

THE UNIVERSITY OF MINNESOTA

GRADUATE SCHOOL

Report
of
Committee on Thesis

The undersigned, acting as a Committee of the Graduate School, have read the accompanying thesis submitted by Norris Kenneth Carnes for the degree of Master of Science. They approve it as a thesis meeting the requirements of the Graduate School of the University of Minnesota, and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science.

W. H. Peters
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Date May 8-1922

THE UNIVERSITY OF MINNESOTA

GRADUATE SCHOOL

Report

of

Committee on Examination

This is to certify that we the undersigned, as a committee of the Graduate School, have given Morris Kenneth Carnes final oral examination for the degree of Master of Science. We recommend that the degree of Master of Science be conferred upon the candidate.

Minneapolis, Minnesota

May 8 1922

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THE COMPARATIVE VALUE OF SEVERAL RATIONS
FOR FATTENING STEERS

A THESIS

PRESENTED TO THE FACULTY
IN THE
GRADUATE SCHOOL
OF THE
UNIVERSITY OF MINNESOTA

IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF SCIENCE

By

Norris K. Carnes

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INTRODUCTION

The economical conversion of farm grown grains, forage and vegetable products into animal products of superior quality available for mans use is an important problem that directly confronts the live stock farmer. The production of beef is one of the most satisfactory and economical methods of utilizing grass lands and coarse forage or fodder crops. That beef cattle are of considerable economic importance in contributing to the food supply of this country is evidenced by the fact that in 1920 more than 14,000,000 head of cattle were slaughtered at the live stock slaughtering centers of the country, and at the beginning of the year 1921 there were on hand in the United States 42,870,000 cattle classed as beef cattle.

In order that beef cattle may possess the necessary quality and palatability to compete successfully with other meats on the markets, it is essential that the cattle be fattened, either while they are growing or after they have been grown to practical maturity. In the process of fattening, feeds of a concentrated character, such as corn, the smaller grains and mill feeds are extensively used. It is not difficult to select or to secure feeds that will produce fat on beef cattle. One of the big problems in the fattening of cattle is rather a problem in economy or in other words, the production or purchase of the cattle and feeds at a sufficiently low cost to permit of

financial profit from the fattening process.

Beef cattle can be successfully and profitably grown to maturity in almost any section of the United States. The limiting factor to the profit in growing beef cattle is usually the suitability and value of the land for the production of crops that have a higher value for some other purpose.

In earlier days when land, feed, and labor were cheap and beef high comparatively, almost anyone could fatten cattle at a profit. At present, however, very different conditions prevail. The taking over of thousands of acres of range lands for agricultural purposes due to the rapidly increasing population in this country, the general increase in the price of farm lands, the increase in the price of all feeds, and the growing demand for dairy products have resulted in greatly increasing the cost of producing feeder cattle. Parelleling this, there has been a decrease in the selling value of the finished animal which may be attributed to under-consumption of beef caused by the "meatless days" habit formed during the war period, to quack health writers advocating the use of meat substitutes, to manufacturers advertising competing food products, to increased unemployment, and to decreased exports of beef.

This narrowing of the margin between the cost of the feeder and the selling value of the fattened animal, necessitates great care in the selection of feeder cattle, in the selection

of feeds, and in methods followed in the feeding and care of fattening cattle.

It was the object of the writer in collecting material for this thesis to make a study of the present-day methods and practices in fattening cattle in other states for the purpose of testing their value in feeding cattle under the conditions prevailing in Minnesota. A study has been made of experiments that have been conducted at several experiment stations during recent years. The findings in these trials are supplemented by an original feeding trial conducted by the writer at the Minnesota Experiment Station, with the object in view of gaining further information relative to the most economic rations to use.

REVIEW OF OTHER TRIALS

The Comparative Value of Barley and Corn
As a Grain for Fattening Cattle

Luther Foster and H. H. Simpson (1) at the New Mexico Station during the spring of 1909, fed two lots of five two-year-old steers for ninety-one days, on different fattening rations and found that the steers fed on alfalfa, ground barley, and cottonseed meal, averaged 2.04 pounds of gain daily per head, while the steers fed on a ration in which ground corn was substituted for the ground barley, gained 2.11 pounds daily per head. The steers receiving ground corn in their ration consumed a little more grain and hay per day, but returned more gain for 100 pounds of feed than the steers receiving ground barley in their ration. It required 103.4 pounds of ground barley to produce as much gain as 100 pounds of ground corn.

Table I. Summary of Results

Lot	I	II
Ration	Alfalfa hay Ground barley Cottonseed meal	Alfalfa hay Ground corn Cottonseed meal
Initial weight, lbs.	2992	2978
Final weight, lbs.	3918	3938
Total gain (5 steers), lbs.	926	960
Average gain per head, lbs.	185	192
Average daily gain per head, lbs.	2.04	2.11

	I.	II.
Average daily concentrate per head, lbs.	7.79	7.81
Average daily roughage, per head, lbs.	14.59	15.09
Concentrates fed per lb. gain, lbs.	3.83	3.79
Roughage fed per lb. gain, lbs.	7.17	7.16
Cost per lb. of gain	\$.0952	\$.0932

Feed prices: Alfalfa hay \$10.00 per ton; Corn and barley \$30.00 per ton.

At the Fort Hays Branch Station, Kansas, two lots of eight grade calves were fed by J. G. Haney and O. H. Elling (2), from December 21, 1903 to June 21, 1904, and it was found that the lot receiving barley and alfalfa hay made a smaller average daily gain, consumed less grain and more hay per 100 pounds of gain, sold at a lower price per hundred pounds, and returned less profit per calf than the lot receiving corn and alfalfa hay. The results are shown in the following table.

Table II. Summary of Results

Lot	I	II
Ration	Corn Alfalfa hay	Barley Alfalfa hay
Average initial weight, lbs.	399	400
Average final weight, lbs.	737.5	698
Average gain per head, lbs.	338	297
Average daily gain per head, lbs.	1.85	1.62
Feed required to make) Grain	545	519
100 pounds of gain) Hay	388	421

	I.	II.
Cost of lot	\$102.91	\$103.33
Selling price	\$5.25	\$5.00
Value of lot	\$309.75	\$279.15
Gain per lot	\$109.74	\$57.16

Feed prices: Corn \$.40 per bushel; Barley \$.40 per bushel; Alfalfa hay \$4.00 per ton.

James W. Wilson (3) at the South Dakota Experiment Station during the winter 1913-14 compared different grains for fattening two-year-old steers. The steers in Lot I, fed ground corn and silage, showed a much nicer finish than the steers in Lot II receiving ground barley and silage. The barley was not as palatable as the corn and some difficulty was experienced in getting the steers receiving barley, on feed. The following table shows the results.

Table III. Summary of Results

Lot	I. (4 steers)	II. (4 steers)
Ration	Corn Corn silage	Barley Corn silage
Average initial weight, lbs.	748	729
Average final weight, lbs.	994	948
Average gain per head	246	219
Average gain per head daily (115 days)	2.13	1.90
Average daily ration:		
Corn silage, lbs.	11	11
Ground corn, lbs.	18	13
Oil meal, lbs.	1.8	1.3

	I.	II.
Silage consumed, lbs.	5180	5155
Silage per pound of gain, lbs.	5.2	5.8
Ground corn consumed, lbs.	8455	
Corn per pound of gain, lbs.	8.6	
Oilmeal consumed, lbs.	845	624
Oilmeal per pound of gain, lbs.	.08	.07
Ground barley consumed, lbs.		6245
Ground barley per pound of gain, lbs.		7.1

At the South Dakota Station during the winter of 1914-1915, James W. Wilson (4) fed two lots of four two-year-old steers for 192 days to determine the comparative value of corn and barley when fed with corn silage. The average daily gain per head, and the feed required for a pound of gain was about the same in both lots, but the cost of producing a hundred pounds of gain was \$.20 cheaper in the lot receiving ground barley than in the lot receiving ground corn. The steers receiving ground barley in their ration showed a little higher condition. The results obtained from this trial might be attributed to alfalfa hay feeding in the early part of the feeding trial.

Table IV. Summary of Results

Lot	I.	II.
Ration	Corn silage Clover hay* Ground corn Oilmeal	Corn silage Alfalfa hay* Ground barley Oilmeal

* ninety-one days preliminary.

	I.	II.
Average initial weight, lbs.	983	1005
Average final weight, lbs.	1212	1236
Average gain per head, lbs.	228	231
Average daily gain per head, lbs. (101 days)	2.26	2.28
Average daily gain per head, lbs. (192 days)	2.27	2.38
Silage consumed, lbs.	7040	7040
Silage consumed per pound of gain, lbs.	7.7	7.6
Ground corn consumed, lbs.	6365	
Ground corn consumed per pound of gain, lbs.	6.9	
Ground barley consumed, lbs.		6675
Ground barley consumed per pound of gain, lbs.		7.2
Oilmeal consumed, lbs.	636	667
Oilmeal consumed per pound of gain, lbs.	.07	.07
Cost of producing 100 pounds of gain, covering 192 days	\$7.20	\$7.00

Feed prices: Corn silage, \$3.00 per ton; clover hay \$10.00 per ton; alfalfa hay \$10.00 per ton; ground corn \$.01 per pound; ground barley \$.01 per pound; and oilmeal \$36.00 per ton.

The Effect of Omitting Silage
from the Standard Ration of Corn, Linseed or
cottonseed Meal, Corn Silage and Clover or Alfalfa Hay.

During the winters of 1909-10 and 1910-11, J. H. Skinner, F. G. King, and H. P. Rusk (5) at the Indiana Station found that a ration of shelled corn, cottonseed meal and clover hay was less profitable than a ration of shelled corn, cottonseed meal, corn silage, and clover hay. This was not due to small gains or a lack of finish on the cattle without silage, but to a greater cost of gains. The addition of corn silage to the ration of shelled corn, cottonseed meal, and clover hay, decreased the consumption of shelled corn in amounts closely approximating the grain content of the silage in the ration, and increased the profits per steer in amounts closely corresponding to the saving in cost of gains.

Table V. Summary of Results 1909 - 1910
Length of Experiment, Nov. 17, 1909 - April 26, 1910
(160 days)

Lot	I. . . .	II. . . .	IV.
	Shelled corn	Shelled corn	Shelled corn
	Cottonseed meal	Cottonseed meal	Cottonseed meal
	Clover hay*	Clover hay	Clover hay*
	Corn silage**		Corn silage***

* morning.

** evening.

*** morning and evening.

Lot	I.	II.	IV.
Initial value per cwt.	\$4.65	\$4.65	\$4.65
Average initial weight, lbs.	900	889.5	892.5
Average final weight, lbs.	1312.7	1255	1313
Average daily gain per steer, lbs.	2.58	2.28	2.63
Average daily feed per steer:			
Shelled corn, lbs.	15.33	15.78	14.44
Cottonseed meal, lbs.	2.61	2.52	2.58
Clover hay, lbs.	7.67	11.77	4.43
Corn silage, lbs.	13.93		27.76
Feed consumed per lb. of gain:			
Shelled corn, lbs.	5.94	6.91	5.50
Cottonseed meal, lbs.	1.02	1.10	.98
Clover hay, lbs.	2.97	5.15	1.69
Corn silage, lbs.	5.40		10.56
Cost of gain, per cwt.	\$9.76	\$10.98	\$9.56
Selling value, per cwt.	\$7.25	\$ 7.30	\$7.60
Profit per steer (including pork)	\$21.04	\$16.54	\$28.21

Feed prices: Clover hay, \$10.00 per ton; Cottonseed meal, \$33.00 per ton; corn silage, \$3.50 per ton; Shelled corn, first month, \$.499; second month, \$.557; third month \$.567 fourth month, \$.537; fifth month, \$.519; last ten days, \$.502 per bushel.

Table VI. Summary of Results 1910 - 1911

Length of Experiment, Nov. 18, 1910 - April 17, 1911 (150 days)

Lot	I.	II.	IV.
Ration	Same as Table V.	Same as Table V.	Same as Table V.
Initial value, per cwt.	\$5.00	\$5.00	\$5.00
Average initial weight, lbs.	1122	1121.3	1116.9
Average final weight, lbs.	1510.3	1486.2	1479.6
Average daily gain per steer, lbs.	2.59	2.93	2.42
Average daily feed per steer, lbs:			
Shelled corn	18.26	20.41	14.38
Cottonseed meal	3.04	2.96	3.00
Clover hay	5.83	11.01	4.50
Corn silage	20.77		31.00
Feed consumed per lb. of gain:			
Cottonseed meal, lbs.	1.18	1.22	1.24
Shelled corn, lbs.	7.05	8.39	5.92
Clover hay, lbs.	2.25	4.53	1.86
Corn silage, lbs.	8.02		12.82
Cost of gain, per cwt.	\$8.82	\$9.71	\$8.71
Selling value, per cwt.	\$5.95	\$5.85	\$5.85
Profit per steer (including pork)	\$4.36	\$1.46	\$3.04

Feed prices: Clover hay, \$10.00 per ton; Cottonseed meal, \$30.00 per ton; Corn silage, \$3.00 per ton: Shelled corn, first month, \$.361; second month, \$.37; third month \$378 fourth month, \$.369; and fifth month, \$.393 per bushel.

J. H. Skinner and F. G. King (6) at the Indiana Station during the winter of 1911-12, found that the addition of corn silage to a ration for fattening cattle decreased the consumption of shelled corn in amounts closely approximating the grain content of the silage consumed by the cattle. The addition of corn silage once daily to a ration of shelled corn, cottonseed meal, and clover hay, reduced the cost of gain \$1.83 per hundred pounds and increased the total profit \$8.85 per steer. The addition of corn silage twice daily to a ration of shelled corn, cottonseed meal, and clover hay, reduced the cost of gain \$3.17 per hundred pounds and increased the total profits \$11.19 per steer. Corn silage produced a very rapid finish on the cattle.

Table VII Summary of Results

Length of Experiment, Nov. 17, 1911 to April 25, 1912
(160 days)

Lot	I.	II.	IV.
	Shelled corn	Shelled corn	Shelled corn
	Cottonseed meal	Cottonseed meal	Cottonseed meal
	Clover hay*	Clover hay	Clover hay*
	Corn silage**		Corn silage***

*Morning.

**Evening.

***Morning and Evening.

Lot	I.	II.	IV.
Initial value per cwt.	\$5.55	\$5.55	\$5.55
Average daily gain, lbs.	2.34	2.38	2.32
Average daily feed per steer, lbs.			
Shelled corn	15.40	17.88	13.68
Cottonseed meal	2.75	2.77	2.78
Clover hay	5.81	11.16	2.54
Corn silage	16.03		24.79
Feed consumed per lb. of gain:			
Shelled corn, lbs.	6.58	7.53	5.89
Cottonseed meal, lbs.	1.18	1.17	1.20
Clover hay, lbs.	2.48	4.70	1.10
Corn silage, lbs.	6.85		10.67
Cost of gain, per cwt.	\$12.40	\$14.23	\$11.06
Necessary selling price	\$7.47	\$8.00	\$7.08
Profit per steer (including pork)	\$17.09	\$8.24	\$19.43

J. H. Skinner and F. G. King (7) at the Indiana Station during the winter of 1912-13, found the addition of corn silage to a ration of shelled corn, cottonseed meal and clover hay decreased the grain consumption 2.38 pounds, and the hay consumption 7.84 pounds daily per steer. The addition of corn silage to a ration of shelled corn, cottonseed meal, and clover hay, did not greatly affect the rate of gain on the cattle, but reduced the cost of gain \$1.18 per hundred pounds.

Table VIII. Summary of Results
Length of Experiment - 180 days

Lot	II.	IV.
Ration	Shelled corn Cottonseed meal Clover hay	Shelled corn Cottonseed meal Clover hay Corn silage
Initial value, per cwt.	\$6.65	\$6.65
Initial weight, lbs.	8,270	8,322
Final weight, lbs.	12,595	12,675
Average daily gain per steer, lbs.	2.40	2.42
Average daily feed per steer, lbs.		
Shelled corn, lbs.	15.96	13.58
Cottonseed meal, lbs.	2.58	2.60
Clover hay, lbs.	10.28	2.44
Corn silage, lbs.		25.65
Feed consumed per pound of gain:		
Shelled corn, lbs.	6.64	5.61
Cottonseed meal, lbs.	1.07	1.07
Clover hay, lbs.	4.28	1.01
Corn silage, lbs.		10.61
Cost of gain, per cwt.	\$9.34	\$8.16
Necessary selling price, per cwt.	\$7.57	\$7.17
Profit per steer (including pork)	\$10.98	\$18.50

J. H. Skinner and F. G. King(8) during the winter 1914-15 found that the addition of 24.94 pounds of corn silage to a ration of shelled corn, cottonseed meal, and clover hay decreased the average grain consumption 4.09 pounds daily per head, and the hay consumption 8.60 pounds daily per steer. The silage decreased the rate and cost of gain but had no effect on the finish of the cattle.

Table IX. Summary of Results

Length of trial, Dec. 16, 1914 - May 15, 1915, (150 days)		
Lot	II.	IV.
Ration	Shelled corn Cottonseed meal Clover hay	Shelled corn Cottonseed meal Clover hay Corn silage
Initial value, per cwt.	\$8.00	\$8.00
Initial weight, lbs.	11652	11657
Final weight, lbs.	15660	15060
Average daily gain per steer, lbs.	2.67	2.27
Average daily feed per steer:		
Shelled corn, lbs.	17.66	13.57
Cottonseed meal, lbs.	3.32	3.27
Clover hay, lbs.	13.38	4.78
Corn silage, lbs.		24.94
Feed consumed per pound of gain:		
Shelled corn, lbs.	6.61	5.98
Cottonseed meal, lbs.	1.24	1.44
Clover hay, lbs.	5.01	2.11
Corn silage, lbs.		11.00

Lot	II.	IV.
Cost of gain, per cwt.	\$13.42	\$13.38
Necessary selling price, per cwt.	\$9.39	\$9.22
Loss per steer, including pork	\$10.26	\$7.46

J. H. Skinner and F. G. King (9) during the winter of 1915-16 found that the addition of 28.64 pounds of corn silage to a ration of shelled corn, cottonseed meal, and clover hay reduced the daily corn consumption 2.53 pounds per steer, and the daily hay consumption 10.63 pounds per steer. Silage decreased the rate of gain, but reduced the cost, and increased the selling value and profit per head.

Table X. Summary of Results
Length of Experiment -150 days.

Lot	II.	IV.
Ration	Shelled corn Cottonseed meal Clover hay	Shelled corn Cottonseed meal Clover hay Corn silage
Initial value, per cwt.	\$6.90	\$6.90
Initial weight, lbs.	8,853	8,752
Final weight, lbs.	11,985	11,778
Average daily gain per steer, lbs.	2.09	2.02
Average daily feed per steer:		
Shelled corn, lbs.	12.34	9.81
Cottonseed meal, lbs.	2.47	2.45
Clover hay, lbs.	12.67	2.04
Corn silage, lbs.		28.64

	II.	IV.
Feed consumed per lb. of gain:		
Shelled corn, lbs.	5.91	4.86
Cottonseed meal, lbs.	1.18	1.21
Clover hay, lbs.	6.07	1.01
Corn silage, lbs.		14.20
Cost of gain, per cwt.	\$12.33	\$11.39
Necessary selling price, per cwt.	\$8.32	\$8.05
Actual selling price, per cwt.	\$8.65	\$8.70
Profit per steer (including pork)	\$9.55	\$13.61

J. H. Skinner and F. G. King (10) at the Indiana Station during the winter of 1916-17 found that the addition of 33.88 pounds of corn silage to a ration of shelled corn, cottonseed meal, and clover hay, decreased the daily corn consumption 2.79 lbs. per head, and the daily hay consumption 11.46 pounds per steer. The addition of corn silage to a ration of shelled corn, cottonseed meal, and clover hay increased the rate of gain .19 pounds daily per steer, decreased the cost of gain \$2.48 per hundred pounds, and increased the selling value of the cattle \$.25 per cwt. The profit per steer, not including pork, was increased \$10.08.

Table XI. Summary of Results

Length of Experiment - 140 days

Lot	II.	IV.
Ration	Shelled Corn Cottonseed meal Clover hay	Shelled Corn Cottonseed meal Clover hay Corn Silage
Initial value, per cwt.	\$8.15	\$8.15
Initial weight, lbs.	10,408	10,443
Final weight, lbs.	13,637	13,943
Average daily gain per steer, lbs.	2.31	2.50
Average daily feed per steer:		
Shelled corn, lbs.	16.04	13.25
Cottonseed meal, lbs.	2.90	2.99
Corn silage, lbs.		33.88
Clover hay, lbs.	13.50	2.04
Feed consumed per lb. of gain:		
Shelled corn, lbs.	6.95	5.30
Cottonseed meal, lbs.	1.26	1.20
Corn silage, lbs.		13.55
Clover hay, lbs.	5.85	.82
Cost of gain per cwt.	\$19.99	\$17.51
Necessary selling price per cwt.	\$10.95	\$10.50
Profit per steer (including pork)	\$27.60	\$35.65

Feed prices: Shelled corn, \$.84 per bu.; Cottonseed meal, \$45 per ton; Corn silage, \$6.00 per ton; Clover hay, \$16.00 per ton.

During the winter of 1907-08, B.E. Carmichael (11) at the Ohio Station, conducted a cattle feeding experiment in which he showed a decided reduction in the cost of gains and increased profit, from the use of silage. The following table shows the average daily gain per steer was almost exactly the same for the lots receiving silage as for the lots receiving no silage, so there was no apparent difference between the two rations so far as rate of gain was concerned. The cost of gains was considerably lower in the lots receiving silage.

Table XII. Feed Consumed, Gains Produced,
and
Cost of Gains

Ration	Silage Fed Lots 1, 3, and 5 (20 head)		:	Dry Fed Lots 2, 4, and 6 (21 head)	
	Amount	Value		Amount	Value
Corn, at \$.45 per bu.	746.143 bu.	\$335.764	:	934.054 bu.	\$420.324
Cottonseed meal, at \$26.50 per ton	2.42 tons	\$64.10	:	2.537 tons	\$67.231
Corn silage, at \$3.00 per ton	34.073 tons	\$102.219	:		
Corn stover, at \$4.00 per ton	1.098 tons	\$4.392	:	2.453 tons	\$9.812
Hay, at \$12.00 per ton	7.011 tons	\$84.132	:	16.435 tons	\$197.220
Total cost of feed		\$590.637	:		\$694.587
Gains produced		6,531 lbs.	:		6,801 lbs.
Average daily gain per steer		2.333 lbs.	:		2.313 lbs.
Cost of 100 pounds of gain		\$9.04	:		\$10.21

H. O. Allison (12) at the Missouri Station during the winter of 1910-11, found that cattle which received a ration of shelled corn, linseed oilmeal, corn silage, and clover hay, made greater gains in live weight, produced more economical gains, were better finished, and yielded a greater profit per head than the cattle which received a ration of shelled corn, linseed oilmeal, and clover hay.

Table XIII. Summary of Results

Length of Experiment - 130 days

Lot	I.	IV.
Ration	Shelled Corn Linseed Oilmeal Clover hay	Shelled corn Linseed Oilmeal Clover hay Corn silage
Average initial weight, lbs.	946.13	961.59
Average final weight, lbs.	1,342.13	1,371.53
Average daily gain per steer, lbs.	3.045	3.155
Feed consumed per pound of gain:		
Shelled corn, lbs.	6.06	5.17
Linseed Oilmeal, lbs.	1.01	.86
Corn silage, lbs.		6.59
Clover hay, lbs.	3.09	1.23
Cost per 100 lbs. gain (including pork)	\$6.46	\$5.99
Selling price, per cwt.	\$6.25	\$6.45
Net profit per steer	\$2.82	\$7.41

Feed prices: Corn, \$.40 per bushel; Linseed Oilmeal, \$33.00 per ton; Corn silage, \$3.50 per ton; and clover hay, \$10.00 per ton.

During the winter of 1910-11, a steer feeding trial was conducted at the Iowa State College (13) in which the efficiency of silage in a fattening ration, was clearly demonstrated. The gains cost a little more in the lot receiving corn silage in their ration, but the cattle sold for a higher price per hundred pounds due to their superior finish.

Table XIV. Summary of Results

Length of Experiment - 150 days

Lot	I.	II.
Ration	Shelled corn Cottonseed meal Clover hay	Shelled corn Cottonseed meal Clover hay Corn silage
Average initial weight, lbs.	977.8	988.7
Average final weight, lbs.	1370.	1322.3
Average daily gain, lbs.	2.61	2.22
Feed required per lb. of gain:		
Shelled corn, lbs.	7.36	6.33
Cottonseed meal, lbs.	.79	1.14
Clover hay, lbs.	4.14	1.96
Corn silage, lbs.		10.75
Net cost per pound of gain on steers (including pork)	\$6.44	\$6.46
Selling price, per cwt.	\$6.00	\$6.10

To determine the value of corn silage fed with shelled corn, clover hay and cottonseed meal, two lots of two-year-old steers were fed at the Pennsylvania Station from Nov. 17, 1907 to May 15, 1908 (180 days) (14). One lot received a ration of shelled corn, clover hay, and cottonseed meal, and the second lot was fed the same ration plus corn silage. The following table shows that the daily gain per steer was .22 pounds greater in the lot receiving corn silage than in the lot receiving no silage. The grain consumed per pound of gain was .88 pounds less when silage was fed. The cost of gains when silage was fed was \$1.00 per hundred cheaper than in the lot where no silage was fed. Both lots of cattle sold at the same price, but the profit per steer was \$17.96 in the lot which received no silage, and \$22.68 in the silage fed lot.

Table XV. Summary of Results

Lot	I.	II.
Ration	Shelled corn Cottonseed meal Clover hay Corn silage	Shelled corn Cottonseed meal Clover hay
Initial value, per cwt.	\$4.00	\$4.00
Initial weight (10 steers), lbs.	11235	11300
Final weight (10 steers), lbs.	16021	15700
Average daily gain per steer, lbs.	2.66	2.44

Lot	I.	II.
Average feed consumed daily per steer:		
Shelled corn, lbs.	19.01	19.63
Cottonseed meal, lbs.	2.70	2.67
Clover hay, lbs.	4.51	9.01
Corn silage, lbs.	14.99	
Cost of gain, per cwt.	\$7.91	\$8.75
Actual market value, per cwt.	\$6.70	\$6.70

Feed prices: Corn, \$.40 per bushel; Cottonseed meal, \$28 per ton; Clover hay, \$8.00 per ton; Corn silage, \$2.50 per ton.

The summary of results from feeding silage during the winter of 1908-09 shows that the addition of corn silage to a ration of shelled corn, cottonseed meal, and clover hay, resulted in a more rapid and cheaper gain and a higher finish in the cattle as well as a greater financial gain.

J. H. Skinner and W. A. Cochel (15) at the Indiana Station during the winter of 1908-09, found that the addition of corn silage to a ration of shelled corn, cottonseed meal, and clover hay, resulted in a more rapid and cheaper gain, and a higher finish on the cattle. Corn silage had a beneficial effect in causing cattle to shed their winter coats earlier than those receiving the same ration without the corn silage. When corn silage was used there was a smaller consumption of grain than where it was omitted from the ration. (Table XVIII page 34)

J. H. Skinner and W. A. Cochel (16) carried on similar experiments to the 1908-09 trial during the winter of 1906-07 and 1907-08, with results the same as the 1908-09 trial (Table XIX, page 35).

Paul Gerlaugh (17) at the Pennsylvania Station, during the winter of 1915-16, found that silage played an important part in determining the profit in a fattening steer. The more silage fed, the more profit was realized.

Professor W. H. Pew, assisted by Russell Dunn (18), during the winter of 1915-16 produced further testimony to the efficiency of silage as a cheapener of gain in fattening cattle. The object of this test was to determine the possibilities of a maximum silage ration with a minimum quantity of grain, and the cattle that consumed the greatest amount of silage returned the largest profit.

In 1917 W. H. Tomhave, B. O. Severson, and Paul Gerlaugh (19), found that all rations in which corn silage was used as a part or all of the roughage, proved to be more economical and more efficient than rations without corn silage. The returns per steer, after paying for the feed consumed, were in direct proportion to the amount of silage consumed. In each case the lots receiving the largest amount of silage gave the best returns.

The Effect of Omitting both Corn Silage
And Linseed or Cottonseed Meal From the
Standard Ration of Corn, Linseed or
Cottonseed Meal, Corn Silage, and Clover
or Alfalfa Hay.

It was found at the Nebraska Station (20) during the winter of 1918-19 that cattle fed corn and alfalfa, the ration most commonly used, lost money while the cattle fed corn, hominy, oilmeal, corn silage, and alfalfa made a little money.

The summary of the results obtained from a steer feeding trial conducted at the University of Nebraska (21) from Dec. 6, 1920 to April 12, 1921, shows that the steers fed a full feed of shelled corn and alfalfa hay for 127 days, gained 2.15 pounds per head per day at the rate of 13 pounds of feed for a pound of gain, and at a feed cost of \$.087 a pound of gain. The loss per steer including pork, was \$20.90. The steers fed oilmeal and corn silage in addition to the ration of shelled corn and alfalfa hay gained 2.30 pounds per head a day, at the rate of 12 pounds of feed for a pound of gain (Figuring 3 pounds of corn silage equal to one pound of hay). The cost of a pound of gain was \$.11 $\frac{1}{2}$. The loss per steer, including pork, was \$29.14.

A steer feeding trial conducted at the University of Missouri (22) in 1917 shows clearly that the cost of fattening cattle can be greatly reduced by the extensive use of corn silage with a nitrogenous concentrate.

The Effect of Omitting Corn From the
Standard Ration of Corn, Linseed or
Cottonseed Meal, Corn Silage, and
Clover or Alfalfa Hay.

Two lots of ten steers each, were fed during the winter of 1919-20 at the Wisconsin Station by J. G. Fuller and F. B. Morrison (23). Lot I which was fed shelled corn, consumed on the average of 12.5 pounds of shelled corn, 2.8 pounds of cottonseed meal, 32.6 pounds of corn silage, and 2.2 pounds of mixed hay per head daily, while the average ration for Lot II was 3.6 pounds of cottonseed meal, 56.6 pounds of corn silage, and 2.6 pounds of mixed hay, with no shelled corn. The steers which did not receive shelled corn made as large daily gains as the steers receiving corn (2.31 pounds gain per day). The feed cost of 100 pounds of gain was only \$15.88 for the steers fed no shelled corn, as compared with \$23.23 for the steers receiving shelled corn. Owing to a better finish, the steers fed shelled corn sold for \$.50 more per 100 pounds than those fed no shelled corn. The pigs following the lot receiving shelled corn made greater gains than those in the lot receiving no shelled corn. The average return per steer over the cost of feed was \$17.28 in the lot receiving no shelled corn, and \$13.86 in the lot receiving shelled corn as a part of the ration.

During the winter of 1917-18 five lots of twelve steers each, were fed for 140 days at the Pennsylvania Experiment Station (24). The most profitable ration was an average daily of 45 pounds of corn silage, 3.6 pounds of shredded corn stover, and 2.7 pounds of cottonseed meal. With silage at \$8.00 per ton, corn stover at \$6.00 per ton, and cottonseed meal at \$54.00 a ton, the cost of 100 pounds of gain was \$14.85, and the profit per steer over cost of feed was \$30.25. The next most profitable lot was fed about the same during the first three months, but broken ear corn was added during the last two months at the rate of 13 pounds daily. The addition of corn increased the rate of gain, selling price, and pork produced, whereas there was no pork in the lot receiving no corn. The profit per steer over feed cost was \$26.72.

H. O. Allison (25) at the Missouri Station, during the winter 1915-16, found that a larger daily gain in live weight is made in fattening cattle where corn is fed in addition to a high protein concentrate, with silage and hay. A fairly satisfactory finish was obtained, however, without the corn, and the market price received for the additional gain did not justify the superior finish.

Table XVI. Summary of Results

Lot	I.	II.	III.	IV.	V.
No. of Steers	6	6	6	6	6
Average initial wt. per steer, lbs.	925	923	938	926	912
Average final wt. per steer, lbs.	1286.94	1249.44	1199.77	1243.05	1206.66
Average daily gain per steer, lbs.	2.72	2.45	1.97	2.38	2.14
Average daily ration per steer:					
Shelled corn, lbs.	15.60	15.24			15.27
Cottonseed meal, lbs.	2.60		5.05		
Linseed Oilmeal, lbs.		2.54		5.05	
Corn silage, lbs.	17.47	16.47	36.22	37.62	16.26
Alfalfa hay, lbs.	3.69	2.27	3.00	4.03	3.90
Cost per 100 lbs. gain (including hogs)	\$10.42	\$10.58	\$10.15	\$8.57	\$10.88
Selling price	\$9.60	\$9.75	\$9.65	\$9.65	\$9.75
Net Profit	\$6.77	\$9.32	\$9.87	\$14.56	\$10.53

Feed prices: Corn, \$.70 per bushel; Corn silage, \$4.50 per ton; Cottonseed meal, \$37.00 per ton; Linseed Oilmeal \$37 per ton; Alfalfa hay, \$14.00 per ton.

H. O. Allison (26) at the University of Missouri, during the winter of 1916-17 found that the average daily gains in live weight made by the two-year-old steers which received linseed oilmeal, corn silage and alfalfa hay, but no corn other than that contained in the silage, while not as large as when shelled corn was fed, were satisfactory for fattening cattle. The cost of gain was the least in the lots which received a ration of linseed oilmeal, corn silage and alfalfa hay. The lots receiving shelled corn, linseed oilmeal, corn silage, and alfalfa hay did not sell for enough more to justify the feeding of shelled corn.

J. H. Skinner and F. G. King (27) at the Indiana Experiment Station during the winter of 1919-20, found that cattle fed a ration of corn silage, cottonseed meal, and clover hay, made an average daily gain of 1.66 pounds per steer on an average daily ration of 2.78 pounds of cottonseed meal, 45.56 pounds of silage, and 5.75 pounds of clover hay. The cattle made their gains at a cost of \$23.83 per hundred pounds and would have had to sell for \$13.14 per hundred, to pay for the cost of feed and cattle. They were valued at \$11.15 per hundred pounds and returned a loss of \$24.98 per steer, not including pork. The gains on the hogs did not pay for the corn fed. Cattle fed a full feed of corn in addition to corn silage, cottonseed meal, and clover hay made an average daily gain of 2.01 pounds per steer on an average daily ration of

12.54 pounds of shelled corn, 2.78 pounds of cottonseed meal, 31.93 pounds of corn silage, and 3.86 pounds of clover hay. The cattle made their gains at a cost of \$31.04 per hundred pounds, and would have had to sell for \$15.23 per hundred pounds to pay for feed and cattle. They were valued at \$11.65 per hundred pounds, and returned a loss of \$46.94 per steer, not including pork. The gains of the hogs following, amounted to 1529 pounds, against which was charged the value of 3810 pounds of corn. This left a net value of \$13.29 worth of pork per steer.

J. H. Skinner and C. M. Vestal (28) at the Indiana Experiment Station during the winter of 1918-19 found that cattle fed a ration of corn silage, clover hay, and cottonseed meal made an average gain of 2.07 lbs. daily per head. They consumed 51.26 pounds of silage daily per head. The cost of producing 100 pounds of gain was \$16.06. The cattle were valued at \$14.50 per hundred and returned a profit of \$22.03, not including pork, and \$25.52 with hog gains included. Cattle fed the above ration with the addition of a full feed of corn, gained 2.36 lbs. daily per head. They consumed 29.11 pounds of silage daily, and the cost of producing 100 pounds of gain was \$23.26. They were valued at \$15.65 per hundred pounds and returned a profit per head of \$11.50, not including pork, and \$23.50 per head, with gains on hogs included.

The summary of a steer feeding trial conducted at

the Indiana Station (29) from December 16, 1920 to April 25, 1921, shows that steers fed a full feed of shelled corn, cottonseed meal, corn silage, and clover hay for 130 days, gained 2.72 pounds per head a day, at a cost of \$.104 a pound, and at a loss of \$9.65 a steer, including pork. The steers which were fed cottonseed meal, corn silage, and clover hay, or the standard ration minus the shelled corn, gained 2.28 pounds a head per day at a cost of \$.106 a pound, and at a loss of \$16.39 per steer, including pork.

The summary of a steer feeding trial conducted at the Nebraska Station (30) from December 6, 1920 to April 12, 1921, shows that when corn was omitted from the standard ration for fattening cattle, namely - shelled corn, oilmeal, corn silage and alfalfa hay, the steers gained only 1.93 pounds a head per day, and required 12 pounds of feed for a pound of gain, at a cost of \$.125 per pound of gain. The loss per steer including pork, was \$35.28. The steers which were fed the standard ration gained 2.30 pounds a day, and required 12 pounds of feed per pound of gain (Figuring 3 lbs. of silage equal to 1 pound of hay). The gains cost \$.11 $\frac{3}{4}$ per pound, and the loss per steer, including pork, was \$29.14.

The Effect of a Nitrogenous Concentrate
In a Ration For Fattening Cattle.

J. H. Skinner and W. A. Cochel (31) at the Indiana Station during the spring of 1907, found that a nitrogenous supplement added during the finishing period, to a ration deficient in protein, increased the rate and decreased the cost of gain.

Table XVII. Summary of 60 day Feeding Trial.

	Lot 1.	Lot 2.
Ration	Shelled corn Cottonseed meal Clover hay Corn silage	Shelled corn Clover hay Corn silage
Number of steers,	10 (2 yr.old)	10 (2 yr.old)
Average daily gain per steer, lbs.	2.06	1.56
Average feed consumed daily per steer:		
Shelled corn, lbs.	17.6	19.58
Cottonseed meal, lbs.	3.37	
Clover hay, lbs.	3.32	3.27
Corn silage, lbs.	10.00	10.00
Feed Consumed per lb. of gain:		
Shelled corn, lbs.	8.52	12.48
Cottonseed meal, lbs.	1.63	
Clover hay, lbs.	1.60	2.08
Corn silage, lbs.	4.83	6.37
Cost of 100 lbs. of gain (Corn at \$.40 per bu.)	\$9.60	\$10.55
Profit per steer	\$2.26	\$.40

H. O. Allison (32) at the University of Missouri, during the winter of 1915-16 and 1916-17, found that the average daily gains on fattening steers were materially increased by adding linseed oilmeal to a ration of shelled corn, corn silage, and alfalfa hay.

H. R. Smith (33) at the Nebraska Station during the winter of 1903-04, found that the substitution of ten percent of oilmeal for ten percent of corn in a ration of shelled corn and prairie hay, increased the average daily gain on two-year-old steers from 1.35 pounds to 1.91 pounds; - decreased the grain required for a pound of gain, from 10.5 pounds to 8.10 pounds; - and decreased the hay required for a pound of gain from 6.50 pounds to 4.60 pounds.

H. O. Allison (34) at the Missouri Station, points out that when silage is fed as part of a ration, the addition of a nitrogenous concentrate increases the profit.

It was found at the Nebraska Station (35) during the winter 1918-19, that the addition of oilmeal to the corn and alfalfa ration for fattening steers, did not increase the daily gain but did increase the cost of gain and loss per steer. The addition of oilmeal to a corn, corn silage, and alfalfa ration increased the daily gain .08 pounds, cost of gain \$.93 per hundred pounds, and the loss per steer \$3.14.

Experiments at the University of Kentucky (36) show that the addition of a little cottonseed meal or linseed oilmeal to a ration of corn, corn silage and clover hay, for fattening

cattle, resulted in more rapid and economical gains.

J. H. Skinner and W. A. Cochel (37) at the Indiana Station, during the winter 1908-09, found that the addition of cottonseed meal to a ration of shelled corn and clover hay, resulted in a more rapid and cheaper gain, a higher finish and a greater profit per steer.

Table XVIII. Summary of Results

	Lot I.	Lot II.	Lot III.
	Shelled corn Cottonseed meal Clover hay	Shelled corn Cottonseed meal Clover hay Corn silage	Shelled corn Clover hay
Initial value, per cwt.	\$4.55	\$4.55	\$4.55
Average initial weight, lbs.	966	963.1	964.6
Average final weight, lbs.	1375.6	1384.3	1306.3
Average daily gain per steer, lbs.	2.27	2.33	1.87
Average daily feed per steer, lbs.			
Shelled corn	17.37	16.83	19.29
Cottonseed meal	3.01	3.01	
Clover hay	9.48	4.96	9.94
Corn silage		15.34	
Average feed consumed per lb. of gain:(lbs.)			
Shelled corn	7.63	7.19	10.15
Cottonseed meal	1.32	1.29	
Clover hay	4.12	2.12	5.23
Corn silage		6.55	

	Lot I.	Lot II.	Lot III.
Cost per cwt. gain	\$11.44	\$10.93	\$12.35
Selling value after six months feeding	\$6.75	\$6.80	\$6.55
Profit per steer	\$12.79	\$15.80	\$9.89

Feed prices: Cottonseed meal, \$28.00 per ton; Clover hay, \$8 per ton; Corn silage, \$2.50 per ton.

J. H. Skinner and W. A. Cochel (38) at the Indiana Station during the winter 1906-07 and 1907-08 found that the addition of a nitrogenous concentrate to a ration composed of shelled corn, and clover hay, required less feed to produce 100 pounds of gain, and resulted in more rapid and cheaper gains.

Table XIX. Summary of Results

Length of Experiment - 180 days

	Lot I.	Lot II.
Ration	Shelled Corn Cottonseed meal Clover hay Corn silage	Shelled corn Cottonseed meal Clover hay
Initial value per cwt.	\$4.00	\$4.00
Initial weight, lbs. (10 steers)	11,235	11,300
Final weight, lbs. (10 steers)	16,021	15,700
Average daily gain per steer, lbs.	2.66	2.44
Average feed consumed daily per steer:		
Shelled corn, lbs.	19.01	19.63
Cottonseed meal, lbs.	2.70	2.67
Clover hay, lbs.	4.51	9.01
Corn silage, lbs.	14.99	

	Lot I.	Lot II.
Feed consumed per lb. of gain:		
Shelled corn, lbs.	7.15	8.03
Cottonseed meal, lbs.	1.02	1.09
Clover hay, lbs.	1.69	3.58
Corn silage, lbs.	5.64	
Cost of gain per cwt. (Corn at \$.40 per bushel)	\$7.91	\$8.75
Necessary selling price per cwt.	\$5.16	\$5.33
Actual value	\$6.70	\$6.70

Feed prices: Cottonseed meal, \$28.00 per ton; Clover hay, \$8.00 per ton; Corn silage, \$2.50 per ton.

ORIGINAL FEEDING TRIAL

In planning the feeding trial reported in the following pages it has been the aim of the writer to conduct a trial of such a nature that results secured might be directly applicable to Minnesota farm conditions. It will be noticed that all feeds used are feeds that are generally grown in Minnesota or by-products that are readily available in Minnesota. Because of the fact that the southern half of the state grows corn as the principal grain crop suitable to fattening purposes and the northern half grows barley and not corn, a double comparison of corn with barley has been made. In the one case the barley and corn each being supplemented by corn silage and linseed meal, and in the other case each grain being fed alone with clover hay.

ORIGINAL WORK
Plan of Experiment

Objects of the Experiment.

1. To determine the cost of fattening cattle for market during the winter of 1920-1921.
2. To determine the comparative value of barley and corn as a grain for fattening cattle. Barley is grown successfully in sections of the State of Minnesota where corn will not mature.
3. To determine the effect of omitting silage from the standard ration of corn, linseed meal, corn silage and clover hay.
4. To determine the effect of omitting both silage and linseed meal from the standard ration of corn, linseed meal, corn silage and clover hay.
5. To determine the effect of omitting corn from the standard ration of corn, linseed meal, corn silage and clover hay.

Methods of Experimentation.

1. Animals Used.

(a) Number, Source and Type.

Forty-eight two-year-old feeder steers were purchased on the South St. Paul Market, December 20, 1920 for \$7.75 per hundred pounds. Taking into consideration the cost of vaccinating, freight, straw, hay at the yards and University Farm prior to December 29th, the cattle cost \$8.20 per hundred pounds in the feed lot. If the cattle had been purchased at an earlier date a little more type and quality could have been secured, because more and better feeders were on the market at that time. However, the cattle were bought at a lower price than they could have been purchased for earlier in the season, so what was lost in type and quality was probably made up in price. Excellent type and quality were not desired because cattle were wanted that would more nearly represent the kind fed by the average cattle feeder in the State of Minnesota.

(b) Breeding.

The cattle selected were branded South Dakota cattle showing considerable Shorthorn and Hereford breeding.

(c) Condition.

The cattle purchased averaged right at 1,000 pounds in weight. They appeared as though they might already have received a little grain.

2. Allotment of Steers.

On December 29th the forty-eight head of steers were divided into six lots of eight each. They were divided as evenly as possible in respect to size, quality, thriftiness, condition and breed. There were only seven pounds difference between the averages of the heaviest and lightest lots at the beginning of the trial. (Table XXV) There were about five good steers and three of the more common kind in each lot. Each lot contained an equal number of steers showing Shorthorn and Hereford breeding.

3. Rations Fed.

The several groups of steers received the following rations:

Lot I. Shelled corn, linseed meal, corn silage, and clover hay.

Lot II. Ground barley, linseed meal, corn silage, and clover hay.

Lot III. Linseed meal, corn silage, and clover hay.

Lot IV. Shelled corn and clover hay.

Lot V. Ground barley and clover hay.

Lot VI. Shelled corn, linseed meal, and clover hay.

4. Length of Feeding Trial.

The steers were fed from December 30, 1920, to April 20, 1921 inclusive (112 days).

5. Weights.

Each animal was weighed for three consecutive days at the beginning and end of the trial, and once every twenty-eight days during the trial. The average of the three weights at the beginning and end of the feeding period were taken as the initial and final weights respectively. The weights were always taken at 2 p.m. on the day of weighing, without change in feed or water.

The identity of each steer was known by a numbered brass tag on a strap fastened around the neck.

6. Methods of Feeding.

The method of feeding the steers was about the same in each lot. Grain and silage were fed twice daily at approximately 6:30 a.m. and 4:30 p.m. The lots receiving silage in their ration were fed silage first and the corn or barley^{and} linseed meal were sprinkled over it. Clover hay was fed twice a day to all lots. Each lot was given just about what they would nicely clean up by the next feeding time. By this method of feeding the steers always had fresh hay before them. Cattle do not like to eat hay that has been blown over or lying in a rack for any length of time. Salt was kept before the cattle at all times in boxes nailed to the wall for that purpose.

7. Sheds, Lots, and Water Supply.

Each lot of eight steers occupied similar quarters, which consisted of an uncovered lot 24 feet by 120 feet, and

a shed 23 feet by 24 feet, opening on the south into the lot through sliding doors. The hay racks over the feed bunks, extended along the shed walls on the inside. Three feet of bunk and rack space was allowed for each steer. Water was supplied in galvanized iron tanks, inside the sheds. The tanks were insulated and covered. The covers were dropped down on cold nights and very little freezing of the water occurred. Care was taken to see that the cattle had fresh water before them at all times. The sheds were cleaned once a week and bedded twice a week, careful weights being kept of the manure produced and the straw supplied.

8. Quality of Feeds.

The corn fed in this trial was sound and of good quality, grading Number 3, yellow. The barley was of good quality, grading Number 3 feed barley. The linseed meal was of choice grade, guaranteed to contain 32% protein, 6% fat, 42% nitrogen-free-extract and 10% fiber. It was purchased in the fall and stored in the main cattle barn. It remained in good shape throughout the trial. The clover hay was of good quality, but contained some timothy, perhaps about ten percent. The corn silage fed, was good, being made from corn yielding ten and one half tons of green material per acre. The percentage of corn in the silage was rather low.

Table XX. Analysis of Feeds.

By

C. H. Bailey, Assoc. Agr. Biochemist,
University of Minnesota

Sample	Moisture	Calculated to dry basis				
		Crude protein N X 6.25	Ash	Ether Extract	Crude Fiber	Nitrogen Free Extract
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Corn (average)	17.06	10.66	1.44	4.70	1.69	81.49
Barley	14.27	13.60	3.59	2.45	3.08	77.28
Corn Silage	72.97	5.73	4.23	2.40	25.16	62.48

9. Prices of Feeds.

The prices of corn, barley, and clover used in figuring financial results were taken from The Monthly Crop Reporter, and represent the average price for the State of Minnesota. The price charged for corn silage was based on the price of corn at silo filling time plus the cost of filling the silos. The prices charged for linseed meal, tankage, and salt were the prices which the average Minnesota farmer had to pay in the fall of 1920. The fall of the year is the time the winter supply is generally purchased.

Table XXI.

Feed Prices

	First 28 days	Second 28 days	Third 28 days	Fourth 28 days	Average
Corn, per bu.	\$.50	\$.45	\$.46	\$.43	\$.46
Barley, per bu.	\$.57	\$.49	\$.47	\$.48	\$.50 $\frac{1}{2}$
Linseed meal, per ton	\$55.00	\$55.00	\$55.00	\$55.00	\$55.00
Tankage, per ton	\$70.00	\$70.00	\$70.00	\$70.00	\$70.00
Silage, per ton	\$5.03	\$5.03	\$5.03	\$5.03	\$5.03
Clover hay, per ton	\$14.70	\$14.00	\$13.00	\$11.90	\$13.40
Salt, per ton	\$30.00	\$30.00	\$30.00	\$30.000	\$30.00

10. Hogs.

Lots I, IV, and VI were supplied with six hogs each; Lots II, V, and check four hogs each; and Lot III, two hogs. These hogs averaged in weight 115 pounds each at the beginning of the trial. Enough corn and tankage were supplied in addition to the droppings to secure satisfactory gains, but it was always planned to keep the hogs a little hungry, so that they would consume most of the grain in the droppings. What the hogs actually did is best explained by a careful study of Table XXVI.

11. Starting the Cattle on Feed.

The cattle in Lots I, II, IV, V and VI were started on feed December 30, 1920, with about six pounds of concentrates five pounds of silage, and hay at will. Lot III was started with ten pounds of silage, one pound of linseed meal, and hay

at will. All lots were gradually increased, and were on full feed in about three weeks after the beginning of the trial.

12. Valuing.

In order that an accurate valuation could be placed on the cattle, on the basis of the South St. Paul market, N. P. Rogers and C. P. Morrissey, of the Rogers and Rogers Commission Co., and Mr. Dobney, cattle buyer for Swift & Co., at South St. Paul, were asked to value them. The cattle were valued on April 18, 1921 as follows:

Lot I.	\$7.70 per hundred
Lot II.	\$7.50 per hundred
Lot III.	\$6.75 per hundred
Lot IV.	\$7.40 per hundred
Lot V.	\$7.40 per hundred
Lot VI.	\$7.25 per hundred

From these figures \$.40 per cwt. was deducted to cover the cost of marketing (Table XXV).

DISCUSSION OF DATA

Table XXII gives the average amounts of feed consumed daily per steer by 28 day periods, and the average daily ration per steer for 112 days.

When we compare the feed consumed by Lots I and IV with that consumed by Lots II and V, it will be observed that the grain, hay, and corn silage used in the lots receiving corn was about the same amount as in the lots receiving ground barley.

Table XXII also shows that it required a larger amount of corn to satisfy the appetites of the cattle not receiving corn silage (Lot VI) than it did to satisfy those receiving corn silage (Lot I), and that it required a still larger amount of shelled corn or ground barley to satisfy the wants of the cattle not receiving linseed meal and corn silage (Lots IV and V), than it did to satisfy those (Lots I and II) receiving linseed meal and corn silage.

The difference in grain consumption between Lots I and IV, and Lots II and V, increased as the feeding period progressed.

Table XXIII. Average Amount of Feed Consumed

Daily per Head by Fattening Steers

December 30, 1920 to April 20, 1921
112 days

	<u>Lot I.</u>	<u>Lot II.</u>	<u>Lot III.</u>	<u>Lot IV.</u>	<u>Lot V.</u>	<u>Lot VI.</u>
Ration . . .	Corn Linseed meal Corn- silage Clover hay	Barley Linseed meal Corn- silage Clover hay	Linseed meal Corn- silage Clover hay	Corn Clover- hay	Barley Clover- hay	Corn Linseed meal Clover hay
First 28 day period						
Corn, lbs.	11.37	:	:	12.41	:	12.75
Barley, lbs.	:	11.51	:	:	15.03	:
Linseed meal, lbs.	2.03	2.03	2.50	:	:	2.27
Corn silage, lbs.	18.75	19.82	28.61	:	:	:
Clover hay, lbs.	8.86	9.94	10.73	11.13	11.52	11.70
Second 28 day period						
Corn, lbs.	15.00	:	:	18.52	:	18.06
Barley, lbs.	:	16.00	:	:	21.00	:
Linseed meal, lbs.	2.75	2.75	3.00	:	:	3.00
Corn silage, lbs.	30.08	30.62	50.00	:	:	:
Clover hay, lbs.	6.49	7.24	10.07	12.78	11.36	12.28
Third 28 day period						
Corn, lbs.	15.92	:	:	20.92	:	18.25
Barley, lbs.	:	16.00	:	:	21.00	:

Table XXII (cont)

	Lot I.	Lot II.	Lot III.	Lot IV.	Lot V.	Lot VI.
Linseed meal, lbs.	2.75	2.75	3.00			3.00
Corn silage, lbs.	30.00	30.00	50.00			
Clover hay, lbs.	5.82	5.85	11.04	13.85	13.62	14.59
Fourth 28 day period						
Corn	16.00			21.00		18.25
Barley		16.00			21.00	
Linseed meal, lbs.	2.75	2.75	3.00			3.00
Corn silage, lbs.	30.00	30.00	50.00			
Clover hay, lbs.	5.23	5.48	9.56	11.66	11.76	12.73
Average Daily Feed For Entire Period						
Corn, lbs.	14.58			18.21		16.82
Barley, lbs.		14.88			19.50	
Linseed meal, lbs.	2.57	2.57	2.88			2.81
Corn silage, lbs.	27.20	27.61	44.65			
Clover hay, lbs.	6.60	7.12	10.35	12.35	12.06	12.83

Table XXIII shows that by omitting corn silage from a ration of shelled corn, linseed meal, corn silage, and clover hay, the rate of gain is decreased during the entire period, from 2.33 pounds per head per day to 2.25 pounds per head per day. During the first two twenty-eight day periods the cattle not receiving silage made larger gains than those receiving silage.

Omitting both corn silage and linseed meal from a ration of shelled corn, linseed meal, corn silage, and clover hay, decreased the daily gain per head for the entire period from 2.33 pounds to 2.08 pounds. The omitting of both corn silage and linseed meal from the ration of ground barley, linseed meal, corn silage, and clover hay, decreased the daily gain per head from 2.56 pounds to 2.09 pounds.

By omitting shelled corn from the ration of shelled corn, linseed meal, corn silage, and clover hay the daily gain per head was decreased from 2.33 pounds to 1.69 pounds.

In comparing the average daily gains made by Lots I and IV and that of Lots II and V respectively, we find that there was very little difference in gain between the lots receiving shelled corn and those receiving ground barley.

Table XXIII. Average Weight, Gain, and Daily Gain per Steer by 28 day Periods

December 30, 1920 to April 20, 1921
(112 days)

	Lot I	Lot II	Lot III	Lot IV.	Lot V	Lot VI
Ration .	Corn Linseed meal Corn- silage Clover hay	Barley Linseed meal Corn- silage Clover hay	Linseed meal Corn- silage Clover hay	Corn Clover hay	Barley Clover hay	Corn Linseed meal Clover hay
First 28 day period						
<u>Avg. wt.</u>	1097	1094	1061	1028	1078	1095
Avg. gain	86	80	50	14	70	88
<u>Avg. daily gain</u>	3.07	2.85	1.78	.5	2.5	3.14
Second 28 day period						
<u>Avg. wt.</u>	1165.62	1196.25	1109.37	1123.25	1176.87	1181.25
Avg. gain	68.62	102.25	48.37	95.75	98.87	86.25
<u>Avg. daily gain</u>	2.45	3.65	1.72	3.42	3.53	3.08
Third 28 day period						
<u>Avg. wt.</u>	1240	1259.37	1176.25	1201.25	1231.25	1228.75
Avg. gain	74.38	63.12	66.88	78.00	54.38	47.50
<u>Avg. daily gain</u>	2.65	2.25	2.38	2.78	1.94	1.69
Fourth 28 day period						
<u>Avg. wt.</u>	1273	1301	1201	1248	1243	1260
Avg. gain	33	41.63	24.75	46.75	11.75	31.25
<u>Avg. daily gain</u>	1.17	1.48	.88	1.66	.42	1.11

Table XXIII.(cont)

	Lot I	Lot II	Lot III	Lot IV	Lot V	Lot VI
Total gain per steer	262	287	190	234	235	252
Avg. daily gain for entire period	2.33	2.56	1.69	2.08	2.09	2.25

Table XXIV shows that where silage was omitted from a ration, a larger amount of corn was required to produce a pound of gain than where silage was fed. Comparing Lots I and VI, we find that 11.63 pounds of corn silage replaced 1.21 pounds of corn, .15 pounds of linseed meal, and 2.85 pounds of clover hay in the feed required to make a pound of gain. When corn silage was omitted from a ration of shelled corn, linseed meal, corn silage, and clover hay, the gains cost \$.12 per hundred pounds more than when silage was fed. When corn silage and linseed meal were both omitted from a ration of shelled corn, linseed meal, corn silage, and clover hay, gains were made at a cost of \$1.93 per hundred less than when corn silage and linseed meal were fed. When shelled corn was omitted from a ration of shelled corn, linseed meal, corn silage, and clover hay, gains were made at a cost of \$3.75 per hundred more than when shelled corn was fed.

These results are quite remarkable and are probably due to the high prices for corn silage and linseed meal in comparison with shelled corn. When shelled corn was omitted

from the standard ration it was found that considerable more linseed meal, corn silage, and clover hay were required to produce a pound of gain. Comparing Lots I and III, it was found that 6.23 pounds of shelled corn replaced .58 pounds of linseed meal, 14.69 pounds of silage, and 3.28 pounds of clover hay, in the feed required to make a pound of gain.

The addition of linseed meal to a ration of shelled corn and clover hay decreased the amount of feed required for a hundred pounds of gain, but with feeds figured at the market prices during the time of this trial was being conducted, the ration without the supplement was the cheaper. The steers in Lot VI, the lot receiving linseed meal in addition to shelled corn and clover hay, sold at a lower price on the average than the steers in Lot IV, the lot receiving shelled corn and clover hay. This may have been due to the fact that there was perhaps one more of the common steers in Lot VI than in Lot IV.

Table XXIV. Average Amount of Feed Consumed
Per Hundred Pounds of Gain
And Cost
Per Hundred Pounds Of Gain

December 30, 1920 - April 20, 1921 (112 days)

Ration .	<u>Lot I</u> Corn Linseed meal Corn- silage Clover hay	<u>Lot II</u> Barley Linseed meal Corn- silage Clover hay	<u>Lot III</u> Corn- silage Linseed meal Clover hay	<u>Lot IV</u> Corn Clover hay	<u>Lot V</u> Barley Clover hay	<u>Lot VI</u> Corn Linseed meal Clover hay
Feed required per 100 lbs. gain	:	:	:	:	:	:
Shelled corn 623.09	:	:	:	872.00	:	744.96
Ground barley	:	580.66	:	:	929.78	:
Linseed meal 109.92	:	100.34	167.47	:	:	124.70
Corn silage 1163.16	:	1077.52	2632.23	:	:	:
Clover hay 282.44	:	278.22	610.52	591.55	575.23	567.98
Cost of 100 lbs. of gain, excluding hogs	\$13.07	\$13.31	\$15.45	\$11.26	\$13.50	\$13.48
Crediting Feed Saved By Hogs	\$12.13	\$13.23	\$15.35	\$10.24	\$13.51	\$12.36
Crediting hog gains at \$8.28 per 100 lbs.	\$11.54	\$13.19	\$15.29	\$9.61	\$13.51	\$11.66

A summary of the data secured from the six lots of cattle for the entire period of 112 days is shown in Table XXV.

A summary of the data collected on the seven lots of hogs during the feeding trial is shown in Table XXVI. It is interesting to note that the hogs following the steers receiving ground barley in their ration in place of shelled corn, made practically no gains on the feed gleaned from the droppings.

The prices for the feeds used in the feeding trial covered by this thesis are given in Table XXI, page 43.

One hundred and twenty-eight tons of manure were hauled from the feeding sheds during the trial. Data secured by the Farm Management Department, University of Minnesota, indicates that manure applied to crop land will return in increased crops a value of about \$2.00 per ton. At this figure the value of the manure would cover the cost of 16.9 tons of rye straw used for bedding, salt, interest, and labor of one man for half time.

Table XXV.

Fattening Two-year-old Steers For Market
December 30, 1920 - April 20, 1921 - 112 days

Eight two-year-old steers in a group, pigs following;
Figures on single average steer
basis in terms of pounds
and dollars

Lot No.	I	II	III	IV	V	VI
Initial cost per 100 lbs.	\$8.20	\$8.20	\$8.20	\$8.20	\$8.20	\$8.20
Initial cost per steer	\$82.86	\$83.10	\$82.86	\$83.10	\$82.61	\$82.53
Initial wt.	1011	1014	1011	1014	1008	1007
Final wt.	1273	1301	1201	1248	1243	1260
Total gain	262	287	190	234	235	253
Average daily gain	2.33	2.56	1.69	2.08	2.09	2.25
Average daily feed:						
Shelled corn	14.58			18.21		16.82
Ground barley		14.88			19.50	
Linseed meal	2.57	2.57	2.88			2.81
Corn silage	26.98	27.61	44.65			
Clover hay	6.60	7.12	10.35	12.35	12.06	12.83
Feed required per 100 lb. gain:						
Shelled corn	623.09			872.00		744.96
Ground barley		580.66			929.78	
Linseed meal	109.92	100.34	167.47			124.70
Corn silage	1163.16	1077.52	2632.23			
Clover hay	282.44	278.22	610.52	591.55	575.23	567.98
Total feed cost	\$34.25	\$38.40	\$29.37	\$26.35	\$31.73	\$34.12

Table XXV (cont)

Lot No.	I	II	III	IV	V	VI
Feed cost per 100 lb. gain excluding hogs	\$13.07	\$13.31	\$15.45	\$11.26	\$13.50	\$13.48
Crediting feed saved by hogs	\$12.13	\$13.23	\$15.35	\$10.24	\$13.51	\$12.36
Crediting hog gains at \$8.28 per 100 lbs.	\$11.54	\$13.19	\$15.29	\$9.61	\$13.51	\$11.66
Necessary selling price of steers per 100 lbs. to break even excluding hogs	\$9.20	\$9.33	\$9.34	\$8.77	\$9.20	\$9.25
Crediting feed saved by hogs	\$9.00	\$9.32	\$9.33	\$8.66	\$9.20	\$9.03
Crediting hog gains at \$8.28	\$8.88	\$9.31	\$9.32	\$8.46	\$9.20	\$8.89
Selling price based on South St. Paul Market April 20th	\$7.70	\$7.50	\$6.75	\$7.40	\$7.40	\$7.25
Selling price Univ. Farm	\$7.30	\$7.10	\$6.35	\$7.00	\$7.00	\$6.85
Loss per steer excluding hogs	\$24.18	\$29.13	\$35.97	\$22.09	\$27.33	\$32.74
Crediting feed saved by hogs	\$21.69	\$28.90	\$35.78	\$19.70	\$27.35	\$29.90
Crediting hog gains at \$8.28	\$20.17	\$28.76	\$35.66	\$18.22	\$27.35	\$28.13

Table XXVI Summary of Hogs Following Steers

Initial value, 3,580 lbs. (32 hogs) at \$9.65 per cwt.	\$345.47
Cost of dipping	\$4.80
Cost of vaccinating	\$46.54
Straw	.90
Corn	15.00
Drayage	10.00
Feed before noon January 19th	8.89
	<hr/>
Total cost, Dec. 29th, 3654 lbs.	\$431.60
Cost per pound	\$.11811

Lot No.	I	II	III	IV	V	VI	Check
	6 pigs	4 pigs	2 pigs	6 pigs	4 pigs	6 pigs	4 pigs
Ration	Corn tank.						
	linseed meal						
Initial value per lb. \$.11811	.11811	.11811	.11811	.11811	.11811	.11811
Initial weight	676	457	232	696	491	661	441
Initial value	\$79.84	53.98	27.40	82.20	57.99	78.07	52.09
Total feed consumed:							
Corn, lbs.	444.00	762	497	444	762	444	1628
Tankage	198.50	132.23	67.50	198.50	132.23	198.50	134.33
Linseed meal	29	19	34.50	29	19	29	68
Total cost of feed	\$11.71	\$11.95	\$7.75	\$11.71	\$11.95	\$11.71	\$21.11

Table XXVI (cont)

Lot No.	I	II	III	IV	V	VI	Check
Final wt.	1293	727	414	1299	723	1336	855
Total gain	617	270	182	603	232	675	414 \$.05099
Value of feed saved	\$19.75	\$1.82	\$1.53	\$19.04	-\$0.13	\$22.70	
Credit gain at \$.75	384.4 \$33.89	35.65 \$3.12	30.1 \$2.63	373.4 \$32.67	-\$.20	445.4 \$38.97	
Credit cost of marketing \$31.00 at \$.08284	\$32.09	\$2.95	\$2.49	\$30.93	-2.3 -\$0.19	\$36.90	
Final value	\$107.11	\$60.22	\$34.30	\$107.61	\$59.89	\$110.67	\$70.82
Profit	\$15.56	-\$5.71	-\$0.85	\$13.70	-\$10.05	\$20.89	-\$2.38

Feeds figured as follows: Corn \$.46 per bu; Barley \$.49 per bu; Tankage, \$70.00 per ton; Linseed meal \$55.00 per ton; Salt \$.015 per pound; Clover \$13.80 per ton.

SUMMARY

Although creditable gains were made, they did not approach expectations, and a considerable loss was sustained on all groups of steers. Perhaps the mild winter weather had a retarding effect on rapid gains. The cattle should have consumed more feed, but when the daily ration was increased there followed immediately loss of appetite and scouring. Lot IV was the only group "off feed" at any time during the trial. Their ration was immediately reduced, and they were on full feed again within a few days.

Although the trial covered by this thesis shows ground barley fully equal to shelled corn, pound for pound, in producing gains in weight when fed to fattening cattle, results at some of the other experiment stations seem to show a slight advantage in favor of shelled corn for producing gains in weight. Steers fed on ground barley will consume about the same amount of grain per day as steers fed on shelled corn, but the amount of feed required to produce 100 pounds of gain will be more with the steers fed ground barley. Steers fed on ground barley have as good appetite and are as easy to keep on feed as steers fed shelled corn. Whether to feed shelled corn or ground barley to fattening cattle will depend upon the comparative prices of the two

feeds, and upon whether it is intended to run hogs behind the cattle or not. Pigs following cattle receiving ground barley, will make practically no gains on feed obtained from the droppings.

All groups of cattle in the trial covered by this thesis received as much clover hay as they would consume, and as in many previous tests, the quantities of hay consumed varied with the amount of grain and silage fed. Omitting corn silage from the standard ration of shelled corn, linseed meal, corn silage and clover hay, will not materially affect the daily gains, but will increase the grain required to produce a pound of gain, and the cattle will probably not show quite the finish.

Omitting corn silage and linseed meal from the standard ration of shelled corn, linseed meal, corn silage, and clover hay will materially decrease the daily gains, increase the amount of grain required to produce a pound of gain, and the cattle will not show the finish or sell for as high a price. Whether to feed corn silage and linseed meal will depend upon their price, and the price of corn. The trial covered by this thesis shows a decided financial advantage in omitting corn silage and linseed meal.

The addition of a nitrogenous concentrate to a ration of shelled corn and clover hay, decreases the amount

of feed required for a pound of gain. Whether it will pay to add a nitrogenous concentrate to a ration of shelled corn and clover hay will depend largely on the relative prices of feeds, and upon the degree of finish demanded by the market. "Until well advanced in fattening, cattle will eat enough hay to balance their ration fairly well, but later on a nitrogenous concentrate will result in larger and more economical gains from a feed standpoint."

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Fig. 1. Lot I, on shelled corn 85%, linseed meal 15%, corn silage and clover hay, as they appeared at the close of the experiment.



Fig. 2. Lot II, on ground barley 85%, linseed meal 15%, corn silage, and clover hay, as they appeared at the close of the experiment.



Fig. 3. Lot III, on linseed meal 3 lbs. per head per day, corn silage, and clover hay, as they appeared at the close of the experiment.



Fig. 4. Lot IV, on shelled corn, and clover hay, as they appeared at the close of the experiment.



Fig.5. Lot V, on ground barley, and clover hay, as they appeared at the close of the experiment, April 20, 1921.



Fig.6. Lot VI, on shelled corn 85%, linseed meal 15%, and clover hay, as they appeared at the close of the experiment.