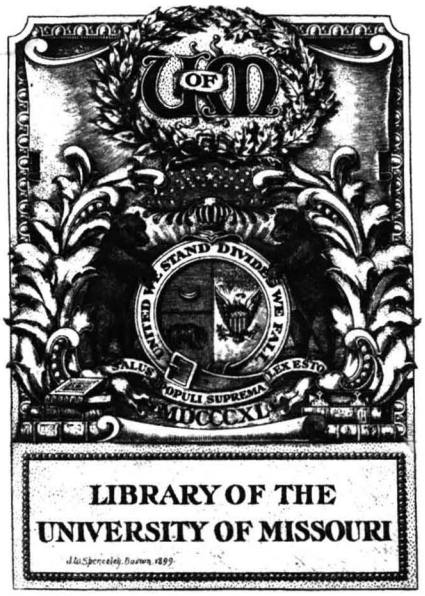

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THE BEST WINTER RATION FOR THE DAIRY HEIFER

by

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THE BEST WINTER RATION FOR THE DAIRY HEIFER.

INTRODUCTION.

The census figures show there are approximately twenty million dairy cows being milked in the United States. This number has been increasing, and today dairying is considered the leading animal industry.

This increasing demand for dairy cows, and cows of greater efficiency has led to a more systematized rearing of the dairy heifer by the average farmer and breeder of dairy animals.

The need of a winter ration, or series of rations, considering the economic price and amount of food consumed, between the weaning and mature stage, is showing itself more clearly now than heretofore.

Experiments previously carried on give the relative amounts of feed consumed for the calf before weaning time and for the mature cow. Very

few, however, have spanned the space which lies between these two points, viz; the amount used by the heifer from the time she is put on dry feed until maturity.

In treating this subject the practical side as far as possible is only to be dealt with. The cost being taken up as a secondary consideration.

REVIEW OF LITERATURE.

The experimental data on the feeding of growing animals on dry feed is very meagre indeed. Most of the experiments conducted with growing animals after the weaning stage has been with steers. The feeding records for the steers cannot be taken for the dairy heifer, for generally steers are pushed for fattening purposes, but they will help in giving a relative bearing as to the amount of protein and energy used by the dairy heifer.

Review of Feeding Standards on Growing Cattle -- In the study we find no feeding standard that is universally used as a guide to follow in the feeding of growing cattle.

Armsby[1] of the Pennsylvania State College gives the following table. The protein is amide free protein. The therms are heat units equivalent to 1,000 calories.

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1. Farmers Bul. 346, U.S. Dept. Agr.

Estimated Requirements Including Maintenance Per Day and Per Head For Growing Cattle.

Age Months	Live Weight Pounds	Digestible Protein Pounds	Energy Value Therms
3	275	1.10	5.0
6	425	1.30	6.0
12	650	1.65	7.0
18	850	1.70	7.5
24	1000	1.75	8.0
30	1100	1.65	8.0

The author states in his work that the weight of the animal rather than the age should be considered in using the standard. It will be noticed that as the age of the animal advances, up to the time of maturity, the protein increases. The older the animal, however, the more constant becomes the protein requirement. After maturity the protein requirement, for maintenance, becomes fairly constant.

The Wolff-Lehman feeding standards giving the nutrients set forth for growing cattle is as follows[1]:

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1. Henry, Feeds and Feeding, 1912 Edition, p. 592.

Growing Cattle : Dairy Breeds : Per day per 1,000 pounds live weight						
Age :	Weight :	Dry :	Digestible Nutrients			
Months:	Pounds :	Matter :	Prot. :	Carbo. :	E.Ext. :	Nut. Ratio
2-3 :	150 :	23 :	4.0 :	13.0 :	2.0 :	1:4.5
3-6 :	300 :	24 :	3.0 :	12.8 :	1.0 :	1:5.1
6-12:	500 :	27 :	2.0 :	12.5 :	0.5 :	1:6.8
12-18:	700 :	26 :	1.8 :	12.5 :	0.4 :	1:7.5
18-24:	900 :	26 :	1.5 :	12.0 :	0.3 :	1:8.5

Experiment Station Results -- P. N. Flint conducted an experiment to determine the protein and nutriment requirements for growing dairy animals under one year of age. Considerable data from various experiment stations tend to show the protein requirements of the Wolff-Lehmann Standard to be in excess for mature cattle. This experiment was conducted to ascertain whether this was true of growing cattle.

Twenty-three animals were used in this experiment, all had Jersey blood predominating with the exception of two.

There were three lots of animals in the experiment fed as follows:-

Lot 1. Twenty-five per cent less protein than is prescribed by the Wolff-Lehmann Standard.

Lot 3. Twenty-five per cent more protein than is prescribed by the Wolff-Lehman standard.

Lot 2. Was to receive the exact amount of protein that is prescribed by the Wolff-Lehmann standard.

Lot 1. Consuming corn meal and oat straw, had the greatest portion of carbohydrates.

Lot 3. Consuming linseed meal and alfalfa hay had the greatest portion of protein feed.

Lot 2. Consumed a greater portion of protein feed than Lot 1, but a smaller portion than Lot 3. Lot 2 consumed a smaller portion of the carbohydrate feed than Lot 1, but a greater portion than Lot 3.

The average daily quantity of digestible protein consumed per lot stands in the same order as the average gain in weight per lot. Lot 1 consumed an average of 0.48 pounds of digestible protein daily; Lot 2, 0.6 pounds and Lot 3, 0.8 pounds. Lot 1 made an average gain per animal in 88 days of 69.4 pounds. However, there was a difference of but three pounds per animal between the gains of Lot 1 and Lot 2. The following table shows there is but very little difference in the energy content of the ration of the three lots.

Daily Average for Lots and Average Per 1,000 Pounds

Lot		Dry Matter: Lbs.	Digestible Protein Lbs.	Energy Value Therms:	Average Weight Lbs.	Gain 88 Da: Lbs.:
1	Average-	4.80:	0.48	3.22:	223.5:	69.4:
	Av. per 1000 lbs.:	21.47:	2.15	14.40:	:	:
2	Average-	4.56:	0.60	3.12:	198.9:	72.4:
	Av. per 1000 lbs.:	22.92:	3.02	15.69:	:	:
3	Average-	5.37:	0.80	3.40:	216.1::	98.4:
	Av. per 1000 lbs.:	24.66:	3.70	15.73:	:	:

The ration of Lot 3 conformed more nearly to the feeding standard in respect to the digestible protein than either of the other lots. This lot also made the greatest gains.

"However, since the digestible carbohydrates and fats were lower than prescribed by the feeding standard not only in the case of lot three, but in the case of the other lots as well, it would be erroneous to conclude from the data presented that the Wolff-Lehmann feeding standards do not prescribe too great an amount of protein, because had more carbohydrates been consumed it is probable that a greater gain would have been made on less digestible protein. Also judging by the varia-

tions in gains by individuals of the different lots it would be necessary, before true comparison could be made, to feed a larger number of animals in order to eliminate the factor of individuality. These results bring out the fact that no single feeding standard can be devised which will prescribe an amount of digestible food nutrients to meet the exact requirements of all animals."

Jordan[1] of the Maine Experiment Station reports an experiment with growing beef steers beginning with calves and feeding to maturity. The object of the test was to determine the influence of a ration high in protein and one relatively low in protein on the rate of growth and character of flesh produced.

Four shorthorn calves were selected for the test ranging in age from 5 to 7 months. The calves were divided into two lots. The roughage for the four steers was the same, the difference being in the grain received, making the ration either high or low in its protein content. The roughage consisted mostly of timothy hay, some fodder, and corn fodder being fed during the winter

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1. Rpt. Maine Exp. Sta., 1895, p. 64.

months only. The concentrates, the mixtures being by weight, were as follows:

Lot 1. - High Protein.

Bran - 1 part.

Linseed meal - 2 parts.

Corn meal - 1 part.

Lot 2. - Low Protein.

Corn meal - 2 parts

Bran - 1 part.

In this trial no attempt was made to force the steers to rapid growth, the aim being to keep them steadily gaining. At the end of 17 months, two steers were slaughtered, the other two were carried on until 27 months of age. Up to 17 months of age the steers getting the high protein ration made the better gains, weighing 174 pounds more than the low protein lot. They also looked better and showed more thrift at all times. During the latter 10 months, the growth conditions were reversed, the steers receiving the low protein ration made better gains than the one on high protein ration, weighing 43 pounds more at the end of the experiment.

When the calves were building up flesh and bone the high protein ration was much more effective than the other. From the beginning to the end of 15 months feeding, 5.11 pounds of digestible nutrients in the high protein ration proved as effective as 6.16 pounds in the protein poor ration.

During the latter 10 months of feeding with two steers it required 7.73 pounds of digestible nutrients for the high protein steer against 7.08 pounds for the lower animal for one pound of gain. While the high protein ration was more effective during the growing stages, the one with less protein but more carbohydrates proved the most efficient by the end of the 27 months of feeding.

Jordan concludes from this experiment, "that rations high in protein were more favorable to rapid growth and finer general appearance of animals when young than rations high in carbohydrates and low in protein." It appears that when the protein poor ration contains enough nitrogen and ash to supply the actual demands of the body, the animal carefully conserves them, being enabled thereby to fulfill the laws of nature as to growth.

No doubt if the steers getting the least protein and ash had been supplied with less protein and ash than nature requires for good body building, they would have plainly shown it by an abnormal development. Fortunately, however, such conditions were not laid down in this experiment."

The Utah Experiment Station[1] conducted an experiment on the cost of raising calves to two years of age. The animals were of the Shorthorn, Guernsey, and Holstein breeds. The results are given in cost for feed of the immediate locality, and are, therefore, of very little importance.

Skinner and Cochel[2] on a winter steer feeding experiment found that a greater gain was made with a ration of shelled corn and clover hay than when corn silage was added to this ration. A smaller amount of grain was consumed in the lot receiving silage as to the lot consuming silage as compared to the lot without corn silage.

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

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1. Utah Exp. Sta., Bul. No. 101, p. 194.
2. Indiana Exp. Station Bul. No. 129.

greater profit per steer. "The results of three experiments indicate that corn silage may profitably be used as a portion of a ration in finishing steers."

Corn silage when added to a ration of shelled corn and clover hay, had a feeding value of $2.50 per ton in the winter of 1906-7, and of $4.02 in the winter of 1907-8. When added to a ration of shelled corn, cottonseed meal and clover hay, it had a feeding value of $6.01 per ton.

In running a second experiment[1] on winter feed for steers the most efficient ration was one of shelled corn, cottonseed meal and corn silage, as was shown by the rate of gain and the finish of the cattle. The larger gains of the steers and their better condition was attributed to the addition of corn silage to the ration. When corn silage was added to the ration the grain consumed was less than when there was no silage added.

At Kansas[2] there were experiments run to determine the growth of young stock. The object of the experiment was to ascertain the average growth and gains for food consumed under ordinary

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1. Indiana Exp. Sta., Bul. No. 136.
2. Kansas Exp. Sta., Bul. No. 72.

farm management. These heifers were treated in all respects as all the stock had been in previous years.

The grain mixture consisted of 1/8 corn meal, 2/8 bran, 5/8 corn meal, by weight. The silage was made from corn. The hay was fair quality of prairie hay. The soy bean hay was cut and cured when the bean in the pod was about half mature, and was saved in good condition. The alfalfa hay was of fair quality.

Average Daily Ration and Food Consumed Per Pound of Gain.

Shorthorn Heifers

No.	Av. Daily Gain	Average daily ration. Grain Lbs.	Silage Lbs.	Soybean hay Lbs.	Consumed per lb. gain Grain Lbs:	Silage Lbs:	Soybean Hay Lbs.
118	.92	3.0	15.50	3.14	1.56	8.07	1.64
119	.62	3.0	15.19	2.82	1.85	9.38	1.74
121	1.24	3.0		3.20	2.46		2.46

These heifers were on their ration between February 1, and April 26.

Four Jersey heifers, all beginning their ration on November 30, were kept on this winter ration until April 26, with but one exception; No. 7 was run until April 19. The feeds in the following table is given in pounds.

Average Daily Ration and Food Consumed Per Pound of Gain.

No.	Av. Daily Gain	Average daily ration: Grain Lbs.	Hay Lbs.	Consumed per lb. gain: Grain Lbs.	Mangels Lbs.	Hay Lbs.
4	1.33	6.13	6.67	4.60	3.22	5.0
5	1.15	6.15	5.02	5.34	3.74	4.3
6	1.27	6.15	5.80	4.83	3.38	4.56
7	1.09	5.55	4.30	5.08	4.00	3.93

The ration fed these heifers consisted partly of mangels for the first five weeks only. The amount of food consumed per pound of gain was calculated at this time.

Following is a table which was worked out using Armsby's feeding standard, of the heifers that have just been noted.

No.	Days in Feed	Weight Lbs.	Gain Lbs.	Average per Da. Protein Lbs.	Average per Da. Therms	Av. per lb. Gain Protein Lbs.	Av. per lb. Gain Therms
			Shorthorns				
118	63	409	121	.736	6.16	.384	3.18
119	63	381	102	.708	5.93	.437	3.66
121	65	400	106	.553	3.56	.449	2.89
			Jerseys				
4	147	505	196	.700	6.02	.530	4.66
5	147	490	169	.683	5.69	.599	5.02
6	147	490	187	.691	5.85	.539	4.71
7	140	447	153	.616	5.12	.570	4.87

In the calculation of this table timothy hay was substituted for prairie hay as there is but little difference in the protein content or therm value.

It will be seen by this table that the therm energy, according to weight, is fairly constant; that the Shorthorn heifers used their feed to better advantage in making a pound of gain than did the Jersey heifers; this making the most striking difference shown in the table.

The Nebraska Experiment Station[1] conduct-

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1. Nebraska Exp. Sta., Bul. No. 85.

ed an experiment of feeding hay with and without grain to calves. This experiment would indicate that the cost of producing gains in calves during winter is least when considerable grain is fed along with hay. The results of the preceeding winter were more favorable for grain feeding from the standpoint of economy in production. For the entire year, with no grain during the summer while on grass, the results would go to show that a moderate grain ration in winter, not more than 1/3 full feed, along with hay is most economical.

Calves that have been full grain fed during the winter are sure to loose part of their grain flesh when placed on green grass without grain. On the other hand, wintering without grain of any kind and allowing calves to run down in flesh and loose weight and vitality is not economical. A small grain addition to hay or stalks or both keeps the digestive tract in better condition and produces enough better gains to pay a good price for the grain fed. The grain does not keep young stock from eating roughage.

The cost of wintering heifers[1] was carried on with four lots of heifers, two in each lot,

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1. New Hampshire Exp. Sta., Bul. No. 129.

also to compare different rations. Lot 1 received bran, corn meal and linseed meal; Lot 2 received bran, corn meal and gluten meal; Lot 3 received bran, corn meal and cottonseed meal; Lot 4 received bran and corn meal. Each lot received hay and ensilage for roughage. During the five and one-half months of the experiment the cost of keeping was, $19.28 for Lot 1; $20.86 for Lot 2; $20.95 for Lot 3; and $20.46 for Lot 4. Aside from the cost of keeping Lot 1, which received linseed meal, came out of the experiment in the best condition. This lot was followed by Lots 3, 4, and 2 respectively.

W. H. Tomhave[1] and B. O. Steverson run experiments on two lots of 12 steers, each weighing approximately 900 pounds. They were fed during 140 days as follows:- The steers in Lot 1 received all the corn silage they would consume during the first two months of the feeding period, together with 3 pounds of cottonseed meal per 1000 pounds live weight daily. At the end of 56 days they were fed in addition to this all the ear corn they would consume, this being replaced during the last two months

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1. Penn. Sta., Bul. No. 124, pp. 23-39.

by shelled corn. Lot 2 received as roughage 20 pounds of corn silage per day per head and all the mixed hay they would consume during the first 56 days, together with 3 pounds of cottonseed meal per 1000 pounds of live weight daily. During the remainder of the period they were fed shelled corn as was Lot 1.

The average daily gains of Lot 1 per head was 1.94 pounds; for Lot 2, 1.80 pounds. The respective cost per pound of gain was 08.31 and.09.46 cents. The profit per steer was $14.10 and $11.22 respectively for Lots 1 and 2.

It is concluded that the feeding of silage alone as a roughage is the most satisfactory of the two methods of feeding. This experiment bears out the results of previous tests. Because of the palatability of corn silage the advisability of limiting the amount of silage in the ration in order to insure the greatest gains in flesh during the finishing periods was demonstrated.

H. M. Cottrell[1] conducted feeding experiments to determine the feeding value of alfalfa. The heifers were fed on alfalfa hay only, without any grain whatsoever, from September 2 to April 4 -

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1. Kansas Exp. Sta., Bul. 114.

214 days - and made an average gain of 1.2 pounds daily per head. The largest and best gains was secured when 23 pounds of hay was fed daily to heifers of two and three years of age. This experiment shows that alfalfa hay furnishes a maintenance ration thru the winter months, and, in addition, a gain of 104 pounds for each ton fed. These heifers were treated in every way as are most of the cattle with ordinary farm conditions.

J. M. Truman[1] reports on the cost of feeding heifers to two years of age. In this experiment five heifers were used, taking them at birth and calculating the cost of feed and amount of feed used during the first two years. Two Jerseys, one Guernsey and two Holsteins were used. During the spring and summer months the heifers were turned to pasture, making it impracticable to calculate the nutrients used during these periods. During the winter months while receiving grain and hay, the nutrients can be calculated with reasonable accuracy. The nutrients received and the growth made during the two six month periods while on hay and grain has been calculated. During the second and

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1. Storrs Exp. Sta., Bul. No. 63.

fourth periods the animals were kept on pasture.

First Period - Six Months.

Breed	Av. Wt.	Per pound of growth: Protein	Therms	Av. Daily Gain	Av. cost for Period
				Lbs.	
Guernsey: Jersey	155	.59	2.20	1.15	$16.13
Holstein:	239	.33	1.52	1.64	$18.21

Third Period - Six Months.

Guernsey: Jersey	441	.96	5.95	.84	$19.36
Holstein:	566	.87	5.76	.95	$21.76

A careful consideration of the literature indicates clearly that as the animal grows older, a pound of growth including maintenance requires more nutrients.

In the foregoing tables it will be seen that a pound of gain with the Holstein group is made with less therm value in both the first and third periods. It will also be noticed that the cost of feeding the Holstein group is greater, this however, would readily be expected from the greater weight of the Holsteins.

Caine[1] in running an experiment on heifers

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1. A. B. Caine, Thesis Univ. of Mo., 1914.

fed silage and clover hay has sumed up his results as follows:- "The two groups of heifers receiving silage and clover hay show some little variation in the amount of nutrients received as well as a difference in the size of the animal. The clover group received slightly more protein and energy than the silage group but the gain in growth on the average is but very little better. They apparently did not utilize their feed as well as the silage group. The silage fed heifers seemingly needed dry roughage because their protein is practically the same as the clover group and is nearly sufficient for normal gains but the heifers appeared thin. The gains made by the clover group were much steadier than the silage group. The latter showed wide variations from one period to another. The first few months the animals were on the experiment, it was hard to detect any difference in the two groups but the longer the feeding continued, the difference became more apparent. The animals on silage looked much thinner and did not shed well while the clover group were comparatively fat and sleek. The heifers were all very active and showed very little difference in respect to vigor. It does not appear that

the animals on silage were hurt at all and it seems probable that a few months on grass would put them in good condition. These animals when turned on pasture in May looked better than heifers with average farm conditions.

The amount of protein per pound of growth was about the same with the two groups. The clover group required more energy per pound of gain. Had the silage group been able to consume enough to get the same amount of energy as the clover group, the results would undoubtedly have been similar in every respect.

The animals were all apparently low in their protein intake. However, being on a short period and having a surplus of protein stored in their body, the heifers grew fairly well."

The three heifers on the silage ration had an average weight of 509 pounds. They consumed 2 pounds of grain (corn) and 18.8 pounds of silage, with .58 pounds of protein and 4.83 therms of energy as the daily average for the 158 days. The three heifers on the clover ration had an average weight of 499 pounds. They consumed 3 pounds

of grain (corn) and 8.8 pounds of clover hay, with .47 pounds of protein and 5.72 therms of energy, daily average for the 158 days.

P. M. Brandt[1] gives a discussion of light and heavy fed heifers in running an experiment to determine the nutrients required for growth by the growing dairy animal. In this experiment the light fed group, four Jerseys, four Holsteins, and one Ayrshire, was fed on roughage alone consisting of leguminous hays as alfalfa, cowpeas, or clover. The heavy fed group, three Jerseys, four Holsteins and one Ayrshire, was fed, in addition to the same roughage as the light fed group, grain of uniform mixture of two parts of corn and one part of oats.

In this experiment the calves were fed from birth and calculations made of all feed consumed. The calves were put on their respective rations at weaning time. The animals in both groups were given all the hay they would eat up clean at all times. Alfalfa hay was generally used, altho at times when not available the other named leguminous hays were fed.

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1. P. M. Brandt, Thesis, Univ. of Mo., 1913.

The following table shows the average nutrients fed per day, the average gain per day, and the nutrients required per pound of growth for both light and heavy fed groups.

Light Fed Group

Period	Energy Therms	Dig. Protein Pounds	Gain per Day
1	2.27	.72	1.04
2	3.64	.72	0.61
3	5.03	.93	0.81
4	6.10	1.17	0.67
Average:	4.26	.88	0.78
Used per lb. gain	5.39	1.11	

Heavy Fed Group.

1.	3.97	.63	1.47
2	7.32	.91	1.26
3	8.92	1.08	1.06
4	9.16	1.19	1.16
Average :	7.34	.95	1.24
Used per: lb. gain:	5.73	.74	

It will be seen that the light fed animals used considerable more protein for a pound of

gain than did the heavy fed group. "Bearing in mind the fact that the two groups received practically the same amount or protein per day and that the heavy feds received more than 3 therms energy per day in excess of that received by the light feds it can be seen that the latter did not require a greater amount of protein for a pound of gain but simply took it because it was in the feed in greater proportion to the energy."

DISCUSSION OF EXPERIMENTAL HEIFERS.

Description of Heifers -- The animals used in this experiment were pure bred Jersey and Holstein heifers. There was a great deal of difference in the age of the animals, the youngest being 8 months old and the oldest 18 months old, at the beginning of the experiment. Before the experiment these animals were treated similiar in every respect, as the young stock of the herd had previously been treated. They were all in the same condition of flesh.

Rations -- The heifers were divided into three lots. Each lot comprised four animals, - two each of the Jersey and Holstein breeds. Each lot received different rations as follows:-

Lot 1 -- Two pounds of corn each per day and all the alfalfa hay they would eat.

Lot 2 -- Two pounds of grain, equal parts by weight of corn and cottonseed meal, two pounds of timothy hay, and all the silage they would eat.

Lot 3 -- All the roughage they would eat consisting of alfalfa hay and corn silage in the proportion of 1 pound of alfalfa to 3 pounds of silage.

The timothy hay was added to the ration of Lot 2 for the reason that in previous experiments it was noticed that animals on silage alone for roughage craved some dry roughage and would eat their straw bedding.

Feeds -- All feeds used were of the best quality. The silage was taken from the silos of the Dairy Department and was of good quality. The alfalfa was the best that could be purchased. The corn and cottonseed meal was of good quality, the corn was ground.

Feeding -- The feed was weighed out every night and morning to each individual animal. They were fed at regular intervals only twice daily. A careful account of each feeding was kept, after removing the feeding sheets from the barn they were copied in permanent record books at the Dairy Building. If any feed was returned by any of the animals it was weighed back and deducted from the amount given the animal. It was impossible to have the animals on the alfalfa and silage ration consume their feed in the ratio of one pound of alfalfa to three pounds of silage, and yet have them return some

of the feed to indicate that they were getting all they wanted. For when any of the feed was returned it was in every case the silage that was returned. The amount returned in any of the cases was not very much, however, making all rations practically as planned.

Water -- Plenty of fresh clean water was furnished the animals at all times while they were in the lot. During disagreeable weather they were turned out to drink at least twice daily.

Salt -- Salt was placed in a box where the animals had access to it during the day.

Stabling -- The animals were housed in a small building constructed expressly for this experiment. Each animal had a box stall with cinder floor. There was no trouble found with the heifers eating the straw with which they were bedded.

Weighing -- The heifers were weighed every ten days. At the beginning, at the end of the experiment, and at the end of every thirty days they were weighed three days in succession to eliminate the possible daily fluctuations that are common to single daily weights. They weights are given in Tables 2 - 13 inclusive.

Measurements -- Measurements were taken every 30 days of the height at withers and the heart and paunch girth. The measurements of height at withers are given in Table 1. The period covered by the experiment was of too short duration to show a difference in the measurements of the animals of different groups for either the paunch or heart girth.

Feeding Standard Used -- Armsby's[1] method was used in calculating the protein and therm value of all the rations. In his method only the amide-free protein is used. The total nutritive value is given in therms equal to 1,000 calories.

Height and Age -- Table 1 gives the age of the heifers at the beginning of the experiment together with the growth at withers in centimeters. The experiment being of short duration the growth could best be shown by comparing the heifers on this experiment with figures worked out by Burlingham and Gillette[2] which they call "Standard Growth".

The growth in most instances is shown to be normal, and in some cases the laying on of fat at

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1. Farmers Bul. 346, U. S. Dept. Agric.
2. Thesis - Burlingham and Gillette, Univ. of Mo. 1914.

TABLE I.

AGE, WEIGHT AND GROWTH COMPARED WITH "STANDARD GROWTH" FOR THE 150 DAYS.

Number	Age at beginning of experiment		Weight at beginning	Standard Growth Height at Withers	Animals on experiment Height at Withers
	Months	Days	Lbs.	Centimeters	Centimeters
Jersey 95	18	12	615	3.1	4.9
" 96	15	9	490	6.0	5.3
" 98	12	26	530	7.4	6.5
" 100	10	11	375	8.0	9.1
" 101	9	27	415	8.0	8.3
" 102	7	26	320	9.0	9.7
Holstein 243	15	1	650	4.5	6.7
" 244	13	28	510	5.3	7.2
" 245	12	12	570	7.0	7.3
" 246	11	21	565	7.0	7.2
" 248	10	27	535	7.5	9.4
" 249	9	1	400	8.6	11.4

the top of the withers had a tendency to increase the height measurements. The Jerseys that showed the least gains in height were older animals and did not lay on flesh readily as can be seen by the total gains.

By comparing animals of the same age of both the Jersey and Holstein breeds it will be seen in every case the Holsteins made the greater gains in height. The "Standard Growth" shows the Jerseys grow faster up to 11 months of age and then are surpassed by the Holsteins.

Tables 2 - 13 inclusive show the amount of food consumed together with the amount of protein and energy in therms as calculated according to Armsby's method. During each 10 day period the weights of the animals were taken. At the end of every 30 days the average weight for three consecutive days was taken to eliminate the error which might result from a single weight during the 10 day period. Even when taking this precaution the possible error is only partially eliminated, as there is some factor which has not fully been determined causing a fluctuation in the weights.

TABLE 2.

TOTAL NUTRIENTS RECEIVED.

BY 10 DAY PERIODS.
JERSEY HEIFER 101.

Ration 1*.

Period	Corn Lbs.	Alfalfa Lbs.	Protein Lbs.	Energy Therms	Weight Lbs.
1	20	100.0	8.29	52.18	415
2	20	100.0	8.29	52.18	435
3	20	106.0	8.71	54.24	452
4	20	120.0	9.68	59.06	456
5	20	120.0	9.68	59.06	463
6	20	115.0	9.33	57.34	480
7	20	100.0	8.29	52.18	485
8	20	100.0	8.29	52.18	480
9	20	100.0	8.29	52.18	484
10	20	100.0	8.29	52.18	490
11	20	116.0	9.40	57.68	481
12	20	136.0	10.78	64.57	540
13	20	140.0	11.06	65.94	525
14	20	134.4	10.67	64.02	557
15	20	138.0	10.92	65.26	557
Total	300	1725.4	139.97	860.25	

*Corn and alfalfa.

TABLE 3.

TOTAL NUTRIENTS RECEIVED BY 10 DAY PERIODS. JERSEY HEIFER 102.

Ration 1*.

Period	Corn Lbs.	Alfalfa Lbs.	Protein Lbs.	Energy Therms	Weight Lbs.
1	20	78.0	6.77	44.61	320
2	20	80.0	6.90	45.30	332
3	20	86.0	7.32	47.36	338
4	20	81.4	6.94	45.47	340
5	20	80.5	6.94	45.47	353
6	20	88.0	7.46	48.05	376
7	20	92.8	7.79	49.70	374
8	20	79.5	6.87	45.13	376
9	20	68.0	6.71	42.18	380
10	20	77.0	6.64	43.99	367
11	20	96.0	8.01	50.80	400
12	20	116.0	9.39	57.68	411
13	20	120.0	9.67	59.05	410
14	20	120.0	9.67	59.05	440
15	20	114.0	9.29	56.99	442
Total	300	1377.2	116.37	740.83	

* Corn and alfalfa.

TABLE 4.

TOTAL NUTRIENTS RECEIVED

BY 10 DAY PERIODS.
HOLSTEIN HEIFER 243.

Ration 1*.

Period	Corn Lbs.	Alfalfa Lbs.	Protein Lbs.	Energy Therms	Weight Lbs.
1	20	180.0	13.83	79.73	650
2	20	180.0	13.45	77.81	680
3	20	174.4	13.44	77.78	685
4	20	178.0	13.70	79.02	693
5	20	151.5	11.86	69.90	705
6	20	156.5	12.20	71.62	707
7	20	141.0	11.13	66.29	700
8	20	140.0	11.06	65.94	695
9	20	140.0	11.06	65.94	738
10	20	140.0	11.06	65.94	727
11	20	140.0	11.06	65.94	758
12	20	160.0	12.45	72.82	790
13	20	158.0	12.31	72.13	773
14	20	160.0	12.45	72.82	830
15	20	155.0	12.10	70.56	799
Total	300	2354.4	183.16	1074.24	

* Corn and Alfalfa.

TABLE 5.

TOTAL NUTRIENTS RECEIVED BY 10 DAY PERIODS. HOLSTEIN HEIFER 246.

Ration 1*.

Period	Corn Lbs.	Alfalfa Lbs.	Protein Lbs.	Energy Therms	Weight Lbs.
1	20	150.0	11.75	69.38	565
2	20	150.0	11.75	69.38	582
3	20	156.0	12.17	71.45	607
4	20	170.0	13.14	76.27	620
5	20	170.0	13.14	76.27	654
6	20	170.0	13.14	76.27	644
7	20	170.0	13.14	76.27	655
8	20	170.0	13.14	76.27	673
9	20	170.0	13.14	76.27	703
10	20	170.0	13.14	76.27	695
11	20	178.0	13.70	79.02	711
12	20	180.0	13.83	79.73	735
13	20	180.0	13.83	79.73	748
14	20	180.0	13.83	79.73	762
15	20	179.0	13.76	79.35	734
Total	300	2543.0	196.60	1141.66	

* Corn and Alfalfa.

TABLE 6.

TOTAL NUTRIENTS RECEIVED.

BY 10 DAY PERIODS.
JERSEY HEIFER 96.

Ration 2*.

Period	Grain Lbs.	Timothy Lbs.	Silage Lbs.	Protein Lbs.	Energy Therms	Weight Lbs.
1	20	20	180.0	6.19	53.82	490
2	20	20	180.0	6.19	53.82	532
3	20	20	174.4	6.14	52.90	523
4	20	20	178.0	6.17	53.49	530
5	20	20	154.5	5.96	49.60	534
6	20	20	200.0	6.36	57.14	569
7	20	20	200.0	6.36	57.14	570
8	20	20	200.0	6.36	57.14	542
9	20	20	200.0	6.36	57.14	575
10	20	20	200.0	6.36	57.14	572
11	20	20	200.0	6.36	57.14	585
12	20	20	220.0	6.34	57.55	597
13	20	20	224.0	6.37	58.22	593
14	20	20	240.0	6.62	60.87	560
15	20	20	240.0	6.62	60.87	613
Total	300	300	2990.9	94.76	843.98	

*Silage, Timothy, Corn, and Cottonseed Meal.

TABLE 7.

TOTAL NUTRIENTS RECEIVED.

BY 10 DAY PERIODS.
JERSEY HEIFER 100.

Ration 2*.

Period	Grain Lbs.	Timothy Lbs.	Silage Lbs.	Protein Lbs.	Energy Therms	Weight Lbs.
1	20	20	180.0	6.19	53.82	375
2	20	20	180.0	6.19	53.82	390
3	20	20	186.0	6.24	54.82	401
4	20	20	200.0	6.36	57.14	415
5	20	20	200.0	6.36	57.14	435
6	15**	20	192.0	5.24	51.47	444
7	11**	20	200.0	4.47	49.35	447
8	20	20	200.0	6.36	57.14	445
9	20	20	196.8	6.34	56.61	462
10	20	20	178.7	6.18	53.51	458
11	20	20	174.0	6.14	52.90	463
12	20	20	175.8	6.16	53.23	478
13	20	20	180.0	6.19	53.82	482
14	20	20	180.0	6.19	53.82	500
15	20	20	180.0	6.19	53.82	505
Total	184	300	2803.3	90.80	812.41	

*Silage, Timothy, Corn, and Cottonseed Meal.

**Off feed.

TABLE 8.

TOTAL NUTRIENTS RECEIVED.
BY 10 DAY PERIODS.
HOLSTEIN HEIFER 244

Ration 2*.

Period	Grain Lbs.	Timothy Lbs.	Silage Lbs.	Protein Lbs.	Energy Therms	Weight Lbs.
1	20	20	180.0	6.19	53.82	510
2	20	20	180.0	6.19	53.82	545
3	20	20	186.0	6.24	54.82	546
4	20	20	200.0	6.36	57.14	540
5	20	20	200.0	6.36	57.14	555
6	20	20	200.0	6.36	57.14	561
7	20	20	200.0	6.36	57.14	565
8	20	20	200.0	6.36	57.14	572
9	20	20	200.0	6.36	57.14	591
10	20	20	200.0	6.36	57.14	597
11	20	20	200.0	6.36	57.14	601
12	20	20	220.0	6.13	53.74	627
13	20	20	224.0	6.16	54.40	615
14	20	20	240.0	6.31	57.05	655
15	20	20	240.0	6.31	57.05	653
Total	300	300	3070.0	94.41	841.82	

* Silage, Timothy, Corn and Cottonseed Meal.

TABLE 9.

TOTAL NUTRIENTS RECEIVED.
BY 10 DAY PERIODS.
HOLSTEIN HEIFER 248

Ration 2*.

Period	Grain Lbs.	Timothy Lbs.	Silage Lbs.	Protein Lbs.	Energy Therms	Weight Lbs.
1	20	20	180.0	6.19	53.82	535
2	20	20	180.0	6.19	53.82	530
3	20	20	186.0	6.24	54.82	548
4	20	20	200.0	6.36	57.14	560
5	20	20	200.0	6.36	57.14	690
6	20	20	200.0	6.36	57.14	582
7	20	20	200.0	6.36	57.14	585
8	20	20	200.0	6.36	57.14	588
9	20	20	200.0	6.36	57.14	625
10	20	20	200.0	6.36	57.14	615
11	20	20	200.0	6.36	57.14	635
12	20	20	186.0	6.24	54.82	648
13	20	20	196.0	6.33	55.11	648
14	20	20	184.0	6.22	54.59	652
15	20	20	164.5	6.05	49.67	631
Total	300	300	2876.5	94.34	833.77	

* Silage, Timothy, Corn, and Cottonseed Meal.

TABLE 10.

TOTAL NUTRIENTS RECEIVED.

BY 10 DAY PERIODS.
JERSEY HEIFER 95

Ration 3*.

Period	Alfalfa Lbs.	Silage Lbs.	Protein Lbs.	Energy Therms	Weight Lbs.
1	60	180.0	5.74	50.45	615
2	60	180.0	5.74	50.45	645
3	63	189.0	6.03	52.98	651
4	70	210.0	6.70	58.86	643
5	70	210.0	6.70	58.86	652
6	69	187.0	6.43	54.71	641
7	60	180.0	5.74	50.45	640
8	60	176.0	5.71	49.86	628
9	60	174.0	5.68	49.45	642
10	60	180.0	5.74	50.45	637
11	60	180.0	5.74	50.45	626
12	60	180.0	5.74	50.45	638
13	60	180.0	5.74	50.45	615
14	60	180.0	5.74	50.45	670
15	60	180.0	5.74	50.45	653
Total	932	2766.0	88.91	778.77	

* Alfalfa and Silage.

TABLE 11.

TOTAL NUTRIENTS RECEIVED.
BY 10 DAY PERIODS.
JERSEY HEIFER 98

Ration 3*

Period	Alfalfa Lbs.	Silage	Protein	Energy	Weight
1	60	180.0	5.74	50.45	530
2	60	180.0	5.74	50.45	522
3	63	189.0	6.03	52.98	542
4	70	205.5	6.66	58.12	555
5	65	184.0	6.12	52.84	572
6	60	163.5	5.60	47.72	561
7	60	177.0	5.72	49.96	558
8	60	174.0	5.68	49.45	561
9	48	110.3	4.30	34.77	558
10	43	129.0	4.12	36.15	542
11	52	154.3	4.96	43.44	570
12	64	173.6	5.96	50.77	570
13	60	168.5	5.64	48.55	590
14	60	173.0	5.68	49.29	600
15	60	160.5	5.57	47.22	581
Total	885	2522.2	83.52	722.16	

*Alfalfa and Silage.

TABLE 12.

TOTAL NUTRIENTS RECEIVED.

BY 10 DAY PERIODS.
HOLSTEIN HEIFER 245

Ration 3*.

Period	Alfalfa Lbs.	Silage Lbs.	Protein Lbs.	Energy Therms	Weight Lbs.
1	70	208.2	6.68	58.56	570
2	70	210.0	6.70	58.86	565
3	73	219.0	6.98	61.38	587
4	80	240.0	7.65	67.26	601
5	80	240.0	7.65	67.26	630
6	76	205.5	7.07	60.18	611
7	68	204.0	6.50	57.18	617
8	70	210.0	6.70	58.86	627
9	70	210.0	6.70	58.86	657
10	70	210.0	6.70	58.86	630
11	75	225.0	7.17	63.06	659
12	80	234.0	7.60	66.28	695
13	80	240.0	7.65	67.26	700
14	80	240.0	7.65	67.26	715
15	80	235.0	7.61	66.43	694
Total	1122	3330.7	107.01	937.25	

*Alfalfa and Silage.

TABLE 13.

TOTAL NUTRIENTS RECEIVED.

BY 10 DAY PERIODS.
HOLSTEIN HEIFER 249

Ration 3*

Period	Alfalfa Lbs.	Silage Lbs.	Protein Lbs.	Energy Therms	Weight Lbs.
1	60	175.8	5.71	49.86	400
2	60	180.0	5.74	50.45	415
3	63	189.0	6.03	52.98	417
4	66	179.9	6.15	52.50	430
5	60	180.0	5.74	50.45	453
6	60	180.0	5.74	50.45	442
7	60	180.0	5.74	50.45	453
8	60	180.0	5.74	50.45	470
9	60	180.0	5.74	50.45	487
10	60	180.0	5.74	50.45	470
11	65	195.0	6.22	54.65	483
12	78	228.8	7.42	64.73	517
13	80	232.5	7.59	66.03	518
14	80	231.5	7.58	65.85	530
15	80	215.0	7.44	63.13	514
Total	992	2907.5	94.32	822.88	

*Alfalfa and Silage.

The experiment was carried on primarily to give a practical knowledge of the amount of common food stuffs a dairy heifer will consume during the winter months. Also to give a direct comparison of the different rations as to the amount of gain and the amount which the animal has to consume to produce a pound of gain.

It is possible for a dairy farmer to figure the amount of feed needed to winter his young stock by taking any dairy heifer and comparing her in age and weight with one of the experimental animals given in the tables. The amount of food stuff she will consume during the winter months can be figured within a very close margin when foods of the same or similiar character are used in feeding.

Protein and Energy of Each Lot -- Lot 1 received more protein than either Lot 2 or 3 and the therms of energy were greater than Lot 3 but practically the same as Lot 2. This is shown by Tables 14, 15 and 16.

The protein content of the different rations was not considered one of the main factors of the experiment. It is believed, however, that

TABLE 14.

NUTRIENTS RECEIVED PER DAY AND PER POUND GAIN.

By Thirty Day Periods.

Lot 1.*

No. 101

Period	Digestible Protein Lbs. Per Day	Energy Therms Per Day	Gain Per Day Pounds	Protein Per Lb. Gain	Therms Per Lb. Gain
1	.843	5.287	1.23	.683	4.286
2	.956	5.849	.93	1.024	6.266
3	.829	5.218	.13	6.222	9.135
4	.949	5.814	1.87	.508	3.115
5	1.088	6.507	.57	1.920	11.484
Average	.933	5.734	.95	.985	6.058

No. 102

1	.699	4.576	.60	1.166	7.626
2	.711	4.633	1.27	.562	3.657
3	.712	4.567	.13	5.342	34.252
4	.801	5.082	1.03	.775	4.918
5	.955	5.836	1.03	.924	5.645
Average	.776	4.939	.81	.954	6.072

No. 243

1	1.357	7.811	1.17	1.165	6.695
2	1.259	7.351	.73	1.716	10.024
3	1.108	6.606	1.03	1.072	6.393
4	1.152	6.823	1.73	.665	3.983
5	1.229	7.184	.30	4.096	23.945
Average	1.221	7.161	.99	1.229	7.209

No. 246

1	1.189	7.007	1.40	.849	5.005
2	1.314	7.627	1.23	1.065	6.184
3	1.314	7.627	1.97	.668	3.878
4	1.356	7.834	1.07	1.271	7.344
5	1.381	7.960	Loss.03	-----	-----
Average	1.311	7.611	1.13	1.163	6.755

*COrn and Alfalfa.

TABLE 15.

NUTRIENTS RECEIVED PER DAY AND PER POUND GAIN.

By Thirty Day Periods.

Lot 2*.

No. 100

Period	Digestible Protein Lbs. Per Day	Energy Therms Per Day	Gain per Day Pounds	Protein Per Lb. Gain	Therms PerrLb. Gain
1	.621	5.415	.87	.716	6.249
2	.599	5.518	1.43	.417	3.853
3	.572	5.437	.60	.954	9.061
4	.616	5.321	.53	1.155	9.977
5	.619	5.382	.90	.688	5.980
Average	.605	5.416	.87	.798	6.249

No. 96

1	.617	5.384	1.10	.560	4.894
2	.616	5.341	1.53	.402	3.488
3	.636	5.714	.20	3.180	28.570
4	.635	5.728	.73	.866	7.810
5	.654	5.999	.53	1.226	11.247
Average	.631	5.626	.82	.770	6.861

No. 244

1	.621	5.415	1.20	.517	4.513
2	.636	5.714	.50	1.272	11.430
3	.636	5.714	1.00	.636	5.720
4	.628	5.601	1.20	.523	4.667
5	.626	5.617	.87	.722	6.481
Average	.629	5.612	.95	.660	5.886

No. 248

1	.621	5.415	.43	1.430	12.450
2	.636	5.714	1.13	.560	5.042
3	.636	5.714	1.43	.444	3.986
4	.632	5.637	.77	.824	7.352
5	.620	5.312	Loss.57	----	-----
Average	.629	5.558	.64	.982	8.685

* Corn - Cottonseed Meal - Timothy - Silage.

TABLE 16.

NUTRIENTS RECEIVED PER DAY AND PER POUND GAIN.

By Thirty Day Periods.

Lot 3*.

No. 95

Period	Digestible Protein Lbs. Per Day	Energy Therms Per Day	Gain per Day Pounds	Protein Per Lb. Gain	Therms Per Lb. Gain
1	.583	5.129	1.20	.486	4.274
2	.661	5.748	Loss.33	----	----
3	.571	4.992	.03	19.130	149.760
4	.574	5.045	Loss.13	----	-------
5	.574	5.045	.50	1.148	10.090
Average	.593	5.192	.25	2.340	20.494

No. 98

1	.584	5.129	.40	1.459	12.823
2	.613	5.289	.63	.967	8.351
3	.523	4.473	Loss.10	----	-----
4	.501	4.345	.40	1.253	10.863
5	.563	4.835	.31	1.535	13.187
Average	.557	4.814	.34	1.637	14.160

No. 245

1	.679	5.950	.57	1.197	10.500
2	.746	6.490	.80	.932	8.112
3	.663	5.827	1.53	.435	3.800
4	.716	6.273	1.27	.565	4.952
5	.764	6.698	Loss.01	----	-----
Average	.713	6.248	.83	.863	7.558

No. 249

1	.583	5.109	.57	1.028	9.017
2	.588	5.113	.83	.705	6.136
3	.574	5.045	1.50	.383	3.363
4	.646	5.661	1.00	.646	5.661
5	.754	6.500	Loss.01	---	----
Average	.629	5.486	.76	.828	7.217

* Alfalfa and Silage.

all the animals in the experiment had sufficient protein for normal growth. The growth of the animals seems to follow the energy content of the ration rather than the protein content; i.e., the largest gains follow the ration that had the largest energy value.

Of the three rations Lot 3 used the greatest amount of protein and energy per pound of gain. There were no animals in Lot 3 but that showed a loss in weight during one or more of the thirty day periods.

There was a greater amount of protein used per pound of gain by the animals of Lot 1 and Lot 2, but the energy value of the food is practically the same for each of these two Lots. The animals of Lot 1 and Lot 2 showed an average uniform gain per day. The age seemed to have little or no effect on the animals of these two lots.

By averaging the figures of three or more heifers on experiment and comparing the results with the figures advanced by Armsby[1], as to age and weight, and protein and energy requirement, the following differences are found:

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1. Farmers' Bul. 346, U.S. Dept. Agri.

Armsby's figures for growing animal six months old, weighing 425 pounds are - 1.30 pounds of protein and 6.0 therms of energy.

For heifers on experiment ten months old, weighing 444 pounds, .736 pounds of protein and 5.39 therms of energy was used.

Armsby's figures for growing animals twelve months old, weighing 650 pounds are - 1.65 pounds of protein and 7.0 therms of energy.

Experimental heifers fifteen months old weighing 649 pounds - .872 pounds of protein and 6.35 therms of energy.

Armsby's figures were probably based upon experiments where more concentrates were fed than was the case in this experiment. It would be very easy to raise both the protein and energy content of any of the rations fed by adding more concentrates and limiting the supply of roughage.

The ration consisting of corn, cottonseed meal, timothy and silage, altho being the more economical ration, is deficient in ash. It is questionable whether it would have any detrimental effect on animals if fed for periods extend-

ing over one or two years. There was no detrimental effect noticed on the animals on this experiment.

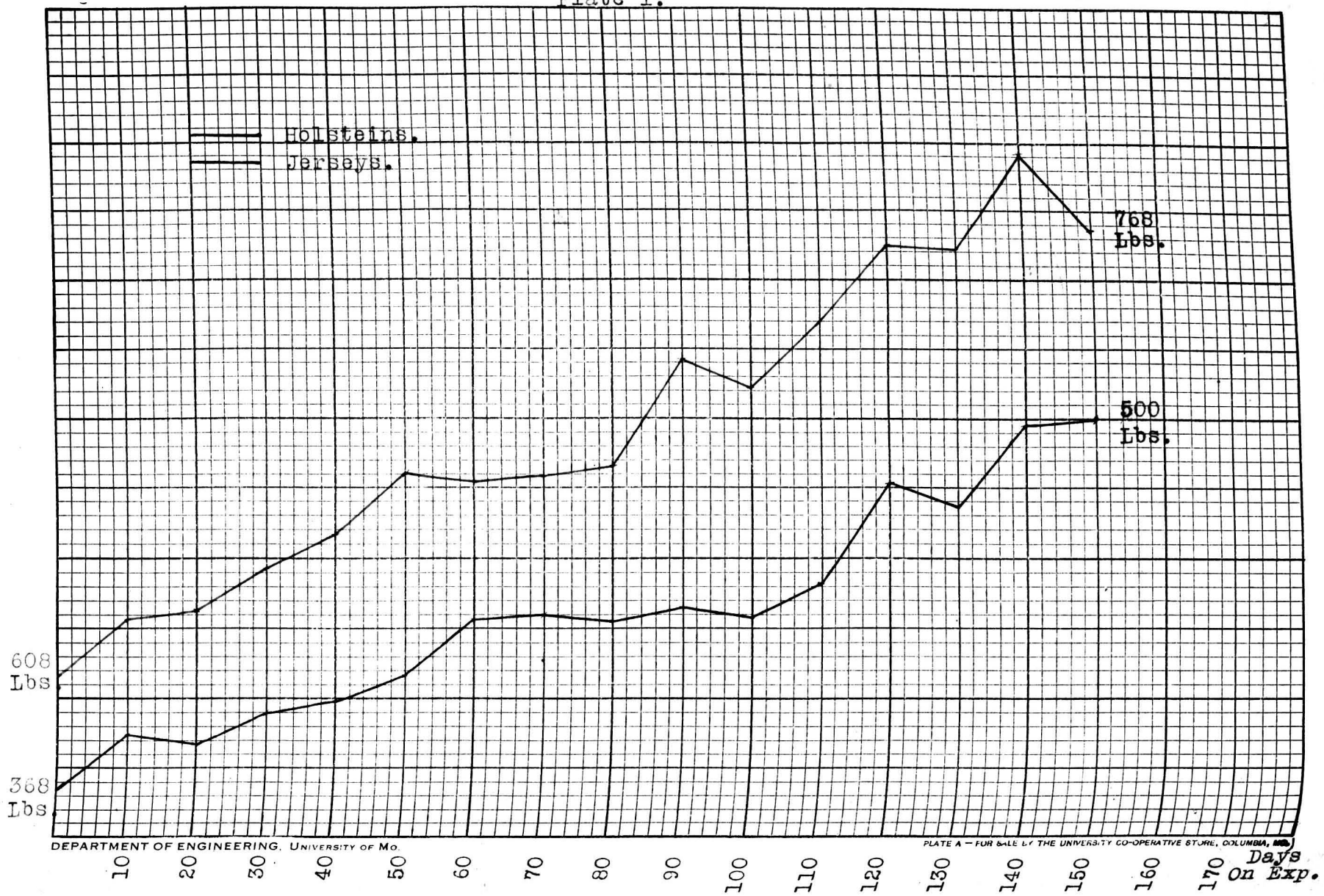
Breed Difference in Utilization of Ration -- A difference was noticed between the condition of the Jerseys and Holstein animals of the same lot in the utilization of their ration.

Plate 1, 2, and 3 show the average gain in weight of the two animals of each breed on the same ration. This difference is shown more clearly by the Lot receiving alfalfa hay and silage with no grain (Plate 3). This great difference might have been typical of these individual animals only. The question of the age of the animals might have some influence on this ration, for the Jerseys were older and nearing maturity. This factor would not keep them from gaining in flesh and showing better condition. The Jerseys, Nos. 95 and 98, on this ration gained 38 and 51 pounds respectively during the experiment, while the Holsteins, Nos. 245 and 249, gained 124 and 114 pounds respectively.

Eliminating age as a factor influencing the gain in weight of these heifers it would then

GAINS MADE BY ANIMALS OF DIFFERENT BREEDS.

Lot 1.
Plate 1.



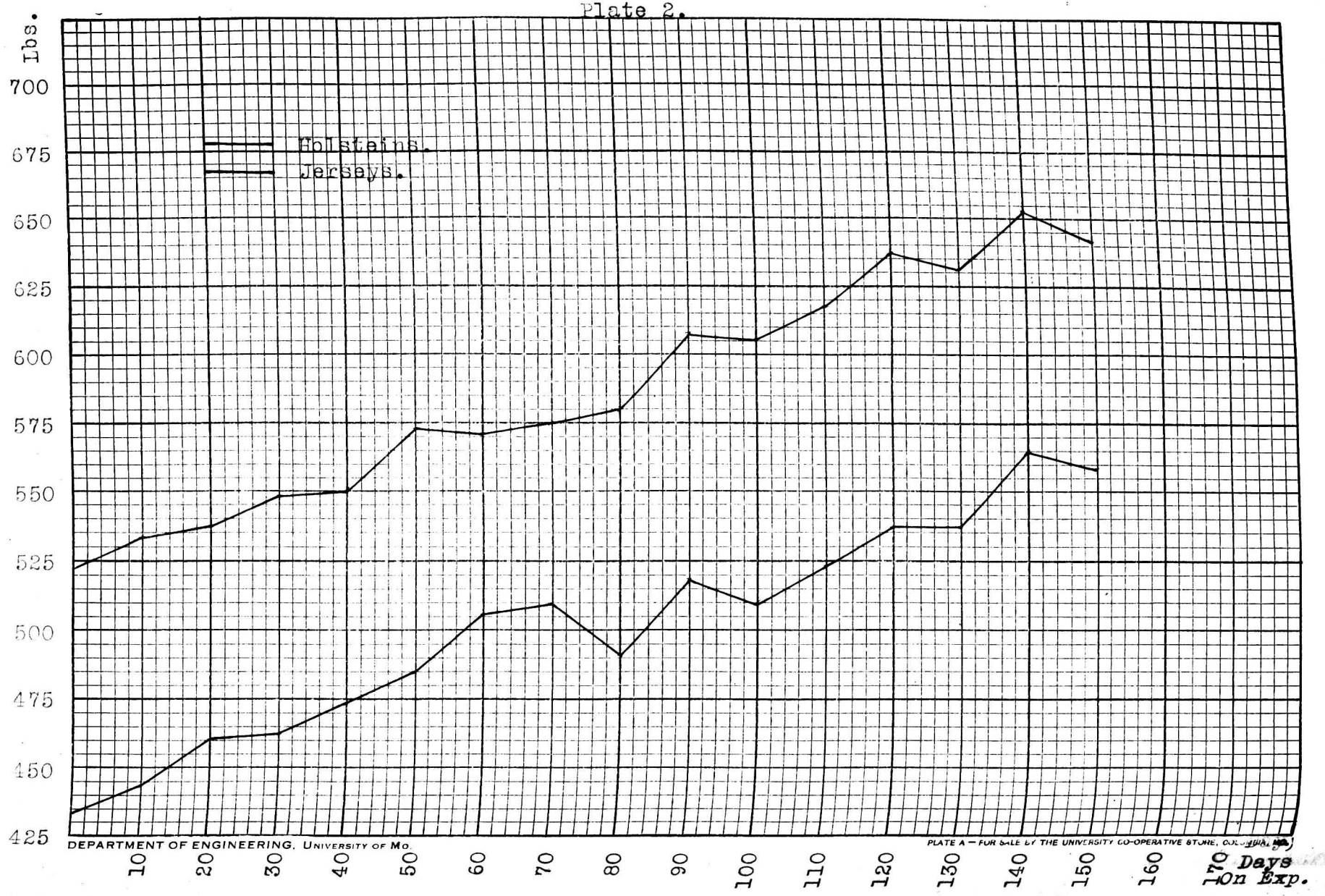
DEPARTMENT OF ENGINEERING. UNIVERSITY OF MO.

PLATE A — FOR SALE BY THE UNIVERSITY CO-OPERATIVE STORE, COLUMBIA, MO.

GAINS MADE BY ANIMALS OF DIFFERENT BREEDS.

Lot 2.

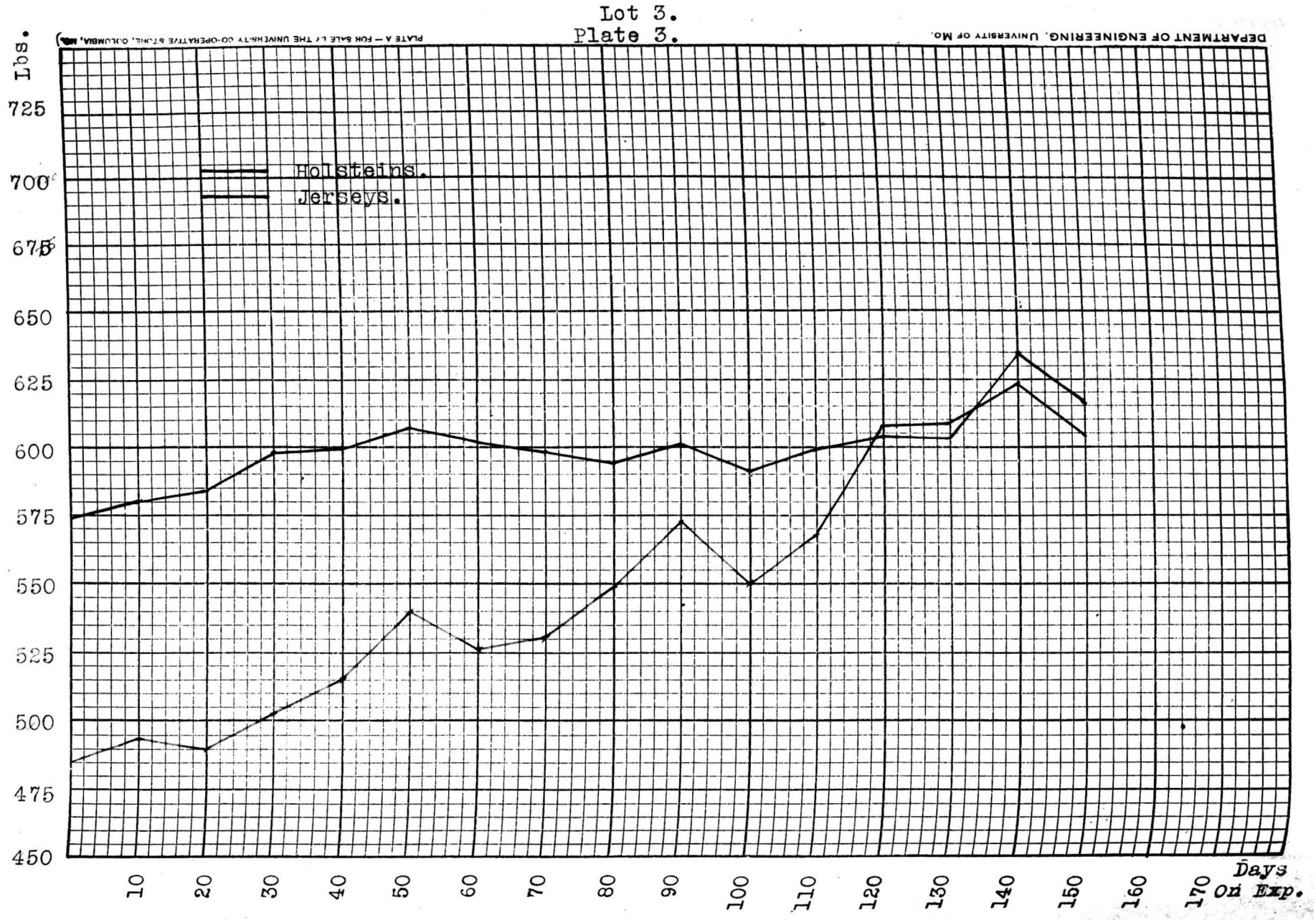
Plate 2.



DEPARTMENT OF ENGINEERING, UNIVERSITY OF MO.

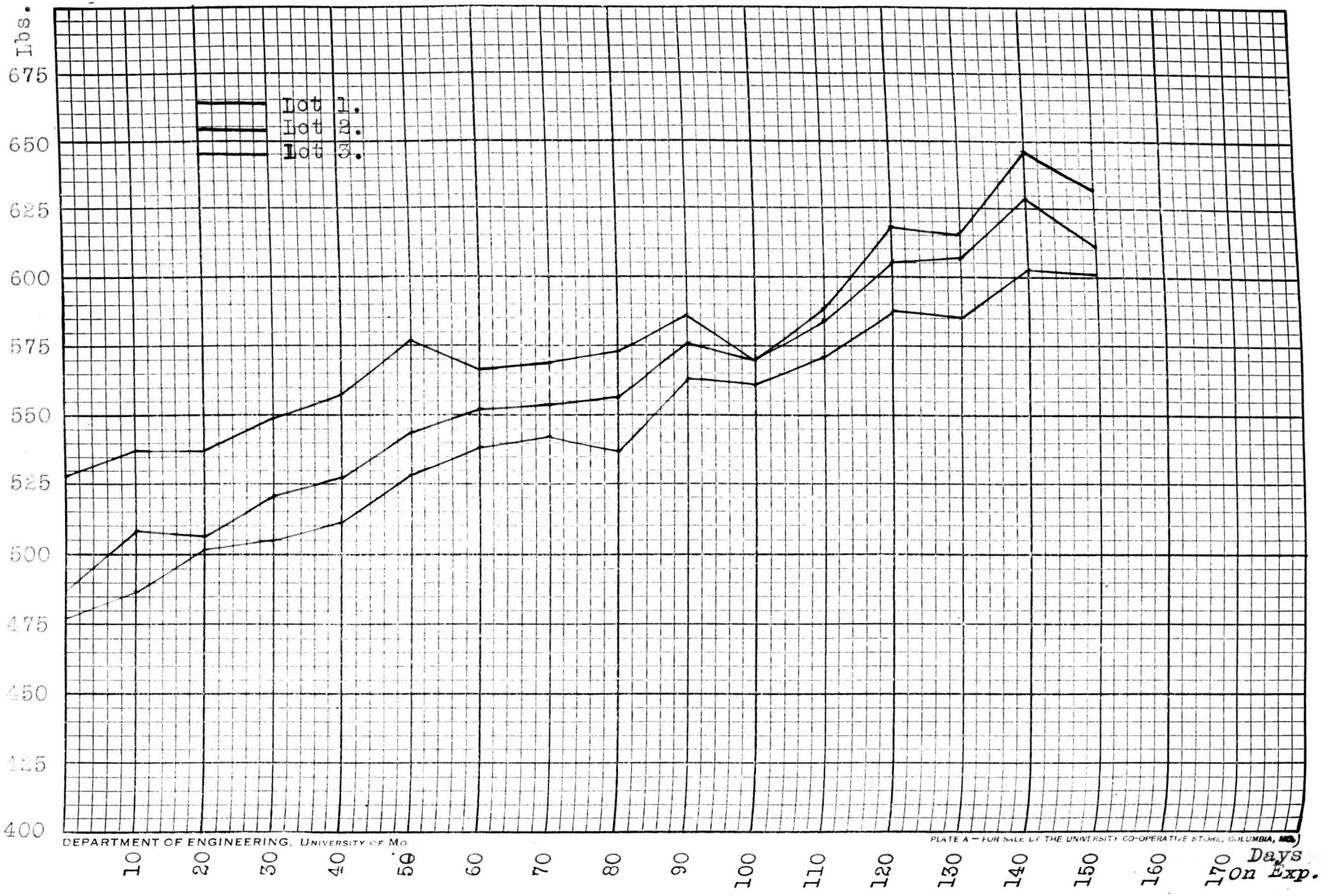
PLATE A — FOR SALE BY THE UNIVERSITY CO-OPERATIVE STORE, COLUMBIA, MO.

GAINS MADE BY ANIMALS OF DIFFERENT BREEDS.



GAIN IN WEIGHT MADE BY EACH LOT.

Plate 4.



be plausible to say, the Holsteins utilized their ration to better advantage.

A greater number of individuals would need to be placed on the different rations before any definite conclusions could be drawn.

Considering gain in weight again as a deciding factor representing the best ration, the difference in Lot 1 and 2 is of very little consequence (Plate 4). If there was any preference given it would be in favor of those of Lot 1, receiving corn and alfalfa. Both Lot 1 and 2 show their superiority over Lot 3 in that the Lots show better gains and the animals were in better condition at the end of the experiment.

It can be said of all the animals on the experiment that they were in excellent condition and some of them showing the largest gains were fat for animals of the dairy breed, with the exception of the two Jersey animals in Lot 3 on roughage alone. These animals were what could be called in average condition.

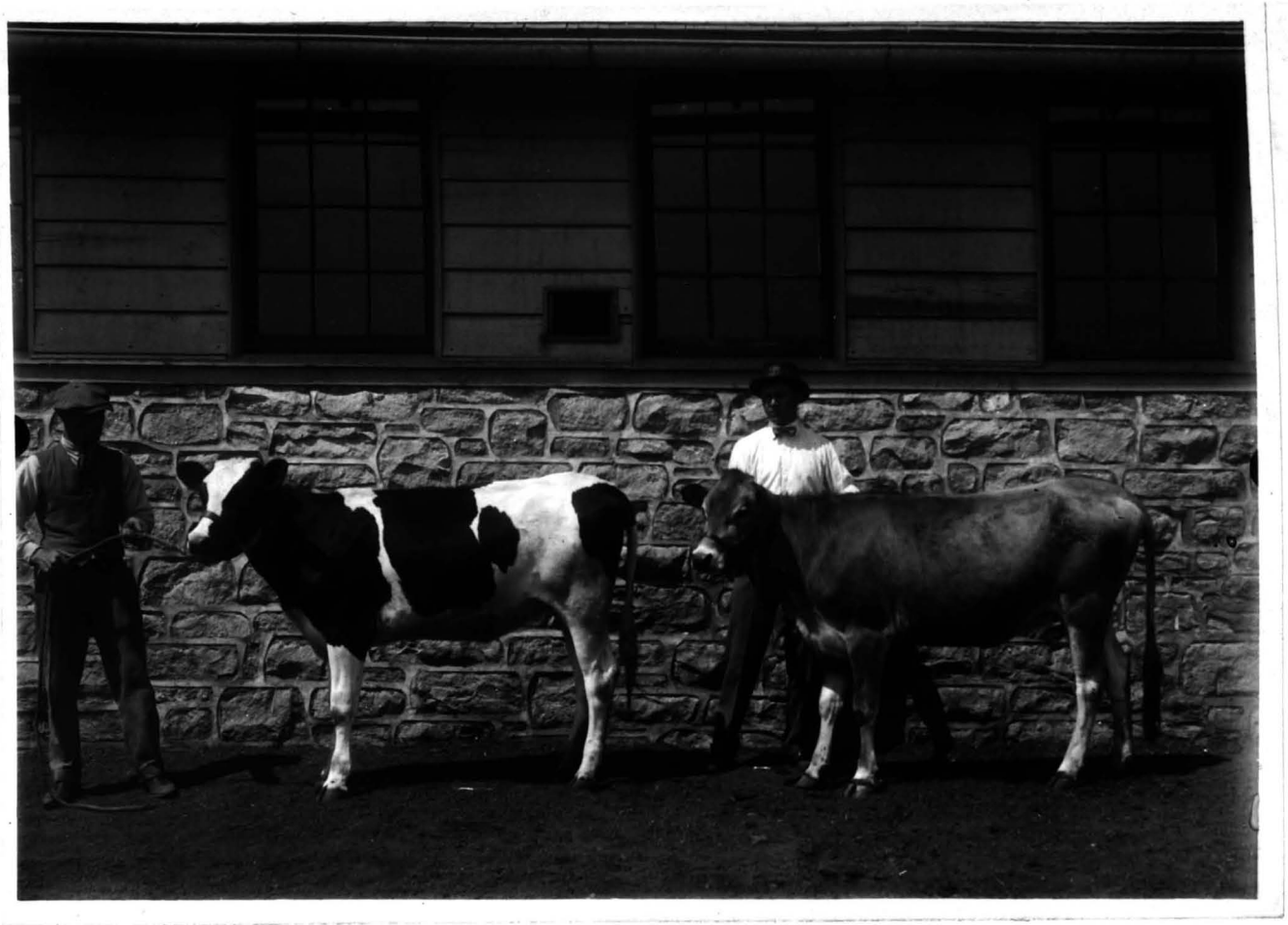
This would seem to show that in order to get the best results with the growing heifer during the winter months the ration should contain some concentrates.

It would be expected that the Holsteins would make somewhat larger gains, for the breed as a whole is larger.

Lot 1.

Nos. 243, 101. April 20, 1915.

Lot 2.



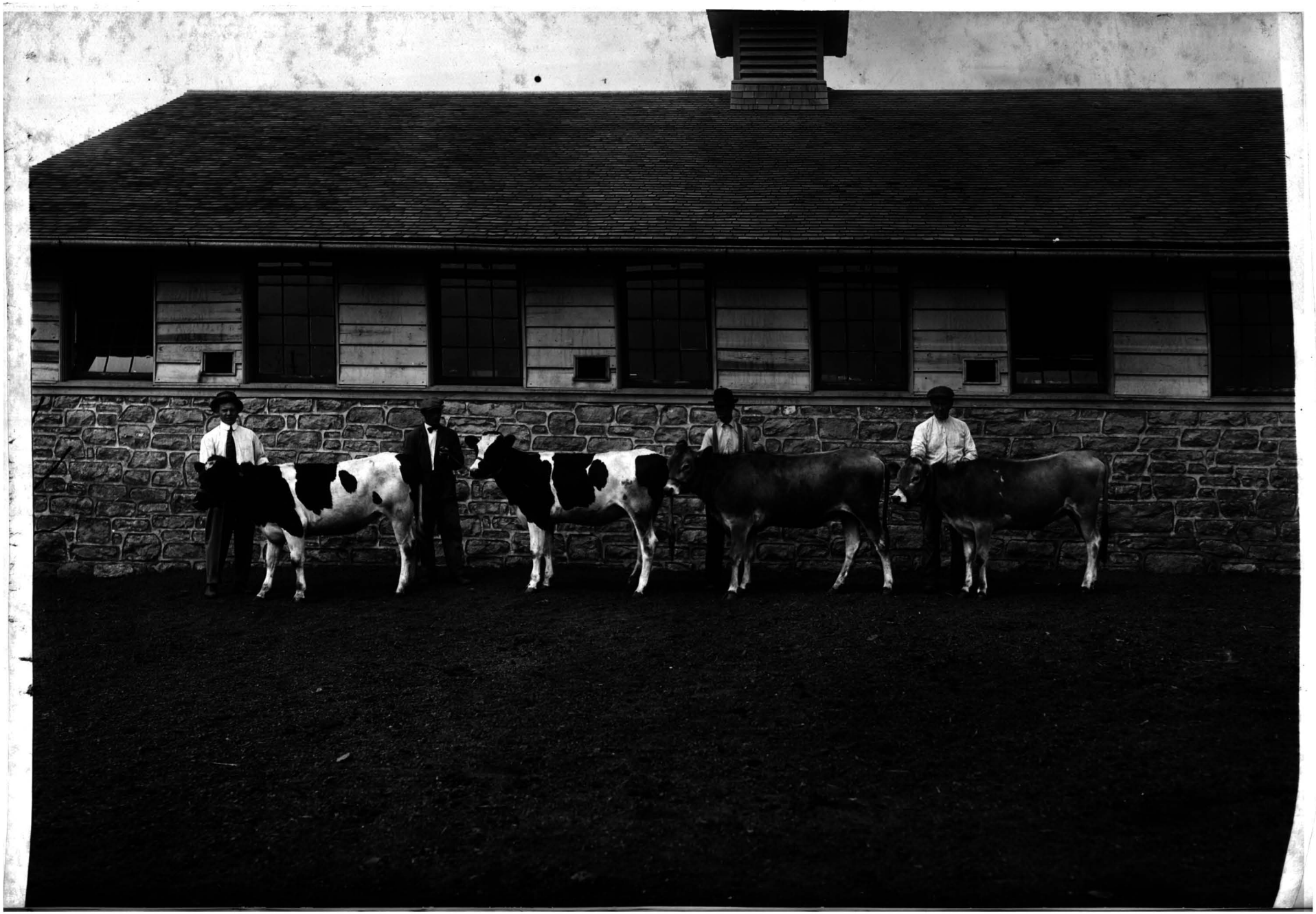
Nos. 278, 96, April 20, 1915.

Lot 3.

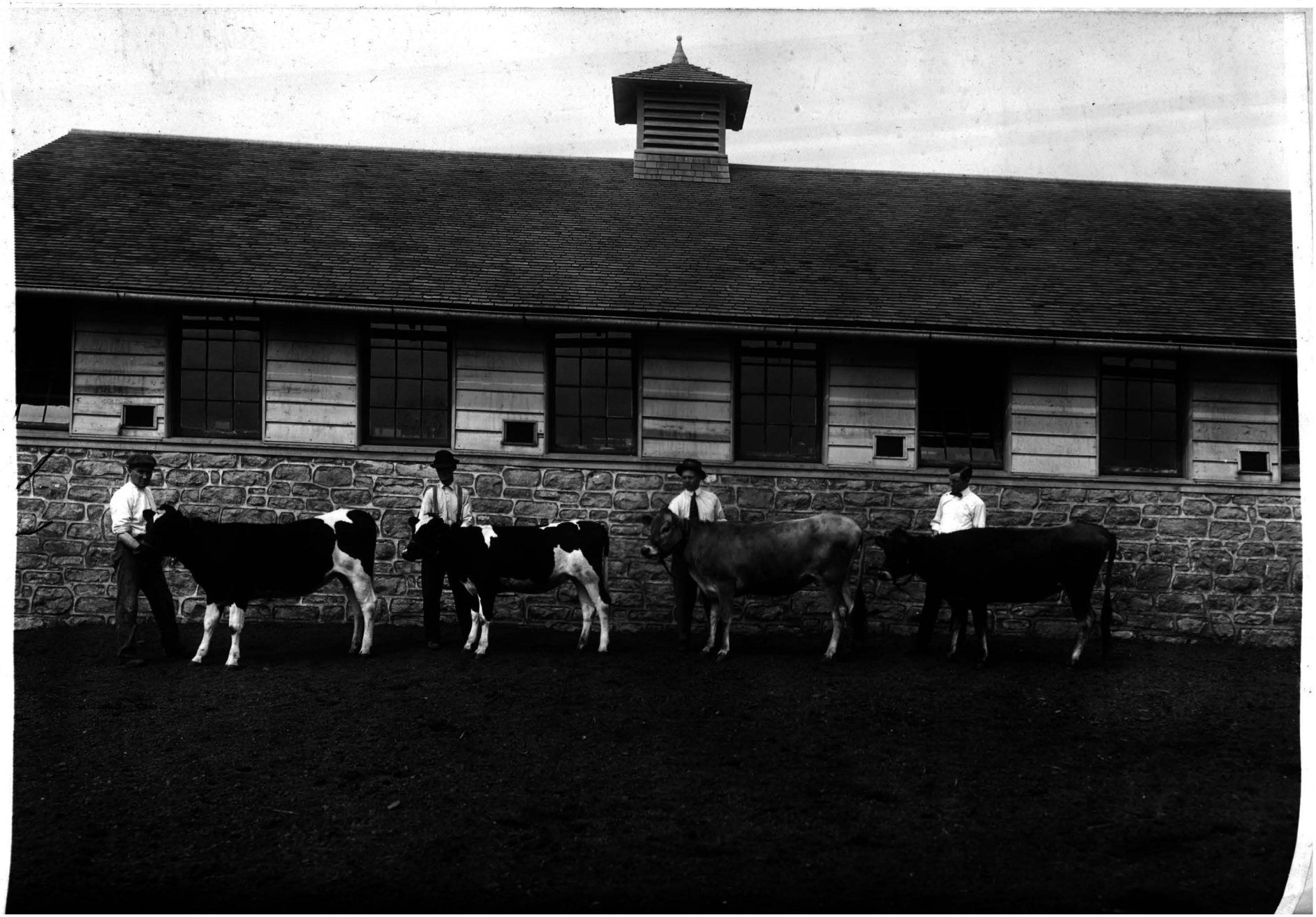
Nos. 249. 98. April 20. 1915.

Lot 1-

Lot 2



Lot 3.



COST OF RATION.

Two different systems were used in calculating the cost of these rations. They were as follows:-

1st. - Where all the food is purchased at a fair average price for this locality. Under this condition the food stuffs were priced as follows:- corn 50 cents per bushel; cottonseed meal $30.00 per ton; timothy hay $14.00 per ton; alfalfa hay $16.00 per ton; silage $3.00 per ton.

2d. - Where all the food stuffs are raised on the farm with the exception of cottonseed meal. As near as possible the value used was the estimated average farm value of the different feeds on the farm. Under this condition the food stuffs were priced as follows:- corn 50 cents per bushel; cottonseed meal $30.00 per ton; timothy hay $12.00 per ton; alfalfa hay $10.00 per ton; silage $3.00 per ton.

Tables 17, 18 and 19 give the cost of feed during the five winter months and the cost per pound of gain for each animal. By looking over these tables an idea of the cost of the different rations and the gain of each animal will show very plainly.

An average cost of each ration, while the age of the animals are not similiar, will show in a way the marked difference.

TABLE 17.

TOTAL AMOUNT OF FOOD CONSUMED

TOTAL COST AND COST PER POUND GAIN.

150 Days.

Lot 1.

	Corn	Alfalfa	Total Gain	Total Cost	Cost per Lb. Gain
No. 101					
When Purchased	300	1725.4	142	$16.47	11.6¢
When Raised on Farm				$11.30	7.9¢
No. 102					
When Purchased	300	1377.2	122	$13.69	11.2¢
When Raised on Farm				$ 9.56	7.8¢
No. 243					
When Purchased	300	2354.4	149	$21.51	14.4¢
When raised on Farm				$14.44	9.7¢
No. 246					
WHen Purchased	300	2543.0	169	$23.01	13.6¢
When raised on Farm				$15.39	9.1¢

TABLE 18.

TOTAL AMOUNT OF FOOD CONSUMED

TOTAL COST AND COST PER POUND GAIN.

150 Days

Lot 2.

No. 96			66				
	C.S. Meal and Corn	Timothy	Silage	Total Gain	Total Cost	Cost per Lb. Gain	
When Purchased	300	300	2990.9	123	$ 8.85	7.2¢	
When raised on Farm					$ 7.62	6.2¢	
No. 100							
When Purchased	286	300	2803.3	130	$ 7.19	5.5¢	
When raised on Farm					$ 6.01	4.6¢	
No. 244							
When Purchased	300	300	3070.0	143	$ 8.96	6.3¢	
When raised on Farm					$7 .74	5.4¢	
No. 248							
When Purchased	300	300	2876.5	96	$ 8.67	9.0¢	
When raised on Farm					$ 7.44	7.8¢	

TABLE 19.

TOTAL AMOUNT OF FOOD CONSUMED.

TOTAL COST AND COST PER POUND GAIN.

150 Days

Lot 3.

	Alfalfa	Silage	Total Gain	Total Cost	Cost Per Lb. Gain
No. 95					
When Purchased	932	2766.0	38	$11.60	31¢
When raised on Farm				$ 8.81	23¢
No. 98					
When Purchased	885	2522.2	51	$10.86	21¢
When raised on Farm				$ 8.21	16¢
No. 245					
When Purchased	1122	3330.7	124	$13.97	11¢
When raised on Farm				$10.61	9¢
No. 249					
When Purchased	992	2907.5	114	$12.30	11¢
When raised on Farm				$ 9.32	8¢

Lot	Average Total Cost		Cost Per Lb. of Gain	
	When Purchased	When raised on farm	When Purchased	When raised on farm
1	$18.67	$12.67	13¢	9¢
2	$ 8.42	$ 7.20	7¢	6¢
3	$12.13	$ 9.24	18¢	14¢

Lot 1 while producing the largest gains is not the most satisfactory from an economical standpoint.

Lot 2 was almost equal in gains to Lot 1 and yet the cost per animal was only one-third to one-half as much. The cost of a pound of gain, as can be seen by the table above is about half that of the other rations.

Lot 3 had a ration cheaper in total cost than Lot 1 but higher than Lot 2. The cost per pound of gain was higher in this lot than in any other. By taking the average of the Holsteins of this lot a very much smaller figure in cost per pound of gain would result, showing they were about the same as the average of Lot 1.

Taking everything into consideration as far as cost is concerned, the most economical ration of the three tried is that of corn and cottonseed meal (equal parts) - timothy hay - and silage.

SOME SUITABLE RATIONS FOR THE DAIRY HEIFER.

The following is a suggestion of the rations that are most suited for the following sections of the United States: Eastern, Central and Southern.

It is the object to give the amount of different foods required for a heifer; first, between the age of 8 and 12 months; second, between the age of 12 and 18 months.

In feeding the heifer the cost of the ration is the greatest factor with which the average farmer has to contend, no space will be given for this factor, except what has already been given.

Palatability may be the limiting factor that controls the amount consumed by the dairy heifer of some of the common foods. For instance, it is a well known fact that an animal will not consume as great an amount of timothy hay as alfalfa hay and for this reason she will not show the same condition after having all she will consume of the different foods.

In the eastern localities the conditions are such that the different nutrients can be supplied in the form of concentrates about as cheaply as in

the form of roughage. The fact that animals must have a greater amount of their ration in the form of roughage must not be overlooked however.

Eastern Conditions.

10 lbs. clover hay:)
6 lbs. timothy hay) For heifer 12 - 18 months old,
2 lbs. bran) weighing 650 pounds.

7 lbs. clover hay)
5 lbs. timothy hay) For heifer 8 - 12 months old,
2 lbs. bran) weighing 450 pounds.

Central Conditions

5 lbs. alfalfa hay)
20 lbs. silage) For heifer 12 - 18 months old,
2 lbs. corn) weighing 650 pounds.

2 lbs. corn stover)
15-20 lbs. silage) For heifer 8 - 12 months old,
1 lb. corn) weighing 450 pounds.
1 lb. C.S. Meal)

Southern Conditions

10 lbs. prairie hay)
10 lbs. silage) For heifer 12 - 18 months old,
2 lbs. C.S. Meal) weighing 650 pounds.

10 lbs. prairie hay)
5 lbs. silage) For heifer 8 - 12 months old,
2 lbs. C.S. Meal) weighing 450 pounds.

In many localities the suggested feeding stuffs will be impracticable to feed on account of the high price or difficulty to raise or purchase. In case this is true, the following substitutes can probably be secured to take their place, making very little difference in the ration.

Clover, alfalfa, soy bean, and cowpea hay are fair substitutes for each other and in case one of them is not obtainable another can be used.

Timothy hay, corn fodder, and Hungarian and prairie hay can be substituted for each other. They are all rather low in protein content and should when fed be accompanied with concentrates high in protein.

Bran, and malt sprouts are similiar in feeding value. Bran is probably fed to young stock to a greater extent than any other feed with the exception of corn. It has a high protein content and makes a light feed, because it does not pack in the animal's digestive tract, therefore easy to digest.

Silage is in a class where a substitute is difficult. Roots such as carrots, mangels and rut-

abagas are equal to about one-half that of silage in feeding value. By silage is meant corn silage. Other kinds of silage might be able to take its place equally well.

Cottonseed meal, and linseed meal are both known to have a very high protein content and for this reason are used in balancing a ration where protein is deficient. Cottonseed meal is one of the cheapest ways of furnishing protein in a ration. It is fed more in the south but is rapidly gaining in popularity in all localities.

Corn is the most widely distributed of feeds and one that is well suited for feed for growing animals. The protein content of corn is low. Wheat middlings and shorts are more like corn in composition and therefore will make a fair substitute.

NUTRIENTS REQUIRED FOR DAIRY HEIFERS UNTIL TWO YEARS OF AGE.

The figures previously shown in this work, give the amount of nutrients required by the dairy heifer during the winter months. From this and from data of other sources it is possible.

to estimate what the average dairy heifer will consume until two years of age.

The two conditions shown are;- when the heifer is dropt in the spring; and, when dropt in the fall.

The summer and winter periods are assumed to be 180 days each.

Spring Calving.

1st. Summer -- Whole milk 90 pounds,
Skim milk 3001 pounds
Hay 337 pounds,
Corn 127 pounds.

1st. Winter -- Corn 360 pounds
Alfalfa 1818 pounds.

2d. Summer -- Pasture

2d. Winter -- Corn 360 pounds
Alfalfa 2944 pounds.

Fall Calving.

1st. Winter -- Whole milk 90 pounds
Skim milk 3001 pounds
Hay 337 pounds
Corn 127 pounds.

1st. Summer -- Pasture.

2d Winter -- Corn 360 pounds
Alfalfa 2381 pounds.

2d. Summer -- Pasture.

	Spring Calving	Fall Calving
Whole Milk	90 Lbs.	90 Lbs.
Skim Milk	3001 "	3001 "
Corn	847 "	487 "
Alfalfa Hay	5099 "	2718 "
Pasture	6 Mo.	12 Mo.

Where there is plenty of pasture, as is found in the central and western states, the cost of raising the heifer until two years of age will be found much cheaper if dropt in the fall.

SUMMARY AND CONCLUSIONS.

This experiment was conducted in order to find the food stuffs required to winter the dairy heifer, and to make a comparison of the following rations:-

Ration 1 -- Corn 2 pounds; all the alfalfa they would consume.

Ration 2 -- Corn 1 pound; cottonseed meal 1 pound; timothy 2 pounds; all the silage they would consume.

Ration 3 -- Alfalfa and silage in the proportion of 1 pound of alfalfa to 3 pounds of silage. All they would consume in this proportion.

1. Taking into consideration the possible fluctuations in measurements it is believed that all animals on experiment made normal growth in height.

2. It is believed there was sufficient protein for normal growth in all rations fed. This is true of most rations where plenty of energy is furnished.

3. The lot receiving corn and alfalfa made the greatest gains and this ration would be considered the best if preference could be made. The main factor in the efficiency of this ration was the fact that the animals consumed more nutrients per day.

4. The nutrients advanced by Armsby for growing cattle, which apparently are meant to apply to beef cattle, appear unnecessarily large for growing dairy cattle.

5. Holstein heifers on experiment made greater gains per day, thru their growing period, than the Jersey heifers.

6. The gain in weight of all animals on experiment followed the energy content of the ration more closely than the protein content; i.e., the animals making the greatest gains received the largest energy value in their ration.

7. The Holsteins utilized their ration, when composed largely of roughage, to better advantage than the Jerseys.

8. Taking the local cost of all food stuffs, the lot receiving corn, cottonseed meal, timothy, and silage were wintered with the least cost.

ACKNOWLEDGMENT

The writer wishes to express his appreciation to C. H. Eckles, Professor of Dairy Husbandry, University of Missouri, for his helpful suggestions in the preparation of this paper.

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