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WINTER RATIONS FOR DAIRY HEIFERS

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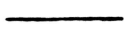
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## WINTER RATIONS FOR DAIRY HEIFERS

### INTRODUCTION

According to recent census statistics there are approximately 21,000,000 dairy cows in the United States. The problem of maintaining and increasing this number year after year is of vital importance to the future development of the dairy industry. It is estimated that this would require the feeding annually of 8,400,000 heifers to replace these cows. The experiment station reports show that it costs \$70 to raise a heifer to two years old, and that 70 percent of this cost is for feed. The greater portion of this cost is for feed when the animals are not on pasture. This makes the winter ration the greatest item of cost in raising a dairy heifer to maturity. It is thus of much importance that these rations shall produce normal

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growth at a reasonable cost. Most of the experiments which have been conducted along this line have been with beef cattle and can not be taken as a guide for feeding dairy heifers.

The problem of determining some suitable rations for wintering dairy heifers is made the basis of this work. Some consideration has been given to the scientific phases of the subject, but the study of the subject has been mostly from the practical point of view.

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GENERAL REVIEW AND DISCUSSION  
OF LITERATURE.

Very little experimental work has been done with rations for growing dairy heifers after the time of weaning. Most of the experiments which have been conducted have been with beef cattle. Although these have no direct relation to rations for dairy heifers, yet many of the principles involved have a direct bearing on this subject.

Feeding Standards for Growth.

There are three well known feeding standards which are designed to show the requirements for growing cattle. These are the Armsby<sup>1</sup>, Wolff-Lehmann<sup>2</sup>, and Kellner<sup>3</sup> Standards as shown in the following tables.

Armsby Standard for Growing Cattle.

Age Months	:Live :Weight :Pounds	:	:Digestible Protein: :Pounds.	:	: Net energy : value : Therms	:
3	: 275	:	1.1	:	5.0	:
6	: 425	:	1.3	:	6.0	:
12	: 650	:	1.65	:	7.0	:
18	: 850	:	1.7	:	7.5	:
24	: 1000	:	1.75	:	8.0	:
30	: 1100	:	1.65	:	8.0	:

Wolff-Lehmann Standard for Growing Dairy Cattle.

Age	Months	Weight	Per Day per 1000 lbs. live weight:			
			Dry	Digestible Nutrients		
		Matter	Protein	Carbohydrates	Fat	
		Pounds	Pounds	Pounds	Pounds	
2-3	150	23	4.0	13.0	2.0	
3-6	300	24	3.0	12.8	1.0	
6-12	500	27	2.0	12.5	.5	
12-18	700	26	1.8	12.5	.4	
18-24	900	26	1.5	12.0	.3	

Kellner Standard for Growing Dairy Cattle.

Age	Months	Live Weight	Per day per 1000 lbs. live weight:			
			Dry	Digestible Nutrients		
		Matter	Protein	Starch	Crude	Fat
		Pounds	tein	Equiv	Protein	Lbs.
			Lbs.	Lbs.	Lbs.	Lbs.
2-3	150	23	3.4	18.5	3.7	2.0
3-6	300	24	2.8	14.7	3.1	1.0
6-12	500	26	2.3	12.5	2.6	.6
12-18	700	26	1.8	10.5	2.2	.4
18-24	900	26	1.3	9.2	1.6	.3

It will be noticed that Armsby's Standard applies to growing cattle in general, while the other two are specifically for growing dairy cattle. Since animals vary in weight for their age, the weight in all of the standards is to be considered more than the age in determining the requirements of an animal.

These standards show a wide variation in the amount of protein for animals of the same age. This is due in part to Armsby making his calculations on a basis of digestible amid-free protein, while the others are for total digestible crude protein or for both of these forms of protein. Kellner's starch values are based on the total starch values of feeds as used by an ox in the process of fattening. Armsby represents the total nutrients in terms of energy, while the total nutrients in the Wolff-Lehmann Standard are shown only in the total dry matter. The fat requirements and the total dry matter are practically the same for both the Wolff-Lehmann and the Kellner Standards.

Proportion of Concentrates to Roughage  
In a Ration.

The feeding standards give the total nutrients required for growing animals of different ages but they do not indicate, except in so far as a figure is given for total dry matter, what proportion shall be in the form of concentrates or of roughage. It is well known that ruminants require some roughage on account of the nature of their

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digestive tracts. While they thrive better if a portion of their ration is in the form of concentrates, it is possible for them to grow to maturity and perform all functions with roughage alone.

The proportion of roughage fed will depend somewhat on whether the young animals are being fed for beef or simply for growth. In cases of fattening beef animals it is often the practice to give almost twice<sup>4</sup> as much grain as roughage, but this is not<sup>to</sup> be recommended for growing animals of any kind.

The Illinois Station<sup>5</sup> has shown that dairy heifers do not do well when roughage is lacking, even though the other feed is given in much variety and in large amounts. Such heifers first showed a ravenous appetite with good digestion and finally an indifference to food and a loss of flesh. Similar results were also obtained at the Utah Station.<sup>6</sup>

The Georgia Station<sup>7</sup> speaks of a normal ration for steers as one in which 70 percent of the net energy is supplied in the form of silage and 30 percent in the form of concentrates. This, however, can not be said of all rations as the percentages of nutrients in both concentrates and roughage vary

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within wide limits. The Indiana Station<sup>8</sup> in a feeding trial with beef animals concluded that any form of dry roughage satisfies the desire of cattle for variety, and that the quantity consumed furnishes - such a small proportion of the food nutrients eaten that the class of dry roughage fed fattening steers makes little difference. This may be true of beef cattle when large amounts of grain are fed, but it is not the general practice with growing dairy cattle.

The Iowa Station<sup>9</sup> reports that when light grain rations are fed to growing beef cattle, more roughage is consumed than when a medium or heavy grain ration is fed. The Indiana Station<sup>8</sup> also found this to be true with beef cattle in feeding silage and that the consumption of shelled corn was decreased in amounts closely approximating the grain contents of the silage consumed by the cattle. More grain and less hay was consumed<sup>10</sup> when clover was used than when alfalfa hay was fed. A ration, the greater proportion of which<sup>11</sup> was roughage, was most efficient in making gains with young cattle.

Character of the Ration -- Three of the factors, under this heading, which influence the proportion

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of concentrates to roughage in a ration are the energy values, the palatability and the bulkiness of feeding stuffs.

The first of these to be considered is the energy values which includes the total nutrients in their various forms. Armsby's table shows that growing cattle of different ages vary in their requirements of total energy and that a certain proportion of this energy must be in the form of digestible amid-free protein. The Wolff-Lehmann standard also gives a definite amount of digestible protein for growing dairy cattle, but represents the other requirements in digestible carbohydrates and fat. By using the analyses of different feeds as published by the United States Department of Agriculture<sup>1</sup> or by manufacturers of feeds, it is possible to make the nutrients of a ration conform approximately to any one of the common feeding standards. Experience has shown that these are a good guide for feeding cattle and that poor results may often be attributed to a poorly balanced ration according to the feeding standard. On the other hand, recent investigations show that the feeding standards cannot be taken entirely as a guide in forming rations.

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Talbot<sup>12</sup> says, "The nutrients advanced by Armsby for growing cattle, which apparently are meant to apply to beef cattle, appear unnecessarily large for growing dairy cattle."

In writing on the same subject Henry and Morrison<sup>13</sup> state that numerous experiments show that mature animals of all classes can be successfully fattened on a much smaller allowance of crude protein than is called for in the Wolff-Lehmann Standard.

Brandt<sup>14</sup> in a feeding trial with dairy heifers concludes, "The energy required for a pound of growth by animals on a light as compared to a heavy ration is practically the same provided they receive as much protein in the light ration as in the heavy ration."

The Kansas Station<sup>15</sup> found that within certain limits the gain of steers depends somewhat upon the available protein, regardless of the amount of carbohydrates in the feed. The results at the Nebraska Station<sup>4</sup> from their work with steers indicates practically the same thing. In this, the energy values for two rations were the same, while the amounts of protein were different. The ration

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with the greater amount of protein gave the greater gains.

The Wisconsin Station<sup>16</sup> summarizes their work in growing dairy cattle to maturity as follows, "Unquestionably the physiological value of a ration is largely dependent upon the chemical constituents, but the usual determinations made on feeding materials do not reveal the character or manner of combination of many of the constituents."

In general practice suitable rations may be made from common feeding stuffs by simply balancing them to the requirements shown by the feeding standards. Until more information is available such standards will remain to the feeder as the only scientific guide, other than practical experience, for feeding dairy heifers.

The second factor to be considered is the palatability of feeds. Practically no work has been done on this subject as related to feeds for cattle, but it is a well known fact that some animals like certain feeds better than others and will eat more of such feeds than they will of others containing apparently the same nutrients. Talbot's<sup>12</sup> figures show that dairy heifers ate more of an alfalfa ration than of a silage ration and thus made greater gains.

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The Tennessee Station<sup>17</sup> gives an example of first crop clover being more palatable for steers than the second crop. The Ohio Station<sup>18</sup> speaks of silage as being a palatable feed for cattle when it has been properly stored. This, however, is not always immediately evident upon feeding different rations as it often happens that animals must become familiar<sup>19</sup> with a new feed before they like it.

If roughage is in such a condition as to be unpalatable the tendency is for animals to eat less roughage and thus require more concentrates. If this is not supplied, an unbalanced ration may result with a falling off in the total nutrients consumed, as was found in the case with steers at the Nebraska Station<sup>4</sup>.

The Illinois Station<sup>5</sup> states that animals will sometimes consume enormous amounts of a ration, for a short time, in a vain attempt to satisfy an abnormal appetite. This may, however, be the result of an unbalanced ration as mentioned above.

The indications are that an animal will thrive better on a palatable ration than on another ration which is not palatable even though it may supply the same nutrients.

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The third factor to be considered is the bulkiness of the feeds. It is quite true that it is possible to have a ration of so great a bulk that animals cannot eat as much as they need to supply the proper amount of nutrients. Caine<sup>20</sup> says in comparing a clover and silage ration for dairy heifers that, "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." Steers<sup>21</sup> are known to consume more of a narrow ration than of a wider one, thus decreasing the proportion of roughage, and increasing the proportion of concentrates.

Waters, Cochel and Vestal<sup>13</sup> working with steers make the following statement, "If insufficient feed is supplied to distend the digestive tract and force out the ribs and hips when yet plastic, the body of the animal will never attain the desired conformation." On the other hand, the work<sup>22</sup> of Eckles with dairy heifers indicates that mature heifers which have been raised largely on roughage do not have a greater capacity for handling feed than those which have received less roughage during

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the growing period. However, the work of the latter showed a temporary difference in the consumption of feed by animals raised on two such rations.

Although roughage is necessary and may often constitute the entire ration yet there are times when a portion of the nutrients must be given in the form of concentrates in order to secure normal growth.

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Age and Size -- Henry says, "Calves will eat roughage at about the same time they begin to eat grain, viz, two to three weeks of age and will consume about the same quantity of each at first. As the calf grows older the proportion of roughage to grain increases and by the time the calf is six months of age it will have consumed about three times as much roughage as grain."

It is well known that the ration at this age is often entirely of roughage. Whether or not this is the best practice for dairy heifers remains to be decided; but most of the experiments with growing beef cattle indicate that some grain should be fed.

The size or maturity of the animal rather than the age is a governing factor in determining the

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nutrients required. The feeding standards show that there is a gradual decrease in the amount of protein required per 1000 pounds live weight, from a comparatively early age up to about two years old. At the same time the total dry matter tends to increase faster than the age or weight. This would tend to indicate that the proportion of roughage to concentrates in a ration may be greater as the animal approaches two years of age and above.

Maintenance Requirements of Animals -- The housing of cattle from exposure is an important factor effecting the maintenance requirements of an animal. A great many experiments have been carried on to show this with reference to cattle. In an experiment with beef cattle the Missouri Station<sup>24</sup> reports the following, "The cost of maintenance is least in the spring and greatest is the winter. During the other seasons it is intermediate." They also found that the cost of maintenance was increased by a previous full-fed period, by greater activity and by poor thrift of animals. At the same time the cost of maintenance tended to decrease with increasing age.

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An increased cost of maintenance is evident from the common observation that an animal eats more feed during cold weather. This is usually taken in the form of roughage, thus indicating that the proportion of roughage to concentrates in a ration may be increased during the cold season of the year.

Cost of Feeds -- The factors already considered have not been related in any respect to the cost of the feeds. An animal may eat more of a palatable ration and make better gains than when fed on one less palatable, yet the latter may make fair gains in weight and be far more economical than the former. Any two feeds may be compared in this respect both as to the growth which they produce and as to the cost of this growth. The cost of different rations varies as the cost of the feeds which compose them, and accordingly the cost of the various feed stuffs becomes a factor in determining the proportion of feeds which go to make up an economical ration. This is a well known fact and has been demonstrated by many experiment stations. The following work referred to shows the cost of feeds to be an important factor in determining the proportion of concentrates to roughage in a ration.

The work of Talbot with growing dairy heifers shows that gains in weight from a ration of

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corn, cottonseed meal and silage were made at a less cost per pound than from a ration of corn and alfalfa, or of alfalfa and silage. At the same time the corn and alfalfa ration produced slightly greater gains.

The Indiana Station<sup>8</sup> found that steers receiving clover hay as the only roughage, or in combination with corn silage, made more economical gains than those fed on alfalfa. In another trial<sup>25</sup> with steers they found that when oat straw was substituted for clover hay in a ration containing shelled corn and cottonseed meal, no marked effect was produced in the gains but the cost of gain was reduced 42 cents per hundred weight. The more<sup>8</sup> nearly corn silage replaced the clover hay in a ration of shelled corn, cottonseed meal and clover hay, the cheaper were the gains in weight, and the greater the profit. The advantages<sup>11</sup> in the use of clover hay instead of timothy were found to be more rapid and cheaper gains, and less feed to produce a pound of gain.

The work at the Iowa Station<sup>9</sup> with beef animals led to the following conclusion, "Gains on fattening cattle can be made at a smaller cost with light or medium grain rations than when heavy grain rations are fed."

The Nebraska Station<sup>4</sup> reports the follow-

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ing from work with steers, "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 one-third full feed along with hay, is more economical."

This of course depends on the character and cost of the feeds used. The cost of the gains from a given ration vary as the cost of the feeds composing it.

Henry says<sup>26</sup>, "That under certain conditions it may be profitable to carry growing animals through the winter on roughage alone, even though they lose slightly in weight, for on a return to good pasture animals in spare but thrifty condition make exceedingly economical gains."

The best basis on which to compare the cost of different feeds is probably the cost per pound of the different nutrients which it contains. There may be times when high priced rations produce the most economical gains. However, when experimental results are lacking in comparing different rations it is best to select the rations according to the cost of the nutrients.

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Amount of Dry Roughage.

The roughage of a ration is usually in a dry form but sometimes this is lacking. Talbot<sup>12</sup> added a small amount of timothy hay to a ration for dairy heifers when the roughage was entirely of silage. In his experiment the animals showed a craving for some kind of dry roughage and the timothy hay seemed to supply this need, otherwise the animals would eat their bedding. Caine<sup>20</sup> had a similar experience with dairy heifers and suggested that some form of dry roughage was needed in the ration. In this case the gains in weight from silage were hardly equal to those of a clover ration, but this may have been due to other influencing factors.

The Pennsylvania Station<sup>27</sup> found that steers made practically the same gains in weight with silage as the only roughage as when mixed hay was added to the ration. Most of the experiments reported show that some form of dry roughage was given with silage. The Indiana Station<sup>8</sup> gave oat straw with silage to steers and got as good gains as when clover hay was given in the ration.

The indications are that dry roughage is not an essential part of a ration for fattening beef

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animals, but that growing animals craving such a feed may be the result of requirements for other nutrients which are essential for normal growth.

### Variety and Succulence

Variety in rations may be obtained by giving several feeds at one time or by changing one feed for another from time to time. In general practice little importance is attached to variety of feeds in feeding growing cattle, yet the most successful feeders of milk cows consider it as an important factor. The Wisconsin Station<sup>16</sup> found in feeding rations from restricted sources to dairy heifers that monotony of ration was not a troublesome factor, and that variety was of less importance in nutrition than is usually supposed. While this experiment does not indicate that the appetites of the heifers were influenced by a lack of variety, yet when a greater variety was used the resulting effects on the animals were more favorable in most cases.

There are many experiments which go to show that the addition of one or more kinds of feed to a ration has improved the results. Such results have probably been due to the addition of some necessary nutrients either known or unknown.

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From these facts we may conclude that the object of variety is not to keep up the appetite of an animal, but to furnish a combination of nutrients which will meet the actual requirements of an animal. When there are few feeds in a ration there is greater chance of some essential nutrient being absent than when other feeds are added. At the same time the ration, in the former case, may meet the requirements of feeding standards. Lack of variety is seldom the case in a ration properly balanced, yet it is possible to make such a combination of feeds and thus hinder the best development of an animal. The results of actual feeding trials is the only guide in such a situation.

Henry and Morrison<sup>28</sup> say that succulence induces the consumption of more feed. Again they say that such feeds have a beneficial laxative action which aids greatly in keeping the digestive tract in good condition. There are many cattle which are raised without any form of succulence so that this factor can be considered of only minor importance.

#### Influence of the Ration.

It is well known that different types of cattle use their feed in different ways. The dairy

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cow will use her feed to produce milk, while the same feed for a beef animal will go to produce flesh. In the case of the latter the ultimate object is to produce meat as shown by gains in weight. At the same time, the feeder realized that growing animals must make reasonable growth in skeleton. With the dairy animal it is more important to get skeleton development than mere gains in weight. Most of the work with skeleton growth has been with growing dairy animals, while that of weight has been with beef animals. There is no known means of expressing growth in one unit, but a number of factors must be considered in expressing it. The earliest experiments show that weight was taken as a measurement of growth and this still remains the most widely used unit of measure.

A few experiment stations have included skeleton dimensions as a measure of growth, which taken with weight is probably better than either taken alone. Recent investigations show that even these cannot be taken as a final measure of growth for dairy cattle, as some rations for growing cattle seem to influence the normal functioning of these animals when mature. It thus becomes apparent that

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in comparing different rations it is necessary to consider the various influences which it may have on an animal. These include the influences on the mature size and conformation of an animal, the breeding and dairy qualities, the sexual maturity, and the length of the growing period.

Armsby<sup>29</sup> fed the same ration to a beef animal and one of dairy type. The beef animal showed a tendency to fatten while the other increased more rapidly in length and height. Flint<sup>30</sup> in his work with growing cattle under one year of age fed a ration of corn meal, linseed meal, and alfalfa hay to each of three groups. Oat straw was added to the ration of two of these. The three rations were so balanced that one contained the amount of protein prescribed by Armsby, while the other two were respectively higher and lower in protein content. At the same time, the energy values in all cases were equal. From his work he concludes, "While the results by lots indicate that the greater protein supply of Lots 2 and 3 caused greater gains, a study of individual gains showed that individuality played a greater part than did the protein supply."

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The Nebraska Station<sup>4</sup> in a feeding trial with steers concludes, "Some protein-rich food like oil meal added in a small quantity to a ration of corn and prairie hay, to give a better balance of nutrients, lessens very considerably the amount of food required for a given gain, and lessens the cost of gains."

"A combination of alfalfa hay and corn makes a satisfactory ration without commercial protein foods, being much superior to corn and prairie hay."

An extensive investigation has been carried on at the Indiana Station in comparing rations for steers. The following report is made, "The addition of corn silage to rations of grain and leguminous hay was followed by a slight increase in the rate of gain made by the cattle."<sup>10</sup> In another experiment<sup>11</sup> clover hay made more rapid gains than timothy hay. In a trial<sup>21</sup> comparing the protein from different sources the following rations were used:

Ration 1. Ear corn and clover hay.

Ration 2. Ear corn and oil meal, with shredded stover and oat straw.

Ration 3. Ear corn, shredded stover and oat straw.

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The results show that Ration 1 followed in order by Ration 2, was most efficient in rate of gains in weight produced, while Ration 3 was not efficient in the gains produced and was unprofitable. This goes to show that the greater portion of the protein may be supplied in a ration either in the form of concentrates or of roughage.

In an experiment with dairy heifers, Caine<sup>20</sup> compared the following daily rations:

Ration 1, Grain 2 pounds, (Corn and cottonseed meal, equal parts)

Silage, all they would clean up.

Ration 2. Corn 3 pounds.

Clover hay, all they would clean up.

In his conclusion he says, "The work with the six animals on the short feeding periods shows that a ration with silage as roughage, while cheaper and adequate to carry heifers through the winter in thrifty, growing condition, is hardly equal, judging from general appearances, to one in which clover furnishes the roughage."

The gains per day were .73 pounds for the silage group and .89 pounds for the clover group.

The New Jersey Station<sup>31</sup> compared a silage

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ration with a soiling crop ration for calves and yearlings. The soiling crops were mostly of green alfalfa. The resulting gains in weight indicated practically no difference between the two rations.

The following rations<sup>12</sup> were compared by Talbot in wintering dairy heifers.

Lot 1. Corn meal, 2 pounds.

Alfalfa hay, all they would clean up.

Lot 2. Grain 2 pounds, (Corn and cottonseed meal, equal parts), Silage all they would eat.

Timothy hay. 2 pounds.

Lot 3. All the roughage they would clean up, consisting of one pound of alfalfa to three pounds of silage.

The gains per day were the following for lots 1, 2 and 3 respectively, .97 pounds, .82 pounds, and .54 pounds.

The work of Waters', Cochel and Vestal with cattle as quoted by Henry and Morrison<sup>32</sup> indicates that supplying a young growing animal with a scant ration for a short period only, will have no permanent effect on its development. Waters'<sup>33</sup> work showed that animals which had been previously well nourished continued to increase in height and in

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width of hip for a considerable length of time even though on a starving ration. This results from an animal drawing on the reserve tissues of the body. He says, "Our experiments indicate that after the reserve is drawn upon to a certain extent to support growth, the process ceases and there is no further increase in height or in length of bone."

"When animals were maintained on a low nutritive plane the effect upon the skeletal width development was more immediate and more marked than it was upon their skeletal height development."

He<sup>34</sup> goes so far as to state that animals will increase in height while starving. At the same time, his work showed that on the whole the full fed animals increased in height more rapidly than did animals on maintenance.

Henry and Morrison<sup>35</sup> say, "The skeleton is not affected by poor nutrition until practically all the fat has been removed from the fatty tissues."

Brandt<sup>14</sup> conducted a feeding experiment with dairy heifers in which a comparison was made of a light ration consisting of alfalfa, cowpea hay and clover hay with a heavy ration of the same

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roughage including grain. The average gains per day on the light ration were .79 pounds and 1.28 pounds on the heavy ration.

Eckles<sup>22</sup> in speaking of the same experiment gives the following, "The heavy ration resulted in a more rapid growth of skeleton, especially during the period of most rapid development. Later the heavy ration resulted in the animals becoming much fatter. The animals receiving the light ration grew less rapidly, but growing continued longer. This group never reached quite the size of those having the heavier ration when young. The difference between a heavy and a light ration for growing heifers shows more strongly upon the weight than upon the rate of skeleton growth."

"The time of sexual maturity of the animal is influenced to a considerable extent by the ration. Those receiving the heavy ration mature sexually at an age of from two to four months younger than those receiving the light ration."

"Heavy feeding when young tends towards the development of larger and somewhat coarser animals than lighter rations. At time of calving the conformation of the animal raised on a heavy

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ration is somewhat different from that of one raised on a ration of roughage. If both are placed on the same ration after calving this difference soon disappears."

"Within limits of variation, even far beyond the normal, the character of the ration with reference to amount of nutrients supplied does not exert any appreciable effect upon the milking functions of the cow when mature."

The results of the above experiment seem to indicate that the ration has little effect upon the reproductive function. On the other hand <sup>16</sup> the work of the Wisconsin Station with dairy cattle, as mentioned above, shows that rations fed from restricted sources had a decided influence upon the reproductive function. In this trial the animals were on experiment from birth to four years old. The rations fed were exclusively from the corn, wheat and oat plants for the respective Lots 1, 2 and 3. The ration received by Lot 4 was a mixture of the feeds in the first three lots.

In discussing the growth of the animals in this experiment the authors give the following,

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"So far as the rates of growth and gains in live weight of all these animals are concerned, there was nothing to indicate that one ration was very much superior to another. Had these animals been males with none of the additional strain of milk production and pregnancy added to their function of growth, the evidence from records would reveal little difference in the physiological effectiveness of these rations".

They summarize their results as follows, "Animals fed rations from different plant sources and comparably balanced in regard to the supply of digestible organic nutrients and production terms were not alike in respect to general vigor, size and strength of offspring and capacity for milk secretion."

In summing up these facts it may be said that the normal gain in the weight of a growing animal is not necessarily an indication of the normal functioning of the animal when mature. Nevertheless, under ordinary conditions, the growth according to weight and skeletal measurements may be used as an indication of the relative values of different rations fed to dairy heifers. Within the limits of ordinary feeding practice the rations used

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for growing animals are not known to vary in their effects on the normal functions of mature animals, yet such a difference is possible and remains to be determined.

Until more complete information is available a combination of weight and skeleton measurements will remain as the only means of comparing the <sup>effect</sup> of different rations for dairy heifers.

#### Utilization of Rations by Different Breeds.

Very little work has been done to compare the utilization of rations by different breeds of dairy heifers. The data at the Missouri Experiment Station<sup>22</sup> from an experiment already mentioned, show that light fed Jerseys made greater gains in weight than light fed Holsteins. When a heavy ration was given, the results were the reverse. The data indicates that the two methods of feeding produced relatively the same growth in the height at withers for each breed. Brandt<sup>14</sup> in his work on the same experiment shows that the Holsteins made greater gains in weight per day than the Jerseys, but this is to be expected since the Holsteins are a larger breed. In his conclusion he says,

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"Animals of different breeds require practically the same nutrients for a pound of growth".

The Ohio Station<sup>36</sup> showed that Holsteins made greater gains in weight per day than Jerseys even though they received the same ration. Talbot's<sup>12</sup> work with dairy heifers shows the same results. He says in summarizing: "The Holsteins utilized their ration, when composed largely of roughage, to better advantage than the Jerseys".

The data on this subject are so meager, and so few animals have been used in the experiments cited that no definite conclusions can be drawn.

#### Cost of Raising Dairy Heifers

During the last few years more attention than formerly has been given to the cost of raising heifers. In considering this subject, the cost of feed is found to be the largest item. The other things to be considered in determining the total cost are; value of the calf at birth, cost of labor and bedding, taxes, rent, and a number of small miscellaneous items. The following table shows the cost of raising a heifer to two years old as determined by different experiment stations.

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TABLE I.

Cost of Raising a Heifer to 2 Years Old.

	: :Storrs :Conn. (37)	: :Ohio :(36)	: :Mass. :(38)	: :Wis. :(39)	: :Av. :Cost
Cost of feed	: \$ 55.00	: \$ 56.32	: \$ 57.72	: \$ 40.83	: \$ 52.47
Other costs	: 16.00	: 32.68	: 24.51	: 28.58	: 25.44
Total cost	: 71.00	: 89.00	: 82.24	: 69.41	: 77.91
Credit by Manure:	5.00	9.00	8.00	8.00	7.50
Total Net Cost	: 66.00	: 80.00	: 74.24	: 61.41	: 70.41

This table shows that there is little difference in the cost of feed as found by the various stations. The other costs vary considerably. This is due in part to some stations not including all of the items which go to make up the total cost. For example, the Storrs Station did not include the initial value of the calf. The table shows \$70.41 to be the average net cost of raising a heifer to two years old. The following table shows the total cost of feed for a heifer to one year of age. The wide variation in cost here is due in part to differences in the climatic conditions at the various stations.

TABLE 2.

Cost of Feed to 1 Year of Age.

(37): Storrs	(39): Wis.	(36): Ohio	(40): Mich.	(41): Canada	(42): Alabama	Average: Cost
\$28.00	\$24.67	\$28.53	\$27.59	\$34.45	\$11.77	\$25.83

This shows the average cost of feed to one year of age to be \$25.83.

The Ohio Station<sup>36</sup> shows that the cost of raising different breeds is not the same. This with the gains in weight per day are shown in the following table.

TABLE 3.

Cost of Feed for Jerseys and Holsteins.

Time	Holsteins		Jerseys	
	Cost	Gain Per Day	Cost	Gain per day
		Lbs.		Lbs.
1st. year	\$29.31	1.3	\$27.75	1.1
2d year	29.53	1.0	27.12	.8
1st and 2d yrs	58.12		54.51	
To time of calving	66.37		64.22	

This table shows that there is little difference in the cost of feed for the first and second

years within a breed. It also shows that it costs slightly more to raise a Holstein than a Jersey, and that the former makes greater gains in weight per day. The cost of raising a Holstein to calving is shown as \$66.27, and \$64.22 for a Jersey. These figures seem to be a little higher in regard to the total cost of feed than the average found by other stations.

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EXPERIMENTAL DATA.

Plan of Experiment.

The data upon which this thesis is based represent one of a series of experiments concerning the wintering of dairy heifers which was begun in 1913. The experiment planned for 1915 - 1916 was a further comparison of certain rations for wintering heifers. Twelve animals were used, divided into three groups of four each. It was planned to have the animals as near the same weight and age as possible in the different groups. During the 10 day preliminary feeding period it was found that some of the animals would not take to some of the rations and other animals were substituted. The result was that Group III included smaller animals than the other groups as shown by the total weights at the beginning of the experiment.

Animals Used -- The animals used in this experiment were pure bred Holsteins, Jersey and Ayrshire heifers owned by the University of Missouri. Table 4 gives the breed, of each animal and the weight, height at withers, and age at the beginning

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of the experiment.

It will be noticed that all of the animals of Group I were under size as to weight for their age. This was also true of two of the animals in Groups II and three animals in Group III. In height at withers each group had at least two animals which were decidedly below the normal height for their age. The average ages were 17.5, 12.4 and 11.6 months for the respective Groups I, II and III. Taken in the same order the total weights of the groups were 2180, 2007 and 1783 pounds. This shows that Group III was slightly younger and smaller than the other two groups, and may account in part for their smaller gains in weight during the experiment. But under ordinary conditions, we would expect the younger animals to make the greater gains per day.

Rations -- The rations fed were as follows:

Group I - Corn meal 2 pounds, and all the alfalfa hay and silage they would eat. One pound of alfalfa hay was given for each three pounds of silage.

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Group II - Corn meal 2Lbs. and all the alfalfa hay they would eat.

Group III - Grain, equal parts by weight of corn and cottonseed meal, 2 pounds of timothy hay, and all the silage they would eat.

It was planned to give the grain to Group III in such amounts as to make the energy and protein values of the ration according to live weight equal that received by Group II. In calculating this the Holsteins and Jerseys of Group II were taken as the basis for the rations of animals of the same breeds in Group III. The energy values and the protein of the feeds in the rations received by Groups I and II were not the same, and this together with the variable appetites of the two groups made it impossible to keep the nutrients exactly the same by 30 day periods for the two groups. All of the groups were placed on a ten day preliminary feeding period, and were on full feed when the experiment started November 18, 1915. All of the feeds were of good quality. The feed for each animal was weighed each morning and evening and a complete record kept including the weight of any feed which was not eaten.

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Stabling -- The animals were kept as near under the same conditions as possible. Group I was kept in the main dairy barn, while Groups II and III were stabled in a small experimental barn, where each had a separate box stall. Each day the heifers were allowed to run in a dry lot where they had access to salt and to plenty of fresh water. When the weather was favorable they remained outside most of the day.

Weights and Measurements -- The heifers were weighed at the beginning of the experiment, ten days later and at 30 day intervals thereafter, and at the end of the experiment. The weights were obtained by taking an average of the weights for three successive days. This eliminated to a large extent the possible error resulting from daily fluctuations in weight.

The height of each animal was taken at the withers at intervals corresponding to the average weights. The height measurement used is an average of three measurements taken the same day.

Feeding Standard -- The total digestible protein and the total energy of the feeds consumed

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by each animal were calculated according to Armsby's table<sup>44</sup>. This table was also used as a basis for the calculations in keeping the nutrients the same for Groups II and III.

Total Feed Consumed -- The total feed consumed by the experimental heifers during 150 days, November 1 to April 1, for two different years is shown in Tables 17 and 18. These show not only the amounts of different rations consumed by groups, but the ages and the weights of the animals when the experiment was begun. With the corn and alfalfa ration there is a decided difference between the two years in the total feed consumed, but this is due to the fact that the corn was not fed in the same amounts. By referring to Table 27 it will be seen that on the whole there is very little difference in the total dry matter consumed by groups receiving the same ration in different years.

Gains in Weight -- Table 19 shows the total weights of the three groups for the various periods. It will be noticed that the total gains in weights were 713, 543 and 460 pounds for the respective Groups I, II and III, and that the gains

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in pounds per day were 1.18, .90 and .76 for the three groups. Table 20 shows a very marked difference in the gains between Group I and III, as there was no animal in Group III which gained as much as any one animal in Group I. Group II seems to be somewhat intermediate to the other two, as one animal in this group gained as much per day as one in Group I, and three others gained less per day than the two best of Group III. The data show that the alfalfa, silage and corn ration produced the greatest gains. This was followed in order by the corn and alfalfa ration, and the timothy, hay silage and grain ration. The gains in weight by days for the groups are shown in Figure I, and the average gains per day by groups in Figure II.

#### Nutrients Received by Heifers.

Tables 5 to 17 inclusive, show the total feed and nutrients received by each heifer by 10 day periods. The height of the animals at the withers and the weights are also shown in the same tables.

Tables 21, 22 and 23 show the total

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digestible protein and the total therms of energy received by each animal by thirty day periods. They also show the average of these for each day and per 1000 pounds live weight. The averages in all of these tables are calculated from the total digestible protein, and the total therms of energy. In these tables it will be noticed that the Jerseys received more nutrients per 1000 pounds live weight than the Holsteins fed on the same ration. The only exception to this is that the heifer No. 254, Table 22, received more protein for her size than any other animal in the group. This was due in part to the fact that most of the protein was in the form of roughage and as she was much larger than either of the Jerseys of the same group she was able to consume a much larger portion of her ration in the form of roughage. In therms of energy per 1000 pounds live weight she was exceeded to a slight extent by the Jersey heifer 108. The Ayrshires, Table 21, consumed slightly more nutrients for their size than did the Holstein or the Jersey on the same ration. Table 24 shows that on the average the amount of protein consumed per day was dependent more on the ration, Figure III, than on animals of

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different ages, and that there was considerable difference between the various rations. The ration in which the least protein was consumed was one composed of alfalfa, silage and corn, and the greatest was for the ration of alfalfa and corn.

Protein Consumed -- The protein used in proportion to live weight varied but little for animals fed on the same ration as shown in Table 24. In Talbot's experiment two rations show a marked difference in the consumption of protein by breeds, but in all other rations the differences are quite small. This is due in part to the Jerseys Nos. 95 and 98 not being able to consume as much roughage as Holsteins in the same group. The greater amount of protein received by No. 96 and No. 100 is due in part to the fact that the grain was fed in the same amounts to all animals in the group, and this contained most of the protein. Since these two animals were smaller than the other two this resulted in these two receiving more protein for their size than the other two. This was not the case with the animals in any of the other groups, as the feeds furnishing the protein were given according to the appetites of the animals.

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Energy for Growth -- Tables 25 and 26

show the total energy available for growth above maintenance. This is calculated on a basis that 6 therms of energy are required daily for the maintenance of 1000 pounds live weight. In general, the gains in weight tend to follow the energy available for growth of animals receiving the same ration. The large gains for the available energy of No. 102, Table 25, may be due in part to the fact that she was due to calve about a month after the end of the experiment. The water about the foetus would account for a part of this weight.

The amount of protein also seemed to influence the gains in weight to a very slight extent in some cases. There is a marked difference between various rations, Figures IV and V, in this respect as shown by the fact that the corn and alfalfa group, Table 25, received more energy above maintenance than the corn, alfalfa and silage group. At the same time the latter ration produced greater gains in weight, Figure VI.

The ration of alfalfa, silage and corn, Table 25, produced the greatest gains for the available energy of any of the rations. It shows that an average of 2.3 therms of energy were required to

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produce a pound of gain. The ration of alfalfa and silage, Table 26, required 3.68 therms of energy per pound of growth, and this was greater than that of any other ration. There was a little difference in the energy required per pound of growth for the same rations fed in different years, but this may be the result of feeding more grain in the rations. The corn and alfalfa rations produced almost identical gains in weight for groups of four animals for two different years.

Dry Matter -- The total dry matter consumed in proportion to weight of the animal and for different rations is shown in Table 27. It has already been mentioned that the average total dry matter consumed by groups of heifers fed on the same ration varies but little, Figure VII, even though the proportion of the feeds is changed to a slight extent. There is, however, a marked difference in the amount of dry matter consumed from different rations. This table shows that the greatest amounts consumed were those of the corn and alfalfa ration, while the dry matter from the silage, timothy and grain ration was consumed in the least amounts for the size of the animals. The alfalfa and silage

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rations were intermediate to the other two rations in this respect. The different breeds within in a group did not show any regular difference in the amounts of dry matter consumed for their size. In most cases the gains in weight are closely associated to the consumption of dry matter within a group, but this is not true when comparing different rations as the group receiving alfalfa, silage and corn made the greatest gains in weight, and was intermediate to the other groups in the consumption of dry matter. By comparing this table with Tables 17 and 18 it will be noticed that the weights of certain rations was a partial indication that these rations were of too great a bulk to be consumed in the same amounts, as to nutrients, as other rations. The bulkiness of the ration as well as the palatability were probably important factors influencing the amounts of the different rations which were consumed.

Comparison of Different Rations.

Corn and Alfalfa -- Rations composed of the same feeds and fed to animals of approximately the same weight in different years are shown in Tables 28, 29, and 30. Table 28 shows rations of alfalfa hay fed with 2 pounds of corn, and with 3

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pounds of corn. By giving 3 pounds of corn there was a marked decrease in the consumption of alfalfa for animals of the same size. No. 251 receiving 3 pounds of corn does not show as great a decrease as the others, but this is due to the fact that she was much larger than the corresponding animal receiving 2 pounds of corn. According to Table 39 approximately 150 pounds of corn is valued at the same as 240 pounds of alfalfa. This shows that 3 pounds of corn in the rations was slightly more economical, according to assumed values, than 2 pounds of corn when we consider that both rations produced normal growth. The ration containing 2 pounds of corn did, however, produce slightly greater gains in weight and thus offsets its greater cost. On the whole, it may be said that the gains in weight for the two rations were approximately the same, and that the cost per pound of gain was almost equal for the two rations.

Alfalfa and Silage -- Rations of alfalfa and silage with and without corn are shown in Table 29. This does not show any regularity in the decrease in amount of roughage consumed when corn was fed, and when it was not. In one case more roughage

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was consumed when corn was given than when it was not, but this was more than made up in the resulting gains in weight as compared to the same animal receiving no corn. In another case there was a slight decrease in the amount of roughage consumed but it was associated with much greater gains in weight. Animals No. 102 and No. 316 show a decided saving in the amount of roughage consumed, and at the same time they made much greater gains. According to Table 39 the value of 300 pounds of corn is equal in cost to approximately 1 ton of silage. While the ration containing corn cost slightly more than the one containing no corn according to Tables 40 and 41, yet the exceedingly greater gains in weight produced by giving corn make this ration by far the most economical when the prices of feeds are such as indicated in Table 39.

Timothy hay, Silage and Grain -- Table 30 shows rations of timothy hay 2 pounds and silage fed according to the appetites of the animals while grain was given at the rate of 3 pounds per day in one case and in greater amounts in the other. The additional grain given in all cases resulted in the animal consuming less silage. Table 39 shows that 150 pounds

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of grain is approximately equal in cost to one-half ton of silage. This shows that the ration of 3 pounds of grain costs less than when greater quantities of grain were fed, and at the same time it produced greater gains in weight.

Corn and Alfalfa vs. Timothy hay,  
Silage and Grain.

Holsteins -- The two rations which were to be fed so that the nutrients of one equalled in amounts the nutrients of the other according to the weights of the animals in different groups are shown in Tables 31 and 32. These tables show the amount of digestible protein given per 1000 pounds live weight by 30 day periods. The total weight in these periods is obtained by adding together the weights of the two animals at the end of ten days within each 30 day feeding period, Tables 9 and 10. The Table 31 of Holsteins shows that by periods the nutrients varied considerably for the two groups, and that the average nutrients received for the whole time were higher for the corn and alfalfa ration. The digestible protein received per day per 1000 pounds was 1.75 pounds for the corn and

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alfalfa group, and 1.59 pounds for the group receiving timothy hay, silage and grain; while the therms of energy received per day per 1000 pounds live weight were 11.1 for the former group, and 10.3 for the latter. At the same time the two heifers on the corn and alfalfa ration gained 272 pounds in weight against 176 pounds for the ration of timothy hay, silage and grain. This seems to be due to the former group receiving a greater quantity of nutrients in proportion to their weight than the group receiving timothy hay, silage and grain. However, more animals should be used in an experiment to fully determine this point.

Jerseys -- The comparison of the same rations in the same manner for Jerseys is shown in Table 32. In this the corn and alfalfa group received slightly more protein and energy in proportion to their weight and gained 218 pounds in weight against 194 pounds by the group on the other ration. In comparing the Jerseys with the Holsteins, the Jerseys used more digestible protein and energy for their weight than did the Holsteins for either ration. In doing this the Jerseys made a total gain in weight of 412 pounds, while the

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Holsteins gained 448 pounds, thus apparently using their nutrients in this case to better advantage than the Jerseys.

#### Armsby's Feeding Standard

The amount of nutrients which the heifers consumed per day is compared in Table 33 to the requirements given by Armsby for growing cattle. In every case the protein requirements stated by Armsby are greater than the amounts received by the heifers in the experiments. The energy required by this Standard is higher in almost every case than that of the ration consumed by heifers of the corresponding size. The only exceptions were the Holstein heifers No. 254 and No. 251 which received more energy in their ration than set forth by Armsby. Since these animals were given as much roughage as they would consume it is evident that in order to meet the Armsby Standard it would be necessary to give a ration of a different character. It would make necessary the use of more concentrates and of such a character in regard to palatability that the animal would readily consume a larger amount.

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Winter and Summer Gains in Weight.

The gains in weight per day during the summer are compared in Tables 34 and 35 to the gains made in winter. The winter was taken as 151 days, beginning November 1, and the summer for 214 days, beginning April 1. The gains which individual animals made from season to season varied considerably with different rations. In Table 34 the gains were least in winter and greatest in summer for a ration of silage and grain, equal parts by weight of corn and cottonseed meal, and a ration of clover and corn. In the case of a ration of alfalfa and corn, Table 35, the gains were reversed for the seasons. This was also true with a ration of timothy, silage and grain. Table 35 shows striking examples of the relation of the rations to the gains for any season. Heifers No. 95 and No. 98 each gained less in pounds per day during the winter than any other animals shown in this table, but the following summer they made the greatest gains in weight. In all of these tables the rations fed in winter were a stronger factor influencing the gain in weight during both the winter and summer seasons than was

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the season itself. The animals making normal gains in winter tended to make similar gains when turned on pasture, Figures VIII and IA, while animals making abnormal gains during the winter tended to make abnormal gains in the opposite direction during the following summer.

#### Height at Withers.

In Tables 36, 37 and 38 are shown the gains made in height at withers for heifers fed on different rations during the winter months, November 1 to April 1. The actual gains made are compared to the normal gains for the same age as given by Burlingham and Gillette in "Standard Growth"<sup>43</sup>. The fluctuations are such that for so short a period of time there seems to be no relation of the ration to the gain in height at withers. Most of the differences are within the limits of error in measuring. The small differences noted may be due to the individuality of the animals. Other investigators have found that even under extreme conditions the skeleton growth of heifers is influenced to a far less degree by different rations than is the weight of the animals.

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Cost of Rations.

The total cost of feed according to assumed values for wintering heifers fed on different rations is shown in Tables 40 and 41. In these, the winter is taken as the 150 days from November 18 to April 18. In Table 39 is shown the cost of the individual feeds on which the total cost of the rations is based. In these Tables it will be noticed that the cost of a corn and alfalfa ration was greater than the cost of any other ration for either of the two years included. During the winter of 1914-15, Talbot's experiment,<sup>12</sup> the cost of wintering four heifers on this ration was \$78.98, and \$77.04 for the following winter when different animals were used, Fig. 10. Rations of corn and cottonseed meal, timothy hay and silage cost respectively \$46.72 and \$49.31 for the two winters for four heifers. This was a lower cost than any of the other rations for either winter. A ration of silage and alfalfa alone cost \$53.57, while a ration of the same roughage with 2 pounds corn meal added cost \$60.25 for a group of four animals. The cost of this ration was intermediate

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to the cost of the other rations. Considering the gains made in weight for the rations during the winter of 1914-15 and the following summer the ration of corn and cottonseed meal, timothy hay and silage was by far the most economical. Of course it must be remembered that this may not always be the case for any of the rations as the prices of feeds fluctuate within wide limits.

Table 42 shows the amounts of various rations required for wintering heifers of different weights. These are estimates based on the consumption of various rations consumed by heifers during five winter months. The records of cows which have been raised on these various rations at the Missouri Station <sup>47</sup> indicate that no ill effects have resulted from these rations and that the cows have functioned normally during lactation.

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SUMMARY AND CONCLUSIONS

The general purpose of this work is to compare the efficiency of different rations for wintering dairy heifers. The main source of data used is an experiment conducted with 12 animals by the author. Data from previous experiments at the Missouri Experiment Station are used where possible to supplement that taken by the author.

The purpose of the experiment conducted by the author was to compare three rations for wintering dairy heifers. The animals were divided into three groups of four each and fed the following rations:

Group I - Corn 2 pounds, and all the alfalfa hay and silage they would eat, one pound of alfalfa to three pounds of silage.

Group II - Corn 3 pounds, and all the alfalfa hay they would eat.

Group III - Timothy hay 2 pounds, all the silage they would eat, and grain, equal parts of corn and cottonseed meal in such amounts as to make this ration equal

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to the ration of Group II in total energy and total digestible protein per pound live weight. This made the grain for this group average a little more than 3 pounds per day.

The average gains in weight per day for 150 days were 1.18, .9, and .76 pounds respectively for Groups I, II and III. The nutrients consumed by each animal were calculated according to the Armsby Standard. The total gains in weight by animals within a group showed a tendency to follow the total energy received above maintenance, although this was not always the case. Between different rations the total energy available above maintenance was no indication of the gains made by the groups.

The ration of alfalfa, silage and corn was most efficient in the gains produced in proportion to the protein and energy received. The corn and alfalfa ration was the least efficient in this respect, while the timothy hay, silage and grain ration was intermediate to the others.

In practically every case the nutrients received by individual animals were far below the requirements set by Armsby. This was especially

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noticeable with the alfalfa, silage and corn ration.

By comparing these rations with previous experiments it was found that when additional grain was added to the ration the consumption of roughage was decreased to a marked degree, but that the gains in weight were not always materially increased. However, in a ration of alfalfa and silage alone the addition of two pounds of corn showed little difference in the cost of the rations calculated at market prices but the resulting gains in weight were decidedly greater when corn was added.

The total dry matter consumed by animals receiving rations composed of the same feeds varied but little when the proportion of the various feeds was changed. However, there was a marked difference in the total dry matter consumed by groups receiving rations composed of different feeds. In proportion to live weight the group receiving corn and alfalfa consumed the most dry matter, while those fed the timothy hay, silage and grain ration consumed the least. The former was eaten in larger quantities probably on account of its great palatability, while the small consumption of the latter was due in part to its being less palatable and to its greater bulk.

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In comparing the results of the two groups receiving nutrients in approximately the same amount, the corn and alfalfa group received slightly more nutrients and made greater gains in weight, but more animals should be used before definite conclusions can be made on this point.

Animals which made extremely large gains on a winter ration usually made small gains when turned on pasture. When the gains on the winter ration were extremely small they were usually followed by extremely large gains when the animals were pastured the following summer.

There were no apparent differences in the influence of the three rations on the growth of dairy heifers in height at withers.

By assuming present market values for the feeds used, the cost of feed for wintering the groups 150 days was as follows:

Group I - Alfalfa, silage and corn . . . .	\$60.25
Group II - Alfalfa and corn . . . . .	77.04
Group III - Timothy, silage and grain . .	49.31

Judging by the gains in weight, the alfalfa, silage and corn ration was the most economical at the assumed values of the feeds, and the corn and

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alfalfa ration was the least economical.

General Conclusions -- Within the limits of ordinary feeding practices the growth of dairy heifers in height at withers is not appreciably affected by winter rations.

In determining the best winter rations for growing dairy heifers some consideration should be given to the gains made by the animals when turned on pasture the following summer.

There is a tendency for heifers receiving the same ration to make gains corresponding to the total energy received above maintenance. The data indicate that for the rations mentioned, the amounts of protein had little influence on the gains in weight. This experiment tends to show that the efficiency of a ration is not measured entirely by the amount of digestible protein and energy which it contains.

The data indicate that the addition of grain to a ration, within certain limits, tends to decrease the consumption of roughage.

The palatability and the bulkiness of a ration are factors influencing the amount of feed which will be consumed by dairy heifers.

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TABLE 4.

HEIFERS USED IN EXPERIMENT.

No. of Animal:	Breed	Age at Beginning: Mo. - Da.	Weight at beginning: Lbs.	Normal Weight* Lbs.	Ht. at withers at bgn.: cm.	Normal* ht. at withers: cm.
<u>Group I</u>						
249	Holstein	21 - 14	661	832	122	123.7
102	Jersey	20 - 6	586	636	113	119.1
317	Ayrshire	13 - 20	480	516	107.2	109.0
316	Ayrshire	14 - 20	453	541	106.5	110.5
<u>Group II</u>						
251	Holstein	17 - 14	720	691	123.5	121.5
254	Holstein	10 - 29	528	513	112.6	112.3
108	Jersey	9 - 13	329	391	97.2	104.0
105	Jersey	11 - 25	430	463	105.8	108.5
<u>Group III</u>						
252	Holstein	16 - 0	644	648	121.6	119.8
255	Holstein	8 - 6	376	421	100.8	107.0
109	Jersey	7 - 28	282	333	98.0	101.0
104	Jersey	14 - 6	481	533	111.3	111.8

\*Standard Growth - Burlingham and Gillette (43)

TABLE 5

FEED CONSUMED, WEIGHT AND HEIGHT

OF HOLSTEIN HEIFER 249.

Ration\*

Period**	Alfalfa	Silage	Corn	Digestible Protein	Energy	Height	Weight
	Lbs.	Lbs.	Lbs.	Lbs.	Therms	Cm.	Lbs.
Beginning:						122.0	661
1	58	174.	20	6.88	66.52	123.3	657
2	60	180	20	7.19	68.22		
3	60	180	20	7.19	68.22		
4	60	180	20	7.19	68.22	124.0	692
5	60	176.5	20	7.06	67.63		
6	59.7	180	20	7.16	68.10		
7	70	208	20	8.03	76.29	125.5	726
8	66.5	210	20	7.81	75.42		
9	64.0	210	20	7.64	74.56		
10	70	210	20	8.05	76.63	125.8	786
11	70	210	20	8.05	76.63		
12	70	210	20	8.05	76.63		
13	70	210	20	8.05	76.63	127.3	823
14	70	210	20	8.05	76.63		
15	70	210	20	8.05	76.63	128.3	821
Total:	978.2	2958.5	300	114.45	1092.9		

TABLE 6

JERSEY HEIFER 102

Beginning:						113	586
1	60	180	20	7.19	68.22	114.6	602
2	60	180	20	7.19	68.22		
3	60	180	20	7.19	68.22		
4	60	180	20	7.19	68.22	114.6	672
5	60	180	20	7.19	68.21		
6	59.8	180	20	7.17	68.14		
7	69.3	205	20	7.96	75.56	114.5	715
8	70	210	20	8.05	76.63		
9	66.5	199.5	20	7.72	73.68		
10	57	195	20	7.02	69.66	114.0	749
11	59	177	20	7.00	67.37		
12	60	180	20	7.19	68.21		
13	60	180	20	7.19	68.21	114.2	772
14	58.5	180	20	6.97	67.68		
15	59	171.5	20	6.92	66.36	114.2	783
Total:	919.1	2778.0	300	109.14	1042.59		

\*Alfalfa, silage and corn.

\*\* 10 day periods

TABLE 7

FEEED CONSUMED, WEIGHT AND HEIGHT

OF AYRSHIRE HEIFER 317

Ration 1\*

Period**	:			: Digestible:		: Energy	: Height	: Weight:
	: Alfalfa:	: Silage:	: Corn :	: Protein	: Energy			
	: Lbs. :	: Lbs. :	: Lbs. :	: Lbs. :	: Therms	: Cm.	: Lbs.:	
Beginning:	:	:	:	:	:	: 107.2	: 480	:
1	: 50	: 150	: 20	: 6.14	: 59.81	: 109.0	: 495	:
2	: 50	: 150	: 20	: 6.14	: 59.81	:	:	:
3	: 50	: 150	: 20	: 6.14	: 59.81	:	:	:
4	: 50	: 150	: 20	: 6.14	: 59.81	: 111.1	: 556	:
5	: 50	: 146.3	: 20	: 6.10	: 59.14	:	:	:
6	: 50	: 148.9	: 20	: 6.13	: 59.47	:	:	:
7	: 58	: 169.0	: 20	: 6.86	: 65.70	: 112.5	: 573	:
8	: 60	: 176.0	: 20	: 7.06	: 67.55	:	:	:
9	: 60	: 162.0	: 20	: 6.94	: 65.23	:	:	:
10	: 60	: 164.5	: 20	: 6.96	: 65.64	: 113.5	: 619	:
11	: 60	: 176.8	: 20	: 7.07	: 67.68	:	:	:
12	: 60	: 180	: 20	: 7.19	: 68.21	:	:	:
13	: 60	: 180	: 20	: 7.19	: 68.21	: 114.0	: 652	:
14	: 60	: 180	: 20	: 7.19	: 68.21	:	:	:
15	: 60	: 174.8	: 20	: 7.02	: 67.21	: 114.5	: 674	:
TOTAL	: 828	: 2458.3	: 300	: 100.27	: 961.49	:	:	:

TABLE 8

AYRSHIRE HEIFER 316

Beginning:	:	:	:	:	:	: 106.5	: 453	:
1	: 40	: 120	: 20	: 5.18	: 51.40	: 106.5	: 465	:
2	: 40	: 120	: 20	: 5.18	: 51.40	:	:	:
3	: 40	: 120	: 20	: 5.18	: 51.40	:	:	:
4	: 40	: 114.5	: 20	: 5.13	: 50.49	: 108.0	: 496	:
5	: 40	: 100.3	: 20	: 5.01	: 48.08	:	:	:
6	: 40	: 120	: 20	: 5.18	: 51.39	:	:	:
7	: 50	: 147.0	: 20	: 6.11	: 59.31	: 110.3	: 528	:
8	: 50	: 147	: 20	: 6.11	: 59.31	:	:	:
9	: 50	: 148	: 20	: 6.12	: 59.47	:	:	:
10	: 50	: 140.4	: 20	: 6.06	: 58.26	: 112.5	: 569	:
11	: 50	: 143	: 20	: 6.08	: 58.64	:	:	:
12	: 50	: 149	: 20	: 6.13	: 59.64	:	:	:
13	: 50	: 150	: 20	: 6.14	: 59.81	: 111.8	: 582	:
14	: 50	: 150	: 20	: 6.14	: 59.81	:	:	:
15	: 50	: 150	: 20	: 6.14	: 59.81	: 113.0	: 615	:
TOTAL	: 690	: 2019.2	: 300	: 65.89	: 828.22	:	:	:

\*Alfalfa, silage and corn.

\*\* 10 day periods

TABLE 9

FEED CONSUMED, WEIGHT AND HEIGHT

OF HOLSTEIN HEIFER 251.

Ration 2\*

Period **	Alfalfa	Corn	Digestible Protein	Energy	Height	Weight
	Lbs.	Lbs.	Lbs.	Therms	Cm.	Lbs.
Beginning:					123.5	720
1	111.7	30	9.76	65.08	126.0	671
2	120	38	10.89	75.99		
3	134	33	11.52	74.35		
4	136.6	30	11.50	71.84	126.3	731
5	136.4	30	11.48	73.58		
6	144	30	11.08	76.20		
7	168	30	13.67	84.46	128.5	748
8	180	30	14.51	84.59		
9	189.3	30	15.15	91.79		
10	166.9	30	13.59	84.08	129.3	804
11	170	30	13.81	85.14		
12	170	30	13.81	85.14		
13	170	30	13.81	85.14	130.0	825
14	150	30	12.42	78.26		
15	150	30	12.42	78.26	130.5	842
Total	2296.9	461	189.42	1193.9		

TABLE 10

HOLSTEIN HEIFER 254

Beginning:					112.6	528
1	116	30	10.06	66.56	113.1	543
2	120	30	10.35	67.88		
3	120	30	10.35	67.88		
4	118.8	30	10.26	67.53	115.6	607
5	120	30	10.35	67.88		
6	128	30	10.90	70.63		
7	154	30	12.70	79.64	118.6	629
8	160	30	13.11	81.67		
9	173.8	30	14.07	86.46		
10	151.8	30	12.54	78.89	118.6	668
11	150	30	12.42	78.26		
12	150	30	12.42	78.26		
13	150	30	12.42	78.26	119.3	695
14	130	30	11.03	71.38		
15	130	30	11.03	71.38	119.3	708
Total	2072.4	450	174.01	1112.56		

\*Alfalfa and corn.

\*\* 10 day periods



TABLE 11

FEED CONSUMED, WEIGHT AND HEIGHT  
OF JERSEY HEIFER 108.

Ration 2\*

Period **	Alfalfa	Corn	Digestible Protein	Energy	Height	Weight
	Lbs.	Lbs.	Lbs.	Therms	Cm.	Lbs.
Beginning:					97.2	329
1	64.7	22.4	5.96	42.13	97.6	334
2	63.1	30	6.40	48.67		
3	68.7	29.2	6.74	49.57		
4	68.1	25.5	6.74	46.39	101.0	385
5	68.7	29.6	6.76	49.93		
6	74	30	7.16	52.11		
7	92.7	26	7.18	54.99	102.8	397
8	94.2	30	8.56	59.07		
9	91.5	30	8.37	58.15		
10	75.5	30	7.26	52.64	103.2	428
11	70	30	6.88	50.73		
12	70	30	6.88	50.73		
13	70	30	6.88	50.73	104.6	444
14	60	30	6.18	47.29		
15	60	15***	5.15	33.96	105.5	449
Total	1091.2	417.7	103.1	747.09		

TABLE 12

JERSEY HEIFER 105

Beginning:					105.8	430
1	100	30	8.96	61.06	106.1	433
2	100	30	8.96	61.06		
3	99.2	30	8.91	60.78		
4	97.6	30	8.79	60.23	107.0	482
5	98.0	30	8.82	60.37		
6	104.0	30	9.24	62.63		
7	115.5	30	10.04	66.39	109.6	519
8	116	30	10.07	66.57		
9	106.0	30	9.38	63.13		
10	82	30	7.71	54.88	111.6	511
11	70	30	6.88	50.73		
12	78	30	7.44	53.48		
13	90	30	8.27	57.61	110.6	533
14	80	30	7.57	54.17		
15	80	30	7.57	54.17	112.5	551
Total	1416.3	450	128.61	887.26		

\*Alfalfa and corn.  
\*\*\*Off feed

\*\* 10 day periods

TABLE 13

FEED CONSUMED, WEIGHT AND HEIGHT  
OF HOLSTEIN HEIFER 252.

Ration 3\*

Period **	Timothy Lbs.	Silage Lbs.	Grain Lbs.	Digestible Protein Lbs.	Energy Therms	Height Cm.	Weight Lbs.
Beginning:						121.6	644
1	20	136.3	30	7.89	55.17	122.0	639
2	20	71.6	38	9.00	51.44		
3	20	89.8	40	9.58	56.11		
4	20	86.0	40	9.55	55.57	122.1	632
5	20	100	37.6	9.17	55.89		
6	20	126	40	9.90	62.18		
7	20	168	40	10.27	69.16	122.8	636
8	20	180	40	10.38	71.12		
9	20	192	39	10.26	72.24		
10	18.9	200	35	9.48	69.74	125.0	685
11	20	200	35	9.50	70.11		
12	20	200	33.2	9.13	68.55		
13	20	200	37.2	9.93	72.01	125.7	709
14	20	200	38.6	10.25	73.21		
15	20	200	38	10.13	72.70	126.0	738
<u>Total</u>	<u>298.9</u>	<u>2349.7</u>	<u>561.6</u>	<u>144.42</u>	<u>975.20</u>		

TABLE 14

HOLSTEIN HEIFER 255.

Beginning:						100.8	376
1	20	80	30	7.45	45.91	101.1	387
2	20	80	30	7.45	45.91		
3	20	80	30	7.45	45.91		
4	20	78.3	30	7.39	45.63	103.0	416
5	20	76.6	30	7.39	45.35		
6	20	83.5	30	7.42	46.49		
7	20	90	32	7.90	49.29	105.0	436
8	20	90.8	35	8.61	52.02		
9	20	86.5	35	8.50	51.31		
10	19.5	82.2	35	8.46	50.43	106.5	468
11	20	95.5	35	8.58	52.80		
12	20	104.0	33.2	8.28	52.66		
13	20	105.5	36.2	8.92	55.50	107.0	487
14	20	96.5	36.6	8.91	54.25		
15	20	100.0	36	8.83	54.41	108.0	513
<u>Total</u>	<u>299.5</u>	<u>1329.4</u>	<u>494.0</u>	<u>121.54</u>	<u>747.87</u>		

\*Timothy, silage and grain.

\*\* 10 day periods

TABLE 15

FEED CONSUMED, WEIGHT AND HEIGHT  
OF JERSEY HEIFER 109.

Ration 3\*\*

*** : Period	: Timothy	: Silage	: Grain	: Digestible: Protein	: Energy	: Height	: Weight
: Lbs.	: Lbs.	: Lbs.	: Lbs.	: Lbs.	: Therms	: Cm.	: Lbs.
Beginning:						98.0	282
1	19.3	90	30	7.49	47.56	99.0	298
2	20	90	30	7.49	47.67		
3	20	90	30	7.49	47.67		
4	19.7	79.7	28.5	7.08	44.56	101.6	338
5	20	86.4	27.6	6.95	44.89		
6	20	94	30	7.52	48.23		
7	18.5	128	32	8.21	54.43	104.0	365
8	19	136.7	17.6*	5.26	44.33		
9	20	107.2	7.1*	2.83	30.60		
10	19	104.1	19.6*	5.41	40.57	102.2	363
11	20	81.9	25.5	6.47	42.33		
12	20	79	24.5	6.24	40.99		
13	20	109	26.5	6.92	47.68	104.0	372
14	20	86	27	6.81	44.29		
15	20	80	30	7.40	45.90	107.5	388
<u>Total</u>	<u>295.5</u>	<u>1442.0</u>	<u>385.9</u>	<u>99.57</u>	<u>671.70</u>		

TABLE 16

JERSEY HEIFER 104

Beginning:						111.3	481
1	20	158.2	30	8.09	58.85	111.6	495
2	20	159.0	30	8.14	59.00		
3	20	158.1	30	8.15	58.84		
4	20	149.2	30	8.01	57.37	112.5	551
5	20	158.3	30	8.09	58.88		
6	20	160	30	8.10	59.15		
7	20	188	32	8.77	65.42	113.1	576
8	20	199	35	9.49	69.94		
9	20	176.8	35	9.30	66.26		
10	20	160.7	35	9.16	63.59	115.7	581
11	20	155	32.5	8.58	60.49		
12	20	92.5	20.7*	5.54	39.84		
13	20	138.0	30	7.91	55.51	115.0	585
14	20	140	30	7.93	55.84		
15	20	140	30	7.93	55.84	116.0	604
<u>Total</u>	<u>300</u>	<u>2332.8</u>	<u>460.2</u>	<u>123.25</u>	<u>884.82</u>		

\*\*Timothy, silage and grain.      \*\*\* 10 day periods

\* Off Feed.

TABLE 17

TOTAL FEED CONSUMED BY HEIFERS

150 Days.

<u>No. of</u>	<u>Timothy</u>	<u>Silage</u>	<u>Alfalfa</u>	<u>Corn</u>	<u>Grain</u>	<u>Gain</u>	<u>Total</u>	
<u>Animal:</u>	<u>Lbs.</u>	<u>Lbs.</u>	<u>Lbs.</u>	<u>Lbs.</u>	<u>Lbs.</u>	<u>Lbs.</u>	<u>Lbs.</u>	<u>:</u>
249	:	2958	978	300	:	160	4336	:
102	:	2778	919	300	:	197	3997	:
317	:	2458	838	300	:	194	3596	:
316	:	2019	690	300	:	162	3009	:
251	:	:	2296	450	:	122	2746	:
254	:	:	2072	450	:	180	2522	:
108	:	:	1091	417	:	120	1508	:
105	:	:	1416	450	:	121	1866	:
252	298	2349	:	:	561	92	3208	:
255	299	1329	:	:	494	137	2122	:
109	295	1442	:	:	385	106	2122	:
104	300	2332	:	:	460	123	3092	:

TABLE 18.

TOTAL FEED CONSUMED BY HEIFERS\*

150 Days.

No. :	Age	:Begin-:	:Alfal-:	:Sil- :	:Timo- :	Total :			
Heif-er :	Mo - Da :	ning :Weight:	:Corn :Lbs.:	:fa :Lbs. :	:Grain: :Lbs. :	:age :Lbs. :	:Gain :Lbs. :	:thy :Lbs. :	:Feed :Lbs. :
101:	9-27 :	415 :	300:	1725 :	:	: 142 :	:	: 2025 :	
102:	7-26 :	320 :	300:	1377 :	:	: 122 :	:	: 1677 :	
243:	15- 1 :	650 :	300:	2354 :	:	: 149 :	:	: 2654 :	
246:	11-21 :	565 :	300:	2543 :	:	: 169 :	:	: 2843 :	
96:	15- 9 :	490 :	:	: 300 :	2990 :	123 :	300 :	: 3590 :	
100:	10-11 :	375 :	:	: 286 :	2803 :	130 :	300 :	: 3389 :	
244:	13-28 :	510 :	:	: 300 :	3070 :	143 :	300 :	: 3670 :	
248:	10-27 :	535 :	:	: 300 :	2876 :	96 :	300 :	: 3476 :	
95:	18-12 :	615 :	:	932 :	: 2766 :	38 :	:	: 3698 :	
98:	12-26 :	530 :	:	885 :	: 2522 :	51 :	:	: 3407 :	
245:	12-12 :	570 :	:	1122 :	: 3330 :	124 :	:	: 4452 :	
249:	9- 1 :	400 :	:	992 :	: 2907 :	114 :	:	: 3899 :	

\*Experiment by Talbot (12).

TABLE 19

TOTAL WEIGHT OF ANIMALS BY GROUPS

Days on Experi- ment	<u>GROUP I</u>	<u>GROUP II</u>	<u>GROUP III</u>
	Lbs.	Lbs.	Lbs.
	2180	2007	1783
10	2219	1981	1819
40	2420	2205	1937
70	2542	2293	2013
100	2723	2411	2097
130	2829	2497	2153
150	2893	2550	2243
Total Gain:	713	543	460
Gain per da. Av.	1.18	.90	.76

TABLE 20

INDIVIDUAL GAINS PER DAY.

No.	Gain	No.	Gain	No.	Gain
Heifer:	Lbs.	Heifer	Lbs.	Heifer	Lbs.
249	: 1.06	: 251	: .81	: 252:	.62:
102	: 1.3	: 254	: 1.20	: 255:	.91:
317	: 1.2	: 108	: .78	: 109:	.70:
316	: 1.08	: 108	: .80	: 104:	.82:

TABLE 21

PROTEIN AND ENERGY RECEIVED\*

BY 30 DAY PERIODS.

Group I

Heifer							
No. 249							
Period	Total : Dig. : Protein : Lbs.	Total : Energy : Therms	Dig. : rro. : Per da : Lbs.	Energy : per : day : Therms	Dig. rro. : per 1000 : lbs. da.	Energy : per 1000 : lbs. da.	
1	: 21.26	: 202.96	: .708	: 6.765	:	:	:
2	: 21.41	: 203.95	: .710	: 6.798	:	:	:
3	: 23.48	: 226.27	: .782	: 7.542	:	:	:
4	: 24.15	: 229.89	: .805	: 7.663	:	:	:
5	: 24.15	: 229.89	: .805	: 7.663	:	:	:
Total	: 114.45	: 1091.96	:	:	:	:	:
Average	:	:	: .763	: 7.27	: 1.02	: 9.8	:
Heifer							
No. 102							
1	: 21.57	: 204.66	: .719	: 6.822	:	:	:
2	: 21.55	: 204.57	: .718	: 6.819	:	:	:
3	: 23.73	: 225.87	: .791	: 7.529	:	:	:
4	: 21.21	: 205.24	: .707	: 6.841	:	:	:
5	: 21.08	: 202.25	: .702	: 6.741	:	:	:
Total	: 109.14	: 1042.59	:	:	:	:	:
Average	:	:	: .727	: 6.95	: 1.06	: 10.1	:
Heifer							
No. 317							
1	: 18.42	: 179.43	: .614	: 5.981	:	:	:
2	: 18.27	: 178.42	: .612	: 5.927	:	:	:
3	: 20.86	: 198.48	: .695	: 6.616	:	:	:
4	: 21.22	: 201.53	: .707	: 6.717	:	:	:
5	: 21.40	: 203.63	: .710	: 6.787	:	:	:
Total	: 99.99	: 961.49	:	:	:	:	:
Average	:	:	: .666	: 6.409	: 1.15	: 11.1	:
Heifer							
No. 316							
1	: 15.54	: 154.20	: .518	: 5.140	:	:	:
2	: 15.32	: 149.96	: .510	: 4.998	:	:	:
3	: 18.34	: 178.09	: .611	: 5.936	:	:	:
4	: 18.27	: 176.54	: .609	: 5.884	:	:	:
5	: 18.42	: 179.43	: .614	: 5.981	:	:	:
Total	: 85.75	: 838.22	:	:	:	:	:
Average	:	:	: .571	: 5.58	: 1.07	: 10.4	:
Average for group	:	:	:	:	: 1.07	: 10.2	:

\*Ration - Alfalfa, silage and corn.



TABLE 22.

PROTEIN AND ENERGY RECEIVED\*

BY 30 DAY PERIODS.

Heifer		Group II					
No. 251.							
Period:	Dig. protein	Total Energy	Dig. pro. per da.	Energy per day	Dig. pro. per 1000 lbs. da.	Energy per 1000 lbs. da.	
	Lbs.	Therms	Lbs.	Therms	Lbs.	Therms	
1	32.17	215.42	1.075	7.180			
2	32.06	221.62	1.135	7.387			
3	43.33	260.84	1.444	8.694			
4	41.21	254.36	1.373	8.478			
5	38.65	241.66	1.288	8.055			
Total	189.42	1193.90					
Average			1.26	7.95	1.61	10.1	
Heifer							
No. 254							
1	30.70	202.52	1.025	6.744			
2	31.51	206.04	1.050	6.868			
3	39.88	247.77	1.329	8.259			
4	37.38	235.41	1.246	7.847			
5	34.48	221.02	1.149	7.367			
Total	174.01	1142.56					
Average			1.16	7.61	1.87	12.3	
Heifer							
No. 108							
1	19.10	140.37	.636	4.679			
2	20.66	148.42	.688	4.947			
3	24.11	172.21	.803	5.740			
4	21.02	154.10	.700	5.136			
5	18.21	131.98	.607	4.066			
Total	103.10	747.09					
Average			.687	4.98	1.78	12.8	
Heifer							
No. 105							
1	26.83	182.90	.894	6.096			
2	26.85	183.23	.895	6.107			
3	29.49	196.09	.983	6.536			
4	22.03	159.09	.734	5.303			
5	23.41	165.95	.780	5.531			
Total	128.61	887.26					
Average			.857	5.91	1.74	12.0	
Average of group					1.75	11.6	

\* Ration - Corn and alfalfa.

TABLE 23

PROTEIN AND ENERGY RECEIVED\*BY 30 DAY PERIODS.

## Group III

Heifer No. 252		:Total :		:Dig. :	:Energy:	:Dig. pro.:	:Energy :
Period:	Dig. :	Total :	Energy :	pro. :	per :	per 1000 :	per 1000:
	: Protein :	Energy :	Per da:	day :	lbs. da. :	Lbs. da. :	
	: Lbs. :	Therms :	Lbs. :	Therms:	Lbs. :	Therms :	
1	: 26.47 :	162.72 :	.882 :	5.424:	:	:	:
2	: 28.62 :	173.64 :	.954 :	5.788:	:	:	:
3	: 30.91 :	212.52 :	1.030 :	7.084:	:	:	:
4	: 28.11 :	208.40 :	.937 :	6.946:	:	:	:
5	: 30.31 :	217.92 :	1.010 :	7.264:	:	:	:
Total	: 144.42 :	975.20 :	:	:	:	:	:
Average	:	:	.962 :	6.50 :	1.39 :	9.4 :	:
Heifer No. 255		:Total :		:Dig. :	:Energy:	:Dig. pro.:	:Energy :
1	: 22.35 :	137.73 :	.745 :	4.591:	:	:	:
2	: 22.20 :	137.47 :	.740 :	4.562:	:	:	:
3	: 25.01 :	152.62 :	.833 :	5.087:	:	:	:
4	: 25.32 :	155.89 :	.844 :	5.196:	:	:	:
5	: 26.66 :	164.16 :	.888 :	5.138:	:	:	:
Total	: 121.54 :	747.87 :	:	:	:	:	:
Average	:	:	.810 :	4.95 :	1.82 :	11.2 :	:
Heifer No. 109		:Total :		:Dig. :	:Energy:	:Dig. pro.:	:Energy :
1	: 22.47 :	142.90 :	.749 :	4.763:	:	:	:
2	: 21.55 :	137.68 :	.718 :	4.569:	:	:	:
3	: 16.30 :	129.36 :	.542 :	4.312:	:	:	:
4	: 18.12 :	123.89 :	.604 :	4.129:	:	:	:
5	: 21.13 :	137.69 :	.704 :	4.263:	:	:	:
Total	: 99.57 :	671.72 :	:	:	:	:	:
Average	:	:	.663 :	4.47 :	1.98 :	13.3 :	:
Heifer No. 104		:Total :		:Dig. :	:Energy:	:Dig. pro.:	:Energy :
1	: 24.38 :	176.69 :	.812 :	5.889:	:	:	:
2	: 24.20 :	175.40 :	.806 :	5.846:	:	:	:
3	: 27.56 :	201.72 :	.918 :	6.724:	:	:	:
4	: 23.28 :	163.92 :	.776 :	5.464:	:	:	:
5	: 23.77 :	167.19 :	.792 :	5.237:	:	:	:
Total	: 123.19 :	884.92 :	:	:	:	:	:
Average	:	:	.821 :	5.89 :	1.51 :	10.8 :	:
Average for the group		:	:	:	1.67 :	11.8 :	:

\*Timothy, silage and grain.

TABLE 24

PROTEIN RECEIVED

<u>Talbot's Experiment '12)</u>				<u>Experiment 1915-1916</u>			
No. of animal	Av* Weight	Dig. protein Lb.	da. per 1000 live wt.	No. of animal	Av. * Weight	Dig. protein lb.	da. per 1000 live wt.
	Lbs.	Lbs.	Lbs.		Lbs.	Lbs.	Lbs.
<u>Corn and Alfalfa</u>				<u>Alfalfa, Silage and Corn</u>			
101	466	139.9	1.91	249	741	114.4	1.02
102	381	116.3	2.03	102	684	109.1	1.06
243	724	183.1	1.68	317	577	100.2	1.15
246	649	196.6	2.01	316	534	85.8	1.07
Average			1.91				1.07
<u>Timothy, silage and grain</u>				<u>Alfalfa and corn</u>			
96	551	94.7	1.14	251	781	189.4	1.61
100	440	90.8	1.37	254	618	174.0	1.87
244	581	94.4	.97	108	389	103.1	1.78
248	583	94.3	.96	105	490	128.6	1.74
Average			1.11				1.75
<u>Alfalfa and silage</u>				<u>Timothy, silage and grain</u>			
95	634	88.9	.93	252	691	144.4	1.39
98	565	83.5	.98	255	444	121.5	1.82
245	632	107.0	1.12	109	335	99.5	1.98
249	457	94.3	1.37	104	542	123.2	1.51
Average			1.10				1.67

\*Average of first and last weights.

TABLE 25

ENERGY RECEIVED FOR GROWTH\*

150 Days.

Ration - Corn, alfalfa and silage							
No. of Cow	Average Weight : Lbs.	Total Energy** : Therms	Energy for maintenance : Therms	Energy for Growth : Therms	Gain : Lbs.	Growth energy per lb. gain : Therms	
249	741	1092	666	426	160	2.66	:
102	684	1042	615	427	197	2.11	:
317	577	961	519	442	194	2.22	:
316	534	828	480	348	162	2.14	:
Total:	2536	3923	2280	1643	713	2.30Av	***

Ration - Corn and alfalfa							
No. of Cow	Average Weight : Lbs.	Total Energy** : Therms	Energy for maintenance : Therms	Energy for Growth : Therms	Gain : Lbs.	Growth energy per lb. gain : Therms	
251	781	1193	702	491	122	4.02	:
254	618	1112	556	556	180	3.08	:
108	389	747	350	397	120	3.30	:
105	490	887	441	446	121	3.68	:
Total:	2278	3939	2050	1890	543	3.48 Av	:

Ration - Timothy, silage and grain							
No. of Cow	Average Weight : Lbs.	Total Energy** : Therms	Energy for maintenance : Therms	Energy for Growth : Therms	Gain : Lbs.	Growth energy per lb. gain : Therms	
252	691	975	621	354	94	3.76	:
255	444	747	399	348	137	2.54	:
109	335	671	301	370	106	3.49	:
104	542	884	487	397	123	3.14	:
Total:	2012	3277	1808	1469	460	3.19 Av	:

\* Experiment 1915-16

\*\*Average of first and last weights.

\*\*\*Obtained by dividing total energy available for growth by the total gains in weight.

TABLE 26

ENERGY RECEIVED FOR GROWTH\*

150 Days.

Ration - Corn and alfalfa							
No. of Cow	Average Weight : Lbs.	Total Energy : Therms	Energy for main- tenance : Therms	Energy for Growth : Therms	Gain : Lbs.	Growth energy per lb. gain : Therms	:
101	486	860	437.4	423	142	2.97	:
102	381	740	342.9	398	122	3.26	:
243	724	1074	651.6	423	149	2.83	:
246	649	1141	581.1	560	169	3.31	:
Total	2240	3815	2313.0	1804	582	3.09 Av***	:

Ration - Silage, timothy and grain							
96	551	843	495.9	348	123	2.81	:
100	440	812	396.0	416	130	3.20	:
244	581	841	522.9	319	143	2.23	:
248	583	833	524.7	309	96	3.21	:
Total	2155	3329	1939.5	1392	492	2.82 Av:	:

Ration - Alfalfa and silage							
95	634	778	570.6	208	38	5.47	:
98	565	722	508.5	216	51	4.23	:
245	632	937	568.8	369	124	2.97	:
249	457	822	411.3	411	114	3.60	:
Total	2288	3259	2059.2	1204	327	3.68 Av:	:

\* Talbot's Experiment (12)

\*\*Average of first and last weights

\*\*\*Obtained by dividing total energy available for growth by total gains in weight.

TABLE 27

TOTAL DRY MATTER.

150 Days.

No. of Animal*	Av. Weight	Dry Matter	Total Gain	Dry matter per # live wt.	Av. dry matter per # live wt.	Ration
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	
101	486	1847	142	3.7		
102	381	1528	122	4.0		Corn
243	724	2423	149	3.3		and
246	649	2596	169	4.0	3.7	Alfalfa
96	551	1297	123	2.3		Timothy
100	440	1236	130	2.5		Silage
244	581	1317	143	2.2		and Grain
248	583	1267	96	2.1	2.3	
95	634	1561	38	2.4		Alfalfa
98	565	1456	51	2.5		and
245	632	1880	124	2.9		Silage
249	457	1601	114	3.5	2.6	
249	741	1919	160	2.5		Alfalfa
102	684	1820	197	2.6		Silage
317	577	1664	194	2.8		corn
316	534	1416	162	2.6	2.6	
251	781	2504	122	3.2		Alfalfa
254	618	2892	180	4.6		and
108	389	1370	120	3.5		Corn
105	490	1698	121	3.4	3.9	
252	691	1367	94	1.9		Timothy
255	444	1046	137	2.3		Silage
109	335	973	106	2.9		and
104	542	1272	123	2.1	2.3	Grain

\*First 12 animals - Talbot's Experiment (12)

TABLE 28

CORN AND ALFALFA RATIONS\*

150 Days

Corn- 2 Lbs. Per Day**				Corn - 3 Lbs. Per Day***				
No.	Gain	Alfalfa Consumed		No.	Gain	Alfalfa Consumed	Saving in Alfalfa	Excess of Corn
	Lbs.	Lbs.			Lbs.	Lbs.	Lbs.	Lbs.
243	149	2354	::	251	122	2296	58	150
246	169	2543	::	254	180	2072	471	150
102	122	1377	::	108	120	1091	286	117
101	142	1725	::	105	121	1416	309	150
Total:	582		::		543			

\* All the alfalfa hay they would eat

\*\*Talbot's Experiment (12)

\*\*\*Experiment 1915-16.

TABLE 29

ALFALFA AND SILAGE RATIONS\*

No Corn Fed**			2 Lbs. Corn Fed***					
No. of Animal:	Gain : Lbs.	Total : Roughage : Consumed : Lbs.	No.:	Gain : Lbs.	Total : Roughage : Consumed : Lbs.	Saving : in rough- : age : Lbs.	Corn: : Fed : Lbs.:	
95	38	3698	249	160	4036	- 338	300	
98	51	3407	317	194	3296	111	300	
245	124	4452	102	197	3697	755	300	
249	114	3899	316	162	2709	1190	300	
Total	327			713				

\*One pound of alfalfa to three pounds of silage.

\*\* Talbot(s Experiment (12)

\*\*\*Experiment 1915-16



TABLE 30

TIMOTHY, SILAGE AND GRAIN RATIOS\*

150 Days.

Grain** 3 Lbs. ::			Grain in Varying Amounts***				
No. of	Gain	:Silage	No.	Gain	:Silage	:Saving	:Excess
Animal:	: ed	: Consum-	: ed	: Consum-	: in	: Grain	: Consumed
: Lbs.	: Lbs.	: ed	: Lbs.	: Lbs.	: Lbs.	: Lbs.	: Lbs.
96	: 123	: 2990	:: 109	: 106	: 1442	: 1548	: 85
100	: 130	: 2802	:: 255	: 137	: 1329	: 1474	: 208
244	: 142	: 3070	:: 104	: 123	: 2322	: 728	: 160
248	: 96	: 2876	:: 252	: 92	: 2349	: 527	: 261
Total	492	:	::	: 458	:	:	:

\* Grain, equal parts by weight of corn and cottonseed meal.

\*\* Talbot's Experiment (12)

\*\*\*Experiment 1915-16.

TABLE 31

PROTEIN AND ENERGY RECEIVED BY TWO

ANIMALS.

30 Day Periods.

Holstein Heifers 251 and 254 *						
Period:	Total	Dig.	Energy per	Dig. pro.	Total	Total
:	Energy	Protein:	day per	per da.	Weight	Gain
:	Therms	Lbs.	1000 lbs.	per 1000 lbs.	Lbs.	Lbs.
Beginning	:	:	:	:	1248	:
1	417.74	62.93	11.4	1.72	1214	:
2	427.66	65.57	10.6	1.64	1338	:
3	508.61	83.21	17.1	2.01	1377	:
4	487.77	78.59	11.2	1.81	1442	:
5	462.68	73.13	10.2	1.60	1520	:
Total	2304.46	363.43	:	:	:	272
Average	:	:	11.1	1.75	:	:

Holstein Heifers 252 and 255 **						
Beginning	:	:	:	:	1020	:
1	300.45	48.77	9.7	1.58	1026	:
2	311.11	50.82	9.8	1.61	1048	:
3	365.14	55.92	11.3	1.73	1072	:
4	364.29	53.43	10.5	1.54	1153	:
5	382.08	56.97	10.6	1.58	1196	:
Total	1723.07	265.91	:	:	:	176
Average	:	:	10.3	1.59	:	:

\*Ration - Corn and alfalfa.

\*\* Ration - Timothy, silage and corn.

TABLE 32.

PROTEIN AND ENERGY RECEIVEDBY TWO ANIMALS.

30 Day Periods.

JERSEY HEIFERS 108 and 105 \*

Period	Total :Energy :Therms	Total :Dig. :Protein	Energy per :day per :1000 lbs.	Dig. Pro. :per da. per :1000 lbs.	Total :Weight :Lbs.	Total :Gain :Lbs.
Beginning	:	:	:	:	759	:
1	323.27	45.93	13.5	1.96	767	:
2	331.66	47.51	12.4	1.78	867	:
3	368.30	53.60	13.0	1.89	916	:
4	313.19	43.05	11.0	1.52	939	:
5	297.93	41.62	10.3	1.45	977	:
Total	1634.35	231.71	:	:	:	218
Average	:	:	12.5	1.77	:	:

Jersey Heifers 109 and 104 \*\*

Beginning	:	:	:	:	763	:
1	319.59	46.85	13.4	1.96	793	:
2	309.08	45.74	11.5	1.71	889	:
3	330.98	43.86	11.7	1.55	941	:
4	287.86	41.40	10.1	1.46	944	:
5	305.06	44.90	10.6	1.56	957	:
Total	1552.57	222.75	:	:	:	194
Average	:	:	11.1	1.71	:	:

\*Ration - Corn and alfalfa.

\*\* Ration - Timothy, silage and corn.

TABLE 33

NUTRIENTS RECEIVED COMPARED  
TO ARMSBY'S STANDARD.

No. of Animal	Age at Beginning	Av.* Weight	Per Day			Armsby (45)		
			Dig.	Energy	Age	Weight	Dig.	Energy
Mo- Da.	Da.	Lbs.	Lbs.	Therms	Mo.	Lbs.	Lbs.	Therms
109	7-28	335	.663	4.47	4-5	300**	1.2	5.5
108	9-13	389	.687	4.98	6	425	1.3	6.0
255	8- 6	444	.810	4.95	6	425	1.3	6.0
105	11-25	490	.857	5.91	9	537**	1.47	6.5
316	14-20	534	.571	5.58	9	537	1.47	6.5
104	14- 6	542	.821	5.89	9	537	1.47	6.5
317	13-20	577	.666	6.40	9	537	1.47	6.5
254	10-29	618	1.16	7.61	12	650	1.65	7.0
102	20- 6	684	.727	6.95	12	650	1.65	7.0
252	16- 0	691	.962	6.50	12	650	1.65	7.0
249	21-14	741	.763	7.27	15	750**	1.67	7.3
251	17-14	781	1.26	7.95	15	750	1.67	7.3

\*Average of first and last weights.

\*\*Estimated by the author.

TABLE 34

GAINS IN WEIGHT\*

**					
Winter - 151 Days :			Summer 214 days		
No. of:	Total :	Gain :	Total :	Gain :	
Animal:	Gain :	per Day :	Gain :	per Day :	
	Lbs. :	Lbs. :	Lbs. :	Lbs. :	
Ration-Silage & Grain:					
93	: 90	: .58	: 239	: 1.11	:
89	: 76	: .51	: 184	: .85	:
238	: 102	: .67	: 185	: .86	:
Total	: 270	: .59Av	: 608	: .94 Av	:
Ration-Clover & Corn :					
90	: 107	: .70	: 236	: 1.10	:
239	: 113	: .74	: 204	: .95	:
Total	: 220	: .72 Av	: 440	: 1.02 Av.	:

\*Unpublished data Mo. Agr. Exp. Sta.

\*\*Animals on pasture.

TABLE 35

GAINS IN WEIGHT\*

<u>Winter - 151 Days</u>			<u>Summer** 214 Days</u>		
No. of:	Total	Gain	Total	Gain per	
Animal:	Gain	per day:	Gain	Day	
	Lbs.	Lbs.	Lbs.	Lbs.	
<u>Corn and Alfalfa</u>					
101	: 136	: .90	: 83	: .37	:
102	: 115	: .76	: 154	: .72	:
243	: 138	: .91	: 123	: .57	:
246	: 181	: 1.1	: 143	: .66	:
Total	570	: .94 Av:	503	: .58 Av:	
<u>Timothy-Silage and Grain</u>					
96	: 124	: .82	: 143	: .66	:
100	: 112	: .74	: 130	: .60	:
244	: 112	: .74	: 138	: .64	:
248	: 124	: .82	: 152	: .71	:
Total	472	: .78 Av:	563	: .65 Av:	
<u>Alfalfa and Silage</u>					
95	: 46	: .30	: 172	: .87	:
98	: 74	: .48	: 215	: 1.0	:
245	: 138	: .91	: 132	: .61	:
249	: 107	: .70	: 153	: .71	:
Total	365	: .60Av:	672	: .78 Av:	

\* Unpublished data at Mo. Agr. Exp. Sta.

\*\*Ration - pasture only.

TABLE 36

HEIGHT AT WITHERS.

150 Days.

Ration - Alfalfa, Silage and Corn				
No. of Animal	Gain : cm.	Normal* : Gain : cm.	Difference : cm.	:
249	6.3	5.0***	1.3	:
102	1.2	1.4***	-.2	:
317	7.3	5.6	1.7	:
316	6.5	5.1	1.4	:

Ration - Alfalfa and Corn

251	7.0	2.7	4.3	:
254	6.7	7.5	-.8**	:
108	8.2	8.2	.1	:
105	6.7	7.6	-.9	:

Ration - Timothy, Silage and Grain :

252	4.4	3.7	.7	:
255	7.2	9.1	-1.9	:
109	9.5	9.0	.5	:
104	4.7	6.6	-1.9	:

\*Burlingham and Gillette (43)

\*\*The sign (-) indicates below normal.

\*\*\* Thesis by Swett (46).

TABLE 37.

HEIGHT AT WITHERS\*

150 Days

Ration - Alfalfa and Silage				
No. of Animal:	Gain cm.	Normal** Gain cm.	Difference cm.	
249	11.8	9.9	1.9	:
245	7.5	7.4	.1	:
98	6.0	8.3	- 2.3***	:
95	7.0	3.5	3.5	:
Ration - Timothy, Silage and Grain				
244	7.5	5.8	1.7	:
248	10.5	8.7	1.8	:
96	6.2	6.1	.1	:
100	10.5	10.3	.2	:
Ration- Corn and Alfalfa				
246	5.8	8.1	-2.3	:
243	8.0	5.0	3.0	:
101	9.0	9.8	-.8	:
102	11.5	10.5	1.0	:

\*Unpublished data at Mo. Agr. Exp. Sta.

\*\*Standard Growth by Burlingham and Gillette 43)

\*\*\*The sign (-) indicates below normal.



TABLE 38

HEIGHT AT WITHERS\*

150 Days.

Ration - Silage and Grain				
No. of:	Gain	: Normal**	Gain	Difference:
Animal:	cm.	:	cm.	cm.
93	8.5	:	9.0	- .5***:
89	8.5	:	7.6	.9 :
238	6.5	:	5.2	1.3 :
Ration - Clover and Corn				
90	5.5	:	7.0	-1.5 :
314	9.0	:	9.0	0.0 :
239	8.5	:	6.4	2.1 :

\*Unpublished data at Mo. Agr. Exp. Sta.

\*\*Burlingham and Gillette (43)

\*\*\*The sign (-) indicates below normal.

TABLE 29

ASSUMED COST OF FEEDS.

Ground corn per cwt. - - - -	-\$1.25
Cottonseed meal per cwt. - - -	1.50
Timothy hay per cwt - - - - -	.70
Alfalfa hay per cwt. - - - - -	.80
Corn silage per cwt. - - - - -	.175

TABLE 40

COST OF WINTER FEEDING.

Heifers on Experiment

150 Days.

No. of Animal :	Corn :	Grain :	Timothy :	Alfalfa :	Silage :	Total for Animal :	Total for Group :
249	: \$3.75:	:	:	: \$ 7.82 :	: \$ 5.17 :	\$16.74:	:
102	: 3.75:	:	:	: 7.35 :	: 4.86 :	15.96:	:
317	: 3.75:	:	:	: 6.70 :	: 4.30 :	14.75:	:
316	: 3.75:	:	:	: 5.52 :	: 3.53 :	12.80:	\$60.25:
251	: \$5.62:	:	:	: \$18.36 :	:	\$23.98:	:
254	: 5.62:	:	:	: 16.57 :	:	22.19:	:
108	: 8.21:	:	:	: 8.72 :	:	13.93:	:
105	: 5.62:	:	:	: 11.32 :	:	16.94:	\$77.04:
252	: \$ :	: \$ 8.41 :	: \$2.08 :	:	: \$ 4.11 :	\$14.06:	:
255	: :	: 7.41 :	: 2.09 :	:	: 2.32 :	11.82:	:
109	: :	: 5.77 :	: 2.06 :	:	: 2.52 :	10.35:	:
104	: :	: 6.90 :	: 2.00 :	:	: 4.08 :	13.08:	\$49.31:

TABLE 41

COST OF WINTER FEEDING.

Talbot's Experiment (12)

150 Days.

No. of Animal :	Corn :	Alfalfa :	Grain :	Silage :	Timothy :	Total for Animal :	Total for Group :
101 :	\$3.75 :	\$13.80 :	:	:	:	\$17.55 :	:
102 :	3.75 :	11.01 :	:	:	:	14.76 :	:
243 :	3.75 :	18.83 :	:	:	:	22.58 :	:
246 :	3.75 :	20.34 :	:	:	:	24.09 :	\$78.98 :
96 :	:	:	\$ 4.50 :	\$ 5.23 :	\$ 2.10 :	\$11.83 :	:
100 :	:	:	4.29 :	4.90 :	2.10 :	11.29 :	:
244 :	:	:	4.50 :	5.37 :	2.10 :	11.97 :	:
248 :	:	:	4.50 :	5.03 :	2.10 :	11.63 :	\$46.72 :
95 :	:	\$ 7.45 :	:	\$ 4.84 :	:	\$12.29 :	:
98 :	:	7.06 :	:	4.41 :	:	11.49 :	:
245 :	:	8.97 :	:	5.82 :	:	14.79 :	:
249 :	:	9.92 :	:	5.08 :	:	15.00 :	\$53.57 :

TABLE 42.

TOTAL FEED REQUIRED FOR WINTERING  
DAIRY HEIFERS FIVE AND ONE-HALF MONTHS.

Ration	: Weight : : Animal :	: Alfalfa : : Lbs. :	: Silage : : Lbs. :	: Corn : : Lbs. :
Corn 2 lbs.	: 300	: 700	: 2100	: 330
1 lb. alfalfa to	: 400	: 800	: 2400	: 330
3 lbs. silage*	: 500	: 950	: 2800	: 330
	: 600	: 1050	: 3100	: 330
	: 700	: 1100	: 3300	: 330
Corn 3 lbs.	: 300	: 1100	:	: 495
Alfalfa*	: 400	: 1600	:	: 495
	: 500	: 2100	:	: 495
	: 600	: 2300	:	: 495
	: 700	: 2500	:	: 495
Corn 2 lbs.	: 300	: 1500	:	: 330
Alfalfa*	: 400	: 1900	:	: 330
	: 500	: 2400	:	: 330
	: 600	: 2600	:	: 330
	: 700	: 2700	:	: 330
One pound of	: 300	: 800	: 2400	:
alfalfa to 3 lbs	: 400	: 900	: 2700	:
silage*	: 500	: 950	: 2850	:
	: 600	: 1000	: 3000	:
	: 700	: 1050	: 3150	:
Grain 3 lbs.**	: 300	: <u>330</u>	: 2500	: <u>495</u>
Timothy 2 lbs.	: 400	: 330	: 3000	: 495
Silage*	: 500	: 330	: 3200	: 495
	: 600	: 330	: 3300	: 495
	: 700	: 330	: 3400	: 495

\* All they would eat

\*\*Equal parts by weight of corn and cottonseed meal.



PLATE I

May 17, 1916

Group I Ration- Corn, Alfalfa and Silage

Average Gain Per Day 1.18 Pounds for 150 Days

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1916





PLATE II

May 17, 1916

Group II Ration- Corn and Alfalfa  
Average Gain Per Day .90 pounds for 150 Days





PLATE III

May 17, 1916

Group III Ration- Timothy, Silage and Grain

Average Gain Per Day .76 pounds for 150 Days





PLATE IV

May 17, 1916

Jerseys

Group I - Heifer No. 102  
Group II - Heifer No. 105  
Group III - Heifer No. 104





251

249

252

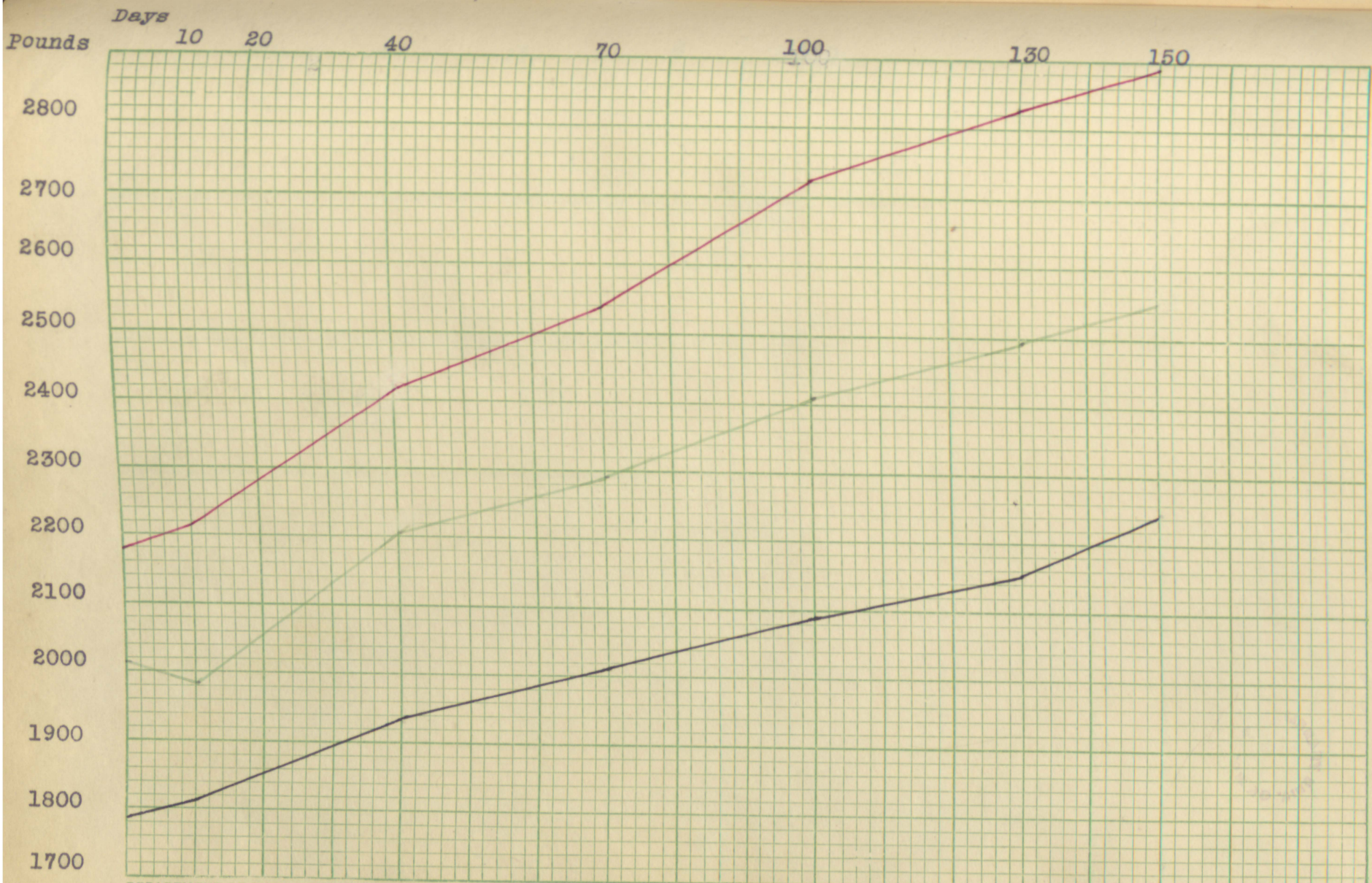
PLATE V  
Holsteins

Group I - Heifer No. 249  
Group II - Heifer No. 251  
Group III - Heifer No. 252

May 17, 1916

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

Fig. I Total Weight of Groups

- Corn, Alfalfa and Silage
- Corn and Alfalfa
- Timothy Silage and Grain



Pounds

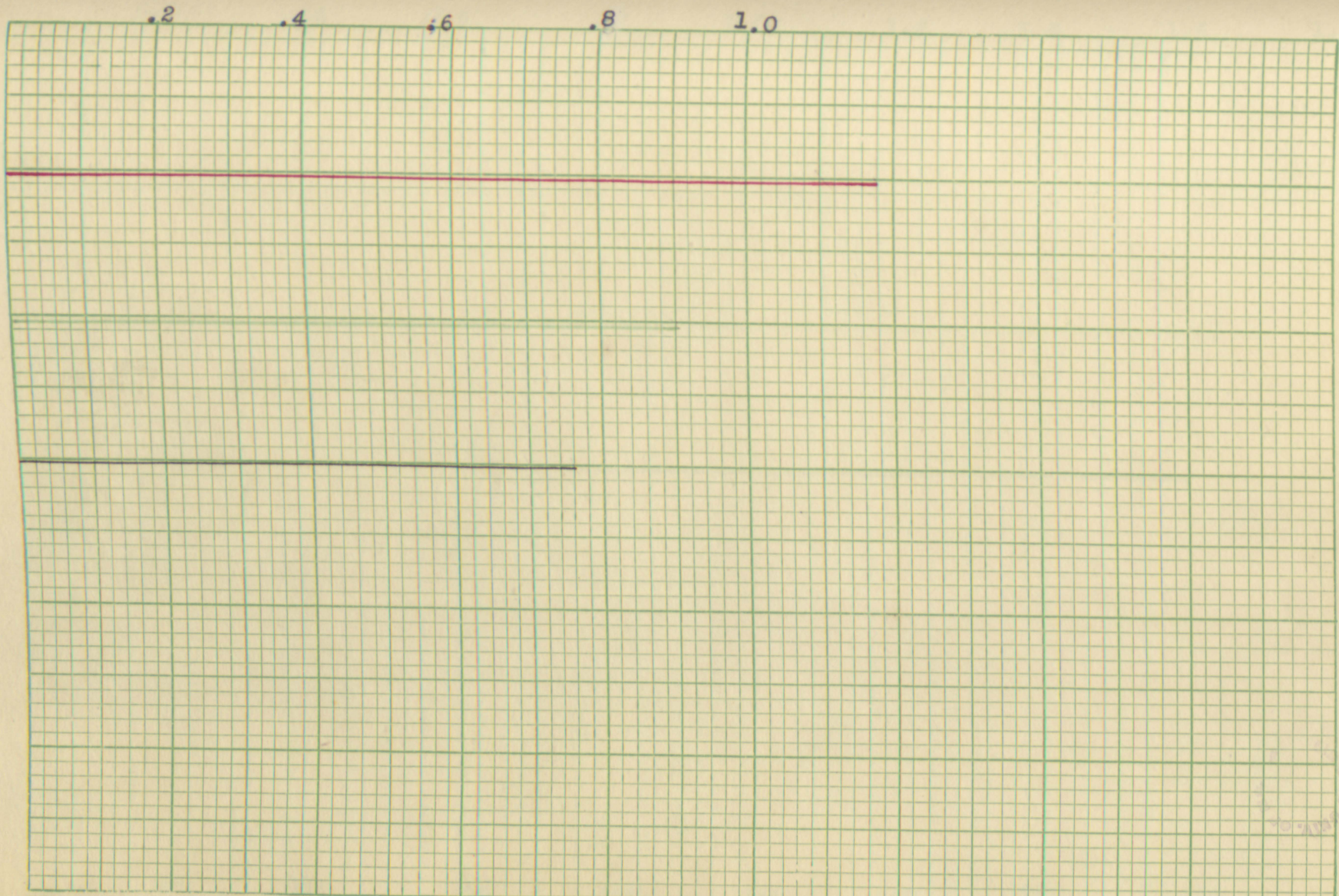


Fig. II Average Gains Per Day by Groups - 150 Days

- Alfalfa, Silage and Corn
- Alfalfa and Corn
- Timothy Silage and Corn

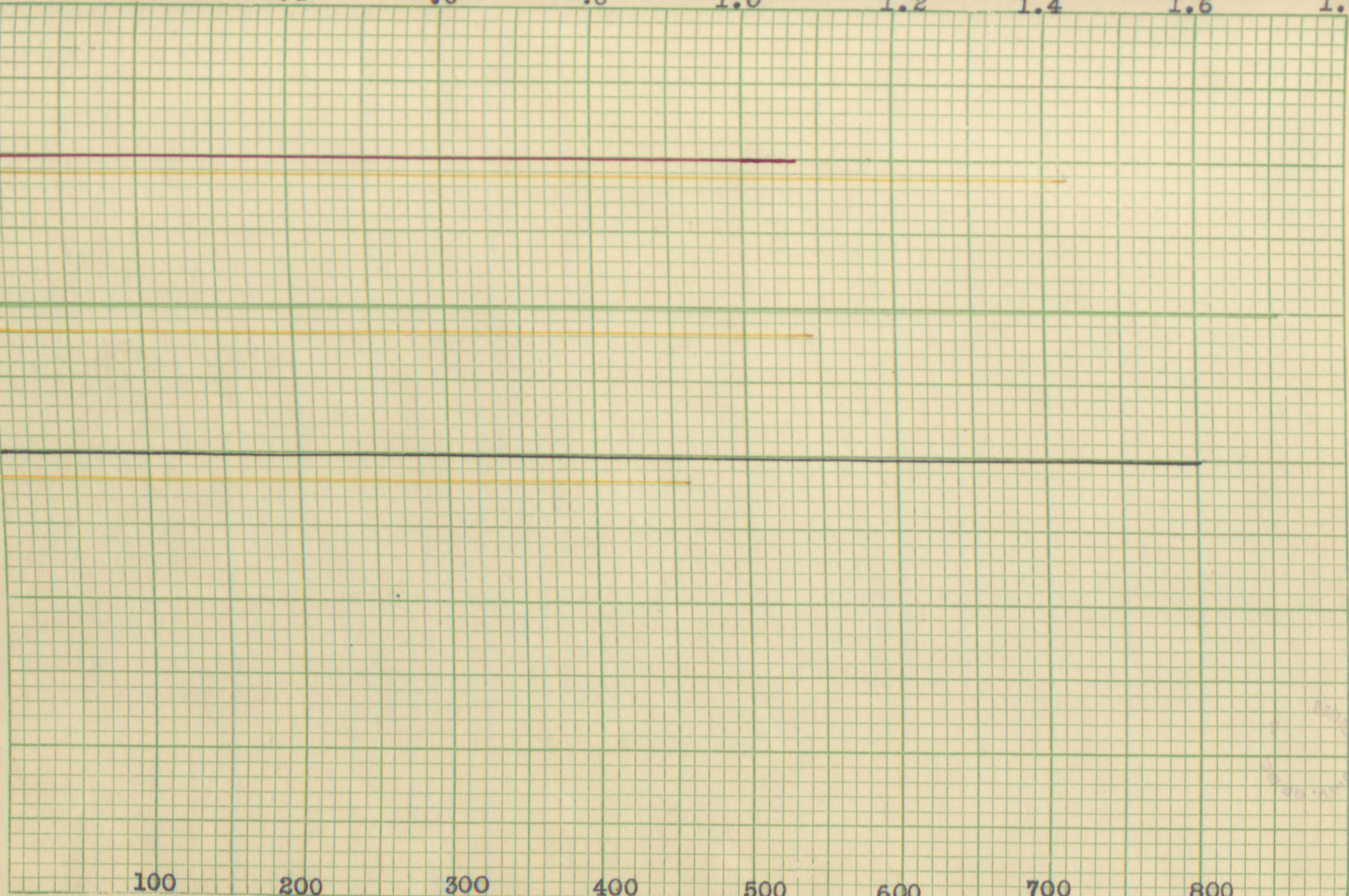


Pounds Protein

.2 .4 .6 .8 1.0 1.2 1.4 1.6 1.8

Pounds Gain

100 200 300 400 500 600 700 800



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

**Fig. III Average Protein Received Per Day Per 1000# Live Weight**  
**Experiment 1915-16**

- Alfalfa, Silage and Corn
- Alfalfa and Corn
- Timothy, Silage and Grain
- Total Gains 150 Days



Therms

300

600

900

1200

1500

1800

Pounds

50

100

200

300

400

500

600

700

800

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

Fig. IV Total Energy Available for Growth  
Experiment 1915-16

- Alfalfa, Silage and Corn
- Alfalfa and Corn
- Timothy, Silage and Grain
- Total Gains in Weight





Therms

300

600

900

1200

1500

1800

Pounds

100

200

300

400

500

600

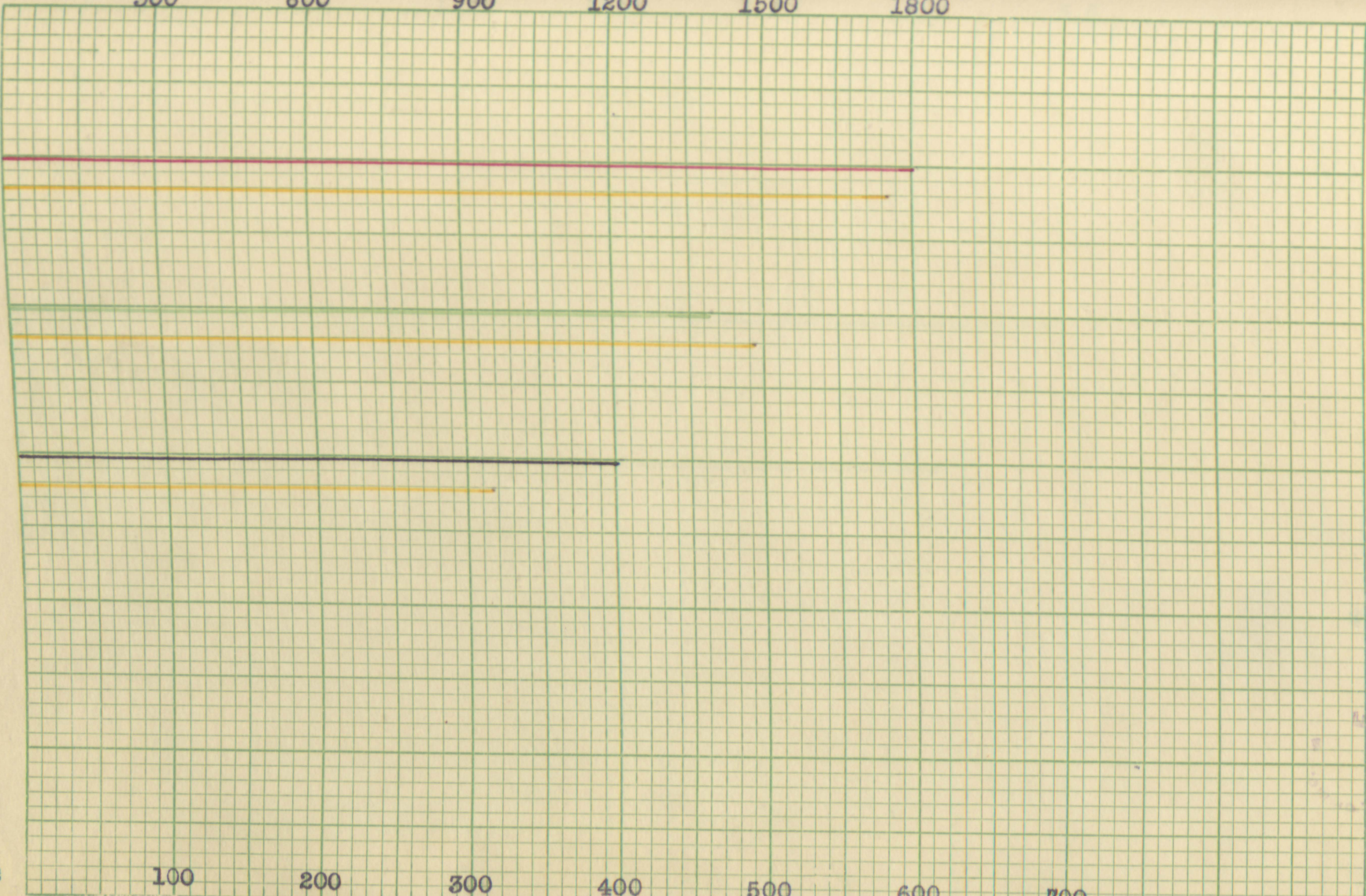
700

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

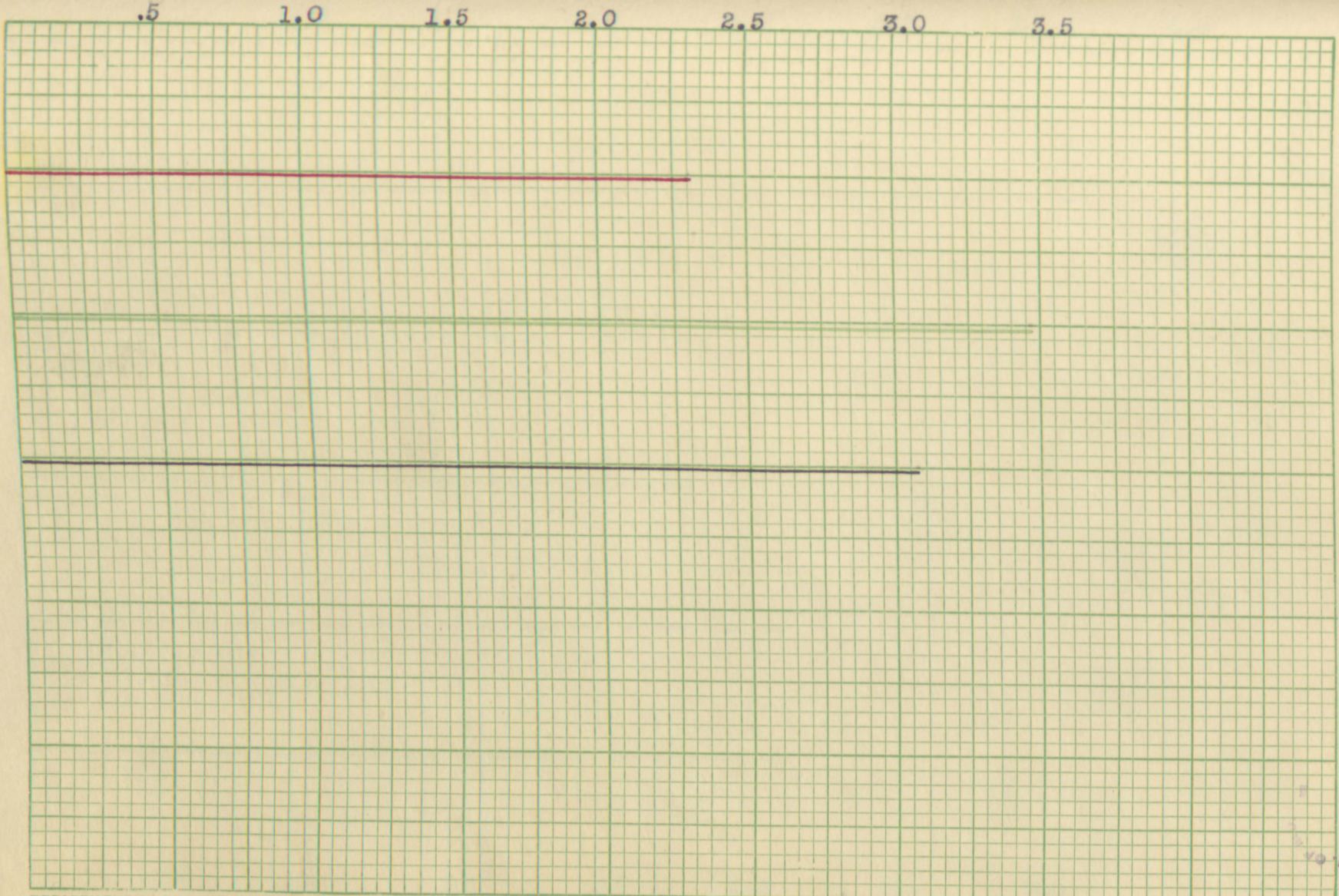
Fig. V Energy Available for Growth  
Talbot's Experiment

- Alfalfa, Silage
- Alfalfa and Corn
- Timothy, Silage and Corn
- Total Gains in weight





Therms



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

Fig. VI Average Therms of Energy Received per Pounds Gain  
Experiment 1915-16

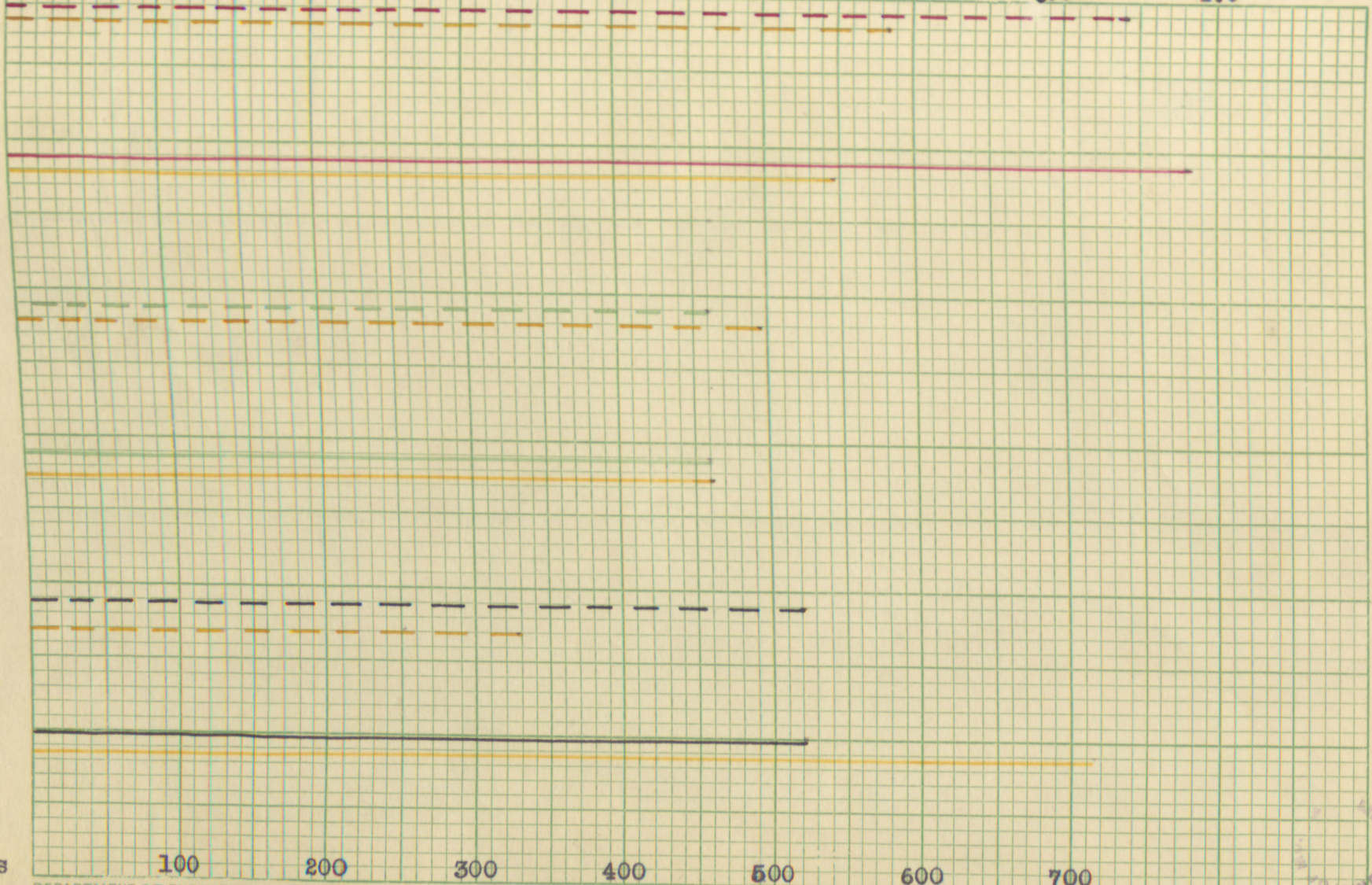
- Alfalfa, Silage and Corn
- Alfalfa and Corn
- Timothy, Silage and Grain





Pounds  
Dry  
Matter

.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0



Pounds  
Gain

100 200 300 400 500 600 700

Fig. VII  
Experiment 1915-16 solid lines  
Talbot's Experiment dotted lines

Average of Total Dry Matter per pound live weight-150 Days

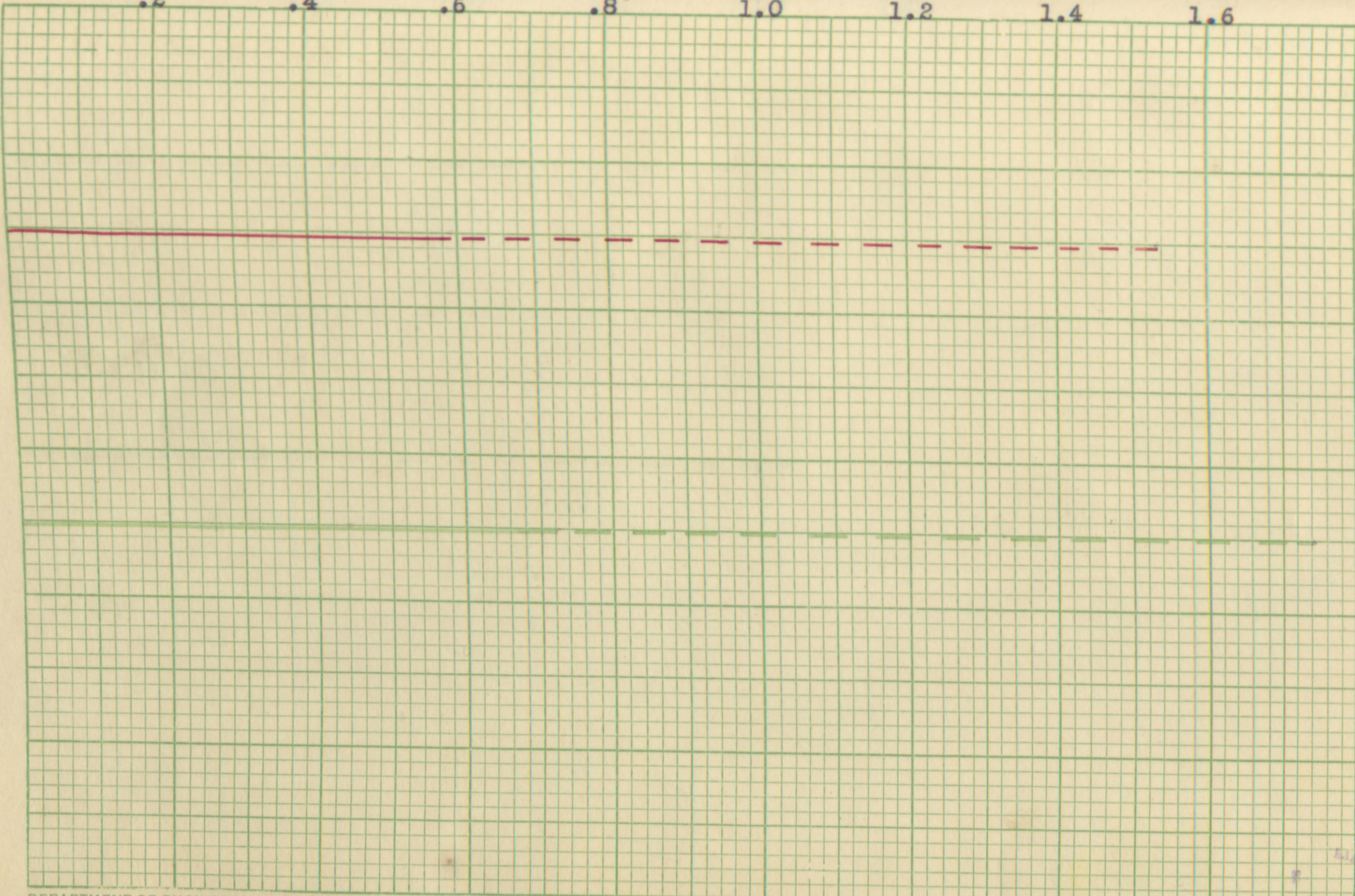
- Alfalfa, Silage and Corn
- Alfalfa and Corn
- Timothy, Silage and Grain
- Alfalfa and Silage
- Total Gain in Weight





Pounds

.2 .4 .6 .8 1.0 1.2 1.4 1.6



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

**Fig. VIII** Average Gain Per Day in Winter and Summer  
Caine's Experiment  
Winter, solid lines-151 Days  
Summer, dotted lines- 214 Days

— Silage and Grain  
— Clover and Corn

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Pounds

200

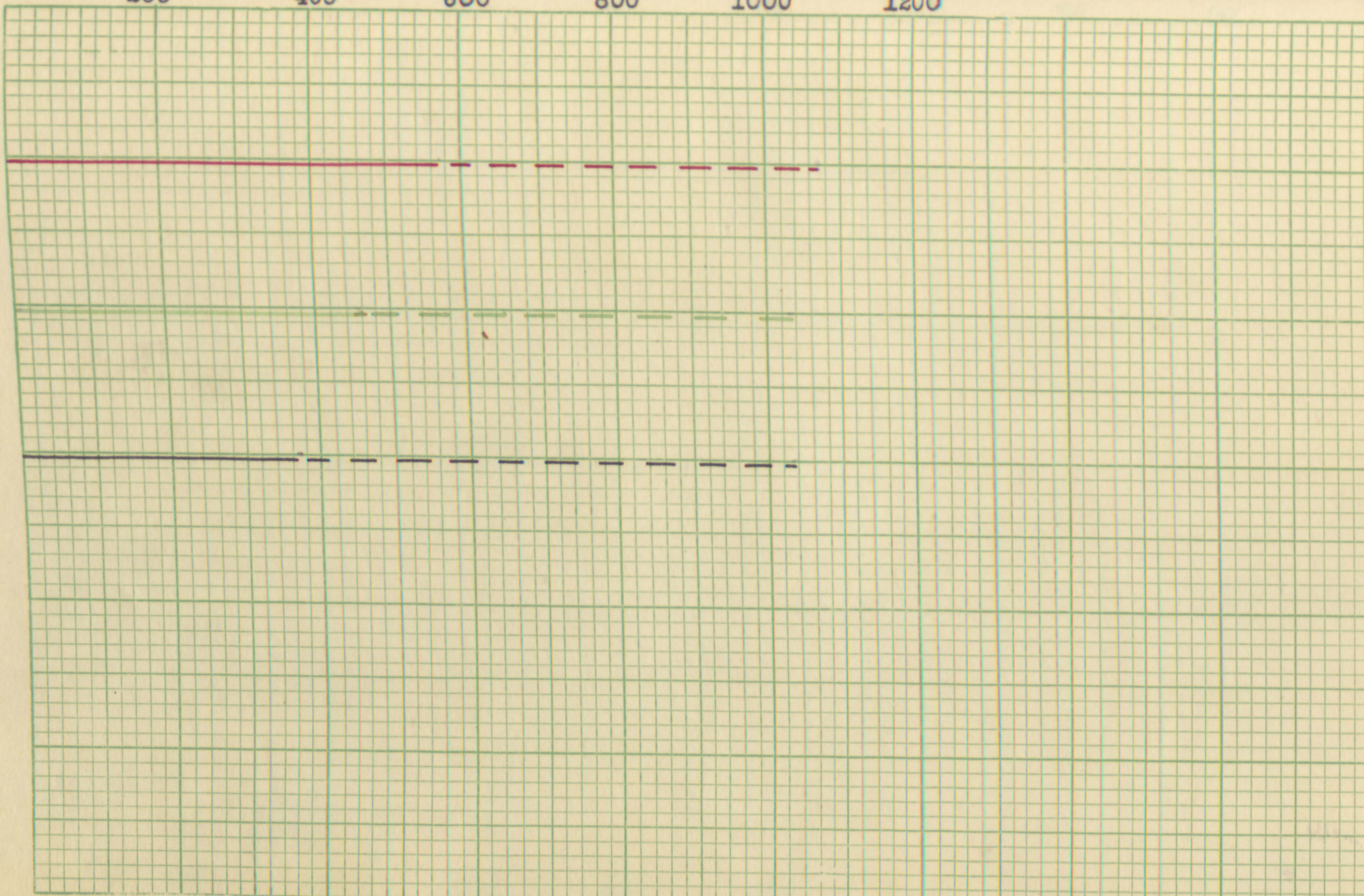
400

600

800

1000

1200



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

Fig. IX

Talbot's Experiment

Winter, solid lines, 151 Days

Summer, dotted lines, 214 Days

Total Gains in Winter and Summer

— Corn and Alfalfa

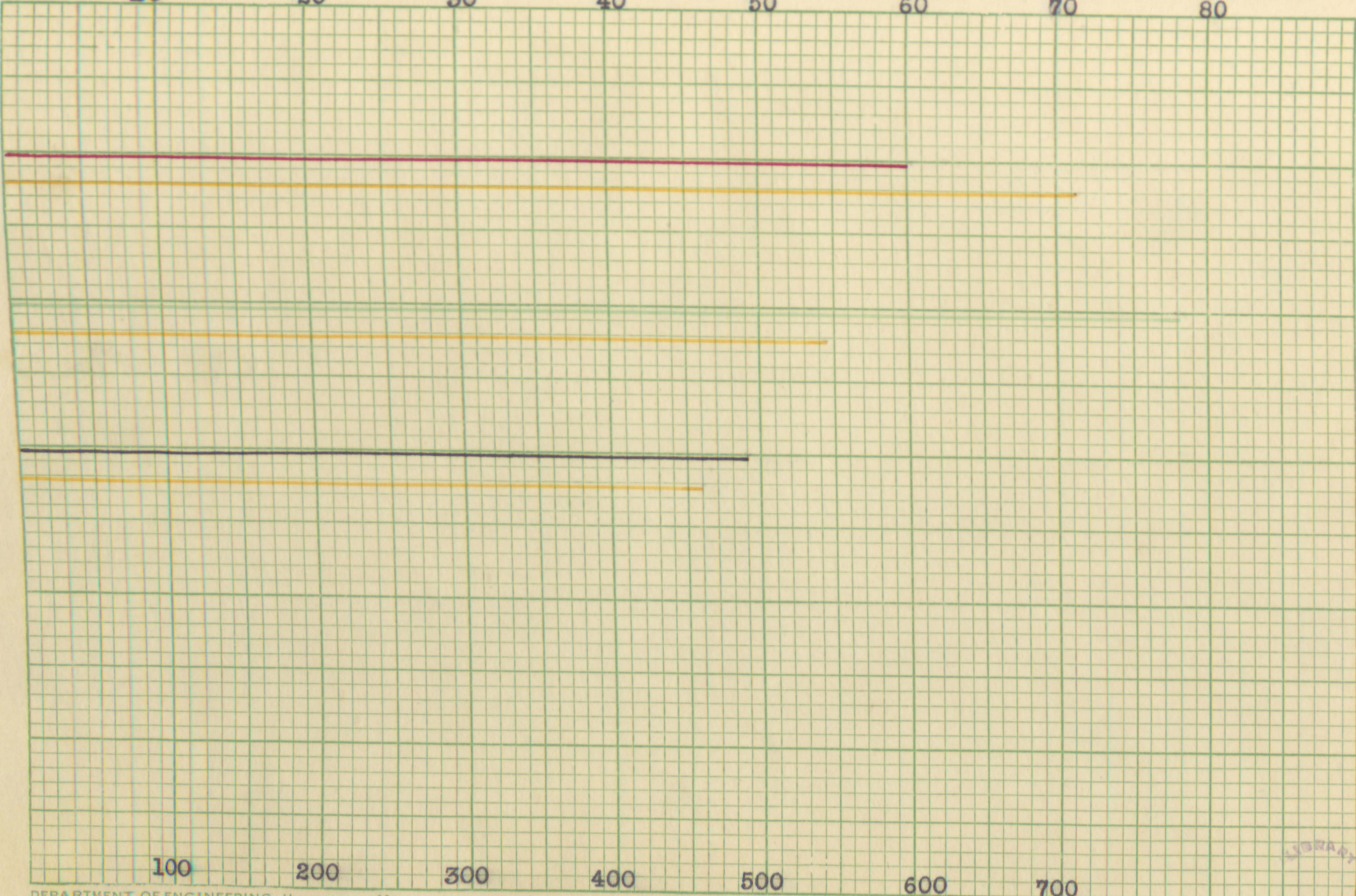
— Timothy, Silage and Grain

— Alfalfa and Silage



Dollars

10 20 30 40 50 60 70 80



Pounds

100 200 300 400 500 600 700

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

Fig X  
Experiment 1915-16

Cost of Rations

- Alfalfa, Silage and Corn
- Alfalfa and Corn
- Timothy, Silage and Grain
- Total Gains in Weight





Dollars

10

20

30

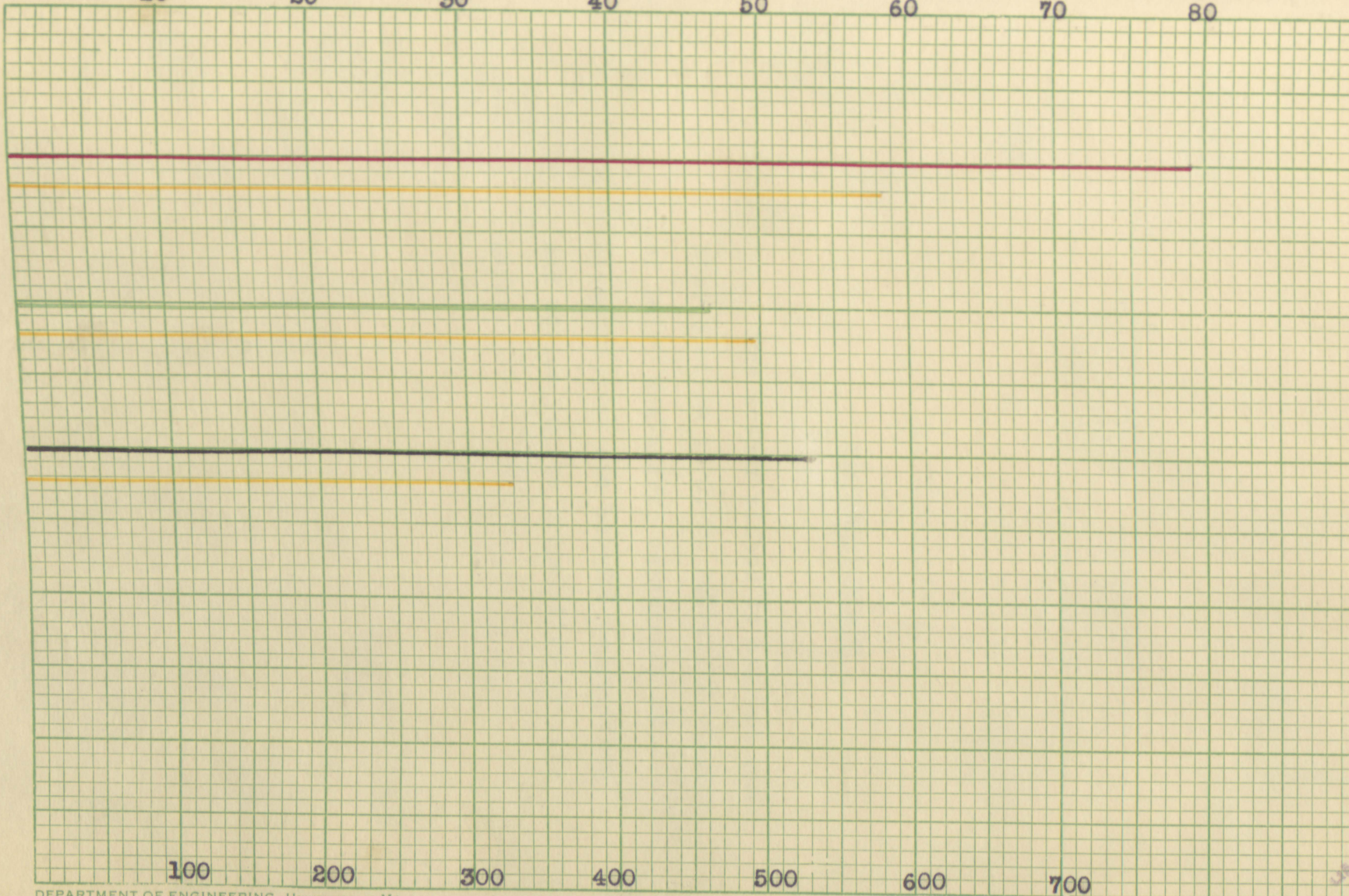
40

50

60

70

80



Pounds

100

200

300

400

500

600

700

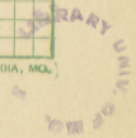
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### Cost of Rations

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

Fig. Xa  
Talbot's Experiment

- Alfalfa and Silage
- Alfalfa and Corn
- Timothy, Silage and Grain
- Total Gains in Weight



### ACKNOWLEDGEMENT

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COLUMBIA

COLLEGE OF AGRICULTURE  
AGRICULTURAL EXPERIMENT STATION  
DEPARTMENT OF AGRICULTURAL CHEMISTRY

May 18, 1916.

Graduate Committee,  
University of Missouri.

Gentlemen:

In accordance with your request of the 16th I have read the thesis on "Winter rations for dairy heifers" submitted by Mr. C. E. Wylie in partial fulfillment of the requirements for the degree of Master of Arts in the Graduate School, and am of the opinion that the dissertation meets the general standard of this University for the Master's dissertation.

I have but very few criticisms to offer on this interesting thesis. He has used consecutive numbering in his references to literature, so that in the course of his discussion a particular authority may be referred to several time by different numbers. This requires the reader to search a second time for the name of the author cited as authority. I suggest that wherever he refers to an authority he should use the same figures for that citation unless he is referring to a different page in the citation.

The tables in the thesis are not paged and as they came to me in the thesis many of them did not appear to be related in position to the discussion in the text. To my mind, it would have been better had the tables all been paged for their correct appearance in the thesis, or else all tables placed in chronological order at the back of the thesis. For example,

on page 38 he refers to tables 5 to 17. These tables are placed in the thesis several pages prior to this.

Table 18 is headed "'Total feed consumed by heifers'", but the left hand legend says "' Number of Cow'", which does not make for uniformity of statement. The same criticism pertains to table 20. Table 19 should have more explanations as the reader has some difficulty in interpreting just what is meant. Tables 21, 22, and 23 refer to the heifers as cows, while in the text on page 39 the author refers specifically to animal No. 254 as Heifer No. 254. The reader can well question whether he is referring to the same animal. These three tables, 21, 22, and 23, ought also have been designated as referring to the groups I, II, and III. These are minor criticisms.

Yours respectfully,

*P. F. Frowburg*

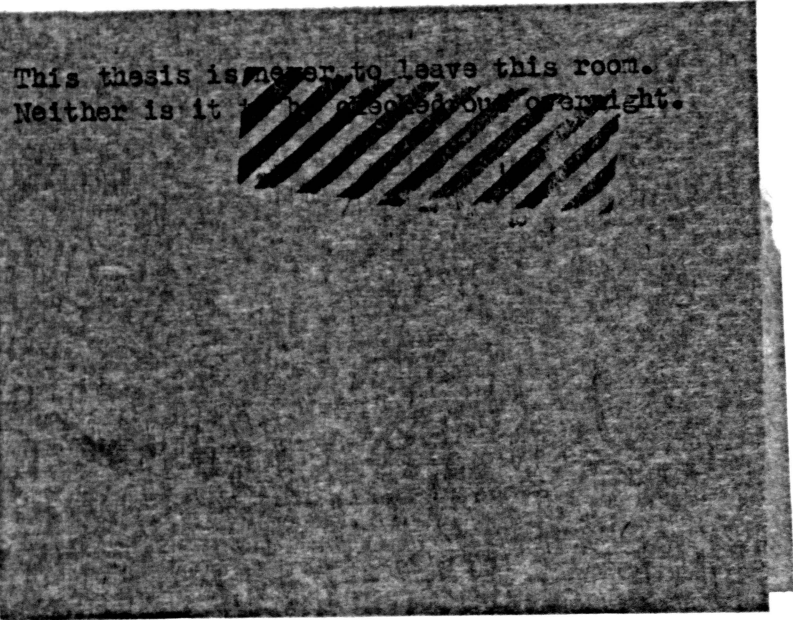


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