

UNIVERSITY OF MINNESOTA



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**AGRICULTURAL EXPERIMENT STATION**

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**BULLETIN NO. 44.**

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**DIVISION OF ANIMAL HUSBANDRY.**

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**December, 1895.**

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**FATTENING STEERS IN WINTER.**

**FATTENING LAMBS IN WINTER.**

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***ST. ANTHONY PARK, RAMSEY COUNTY,  
MINNESOTA.***

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**HARRISON & SMITH, PRINTERS, MINNEAPOLIS.**

# UNIVERSITY OF MINNESOTA.

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## FATTENING STEERS IN WINTER.

THOMAS SHAW.

But little attention relatively has been given to fattening cattle in our state in the past. Of this fact there can be no question, since much of the beef consumed in our metropolitan cities is shipped into the same from Omaha and Kansas City. That beef should be imported for food into a state without a peer in all the Union in its natural facilities for producing the same is peculiarly unfortunate, for beef production is not an industry that can be introduced in a day. Time must needs elapse before the right kind of parent stock can be secured to produce the animals wanted to secure the necessary plant for successful winter feeding, and to educate the people in the methods which relate to successful beef production. And we must have a market within the state that will buy up the best grades of meat at prices not far different from those paid for them at Chicago. It is impossible, therefore, to build up the beef industry in the state in a little while. Like the gourd of the prophet it cannot come in a night. If, therefore, we can but perceive that any considerable proportion of our farmers are moving in the direction of beef production we should feel encouraged.

Many reasons may be assigned for the rearward position occupied by Minnesota in the matter of beef production. First, because of the marked adaptability of the state for wheat production the settlers first gave their attention to wheat growing, and as this branch of agriculture proved remunerative for a time the habit of growing wheat became so deeply rooted that the desire even for other lines of production was smothered. Second, the idea became deeply rooted that beef could never be grown in Minnesota to compete with that grown upon the

ranges where land is cheap and pastures are without limit. Nor can it be thus reared to compete with range grown beef if marketed at the same season of the year. But why do people fail to perceive that our aim should be to market our beef when range meat is not coming to the market. And why do they fail to perceive that money can be made in finishing range steers upon our farms in winter, even though we do not grow them there? Third, the idea prevails that our farmers cannot feed cattle for the market in competition with the farmers of the corn belt to the south of us. This view is wholly untenable, for beef can be made from hay, millet, corn, sorghum, flax, barley, oats, peas and field roots, and which of those states in the corn belt can compete with ours in the production of these foods when taken together? The truth is that our state is unexcelled in natural capabilities for beef production. But we want the breeding stocks and trained feeders to make the work a success. And fourth, but little teaching has been done in the past on this greatly important question, notwithstanding that the best information that could be got on certain lines of agriculture has been proclaimed from year to year in every county in the state, but little has yet been said in regard to beef production. With such mistaken views abroad on this question and with little or no effort to remove them, it would have been strange indeed had the beef interest attained to any importance in the state.

With the view, therefore, of applying the axe to the root of some of those mistaken notions regarding beef production, an experiment was inaugurated at our station in the autumn of 1894. But as is usual with all undertakings, new or comparatively so, the way was beset with difficulties.

The first difficulty to be overcome was the selection of the animals. A very large proportion of the steers in the state are lacking in quality and very deficient in breeding. Much searching was therefore necessary before they could be obtained. This fact is significant, for it explains the lack of profit complained of by many of those who feed steers. And the second difficulty to be met was the purchasing of fodder of a good quality. The advantage to be derived from feeding food cured in the best manner possible does not seem to have been duly considered by many of those who keep cattle, hence

not a little of the food is badly cured, although we have one of the most favorable climates in the world for curing foddors in excellent form. Both these difficulties however were at length overcome.

*The objects of the experiment.*—The following are prominent among the objects sought in the experiment, viz: 1. To compare the methods of feeding cattle that are being fattened on a light, an intermediate and a heavy grain ration respectively. The suspicion has existed for some time in the mind of the writer that much food is oftentimes wasted in preparing animals for the block by feeding them unnecessarily large quantities of grain. The effort was put forth, therefore, to obtain light on this question. 2. To ascertain the profit, if any, from fattening steers in our state under existing conditions. Popular opinion, judging by the present condition of the industry, would seem to say that it does not pay. Those who understand the work know that it can be made to pay when conducted as it ought to be. Hence the demonstration of this question is possessed of peculiar importance; and 3, to demonstrate how unwise it is to feed animals longer after they have reached what may be termed a fairly well ripened condition, and more especially when the warm season is setting in. In instances not a few, feeders are prone to hold their animals longer after they are ready for market in the hope of obtaining a higher price. Those who do seldom realize what they lose by such a policy when the animals are so far ripened that they cease to make good gains.

Chief among the secondary objects sought were: 1. To note the daily increase in weight that may be expected from young steers of fair quality under different modes of feeding. 2. To ascertain the effects of feeding heavy and light grain rations similar in kind on the appetite and digestion of the animals in a long period of feeding; and 3, to compare grades of the Shorthorn, Hereford and Galloway breeds respectively as to suitability for beef making.

*The animals selected.*—Three animals were chosen representing the Shorthorn, Hereford and Galloway breeds respectively, that is to say representing them in their grades and including three of each kind. They were steers and were the offspring of pedigreed animals on the side of the sire. The

dams were of common or mixed breeding. So far as could be ascertained they were possessed of more or less Shorthorn blood except in the case of one of the Herefords which was pure in breeding.

The Shorthorn steers were bred by Mr. F. P. Wells, of Kirkhoven, Minn. They were getting on toward three years old when they reached the station. They were good strong robust animals with probably rather much of bone, and although fairly smooth and straight, were not over-burdened with either symmetry or quality. They reached the farm Nov. 17th, 1894. Taking them all in all they did not quite so well represent the breed as the steers in the other groups. At that time they possessed an average weight of 918 pounds and the price paid for them at the University Experiment Farm was  $3\frac{1}{4}$  cents per pound live weight. They cost the station therefore at that time \$89.54.

The Hereford steers were bought from Mr. Herman S. Berning, St. Michael's, Minn., by whom also they were bred. They were calved in the spring of 1892, between the months of March and May. Two of them were three quarter grades and the third was a pure bred. They were sired by the pure Hereford bull A. 27482, bred by the Cosgrove Live Stock Co., Le Sueur. All three were shapely steers and smooth but just a little under size for the age. They were running in a yard at the time of purchase with the shelter of an open shed and were withal in good store condition. They arrived at University Farm, Nov. 21st, 1894. The average weight at that time was 918 pounds. They were bought at St. Michael's for \$100. The freight from that place to the Minnesota transfer was \$11.50. The sum paid for them therefore was \$111.50 in all or a little more than 34.5 cents per pound.

The Galloways were bought from Mr. Hugh Paul, "Waver-tree Farm," Dundee, Minn., and through Mr. David M. Fyffe the manager. They were calved in February, April and May respectively of the year 1893. They were therefore of an average age of about 19 months when they reached the University Farm on October 18th. They were out of high grade Shorthorn cows and by a pure Galloway bull, owned at "Waver-tree." They were goodly steers, shapely and of fair quality, and they possessed the Galloway characteristics in a fair

degree, that is to say they were essentially black in color, were plentifully supplied with hair, and were polled. They were strong in the back and sturdy, but they were not rough. They were bought at Dundee for  $2\frac{1}{2}$  cents per pound live weight. When they arrived at the University Farm they possessed an average weight of 677 pounds, Oct. 18th. But they were purchased on the basis of the weights at Dundee, viz: 2,160 pounds. They were brought in a car containing other animals for the station, and were charged with a due proportion of the freight, viz: \$8.58. The price paid for them therefore when they arrived at the University Farm was \$62.58, or a fraction over 3 cents per pound.

*Conditions Governing the Experiment.*—The experiment may be conveniently divided into three parts, viz: the period of preparation, the experiment proper and the after experiment. The preparatory experiment covered a period of seven days, the experiment proper a period of 140 days, and the after experiment a period of 56 days.

The steers were divided into three lots, each lot containing one representative of the different breeds. They were all fed the same ration in kind, but they were not fed the same quantities of it as will be shown below, water was given them twice a day in the stall, and they had access to salt at will. They were groomed only sufficiently to keep them presentable, and they were allowed to exercise in a yard twice a week for an hour at a time. The object sought in thus giving them exercise was to put them in a condition that would enable them to stand better the disturbing influence of transportation. The individual weights were taken every week. The experiment proper was divided into five periods of 28 days each. At the end of each period they were weighed two days in succession, and the average of the weights was noted. The object was to secure greater accuracy in the weights at the beginning and ending of the different periods, as there is no little variation in the weights of the animals from day to day, owing to certain disturbing influences, as for instance, variations in atmospheric moisture, which in turn influence eating and drinking.

The animals were tied in the stall with chains. The rings attached to the chains slide up and down on a rod at the side

of each manger. The writer favors dehorning cattle when housed, and fattening them in closed sheds, and without tying. But in many kinds of experimental feeding this is clearly impossible, where the particulars relating to each animal are to be separately ascertained.

*Food and Feeding.*—The food fed consisted of meal, corn, ensilage and hay. The meal, until the close of the experiment proper, consisted of wheat bran, ground wheat and ground corn, in the proportions of 1, 2 and 1 parts respectively. But during the last period some oil cake was added. It was fed in two feeds, viz.: morning and evening, and it was mixed with the ensilage just before being fed. During the first period of the experiment the steers in lot 1 were given 5 pounds each of meal per day; those in lot 2, 7 pounds; and those in lot 3, 9 pounds. The meal was increased 1 pound per day with each animal in the several lots at the end of each feeding period, that is to say, this was done for four successive periods, after which no further increase was made except the addition of some oil cake as already stated. But some changes in the food given were made during the after experiment, which will be duly mentioned in the proper place. The meal fed was, therefore, increased as stated until 9 pounds per head per day were given to the steers in lot 1; 11 pounds to the steers in lot 2; and 13 pounds to the steers in lot 3. The average amount of meal, therefore, fed to the steers in lot 1 was 7 pounds per day, to those in lot 2, 9 pounds, and to those in lot 3, 11 pounds. The aim was to feed 25 pounds of corn ensilage per day, but some of the steers would not take that amount, notably the Galloway grade in lot 1. The ensilage was hardly medium in quality. The exceedingly dry weather of the previous season was against it. The hay was composed of timothy and clover, the latter predominating. This was fed uncut in three feeds per day, and as much was given at each feed as the animals would eat up cleanly. They consumed on an average 8.34 pounds of hay daily during the experiment proper.

*Prices charged for the food.*—The food fed was charged at what may be termed average market values in the state. These values were obtained as follows: Early in 1894 Professor Hays asked for an expression of opinion from certain leading farmers as to the average market values of the chief of the

food products grown in the state. The prices named in the answers for the several food products were averaged, and these averages formed the basis essentially of the prices respectively at which the food was charged in this experiment. The only instance in which any marked variation was made from the average of these estimates, was in the matter of corn ensilage, which the valuator placed unquestionably too high. The following values therefore were put upon the food, viz: wheat bran, \$11 per ton; ground wheat, \$15.866 per ton; ensilage, \$2 per ton; hay, \$6 per ton; and oilcake \$26 per ton.

But here it may be mentioned that the market value of food is considerably in excess of what may be termed the home value of the same. The home value of food is the market value less the cost of marketing. The home value therefore will vary with the character of the commodity to be marketed, with the distance from the market, and with the conditions of the roads. While some kinds of produce, as grain for instance, can be cheaply marketed, bulky products as hay and roots will cost much more to market them. The market value therefore in some instances will probably be less than 10 per cent in excess of the home value, which in other instances may exceed the latter by fully 25 per cent. When the farmer fattens live stock upon his own farm, it is clearly manifest that the food should be charged at its home value.

And the further idea should be borne in mind, that even when food fed to animals is charged at home values, it is usually charged at more than it cost the farmer to raise it. Were it otherwise, he could not carry on his work, for then no profit would arise from his labors, even though he marketed his food. There will usually be some profit in the food to the farmer before it is fed, and the amount of the same will be the difference between the actual cost of the production and the home value of the product. But in the present state of our knowledge we cannot do better in getting at the profits in feeding than charge the food at average market values, and leave it for the farmer himself to determine how much these values exceed the cost of production.

## THE PREPARATORY EXPERIMENT.

The preparatory experiment began on Dec. 2d, and ended on Dec. 9th, thus covering a period of seven days. The food fed to the animals was the same in kind as that given during the experiment proper, and was also the same in quantity. The object of the preparatory experiment was to accustom the animals to the ration and to their surroundings, in other words to start them into the experiment on the basis of evenness of conditions. It sometimes happens that animals will not relish a food at first to which they have not been accustomed, and so it was in the present instance when the corn ensilage was first fed. Some of the animals did not relish it very much for two or three days at the first.

During the preparatory experiment the food consumed by the steers in lot 1 cost \$1.95, in lot 2, \$2.07 and in lot 3, \$2 15. During the same period the food consumed by the Galloway grades cost \$1.75, Herefords \$2.12, Shorthorns \$2.29. And here also it may be proper to mention that the cost of the food prior to the preparatory experiment was for those in lot 1, \$5.22½, in lot 2, \$5.50½ and in lot 3, \$5.24½. And for the Galloway grades it was \$9.22, for the Hereford grades \$2.59½ and for the Shorthorn grades \$3.66.

## THE EXPERIMENT PROPER.

The experiment proper began Dec. 10th, and ended April 28th, thus covering a period of twenty weeks or one hundred and forty days. The particulars governing it have already been given. A careful record of the behavior of the animals was kept and all variations of any considerable importance were carefully noted.

*Food consumed.*—Table XXXIV gives the amounts of each kind of food consumed by every animal during the respective periods of the experiment, and the total consumed by each during the experiment. It also gives the respective amounts of each kind of food consumed by the animals in each lot, and the total amounts of food consumed by them.

TABLE XXXIV.—Food Consumed by the Animals in Each Lot.

	Hay.	Meal.	Ensilage.	Oilcake.	Total.
LOT No. 1.					
	lbs.	lbs.	lbs.	lbs.	lbs.
Galloway .....	989	924	3,274	61	5,248
Hereford .....	1,357	924	3,495	61	5,837
Shorthorn .....	1,320	924	3,500	61	5,805
Total .....	3,666	2,772	10,269	183	16,890
LOT No. 2.					
Galloway .....	1,230	1,204	3,500	61	5,995
Hereford .....	1,251	1,204	3,500	61	6,016
Shorthorn .....	1,274½	1,204	3,500	61	6,039½
Total .....	3,755½	3,612	10,500	183	18,050½
LOT No. 3.					
Galloway .....	922	1,484	3,400	61	5,876
Hereford .....	942½	1,484	3,401½	61	5,889
Shorthorn .....	1,216	1,484	3,008	61	5,769
Total .....	3,080½	4,452	9,818½	183	17,534

It will be observed that the steers in lot 1, notwithstanding the light meal ration fed to them, consumed less hay and ensilage than those in lot 2, but they consumed more of both than those in lot 3, compared with the steers in lot 2 they consumed 89½ pounds less hay and 231 pounds less ensilage. Compared with those in lot 3 they consumed 585½ pounds more hay and 450½ pounds more ensilage. The total consumption of food by lot 1 fell short of that consumed by lot 2 by 1,160½ pounds, and of that consumed by lot 3 by 644 pounds. The extra consumption of hay and ensilage by the steers in lot 1 did not equal the extra consumption of meal by the steers in lot 3 by 644 pounds. In other words the extra consumption of meal, the costly factor of the ration, by the steers in lots 2 and 3 did not effect a corresponding saving in the hay and ensilage, the less costly food factors.

Table XXXV gives the amount of each kind of food consumed by the animals of each grade, the totals of each kind of food consumed by all the animals of each grade, and the totals of food consumed by each animal in the experiment.

TABLE XXXV.—Food Consumed by the Animals of Each Grade.

	Hay.	Meal.	Ensilage.	Oil Cake.	Total.
	lbs.	lbs.	lbs.	lbs.	lbs.
Galloway—No. 1.....	989	924	3,274	61	5,248
No. 2.....	1,230	1,204	3,500	61	5,995
No. 3.....	922	1,484	3,409	61	5,876
Total.....	3,141	3,612	10,183	183	17,119
Hereford—No. 1.....	1,357	924	3,495	61	5,837
No. 2.....	1,251	1,204	3,500	61	6,016
No. 3.....	942½	1,484	3,401½	61	5,889
Total.....	3,550½	3,612	10,396½	183	17,742
Short Horn—No. 1.....	1,320	924	3,500	61	5,805
No. 2.....	1,274½	1,204	3,500	61	6,039½
No. 3.....	1,216	1,484	3,008	61	5,769
Total.....	3,810½	3,612	10,008	183	17,613½

An examination of the contents of table XXXV will show that the total consumption of food was not greatly different with the animals of the three grades. The Herefords consumed the most food, but the Galloways were the greatest consumers of food in proportion to the live weight. The Herefords consumed but 128½ pounds more than the Shorthorn grades and 623 pounds more than the Galloway grades. But the comparison here is weakened by the difference in the ages of the animals of the respective grades. It would not be safe perhaps at present to draw any very hard and fast conclusions from the above table.

Table XXXVI gives the amount of each kind of food consumed daily by the steers in the different lots, the average amount of the same and the total daily consumption of food by each individual.

TABLE XXXVI.—Daily Consumption of Food by the Steers in Each Lot.

	Hay.	Meal.	Ensilage.	Oil cake.	Total.
	lbs.	lbs.	lbs.	lbs.	lbs.
Lot No. 1.					
Galloway.....	7.06	6.80	23.30	.44	37.50
Hereford.....	9.89	6.60	24.96	.44	41.69
Shorthorn.....	9.43	6.60	25.00	.44	41.47
Average.....	8.73	6.60	24.45	.44	40.22
Lot No. 2.					
Galloway.....	8.79	8.60	25.00	.44	42.83
Hereford.....	8.94	8.60	25.00	.44	42.98
Shorthorn.....	9.10	8.60	25.00	.44	43.13
Average.....	8.94	8.60	25.00	.44	42.98
Lot No. 3.					
Galloway.....	6.59	10.60	24.35	.44	41.98
Hereford.....	6.73	10.60	24.30	.44	42.07
Shorthorn.....	8.69	10.60	21.49	.44	41.21
Average.....	7.34	10.60	23.38	.44	41.75

It will be noticed that the average daily consumption of food was not very far different with the steers of the different lots. The average total amounts of food consumed daily by each animal under experiment was 41.65 pounds and the average weight of each steer while under experiment was 1,044 pounds. Hence the conclusion, that under the conditions of the experiment steers of an average weight of 1,044 pounds, if fed daily 25 pounds of corn ensilage and 8.60 pounds of meal, will consume daily 8.34 pounds of hay, or practically from 8 to 9 pounds.

Table XXXVII. gives the amount of each kind of food consumed daily by the steers of the different grades, the average amount of the same and the total daily consumption of food by each in dividual.

TABLE XXXVII.—Daily Consumption of Food by the Steers of Each Grade.

	Hay.	Meal.	Ensilage.	Oilcake.	Total.
	lbs.	lbs.	lbs.	lbs.	lbs.
Galloway—No. 1.....	7.06	6.60	23.39	.44	37.50
No. 2.....	8.79	8.60	25.00	.44	42.83
No. 3.....	6.59	10.60	24.35	.44	41.98
Average.....	7.48	8.60	24.25	.44	40.77
Hereford—No. 1.....	9.69	6.60	24.96	.44	41.69
No. 2.....	8.94	8.60	25.00	.44	42.98
No. 3.....	6.73	10.60	24.30	.44	42.07
Average.....	8.45	8.60	24.75	.44	42.25
Shorthorn—No. 1.....	9.43	6.60	25.00	.44	41.46
No. 2.....	9.10	8.60	25.00	.44	43.14
No. 3.....	8.69	10.60	21.49	.44	41.21
Average.....	9.07	8.60	23.83	.44	41.94

From an examination of the figures in table XXXVII, it will be apparent that the No. 1 grade Galloway consumed the smallest amount of hay of all the animals in the different groups, and that he stands second in the light consumption of ensilage. He was not a first class feeder, and the increase in weight was affected likewise. He did not get "off his feed," but he did not relish the ensilage, and the dislike for it increased so that in the after experiment it was thought advisable to substitute other food for the ensilage before the supply of the latter had been exhausted. Hence the conclusion that individual tastes exercise no little influence in animals that are being fattened. The No. 3 grade Shorthorn was also a light con-

sumer of ensilage and hay. More than once he was somewhat off his feed, so that for a brief period the supply had to be cut down somewhat. Hence the evidence of the greater capacity in some animals to stand heavy grain feeding as the No. 3 grade Galloway and the No. 3 grade Hereford, to which equal amounts of meal were fed, were not similarly affected. And second, of the easy possibility of overcrowding animals that are being fattened by feeding them too much meal.

*Weights of the Animals.*—Table XXXVIII gives the weights of the individual animals in each lot at the commencement and at the close of the experiment, and the total individual increase in weight. It also gives the totals for each group.

TABLE XXXVIII.—Weights of Animals in the Different Lots.

	Weight at begin- ning of experi- ment.	Weight at the end of fifth period.	Total gain.
	lbs.	lbs.	lbs.
Lot No. 1.			
Galloway.....	771	1,002½	231½
Hereford.....	946	1,240½	303½
Shorthorn.....	984	1,240½	256½
Total.....	2,701	3,492½	791½
Lot No. 2.			
Galloway.....	567½	1,135½	268
Hereford.....	987½	1,242½	255
Shorthorn.....	975	1,234	259
Total.....	2,830	3,612	782
Lot No. 3.			
Galloway.....	775	1,069½	294½
Hereford.....	906½	1,211	304½
Shorthorn.....	970	1,232	262
Total.....	2,651½	3,512½	861

The steers in lot 1 made an aggregate gain of 9½ pounds more than those in lot 2, notwithstanding the greater consumption of food by the latter. Those in lot 3 made 69½ pounds more of an aggregate gain in weight than the steers in lot 1, but the greater consumption of the more costly food on the part of the former much more than discounted the advantage of this greater increase in weight as will be shown when treating of the question of cost.

Table XXXIX. gives the weights of the individual animals of each grade at the commencement and at the close of the experiment, and the total individual increase in weight. It also gives the totals for each lot.

TABLE XXXIX.—Weights of the Animals of the Different Grades.

	Weights at the beginning of the experiment.	Weights at the end of the experiment.	Total gain.
	lbs.	lbs.	lbs.
Galloways.....	771 867½ 775	1,002½ 1,135½ 1,060½	231½ 268 294½
Total.....	2,413½	3,207½	794
Herefords.....	946 987½ 906½	1,249½ 1,342½ 1,211	303½ 255 304½
Total.....	2,840	3,703	863
Shorthorns.....	984 975 970	1,240½ 1,234 1,232	256½ 250 262
Total.....	2,929	3,706½	777½

The greatest aggregate gain was made by the Hereford grades. They increased in weight 69 pounds more than the Galloways and 85½ pounds more than the Shorthorns. But too much should not be made of this, since so much depends upon the individuality of the animals.

Table XL. gives the individual increase in weight of each animal during the several periods of the experiment, the total individual increase during the experiment and the aggregate increase in weight of the animals in each lot.

TABLE XL.—Increase in Weight During the Different Periods of the Experiment.

	Gain made during first 28 days of experiment.....	Gain made during second 28 days of experiment.....	Gain made during third 28 days of experiment.....	Gain made during fourth 28 days of experiment.....	Gain made during fifth 28 days of experiment.....	Total gain.....
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Lot No. 1—						
Galloway.....	71	69½	36	39½	15½	231½
Hereford.....	72½	77½	50½	51	52	303½
Shorthorn.....	77½	78½	51	35½	14	256½
Total.....	221	225½	137½	126	81½	791½
Lot No. 2—						
Galloway.....	57	40½	47½	61	42	268
Hereford.....	41	76½	59	57	21½	255
Shorthorn.....	77	63	58½	40½	20	259
Total.....	175	180	165	158½	83½	782
Lot No. 3—						
Galloway.....	58	80½	50½	68½	37	294½
Hereford.....	75	53½	78½	45	52½	304½
Shorthorn.....	62	95½	24	30	50½	262
Total.....	195	229½	153	143½	140	861

From the figures in table XXXIX. it is apparent that the No. 1 animal in lot 1 made but indifferent gains, and the same is true of the No. 3 steer in lot 3. This was owing to indifferent feeding on the part of the steers, but from different causes. It is also worthy of notice that during the fourth and fifth periods but indifferent gains were made by the steers. This was owing in part at least to the less palatable character of the ensilage. Hence the inseparable relation between quality in food and well doing in the animals to which it is fed.

The average aggregate gains of the steers in the several lots were as follows:

Lot 1, 263.8 pounds.

Lot 2, 260.7 pounds.

Lot 3, 287.0 pounds.

The average aggregate gains of the steers of the different grades is given below:

Galloways, 264.7 pounds.

Herefords, 287.7 pounds.

Shorthorns, 259.2 pounds.

While the Herefords made the greatest average gains per day the difference was scarcely enough to found on it any distinct claim as to breed superiority, one Galloway grade fed indifferently and also one Shorthorn grade, and for reasons already given. Taking those facts, which relate to individuality rather than to breed into the account, we have in the results an illustration of the adaptability of all the breeds named for beef making rather than of the superiority of any one of them.

The average daily gain of the individual steers in the several lots was as follows:

Lot 1.	Lot 2.	Lot 3.
lbs.	lbs.	lbs.
1.65	1.91	2.10
2.17	1.82	2.17
1.83	1.85	1.87
Average—1.89	1.86	2.05

These are only moderate gains but for a long feeding term they are at least fair. However this fact is evident and it is one of great significance, that if the meal factors used in the ration had been increased ever so much, better gains would not

have been secured, as the resultant gains from the steers to which the light meal portion was fed, were in excess of those fed 2 pounds more each of meal per day and not far behind those fed 4 pounds more per day of the same.

*Cost of Food.*—Table XLI gives the cost of each food factor fed to the individual animals in the different lots, the total cost of the several food factors fed to each, and the totals of cost in the food fed to the animals of the respective groups.

TABLE XLI.—Cost of Food Consumed.

	Hay.	Meal.	Ensilage.	Oil Cake.	
<b>Lot No. 1.</b>					
Galloway.....	\$2.97	\$6.55	\$3.27	\$ .79	\$13.58
Hereford.....	4.07	6.55	3.50	.79	14.91
Shorthorn.....	3.96	6.55	3.50	.79	14.80
	11.00	19.65	10.27	2.37	43.29
<b>Lot No. 2.</b>					
Galloway.....	3.69	8.54	3.50	.79	16.52
Hereford.....	3.75	8.54	3.50	.79	16.58
Shorthorn.....	3.82	8.54	3.50	.79	16.65
	11.26	25.62	10.50	2.37	49.75
<b>Lot No. 3.</b>					
Galloway.....	2.77	10.52	3.41	.79	17.49
Hereford.....	2.83	10.52	3.40	.79	17.54
Shorthorn.....	3.65	10.52	3.01	.79	17.97
	9.25	31.56	9.82	2.37	53.00

The cost of the food fed to the steers in lot 2 was \$6.46 more than of that fed to the steers in lot 1, and the total gains were 9 pounds less, and the cost of the food fed to the steers in lot 3 was \$9.71 more than of that fed to the steers in lot 1, while the total gains were but 69½ pounds greater. The total cost of the fodder and ensilage fed to the 9 steers was \$62.10 and of the meal and oil cake \$83.94. The meal therefore cost \$21.84 in excess of the fodder. In these figures we are reminded of the great importance of so feeding meal, which is usually the costly ration that it will be turned to good account.

The results obtained from feeding the light and heavy meal factors respectively would certainly tend to show that when animals are being fattened they will take more meal than they can digest and assimilate to the best advantage even when they do not get "off their feed." But of course the results from any one test should not be pressed too far.

The average daily cost of the food consumed by the animals of the respective lots was as follows:—

Lot 1.	Lot 2.	Lot 3.
cts.	cts.	cts.
9.70	11.80	12.49
10.65	11.84	12.53
10.57	11.89	12.84
<hr/>		
Average—10.31	11.84	12.62

The average daily cost of the food consumed by the animals of the different grades is given below:—

Galloways.	Herefords.	Shorthorns.
9.70	10.65	10.57
11.80	11.84	11.89
12.49	12.53	12.84
<hr/>		
Average—11.33	11.67	11.77

The statements given above again remind us first of the greater relative cost of using large quantities of meal in fattening unless when it is cheaper than usual. And second of the comparatively little advantage that any one of the breeds had over the other in what are termed easy keeping qualities.

The average cost of making one pound of gain by the steers of the different lots during the experiment was as follows:

	Lot 1.	Lot 2.	Lot 3.
	cts.	cts.	cts.
G.	5.87	6.16	5.94
H.	4.91	6.50	5.76
Sh.	5.77	6.43	6.86
<hr/>			
Average—5.52	6.36	6.19	

At the date where the experiment proper closed, viz., April 28th, the steers would have readily sold for  $5\frac{1}{4}$  cents per pound live weight. In fact offers were received for them more than the equivalent of that amount. It is manifestly fair then to value the meat at  $5\frac{1}{4}$  cents per pound at the close of the experiment. From the above table then it is evident that with the steers in lot 1 every pound of increase made was worth nearly as much as it cost to make it. And with the Hereford grade steer in the same lot it was worth more than the cost of making it.

These are certainly encouraging results, for as is well known to those who have looked into this question, the cost of the food

used in making one pound of beef during the finishing period is usually considerably more than the beef is worth. The profit in the business comes from the increase in the value of each pound of the original weight of the animals when purchased.

Table XLII gives the food consumed by the animals in each lot, the total gain of each animal, the total cost of food for each, and the total cost of each pound of increase.

TABLE XLII—Food Consumed, Gains and Cost.

	Total food consumed by each animal.	Total gain of each animal.	Total cost of food for each animal.	Total cost of one pound of increase in each animal.
	lbs.	lbs.		Cts.
LOT No. 1.				
Galloway .....	5,248	231½	\$13.58	5.87
Hereford .....	5,837	303½	14.91	4.91
Shorthorn .....	5,805	256½	14.80	5.77
LOT No. 2.				
Galloway .....	5,995	268	16.52	6.16
Hereford .....	6,016	255	16.58	6.50
Shorthorn .....	6,039½	259	16.65	6.43
LOT No. 3.				
Galloway .....	5,876	294½	17.49	5.94
Hereford .....	5,889	304½	17.54	5.76
Shorthorn .....	5,769	262	17.97	6.86

A careful study of the contents of the above table will tend to show the close relation between food consumption of the kind used and rapid or slow increase in weight, and consequently in the cheapness or dearness of the cost of production. As a rule it will be found that the hearty consumption of food will produce the most rapid relative gains in weight and therefore, will make meat more cheaply than where the opposite conditions prevail. But to this there are some exceptions.

*Financial Results.*—The prices paid for the steers, the cost of transit, and the respective weights have been given. A calculation based on these figures will show that a trifle more than 3 4-5 cents was the actual average cost per pound when the steers were laid down at the University Experiment Farm. Taking the prices paid, and also the value of good steers at the time, as the basis of calculation it was deemed equitable to charge them at 3½ cents per pound when the experiment began on Dec. 10th, 1894. And as previously stated they were valued at 5¼ cents per pound when the experiment closed.

Table XLIII gives the total value of the steers in the several lots at the commencement of the experiment and at its close, the cost of the food fed and the total increase in value.

TABLE XLIII.—Values, Food and Profit.

	Total value at commencement of experiment.	Total value at close of experiment.	Total cost of food.	Total increase in value.
Lot 1.....	\$ 91.53	\$183.36	\$ 43.29	\$ 45.54
Lot 2.....	99.05	189.63	49.75	40.83
Lot 3. ....	92.80	184.41	53.00	38.61
Totals.....	\$286.38	\$557.40	\$146.04	\$124.98

As the total value of the animals at the commencement of the experiment was \$286.38 and at its close \$557.40, the increase in value was \$271.02, that is to say, the value of the animals was nearly doubled during the experiment of 140 days. The total profit was \$124.98 and the average profit on each steer was \$13.89. There is a difference of a few cents in these figures as compared with those given in the statement in the Farmers' Institute Annual, No. 8, owing to a slight error in the work when preparing the matter for the said annual, but the difference is so slight that it affects the results but little. Had the light meal portion been fed to the steers in all the groups, basing the computation on the weights at the commencement of the experiment, the total profit would have been \$137.96, and the profit on each animal \$15.32, or \$1.43 more than was realized on each.

In showing the actual profit, viz: \$124.98, the food was charged at market values. If it had been charged at home values the profit would have been considerably increased. On the supposition that a deduction of 10 per cent. on the market value represented the home value, and that the food had been thus charged, the actual profit would have been \$139.58 on the lot, and \$15.51 on each animal.

Table XLIV gives the total value of the steers of the several grades at the commencement of the experiment and at its close, the cost of the food fed and the total increase in value.

TABLE XLIV.—Values, Food and Profit from Commencement of Experiment.

	Total value of animals at commencement of the experiment.	Total cost of food.	Total value of animals at close of the experiment.	Total increase in value.
Galloways .....	\$ 84.46	\$ 47.59	\$ 168.40	\$ 36.35
Herefords .....	99.40	49.03	194.41	45.98
Shorthorns .....	102.52	49.42	194.59	42.65
Total .....	\$ 286.38	\$ 146.04	\$ 557.40	\$ 124.98

The Herefords gave returns somewhat greater for the food fed than either the Galloways or the Shorthorns. It will be remembered however that one of the Galloway steers fed but indifferently. But this does not account for the whole difference in the results. As heretofore stated the Galloways were the greatest consumers of food in proportion to their live weight, and the gains were not quite proportionate. The one Shorthorn mentioned as having been off his feed, lowered the record somewhat for the Shorthorns.

Table XLV gives the cost of the animals of each grade when laid down at the farm, the total cost of the food from that time to the close of the experiment proper, the total value at the end of the experiment and the total profit on the steers of the respective grades.

TABLE XLV.—Cost, Food, and Profit, from the Time of Purchase.

	Cost of animals when brought to the farm.	Total food to end of experiment.	Total value of animals at close of experiment.	Total gain.
Galloways .....	\$62.58	\$58.56	\$168.40	\$47.26
Herefords .....	111.50	53.74	194.41	29.17
Shorthorns .....	89.54	55.37	194.59	49.68
Totals .....	\$263.62	\$167.67	\$557.40	\$126.11

From table XLV it is evident that the Shorthorns have the lead, but only a very little over the Galloways. The Herefords are considerably behind. But it would not be prudent to draw any important conclusions from those results as to the relative adaptability of breeds for fattening. They rather emphasize the importance of careful buying, since the Herefords which gave the greatest profit from the food fed gave the least profit on the transaction.

*Items not considered.*—In the financial results given it will be noticed that the items of interest on cost of stabling and on the money paid for the steers and for the food are not considered. No charge was made for bedding, nor was any allowance made for labor. On the other hand no value has been put upon the manure. In the eastern states it is usually considered that the value of the manure will considerably more than offset all these items combined. And if the manure is valued upon the basis of the price paid for commercial fertilizers by those who have to buy them, the above conclusion is assuredly correct. But in the west it is somewhat different. Fertility is more plentiful here and therefore intrinsically less valuable. Those who burn manure or throw it into the sloughs and streams most assuredly look upon it as a nuisance, something that involves outlay to get rid of it. On the other hand those who are careful to apply all the manure which they make upon their farms will attach to it a considerable value, and those who buy fertilizers, as for instance market gardeners will put a high value upon it.

It would not be wise perhaps in the present state of our knowledge to pronounce upon the value of manure in the west. Each farmer has reached conclusions which seem to him to be correct, each therefore must in the meantime decide for himself as to whether the value of the manure equals or overbalances the other items of outlay named, or whether it falls short of the same. The question of profit will of course be correspondingly influenced, meanwhile the fact should be carefully noted that the value of the manure made in fattening animals is much greater than that made from store animals as ordinarily fed.

The manure was analyzed by Prof. Harry Snyder of our station with a view to determine the exact character of the digestion of the food fed to the steers in lots 1 and 3 respectively. But unfortunately the week fixed upon for the analysis proved to be the week above all others during which the digestion of the animals was disturbed through the want of quality in the ensilage, hence the value of the findings was so neutralized that no apparent good could arise from its publication.

## THE AFTER EXPERIMENT.

The after experiment as already stated commenced on April 29th. It continued until June 24th when the steers were sold. Those in lot 1 left the stables for the shambles June 28th, those in lot 2, July 5th, and those in lot 3, July 12th. They were sold through the firm of E. M. Prouty & Co., South St. Paul, to the Twin City Packing Co., and were finally exposed for sale in the shop of Mr. Arbogast, St. Paul. One object sought in finding for them a home market was to demonstrate to all concerned that if our farmers were sufficiently alive to the possibilities in beef making, it need not be necessary to go to Omaha and Kansas City to secure the best quality of meat for home consumption. The meat production of our State will never rest upon a proper basis until this anomaly is removed.

*Food during the after experiment.*—In the after experiment some changes were made in the kinds of food fed. This was owing in part at least to the greater difficulty found in maintaining a uniformly good appetite when the weather grew warm. The more important of these changes were as follows: On April 29th the supply of good ensilage was exhausted and the steers were thenceforth confined to a fodder diet of hay with meal as specified below. A portion of the hay was run through a cutting box and the meal was mixed with the same. On May 6th the meal factors were changed. From that date until May 20th they were made up of wheat bran, ground wheat and corn, in the proportions of 1, 1 and 2 parts respectively. On May 20th ground oats was substituted for ground wheat, after which no further change was made in the composition of the meal. But during the continuance of the after experiment each animal was given practically 3 pounds of oil cake per day. No other change was made in the relative quantities of the meal fed. Throughout the after experiment therefore the steers in lot 1 were fed 12 pounds of meal per day including the 3 pounds of oil cake; those in lot 2, 14 pounds, and those in lot 3, 16 pounds. Notwithstanding the heavier meal ration fed during the after experiment the average daily gains were not so good as during the experiment proper. In the former instance they were 1.93 pounds, and in the latter 1.65 pounds, and the fact is very significant that while the

steers in lot 1 made an average daily gain during the after experiment of 1.73 pounds, those in lot 3 which were fed daily four pounds more meal made a daily gain of but 1.35 pounds. Those in lot 2 made a better showing as they made an average gain of 1.88 pounds.

*Cost of Food During the After Experiment.*—The total cost of the food fed during the after experiment was \$71.43, of this cost but \$11.65 were paid for hay, while the three pounds of oilcake fed to each animal daily cost \$18.40. The oilcake fed during the after experiment, therefore, cost \$6.75 more than the hay. Attention is called to this fact to show how quickly the cost of feeding increases with food factors that are dear, hence the care with which these should be fed. True, the charge for oilcake, viz.: \$26.00 per ton, will seem high, especially when compared with the figures at which oilcake sells at the present time, but it will be remembered that the price charged is that reported by the farmers themselves as fully explained in the earlier part of the bulletin.

*Weights at the Close of the After Experiment.*—Table XLVI gives the average of the gross weight, the net weight and the shrinkage on the steers when they left the farm for the shambles:

TABLE XLVI.—Weights When Sold.

	Gross weight.	Net weight.	Shrinkage.
	lbs.	lbs.	lbs.
Lot 1.....	1,285	1,233 $\frac{3}{4}$	51 $\frac{1}{4}$
Lot 2.....	1,325	1,272	53
Lot 3.....	1,260	1,209 $\frac{3}{4}$	50 $\frac{3}{4}$
Average.....	1,290	1,238 4-9	51 5-9

Food was withheld from the steers for about 15 hours before they were finally weighed. They were fed as usual at 6 p. m., on the evening previous to the day on which they were weighed. They were then put on the scales the following morning at 9 a. m. It will be noticed that the average shrinkage was 51 $\frac{1}{4}$  pounds on steers averaging 1,290 pounds. The shrinkage therefore averaged 3.99 per cent. on the live weight.

*Financial summary.*—The following figures represent the financial outcome in the transaction:

Total cost of steers, not including food	\$263.62
Total cost of food.....	239.10
	<hr/>
Total outlay.....	\$502.72
Total net receipts when sold.....	585.16
	<hr/>
Total profit.....	\$82.44

Had the steers been marketed April 29th, at the close of the experiment proper, they would have sold for a profit of \$126.11. But from this sum a deduction should be made for shrinkage. When the outcome at that time is compared with the final outcome, fifty pounds probably on each steer would be a fair allowance for shrinkage. Such an allowance would reduce the profit from \$126.11 to \$102.49. The financial outcome therefore when the steers were sold was less by \$20.05 cents than if they had been disposed of at the end of the experiment proper.

Through the kind assistance of Mr. A. Boss, the farm foreman, the steers were conveyed, not driven, to the place of slaughter several miles distant, and the outcome on the block proved satisfactory.

### CONCLUSIONS.

The following are the more important of the conclusions that may be drawn from the experiment:—

1. That under its conditions steers averaging 1,044 pounds in live weight during the fattening period, will consume a daily ration of 25 pounds corn ensilage, 8.34 pounds of hay and 8.60 pounds of meal, or a total of 41.65 pounds per day.

2. It furnishes an illustration of the fair measure of adaptability for fattening possessed by grades of the respective breeds from which the selections were made, without assigning a marked superiority to any one of them.

3. It demonstrates the important truth that when animals are being fattened, they will consume more meal than they can properly digest and assimilate, even when they do not get "off their feed," hence the necessity for adjusting the meal fed to the digestive capacity of the respective animals.

4. It shows the necessity of carefulness in feeding the meal portion of the ration, as the cost of making one pound of increase in weight with the steers in lot 1 was but 5.52 cents, while with those in lot 2 it was 6.36 cents and with those in lot 3, 6.19 cents.

5. The increase in the consumption of meal, the more costly food, by the steers in lots 2 and 3 respectively, did not effect a corresponding decrease in the consumption of the coarser and cheaper food factors.

6. It emphasizes the inability of animals nearly equal in live weight to take similar quantities of food, as evidenced by the Shorthorn grade in lot 3 getting somewhat "off his feed," while the steers of the other grades getting food similar in quantity and kind were not so affected.

7. The inseparable relation between quality in food and well doing in the animals is also emphasized, as when the quality of the ensilage or of the hay diminished, the effect was at once apparant in the decrease in the gains of the steers.

8. The fact should be recognized in fattening cattle, that the same diet in kind may not be equally relished by all the animals, as witnessed in the shy consumption of corn ensilage by the steers, No. 1 in lot 1 and No. 3 in lot 3, hence, in practice, such foods should not be forced upon them.

9. Wheat at \$15.86 per ton or 47.6 cents per bushel, can be fed with advantage and profit to steers that are being fattened, when the prices of the other food factors used and also of the meat are as in this experiment.

10. If the food given to the steers in lot 1 had been charged at home values, the cost of making the increase in the live weight during the experiment proper would have been less than the cost of the food used in making it, a result not often realized in finishing cattle for the block.

11. In fattening steers, when the difference between the buying and the selling price per pound live weight is  $1\frac{3}{4}$  cents, a good profit can be made from feeding well graded steers of the beef breeds when the relation between the prices of food and meat are the same as in this experiment.

12. The value of the animals was nearly doubled in feeding for 140 days, since the value of the animals at the commencement of the experiment was \$286.38, and the increase in the

value at the close of the experiment was \$271.02, hence the wisdom of fattening cattle upon arable farms on which they may have been reared.

13. This experiment emphasizes the importance of selling fat animals with promptness when the conditions of sale are favorable, as the profits from carrying the steers through the after experiment were reduced to the extent of \$20.05.

14. Well finished steers, with an average weight of about 1,200 pounds, will lose about 50 pounds each in live weight, when left in the stall without food or water for 15 hours.

## FATTENING LAMBS IN WINTER.

THOMAS SHAW.

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Fattening sheep in the state of Minnesota in the winter season has hitherto been conducted after what may be termed wholesale methods. It has been confined almost exclusively to the dealer, and has been carried on in the neighborhood of towns and cities, and more especially in the vicinity of the stock yards at South St. Paul, the Minnesota Transfer and New Brighton. The sheep fed at these various places have come chiefly from the ranges, and in the past they have been more commonly finished on such foods as wheat screenings and hay, or wheat screenings, corn and hay. The industry has grown from year to year, so that now many thousands of sheep are thus fattened every season.

This industry should be fostered, and for several reasons. First, it leads to the retention for feeding uses of immense quantities of valuable foodstuffs that would otherwise flow over our borders to the eastward to be fed in other states and for the advantage of the people thereof. Vast quantities of fertilizing matter are thus made accessible to gardeners and farmers, and at a cost that is scarcely worth naming. The day is not far distant when these stores shall be valued at their true worth, and when it comes, the question will not be as it has been, who will draw them away as a gift, but who will be the first in the market to secure the prize. Second, it utilizes capital and gives employment to labor, results which should always prove helpful to the commonwealth. And third, the profits of the industry increase the wealth of the state, for profits must accrue from it or men would not continue to engage in it. It would be for the advantage of our state, therefore, if a double barrier could be erected all along our eastern border, the first to arrest

every unfinished sheep and lamb raised on the western ranges on the journey east, to be properly fattened in Minnesota; and the second, to arrest all the food grown west of us to be used in feeding them.

But there is another feature of the sheep industry in our state that should some day assume dimensions far greater than those of mere fattening at the stock yards, important as that work is. The reference is to rearing and fattening sheep on our farms. The range reared sheep can never be made to equal in quality sheep reared on arable farms where food supplies are uniform and constant. Sheep reared on our farms, therefore, if properly managed and well fattened, will always command superior prices in the market. Every farm in Minnesota should have a flock of sheep. And on many of these farms, sheep and lambs should be fattened with the return of every winter. Our climate and natural facilities for a successful sheep husbandry are of the best, and yet our flocks, according to the statistical returns for 1894, numbered only 346,832 head. There is ample room in our state for several millions of sheep, and without curtailing in any degree other lines of agriculture. It is very proper, therefore, that experiments should be conducted at the University Experiment Farm bearing upon this greatly important question.

The idea that sheep husbandry will not pay at the present time prevails to a regretful extent in all the West. This mistaken idea would seem to be rooted in the mind of the average farmer. It is based upon the mistaken view that primarily sheep should be grown for the wool which they produce. And as the price of wool is low there is therefore no money in sheep husbandry. This idea is pernicious in its tendencies, and that it is so must be made as clear as noon-day, otherwise sheep-husbandry will never stand upon a proper basis in this country. That view may have been correct, at one time doubtless it was, but it does not hold now. Lands that are distinctively wool producing are fit for but little else. To say therefore that this country so splendidly adapted to sheep husbandry was only adapted to wool production would be a libel on its capabilities. In all arable countries the world over on which sheep are kept, the mutton product is now the dominant aim in production, and any attempt to reverse this order where settlement be-

comes general must end in miserable failure. To combat the erroneous view therefore of the primary importance of the wool product in sheep husbandry should be one important aim in much of the experimental work carried on with reference to the sheep industry at the agricultural experiment stations of the West.

*Time Covered by the Experiment.*—The experiment in fattening lambs at our station the details of which are given below began on November 19th, 1894, and ended on March 15th, 1895, thus covering a period of 117 days. This is probably a longer period of feeding than would be proper where wheat and corn are given a prominent place in the grain factors fed.

*The Objects of the Experiment.*—The primary objects of the experiment include the following, viz: 1. To compare the respective systems of fattening lambs in yards and not under cover; of fattening them with liberty of access to sheds and yards all the while; and of fattening them under confinement in sheds. 2. To compare the method of feeding a limited and an unlimited grain ration respectively. 3. To ascertain the respective values of wheat and oil cake, and wheat screenings and oil cake, as grain factors in fattening lambs. And 4, to ascertain the profit, if any, from fattening lambs under conditions such as may be practiced upon the average farm in Minnesota.

Among the secondary objects were: 1. A knowledge of the comparative gains in live weight that would accrue without forced feeding; 2, a knowledge of the gains that would arise in the absence of field roots in the ration; and 3, a knowledge of the comparative gains made by wether and ewe lambs respectively.

*The Animals Selected.*—Forty lambs were used in the experiment, of which 30 were wethers and ten were ewes. Thirty of the number were purchased from Mr. W. D. O'Harman, Dundee, Nobles Co., Minn., and ten were purchased from Mr. David M. Fyffe, manager of "Wavertree farm" of the same place. They were Shropshire grades of good form and type. They had been dropped in March and April of the previous spring. When they reached University Farm, October 18th, 1894, they possessed an average weight of  $76\frac{1}{4}$  pounds.

And here it may be mentioned that no little difficulty was found in securing lambs suitable for feeding. In the first place sheep and lambs of any kind are not plentiful in the state, and in the second place, there is no denying it, the average quality of the lambs found on our farms is deplorably low. They lack form, size and quality, because they lack improved blood, and lacking these they are deficient in feeding qualities. Such lambs will not feed well nor will they bring top prices when they are fed. Because of these things fattening lambs in the state has been far less profitable than it would otherwise have been. Pure bred sires must be used before our lambs will be possessed of sufficient quality.

*Conditions Governing the Experiment.*—The lambs were divided into five lots, with eight animals in each lot, viz., six wethers and two ewes. Care was taken to divide them as evenly as possible as will be manifest by the referring to the weights as given further on. Those in lot 1 were kept outside all the while. They were enclosed in a yard on the sunny side of the piggery which was used as a shed to provide shelter for three of the lots, in the absence of a sheep shed. The piggery in turn was considerably sheltered from the winds on the north and west by the main barn and its extended wing. The shelter thus provided is about what would be equal to that of a grove or a high bluff, to the north and west. The lambs in lots 2, 3 and 4, were allowed liberty of access to yards all the while except in time of storms. The yards were kept clean, that is to say, they were so supplied with bedding when it was wanted, that the lambs could rest comfortably outside. And it is worthy of note that more commonly they rested outside day and night. But they were fed entirely indoors. Those in lot 5 were confined from the beginning to the close of the experiment in an apartment of the barn in dimensions  $12\frac{3}{4} \times 13\frac{3}{4}$  ft. and with a ceiling  $8\frac{1}{2}$  ft. from the floor. One large window faced the east, and ventilation was provided by letting down the window from the top. This of course is not the best way of ventilating, but it was the best that could be adopted under the circumstances without going to overmuch expense.

The lambs were weighed singly at the commencement of the experiment, and each lamb was weighed singly every week

thereafter. A careful record was kept of the weights. All the food fed was accurately weighed. They were given free access to salt and were supplied daily with water.

*Food and Feeding.*—The grain food given to the lambs in lots 1, 2, 3 and 5 consisted of wheat screenings and oilcake. These were given in the proportions of 9 and 1 parts respectively by weight. The screenings were under rather than over the average in quality having but little wheat of any kind in them. The oilcake was fed more as a regulator of digestion in the absence of field roots than with a view to fat-production. The lambs in lots 1, 3 and 5 were fed as much of this mixture as they would eat up cleanly at each time of feeding, but no more. Those in lot 2 were fed the grain in a self-feeder, and therefore they had access to it at will. Lot 4 were given wheat and oilcake in the proportions of 9 and 1 parts respectively, and they were only given what they would consume at each meal. As much hay was given to the lambs in the several lots as they would eat without waste. It consisted of clover and timothy, but there was not much timothy in it. The quality was very fair. The food was given in two feeds daily, viz.: morning and evening.

*Estimated Value of the Food.*—The food was estimated at the average market values in the state. The valuation was essentially based on estimates obtained from various leading farmers in the state in response to questions submitted to them by Professor Hays early in 1895. These estimates were averaged when received. They gave the following market values virtually for the foods used in the experiment, viz.: hay, \$6.00 per ton; wheat, 47.6 cents per bushel; wheat screenings, \$9.00 per ton; and oilcake, \$26.00 per ton.

But as stated in the portion of the Bulletin which relates to feeding steers; the farmer should not charge more than the home value for the food fed. The home value is the market value less the cost of marketing, and it will be a variable quantity, owing to the differences in the location of farms with reference to the markets, and differences in the actual cost of marketing various commodities from the same farm.

*Food Consumed.*—The preparatory experiment commenced October 29th, 11 days after the arrival of the lambs, and it continued until November 19th, when the experiment proper

began. During the intervening days from the arrival of the lambs until the preparatory experiment commenced they were kept on pasture, and had also a small quantity of other food, of which the estimated value is \$3.00.

Table XLVII gives the respective amounts of food consumed by the lambs during the preparatory period:

TABLE XLVII.—Food Consumed During the Preparatory Experiment.

	Hay.	Screenings.	Wheat.	Oilcake.
	lbs.	lbs.	lbs.	lbs.
Lot 1.....	142	172	.....	19
Lot 2.....	126	335	.....	37
Lot 3.....	127	216	.....	24
Lot 4.....	126	.....	192	21
Lot 5.....	123	186	.....	21
Total... ..	644	909	192	122

The experiment proper as heretofore stated covered a period of 117 days. It thus covered a period of more than 16 weeks or very nearly four months of 30 days each. It was divided into periods of four weeks each that a comparison of weights could be made at the end of each 28 days.

Table XLVIII gives the respective amounts of food consumed by each lot of lambs during the experiment.

TABLE XLVIII.—Food Consumed During the Experiment.

	November 19th to December 16th.			December 17th to January 13th.			January 14th to February 10th.			February 11th to March 10th.			March 11th to March 15th.			Total.		
	Hay.....	Screenings...	Oil cake.....	Hay.....	Screenings...	Oil cake.....	Hay.....	Screenings...	Oil cake.....	Hay.....	Screenings...	Oil cake.....	Hay.....	Screenings...	Oil cake.....	Hay.....	Screenings...	Oil cake.....
Lot 1	lbs. 223	lbs. 499	lbs. 55	lbs. 232	lbs. 447	lbs. 50	lbs. 177½	lbs. 563	lbs. 83	lbs. 167	lbs. 542	lbs. 60	lbs. 31	lbs. 59	lbs. 7	lbs. 830½	lbs. 1,707	lbs. 235
Lot 2..	167	569	63	123	655	73	58	746	83	67	679	75	17	72	8	482	2,721	302
Lot 3..	220	392	44	194	462	51	155	570	63	154	509	56	30	70	8	753	2,003	222
Lot 4..	217	375	42	190	361	42	168	401	45	167	357	40	30	63	7	772	1,577	176
Lot 5.	195	385	43	192	436	49	168	519	56	167	507	56	30	71	8	752	1,918	212

It will be observed that as the season of feeding progressed, there was a tendency to consume less hay and more grain. This tendency was not marked in the lambs in lot 2, which were given the grain in a self-feeder. The only instance in which there was a decrease in the consumption of grain in the last period as compared with the first was that furnished by lot 4, to which the wheat and oil cake were fed. The appetite of these failed somewhat under so strong a food.

Table XLVIX. gives the total amount of each kind of food consumed by the lambs in the several lots, and also the total consumption of food by each lot.

TABLE XLVIX.—Summary of Food Consumed.

	Hay.	Screenings.	Wheat.	Oil Cake.	Total Food Consumed.
	lbs.	lbs.	lbs.	lbs.	lbs.
Lot 1 .....	830½	1,707	.....	235	2,772½
Lot 2 .....	432	2,721	.....	302	3,455
Lot 3 .....	753	2,003	.....	222	2,978
Lot 4 .....	772	.....	1,577	176	2,525
Lot 5 .....	752	1,918	.....	212	2,882
Total .....	3,539½	8,349	1,577	1,147	14,612½

The lambs in lot 2 which were given the unlimited grain portion consumed the most food of all the lots to which screenings were fed, and those without shelter consumed the least. The results in both instances are unlooked for, and should, therefore, be followed up by further experimentation in the same line.

*Cost of Food Consumed.*—Table L. gives the cost of food consumed in the experiment proper and also in the preparatory experiment:

TABLE L.—Cost of Food Consumed.

	Cost of food consumed preparatory to experiment.	Cost of food consumed during experiment.	Total cost of food consumed.
Lot 1 .....	\$1.46	\$14.08	\$15.54
Lot 2 .....	1.94	17.47	19.41
Lot 3 .....	1.87	14.16	15.83
Lot 4 .....	2.17	18.02	20.19
Lot 5 .....	1.48	13.64	15.12

The total cost of food was greatest with the lambs in lot 4. This was owing to the greater relative cost of the food consumed. And it was least with the lambs in lot 5, which were subjected to confinement. It was considerably more with the lambs in lot 2, which were given an unlimited grain portion than with those of any of the other lots similarly fed.

*Weights of the Lambs.*—The lambs were weighed singly when they reached the Station, that is to say, when the preparatory experiment began. An ear label was put in the ear of each and these were duly recorded. They were subsequently weighed weekly until the close of the experiment. It was thus possible to trace the progress made by each lamb throughout the experiment. And here it may be proper to mention that while there was a marked difference in the gains made by individual lambs, there were no instances of marked ill-doing. The lambs were all hearty from the first to the last.

Table LI. gives the respective weights of the lambs in each lot at the beginning of the experiment proper, at the close of each period of the same and at the final close of the experiment:

TABLE LI.—Weights of the Lambs.

	November 16th.....	December 18th.....	January 15th.....	February 12th.....	March 11th.	March 16th.	Gain.....
Lot 1.....	lbs. 638	lbs. 741½	lbs. 777	lbs. 845½	lbs. 914	lbs. 900½	lbs. 262½
Lot 2.....	671	765¾	821	921	1,003½	1,004	333
Lot 3.....	624	713½	777¾	844	926½	924	300
Lot 4.....	636	735¾	822	895¾	919¾	914	278
Lot 5.....	621	672½	727¾	806¾	869	886½	265½

Table LII. gives the total increase in weight made by the lambs in each lot during each period of the experiment proper, and during the whole of the experiment, and also the total gains made by all the lots during each period of the same:

TABLE LII.—Gains Made During the Experiment.

	November 19th. to December 18th. ....	December 18th. to January 15th. ....	January 15th. to February 12th. ....	February 12th. to March 16th. ....	Total Gain.
Lot 1 .....	lbs. 103½	lbs. 35½	lbs. 68½	lbs. 54½	lbs. 262½
Lot 2 .....	94½	58½	97	83	333
Lot 3 .....	89½	64½	66½	80	300
Lot 4 .....	99½	86½	76½	15½	278
Lot 5 .....	51½	55½	79	79½	265½
Total.....	438½	299½	387½	312½	1,439

A careful examination of the facts given in the above table will lead to the following conclusions, viz:—First, the greatest total increase in weight was made by the lambs to which the unlimited grain food was given, but as will be shown below the greatest profit was not obtained from these. Second, the least total increase in weight was made by the lambs which had no shelter. In keeping with this fact is the further fact that except with the lambs that were housed there was a marked decrease in the gains made by the lambs in each lot during the second period when the weather was extremely cold as compared with the first period when it was mild. Notwithstanding that the total increase in weight during the second period was 299½ pounds as against 438½ pounds during the first period there was a greater consumption of food during the second period. And in the same line is the further fact, that during the first period the lowest gains were made by the sheep in lot 1 which had no shelter; and the only lot which made any advance in weight during the second period as compared with the first was lot 5 under shelter. These facts would tend to show that even sheep with their warm covering of wool consume much food when unprotected in extremely cold weather in simply keeping up the animal heat. And third, there was a relative decrease in the gains made by the lambs to which wheat was fed during each successive period and this decrease was much more marked than the decrease in the consumption of the food. This would tend to show that wheat as a grain

food for sheep is not well adapted to long periods of feeding when fed in large quantities. The total increase in the weight of the lambs in this lot during the first period was considerably greater than during any subsequent period, and during the fourth and last period the gains were relatively and absolutely very low. During that period extending from February 11th to March 15th, covering 32 days, every pound of increase in weight cost nearly 23.17 cents in food to make it. During the first period the cost of making one pound of increase with the same lambs was but 4.17 cents. In this fact we have another illustration of the importance of marketing animals promptly as soon as they cease to make good gains.

*Results on the Unit Basis.*—These results are stated thus, for greater clearness and simplicity. Table LIII. gives the amounts of hay, screenings, wheat and oil cake consumed by the lambs in the respective lots per day, and also the total daily consumption of food by each lamb:

TABLE LIII.—Daily Consumption of Food.

	Hay.	Screenings.	Wheat.	Oil cake.	Total food.
	lbs.	lbs.	lbs.	lbs.	lbs.
Lot 1.....	.887	1.824	.....	.251	2.962
Lot 2.....	.462	2.907	.....	.322	3.691
Lot 3.....	.905	2.140	.....	.237	3.182
Lot 4.....	.825	.....	1.684	.188	2.697
Lot 5.....	.803	2.049	.....	.226	3.087

The total average daily consumption of food by each lamb in the experiment was 3.123 pounds, or very little more than 3 pounds per day. These amounts are very moderate indeed in a climate of low winter temperatures. The information thus given may be used as an approximate guide to feeders when laying in their food supplies.

The average daily gain per day by one lamb in each lot was as follows:

Lot 1 .....	.280 pounds.
Lot 2 .....	.356 "
Lot 3 .....	.321 "
Lot 4 .....	.297 "
Lot 5 .....	.284 "

The average daily gain made by each lamb in the experiment was .291 pounds or practically nearly  $\frac{1}{3}$  pounds.

The average monthly increase in live weight made by each lamb during the experiment proper was as given below:

Lot 1 .....	8.41 pounds.
Lot 2 .....	10.67 "
Lot 3 .....	9.61 "
Lot 4 .....	8.91 "
Lot 5 .....	8.51 "

Average..... 9.22 pounds.

These gains are certainly very satisfactory when it is borne in mind that no succulent food was used in the experiment. They certainly emphasize the marked adaptability of our climate to fattening lambs in the winter.

The average cost of making each pound of increase in live weight in the respective lots was as follows:

Lot 1 .....	5.36 cents.
Lot 2 .....	5.25 "
Lot 3 .....	4.71 "
Lot 4 .....	6.48 "
Lot 5 .....	5.41 "

Average for all the lots..... 5.44 "

These results are not a little remarkable. As the lambs were sold in Chicago for 6 cents per pound live weight, every pound of increase made during the experiment was worth more than it cost to make it except with the lambs in lot 4, which were fed wheat and oilcake as the grain ration. And this is true when the cost of transportation is deducted. With lambs as with cattle it seldom happens that a pound of gain is made during the finishing period, which is of equal value with the food used in making it. The profit more commonly arises wholly from the advance in price on each pound of the live weight possessed by the animal at the commencement of the finishing process.

*Financial Results.*—A summary of the facts relating to the financial side of the whole transaction is given below:

Cash return for 40 lambs sold in Chicago, March 18th, 1895, weight 4,490 lbs. at 6 cents per pound.....	\$269.40
Cash paid for 40 lambs at Dundee, Minn., October 16th, 1894, 3,165 lbs. at 4 cents per pound	\$126.60
Proportion of freight from Dundee to Minnesota Transfer.....	11.09
Cost of food prior to the preparatory experiment.....	3.00
Cost of food during the experiment.....	86.09
Proportion of freight from the Experiment Station to Chicago.....	13.33
Grain and hay in transit.....	2.40
Commissions in Chicago.....	2.10
Total cash outlay.....	\$244.61
Net cash profit on 40 lambs.....	24.79
Net cash profit on 1 lamb.....	62 cents.

These figures represent a very substantial profit. In feeding 100 lambs they represent a profit of \$62.00, and in feeding 1,000 lambs a profit of \$620.00.

And in securing this profit let it be borne in mind that the food was charged at market values. Reference has already been made to the fact that the market value of food is greater than the home value. When the farmer feeds animals upon home grown food, the same should be charged at home values. The difference between the home value of the food and the market value varies with the locality, hence each farmer who feeds will have to estimate this difference for himself. But suppose that it represents 10 per cent., which is certainly a moderate estimate, and the food in the present experiment had been so charged, then the profit on each lamb would have been 83½ cents instead of 62 cents.

As in the experiment in feeding steers, the labor of feeding, the interest of the money paid for the lambs, the food and the feeding plant, are not reckoned. Even on a western farm it is the opinion of many good judges that the value of the manure will at least offset the items named. On eastern farms the manure is considered worth considerably more than the value of these items. But of this, in the present state of our agriculture,

every person must be his own judge. Whatever the difference of opinion that may be held as to that question, with reference to the following there will surely be agreement, viz: that if a Minnesota farmer can raise lambs on his farm and sell them in Chicago when eleven or twelve months old at an average cash price of \$6.73½, that he is engaged in what ought to prove to him a remunerative industry. And that the same is true of the farmer who can get an average of \$3.16½ for lambs at home when they are about 7 months old.

*General Explanations*—1. The lambs were shipped from Dundee to the Minnesota Transfer in a car which brought other live stock to the station. The charges on the car were \$34.20, and of this a due proportion, viz., \$11.09 was charged against the lambs.

2. They were sent to Chicago in a car along with other lambs which were being shipped from New Brighton by E. M. Prouty & Co., of the South St. Paul stock yards, and were also sold for the Station by the said firm. The due ratio of the expense was charged against the lambs, viz., \$17.83.

3. The weights of the lambs when bought, when they reached the farm, when shipped for sale and when sold in Chicago were as follows:—

	Aggregate Weights. lbs.	Average Weight. lbs.
On leaving Dundee, October 16th . . . .	3,165	79½
On reaching the Farm, October 18th,	3,050	76⅔
Shrinkage in weight . . . . .	115	2¼
When shipped, March 16th . . . . .	4,629	115¼
When marketed, March 18th . . . . .	4,490	112¼
Shrinkage in weight . . . . .	139	3¼

In each instance the figures are supposed to represent shrunk weights. There was a loss therefore of 115 pounds in live weight in the transit from Dundee to the Experiment Station. This, at 4 cents per pound, the price paid for the lambs, represents \$4.60. It is charged against the experiment. But had the lambs been fattened by a farmer at Dundee and shipped directly to Chicago, there are good reasons for believing that the shrinkage in transit would have been less than it

proved to be in the dual shipments. Under no conditions probably can lambs be fattened and marketed with less expense and more profit, than on the farms on which they are raised, for every time they are moved, such movement means loss in weight and for a time hindrance in development.

4. The price received for the lambs in Chicago, viz: 6 cents per pound, was the highest price paid in that market for months previously. They were fed by a student, Geo. Craig by name, while engaged in taking his second year studies at the school of agriculture.

### CONCLUSIONS.

The following are the more important of the conclusions to which the experiment leads:--

1. That lambs possessed of sufficient quality for winter feeding are not plentiful in the state, since no little searching had to be made before suitable feeders could be found.

2. That with the rations used, lambs that are being fattened in winter consume about three pounds of food per day, for every 100 pounds of live weight.

3. That the average gains made by the lambs in this experiment was 9.22 pounds per month, and without any succulent food, as for instance ensilage or field roots.

4. That in this experiment, the average cost of making one pound of increase in live weight was 5.44 cents or less than the cost of producing it, a result which is not seldom attained in winter fattening.

5. That lambs do not gain so rapidly in cold weather as when the temperature is moderate, notwithstanding the greater consumption of food.

6. That in this experiment the greatest profit was obtained from the lambs which were fed a limited grain ration of wheat screenings and oil cake, and which were allowed liberty of access to shelter at will; that next to these come the lambs fed under cover; and that the least profit arose from the lambs to which wheat and oil cake were fed.

7. That since the cost of one pound of increase in live weight with the lambs which were fed wheat and oilcake was

but 4.17 cents during the first period of feeding, as against 23.17 cents during the last period, prompt marketing as soon as good gains cease to be made is greatly important.

8. That since the lambs in lot 4 fed well and gained rapidly during the first periods of the experiment, and since they fed indifferently and gained but little during the last period of the same, a grain portion of wheat and oilcake though well adapted to short periods of feeding, is not well adapted to prolonged periods of the same.

9. That wheat screenings and oilcake is a more suitable grain food than wheat and oilcake for lengthened periods of feeding.

10. That any one of the methods adopted in fattening lambs may be expected to succeed at least fairly well, when due attention is given to the work.

11. That in this experiment the value of the lambs more than doubled during the period of feeding; since they were bought at an average price of \$3.16½ per animal and sold for an average price of \$6.73½.