is quite certain that the death loss will not exceed 2 per cent.

CONCLUSIONS

The enterprise of fattening purchased thin cattle through the winter months is most favorably located when it is one feature of the production policy on a well managed farm on which a large percentage of the acreage is suited to the production of feed crops.

The prevailing market price trend during the feeding period each year, the success of the feeder in selecting low-cost rations that will produce a satisfactory finish in a feeding period of normal length, and the use that can be made of the manure as fertilizer are the most important factors affecting the profit that will be made.