

THE NORMAL GROWTH OF DAIRY CATTLE

by

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INTRODUCTION

In raising dairy cattle many breeders and investigators have felt the need for some standard by which they could tell whether animals were growing normally. If a dairy farmer wanted to know whether his calf had made proper growth, he would have to call in an experienced breeder, who from observation might tell whether or not the animal had made normal gains in weight and height. When investigators wished to run a group of animals on feeding trials they had to run several individuals as controls in order to measure their growth. For this reason it is important to determine normal growth in dairy animals and to establish standards of growth which may be used in experiments with dairy cattle.

Within the last decade some such standards have been published, but the data are meager and in many cases the results do not seem to coordinate with those from other sources, because of different systems of feeding and management and perhaps climatic conditions. Investigators are handicapped in growth studies of dairy cattle because there are so few satisfactory standards on normal growth available.

Since the productive life of the dairy cow is comparatively short at best, it is important to the breeder that these productive qualities be developed in the shortest period of time and at the lowest cost of food and labor.

Therefore, it is obvious that any contribution to our knowledge of growth under normal conditions will be of advantage to investigators and breeders of dairy cattle. With the hope that some further contribution might be made to the knowledge on this subject the following work is presented.

REVIEW OF LITERATURE

Growth and the Growth Impulse

Growth is characteristic of all living organisms. Armsby (1) states that "growth may be characterized as consisting in an increase of the structural elements of the body, chiefly by cell multiplication resulting in gain in size and weight."

That the body contains a force sometimes termed the "growth impulse" is brought out quite clearly by Minot (2) in his studies on growth. He states that in the early embryonic stages, rabbits and other mammals are capable of growing as much as 1000 per cent in a day. This force is rapidly spent so that at birth 98 per cent of the growth impulse has been lost. This brings out the fact that uterine life is characterized by rapid growth. After birth less than two per cent of this growth impulse is left and it is used up gradually until the death of the animal occurs.

Growth Studies

In making a study of the factors influencing the rate of growth, Eckles and Swett (3) concluded that growth could not be represented by a single term for the growth impulse was found to be decidedly stronger in the skeleton than in the fleshy parts and that environmental conditions have a greater effect upon weight than upon skeletal growth. For that reason separate units of measure are needed to measure these two different types of growth. They found that by a difference in rations fed, a variation of 46 per cent gain in weight and a 7 per cent difference in growth of skeleton resulted. They also found that several skeletal measurements could be used, but because of the small limit of error and the ease with which it is taken the height at withers was selected as the best measure of skeletal growth. In considering the effect of gestation, they concluded that the development of the fetus exerted but a slight tax upon the animal and had practically no effect upon the rate of growth of heifers.

In an investigation to determine the effect of rations and age of calving upon the growth of dairy cows, Eckles (4) found that the ration could influence the rate of growth in weight to quite an extent during the growing period by liberal feeding.

Later Eckles (5) made a study of the normal growth of dairy cattle. In this study he presented normal growth curves from birth to maturity representing weight and height at withers for females of the Jersey, Holstein, Ayrshire and Shorthorn breeds. He concluded that these curves would be useful in research work and would help breeders of dairy cattle to determine whether or not their animals were growing normally.

Turner, Ragsdale and Brody (6) investigating the normal growth of the Jersey cow concluded that the Jersey cow reaches the mature weight of 960 pounds at 8 years of age. In a study of the average weights of 15,680 animals from 18 months to 17 years of age they found that the percentage decline of growth impulse was approximately constant.

Brody and Ragsdale (7) concluded that the increase in height at withers practically ceases at 30 months of age, while the increase in weight continues for a much longer period. They found that growth is most rapid at 5 and 20 months of age, the cow having two extrauterine growth cycles with maxima at these months. They also concluded that under ordinary variations of food supply and other experimental conditions the effect on height at withers may be considered negligible and that it may be taken as the unvarying measure of the hereditary size of the animal at any age. Also of importance was the weight-height relationship between

different individuals in the same breed and between different breeds.

Lush and associates (8) in determining the normal growth of range cattle found that measurements for growth seemed to fall in two series. One series, the measurement of height over withers and hips, showed a regular change with age, while the other series such as measurements of width of chest and flank circumference showed a greater variation during the different seasons. This seemed to show that the former series was the most reliable method for the measurement of the normal growth of the skeleton.

In a more recent investigation of the accuracy of measurements of dairy cattle, Lush and Copeland (9) concluded that height over withers and hips are measurements least influenced by plane of nutrition and are especially significant when considered in relation to weight.

EXPERIMENTAL DATA

Source

The data for this problem have been accumulated from all the purebred animals in the station dairy herd. Weights and heights at withers have been taken at monthly intervals from birth to 24 months of age on all heifers dropped in the herd. Similar data were taken on bulls from birth to

twelve months of age. These data have been collected since 1921. After 24 months of age, the cows were weighed twice a year in January and July and from these weights the figure nearest the animals birth date was taken to record the yearly weight up to 8 years of age.

Animals Used

Four breeds of dairy cattle were used, the Ayrshire, Guernsey, Holstein and Jersey breeds. The Jerseys were between the Island and American types in size. The Ayrshires were of the type commonly found in most of the leading Ayrshire herds of the middle west. The Holsteins were of the medium size type as found in most Holstein herds throughout the country. Several well known lines of breeding were represented. The Guernseys would be considered fairly representative of the type found in purebred herds throughout the middle west.

Feeding and Management of Animals

The data were collected from animals kept under conditions which would be considered normal in most purebred herds. The conditions followed good herd management practices. The calves were fed whole milk until they were about two weeks of age. Then a gradual change was made to

skim milk, with hay, silage and grain as a supplement. The feeding of skim milk was discontinued after 6 months of age and the calves were kept in good growing condition by continuing to feed good alfalfa hay, silage and a grain supplement.

Method of Measurement

In starting this problem the workers at this station decided upon a method similar to that used by Eckles and Swett (3) in taking measurements on growth. It was found that weight alone was not a fair measure of growth because of the frequent fluctuations due to various factors. Height at withers, although a uniform measure of the size of the animal, was not a fair measure of full growth in all parts. For these reasons both height at withers and live weight were decided upon as the most feasible method of measuring growth. In securing the measurement of height at withers an ordinary measuring standard graduated in centimeters was used. The animal to be measured was made to stand as nearly normal as possible on a level floor. Then two measurements were taken, the animal being moved between measurements. If the two measurements checked the resultant figure was recorded, otherwise the animal was moved again and a third measurement was made. If two of the three figures checked

they were taken as the final measure. The weight of the animal was taken at the time of the height measurement. Only one weight was taken. The first weight and measure of height was taken as soon after the calf was born as possible and succeeding weights and measurements were taken at monthly intervals on the birth date of the calf thereafter.

It occurred to the writer that some question might be raised regarding the accuracy of the averages obtained from these weights, because of the variations that may occur when only one weight is taken. But since these data were accumulated from a reasonably large number of animals it was felt that the averages would be sufficiently accurate. The question of gestation affecting the normal growth of the animals also had to be considered, but here again with the large number of animals involved and the fact that the cows calved at periods spread throughout the year seemed to minimize this error.

Presentation of Data

With the weights and heights of animals at various ages the average weight and height at withers was determined by breeds for each month from birth to 24 months of age. This was done for the Ayrshire, Guernsey, Holstein and Jersey breeds. Since only weights were recorded for females after

24 months of age and these every 6 months, the average weight was calculated for each of the breeds represented at 30 and 36 months of age and at yearly intervals thereafter to 96 months of age. Greater significance was added to the data by treating statistically. This was done by determining the standard deviation of the mean and the probable error of the mean and standard deviation.

The averages determined were tabulated and in addition growth curves have been plotted comparing the weights of dairy females in the different breeds represented from birth to 96 months of age. Growth curves showing the average height at withers of the four breeds from birth to 24 months of age were also made. Similar curves were plotted for bulls from birth to 12 months of age. Comparative curves have been constructed showing the difference in weights of dairy heifers from birth to 24 months of age at this station and Missouri. The Ayrshire, Holstein, and Jersey breeds were represented.

DISCUSSION OF DATA

Table I gives the average weight of dairy females from birth to 96 months of age. The standard deviation of the averages is given at six months intervals up to 36 months of age and after 36 months it is given for all the yearly

averages up to 8 years of age. The average birth weight of Ayrshire, Guernsey, Holstein and Jersey females were found to be 74, 64, 90 and 48 pounds respectively. At 6 years of age where maturity is apparently reached, their respective weights were 1218, 990, 1422 and 941 pounds. The period of most rapid growth seems to be between 3 and 24 months of age for the Guernsey and Jersey breeds. The Ayrshire and Holstein breeds continued their rapid growth to 30 and 36 months respectively. The standard deviation shows a gradual increase up to 30 months of age. After the animal has reached her first lactation considerable fluctuation is observed in this constant. This is undoubtedly due in large measure to the rather mixed character of the data involved. It must be remembered that after 24 months of age, semi-annual weights only were taken. As a result, when these weights were taken some cows would be advancing in their gestation period and putting on weight, others would be dry and weighing their heaviest, while others again might be declining in weight as holds true for the first month or more following freshening, all of which makes for considerable variation as expressed by the standard deviation. This perhaps may account for the break in the weight curve for Guernseys between the 24th and 30th months in Figure I.

Figure I is a graphical study of the averages presented in Table I. The growth curves in weight picture the dif-

TABLE I

Average Weight of Dairy Females from Birth to 96 Months of Age

<u>AYRSHIRE</u>				<u>GUERNSEY</u>				<u>HOLSTEIN</u>				<u>JERSEY</u>			
Age :	Number :	Mean :	Standard Deviation :	Number :	Mean :	Standard Deviation :	Age :	Number :	Mean :	Standard Deviation :	Number :	Mean :	Standard Deviation :		
Months :	Number :	Pounds :	Deviation :	Number :	Pounds :	Deviation :	Months :	Number :	Pounds :	Deviation :	Number :	Pounds :	Deviation :		
Birth :	70 :	74.4 ± .742 :	9.20 ± .525 :	34 :	64.4 ± 1.075 :	9.29 ± .760 :	Birth :	75 :	90.4 ± .898 :	11.53 ± .635 :	33 :	48.5 ± 1.196 :	10.19 ± .846 :		
1 :	69 :	93.5 :	:	32 :	79.9 :	:	1 :	70 :	116.8 :	:	30 :	65.3 :	:		
2 :	66 :	121.8 :	:	32 :	105.4 :	:	2 :	70 :	151.6 :	:	32 :	85.9 :	:		
3 :	65 :	160.3 :	:	30 :	135.1 :	:	3 :	65 :	191.6 :	:	32 :	115.1 :	:		
4 :	65 :	197.8 :	:	30 :	172.8 :	:	4 :	64 :	236.2 :	:	33 :	147.1 :	:		
5 :	63 :	245.7 :	:	31 :	213.1 :	:	5 :	62 :	284.8 :	:	35 :	189.4 :	:		
6 :	64 :	290.95 ± 3.016 :	35.77 ± 2.133 :	30 :	255.0 ± 4.183 :	33.96 ± 2.958 :	6 :	63 :	335.3 ± 3.283 :	38.64 ± 2.321 :	35 :	228.4 ± 3.785 :	33.20 ± 2.676 :		
7 :	63 :	342.2 :	:	30 :	299.7 :	:	7 :	62 :	386.4 :	:	35 :	268.6 :	:		
8 :	62 :	380.2 :	:	30 :	347.5 :	:	8 :	63 :	441.1 :	:	35 :	312.1 :	:		
9 :	63 :	434.9 :	:	33 :	388.4 :	:	9 :	62 :	487.6 :	:	35 :	349.1 :	:		
10 :	63 :	473.2 :	:	31 :	427.4 :	:	10 :	61 :	533.2 :	:	35 :	387.0 :	:		
11 :	63 :	507.4 :	:	34 :	458.1 :	:	11 :	61 :	576.3 :	:	34 :	412.0 :	:		
12 :	64 :	545.3 ± 5.190 :	61.56 ± 3.67 :	34 :	488.9 ± 5.234 :	45.25 ± 3.701 :	12 :	62 :	615.9 ± 4.964 :	57.96 ± 3.510 :	35 :	445.0 ± 4.866 :	42.68 ± 3.441 :		
13 :	64 :	585.9 :	:	33 :	522.4 :	:	13 :	61 :	658.7 :	:	35 :	470.9 :	:		
14 :	64 :	625.97 :	:	33 :	553.1 :	:	14 :	60 :	693.6 :	:	35 :	499.6 :	:		
15 :	60 :	653.1 :	:	32 :	584.0 :	:	15 :	58 :	731.2 :	:	32 :	519.6 :	:		
16 :	55 :	684.4 :	:	30 :	594.1 :	:	16 :	60 :	768.0 :	:	29 :	542.1 :	:		
17 :	50 :	715.6 :	:	32 :	634.5 :	:	17 :	59 :	807.1 :	:	29 :	580.8 :	:		
18 :	53 :	750.2 ± 6.172 :	66.61 ± 4.364 :	30 :	661.5 ± 7.280 :	59.11 ± 5.148 :	18 :	56 :	843.5 ± 6.721 :	74.56 ± 4.752 :	27 :	588.2 ± 7.989 :	61.54 ± 5.649 :		
19 :	53 :	780.7 :	:	29 :	685.3 :	:	19 :	53 :	890.8 :	:	27 :	605.4 :	:		
20 :	54 :	821.7 :	:	28 :	712.1 :	:	20 :	51 :	920.6 :	:	26 :	628.0 :	:		
21 :	51 :	852.3 :	:	27 :	741.1 :	:	21 :	49 :	956.8 :	:	26 :	648.2 :	:		
22 :	50 :	875.0 :	:	24 :	766.4 :	:	22 :	51 :	994.1 :	:	25 :	661.7 :	:		
23 :	43 :	902.1 :	:	23 :	786.6 :	:	23 :	52 :	1025.4 :	:	22 :	683.3 :	:		
24 :	44 :	927.5 ± 7.104 :	69.86 ± 5.023 :	22 :	812.9 ± 10.209 :	70.98 ± 7.219 :	24 :	47 :	1079.3 ± 9.535 :	96.91 ± 6.742 :	25 :	707.0 ± 9.228 :	68.41 ± 6.525 :		
30 :	33 :	996.4 ± 7.897 :	67.27 ± 5.584 :	25 :	796.9 ± 11.092 :	82.22 ± 7.843 :	30 :	37 :	1183.5 ± 14.651 :	132.13 ± 10.380 :	18 :	784.7 ± 14.375 :	90.43 ± 10.165 :		
36 :	37 :	1034.8 ± 12.599 :	113.63 ± 8.909 :	23 :	847.7 ± 9.892 :	70.33 ± 6.995 :	36 :	29 :	1267.5 ± 18.273 :	145.89 ± 12.921 :	25 :	834.0 ± 11.768 :	87.24 ± 8.321 :		
48 :	28 :	1120.0 ± 12.878 :	101.04 ± 9.106 :	18 :	895.9 ± 15.211 :	95.68 ± 10.756 :	48 :	26 :	1317.8 ± 20.216 :	152.82 ± 14.295 :	17 :	875.4 ± 11.147 :	68.14 ± 7.882 :		
60 :	18 :	1182.5 ± 14.940 :	93.98 ± 10.564 :	8 :	998.1 ± 21.467 :	90.01 ± 15.179 :	60 :	20 :	1359.4 ± 24.269 :	160.90 ± 17.161 :	15 :	940.6 ± 14.852 :	85.28 ± 10.502 :		
72 :	20 :	1218.2 ± 15.063 :	99.87 ± 10.651 :	9 :	990.0 ± 23.967 :	106.30 ± 16.947 :	72 :	10 :	1422.4 ± 21.641 :	101.45 ± 15.302 :	11 :	941.3 ± 13.684 :	67.30 ± 9.676 :		
84 :	17 :	1203.4 ± 16.629 :	101.65 ± 11.758 :	5 :	1014.0 ± 19.208 :	63.68 ± 13.582 :	84 :	9 :	1368.3 ± 18.563 :	82.56 ± 13.126 :	8 :	946.0 ± 22.914 :	96.07 ± 16.202 :		
96 :	7 :	1219.9 ± 19.985 :	78.40 ± 14.131 :	7 :	1025.7 ± 28.001 :	109.85 ± 19.800 :	96 :	8 :	1398.5 ± 34.354 :	131.46 ± 22.170 :	3 :	826.7 ± 8.932 :	22.94 ± 6.316 :		

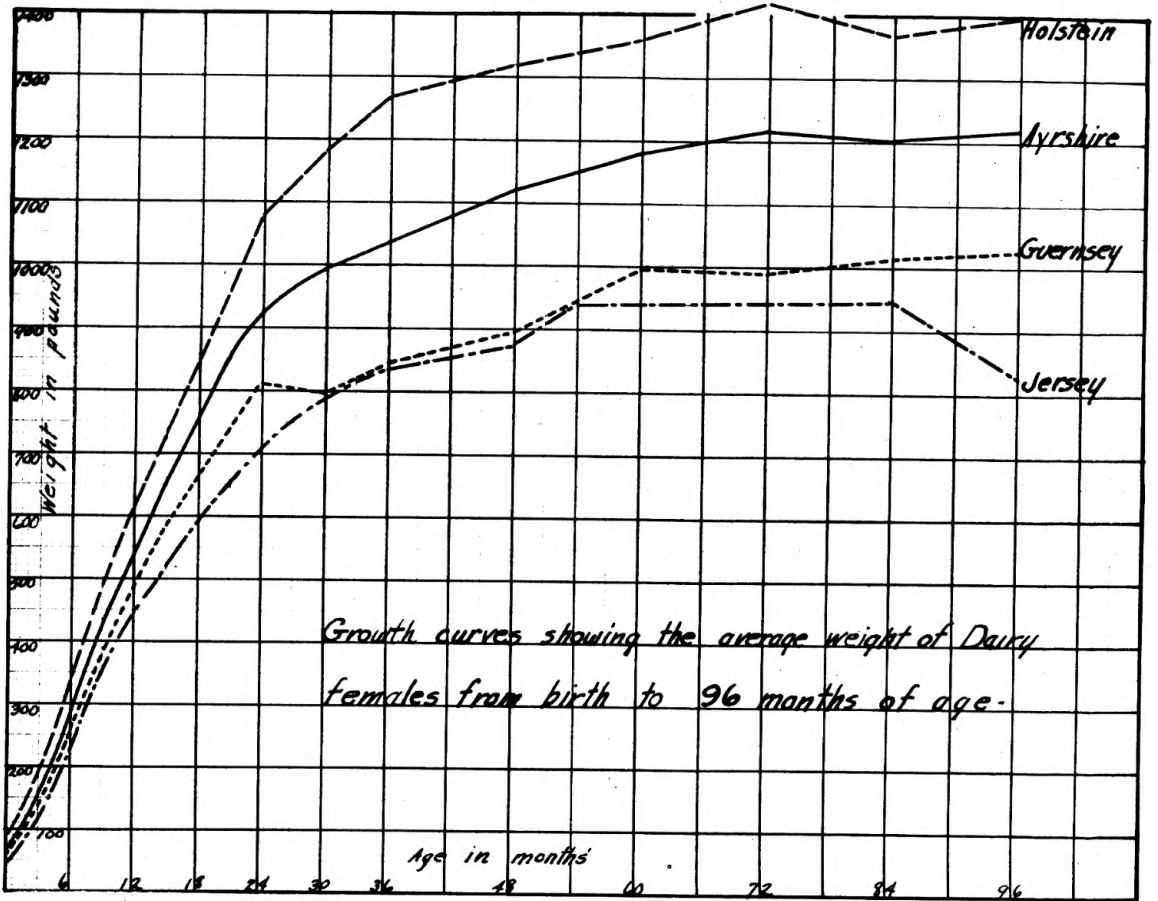


Figure I

ferences in breeds more clearly.

Table II shows the average height at withers for dairy females from birth to 24 months of age with the standard deviation and probable errors given at 6 months intervals. In contrast to the average weights there is much less difference in height at withers as the difference between breeds remains practically the same from birth to 24 months of age. The average height at withers at birth for the Ayrshire, Guernsey, Holstein and Jersey breeds is 70, 68, 75 and 63 centimeters, respectively, making a difference of 2 to 12 centimeters. At 24 months of age the respective heights are 124, 121, 132 and 117 centimeters, a difference of 3 to 15 centimeters between breeds. This seems to indicate that the greatest variation between breeds is in weight and that although the difference in weight increases with age, the difference in height is more nearly uniform from birth to maturity.

The standard deviation of the height at withers is practically the same for 24 months of age as at birth, showing that there is very little variation in these measurements for the ages involved.

Figure II shows the heights of the four breeds represented in Table II in graphical form. The growth curves in height picture more clearly the uniform growth between breeds from birth to 24 months of age.

TABLE II

Average Height at Withers of Dairy Females from Birth to 24 months of Age

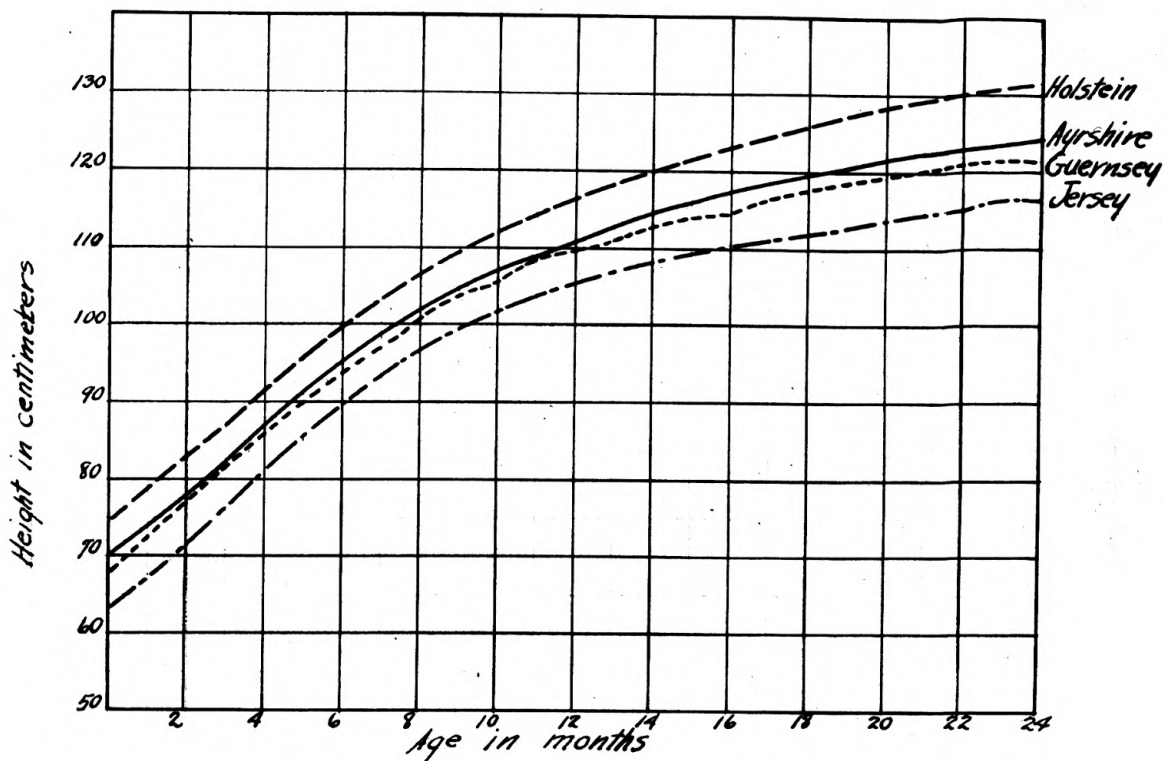
AYRSHIRE

GUERNSEY

HOLSTEIN

JERSEY

Age : Months :	Number :	Mean :	Standard Deviation :	Number :	Mean :	Standard Deviation :	Number :	Mean :	Standard Deviation :	Number :	Mean :	Standard Deviation :			
Centimeters				Centimeters				Centimeters				Centimeters			
Birth :	70 :	70.3 ± .252 :	3.13 ± .178 :	34 :	67.8 ± .436 :	3.76 ± .308 :	74 :	74.5 ± .360 :	4.59 ± .255 :	33 :	63.3 ± .116 :	.984 ± .082 :			
1 :	69 :	75.9 :	:	32 :	72.8 :	:	70 :	78.7 :	:	30 :	67.7 :	:			
2 :	66 :	78.1 :	:	32 :	77.0 :	:	70 :	82.7 :	:	32 :	71.8 :	:			
3 :	65 :	82.0 :	:	30 :	81.3 :	:	65 :	86.8 :	:	32 :	76.3 :	:			
4 :	65 :	86.5 :	:	30 :	85.6 :	:	64 :	91.3 :	:	33 :	80.4 :	:			
5 :	63 :	91.0 :	:	31 :	90.0 :	:	62 :	95.5 :	:	35 :	85.0 :	:			
6 :	64 :	95.0 ± .258 :	3.06 ± .182 :	30 :	93.9 ± .400 :	3.25 ± .283 :	63 :	99.7 ± .310 :	3.64 ± .219 :	35 :	89.5 ± .362 :	3.18 ± .256 :			
7 :	63 :	98.3 :	:	30 :	97.0 :	:	62 :	103.2 :	:	35 :	93.1 :	:			
8 :	62 :	101.8 :	:	30 :	100.9 :	:	63 :	106.3 :	:	35 :	96.5 :	:			
9 :	63 :	104.3 :	:	33 :	103.8 :	:	62 :	109.2 :	:	35 :	99.3 :	:			
10 :	63 :	106.9 :	:	31 :	105.7 :	:	61 :	111.9 :	:	35 :	101.6 :	:			
11 :	63 :	108.8 :	:	34 :	108.5 :	:	61 :	114.2 :	:	34 :	103.8 :	:			
12 :	64 :	110.7 ± .264 :	3.13 ± .187 :	34 :	109.5 ± .341 :	2.95 ± .241 :	62 :	116.1 ± .274 :	3.20 ± .194 :	35 :	105.3 ± .358 :	3.14 ± .253 :			
13 :	64 :	112.8 :	:	33 :	111.0 :	:	61 :	118.2 :	:	35 :	106.9 :	:			
14 :	64 :	114.6 :	:	33 :	112.8 :	:	60 :	119.9 :	:	35 :	108.1 :	:			
15 :	60 :	115.9 :	:	32 :	114.0 :	:	58 :	121.7 :	:	32 :	109.2 :	:			
16 :	55 :	117.2 :	:	30 :	114.3 :	:	60 :	123.1 :	:	29 :	110.3 :	:			
17 :	50 :	118.6 :	:	32 :	116.4 :	:	59 :	124.4 :	:	29 :	111.1 :	:			
18 :	53 :	119.4 ± .235 :	2.54 ± .166 :	30 :	117.2 ± .466 :	3.78 ± .330 :	56 :	125.6 ± .285 :	3.16 ± .202 :	27 :	111.9 ± .516 :	3.97 ± .365 :			
19 :	53 :	120.5 :	:	29 :	118.2 :	:	53 :	127.2 :	:	27 :	112.9 :	:			
20 :	54 :	121.6 :	:	28 :	119.2 :	:	51 :	128.0 :	:	26 :	114.2 :	:			
21 :	51 :	122.5 :	:	27 :	120.1 :	:	49 :	129.1 :	:	26 :	114.8 :	:			
22 :	50 :	122.9 :	:	24 :	120.8 :	:	51 :	130.1 :	:	25 :	115.0 :	:			
23 :	43 :	123.7 :	:	24 :	121.5 :	:	52 :	131.0 :	:	22 :	116.2 :	:			
24 :	44 :	124.2 ± .261 :	2.57 ± .185 :	22 :	121.4 ± .537 :	3.74 ± .380 :	47 :	131.7 ± .328 :	3.33 ± .232 :	25 :	116.6 ± .582 :	4.32 ± .412 :			



Growth curves showing the average height at withers of Dairy females from birth to 24 months of age -

Figure II

Table III shows the average monthly weights of dairy bulls from birth to 12 months of ages with the standard deviation and probable errors at six months intervals. The bull calves average about 5 pounds heavier at birth than the heifer calves. At 12 months, the bulls are from 30 to 103 pounds heavier than the heifers in the four breeds represented. The smaller breeds including the Jersey and Guernsey show the greatest variation, the bulls being respectively 103 and 98 pounds heavier at 12 months.

Table IV presents the average height at withers for dairy bulls from birth to 12 months of age. There is only a slight difference in height between dairy bulls and dairy females. In the Ayrshire, Guernsey and Jersey breeds, the bulls average only 1 to 2 centimeters higher at withers at birth than heifers. In the Holstein breed the average height for heifers is 2 centimeters greater than that for bulls. At 12 months of age the Guernsey, Holstein and Jersey breeds vary from 2 to 3 centimeters in height in favor of the bulls, while in the Ayrshire breed the heifers average one centimeter higher. This indicates that there is no marked difference between the heights of heifers and bulls in the earlier stages of growth. Between breeds there is a difference of from 1 to 7 centimeters at birth and from 2 to 10 centimeters at 12 months of age.

TABLE III. AVERAGE WEIGHT OF DAIRY BULLS FROM BIRTH TO TWELVE MONTHS OF AGE

<u>AYRSHIRE</u>				<u>GUERNSEY</u>			
Age	Number	Mean	Standard Deviation	Number	Mean	Standard Deviation	
Months		Pounds			Pounds		
Birth	69	80.4 ± .736	9.06 ± .520	34	69.5 ± .801	6.93 ± .566	
1	61	100.8		33	85.8		
2	58	129.9		31	110.3		
3	53	168.3		27	143.1		
4	52	208.4		24	182.5		
5	49	253.4		24	226.6		
6	42	306.3 ± 6.163	59.21 ± 4.358	21	283.7 ± 5.573	37.86 ± 3.941	
7	37	354.2		20	338.7		
8	33	401.6		17	388.7		
9	30	444.6		14	436.5		
10	28	474.8		11	483.9		
11	21	519.9		8	532.1		
12	12	514.5 ± 35.462	182.12 ± 25.075	6	587.2 ± 12.299	44.65 ± 8.697	
<u>HOLSTEIN</u>				<u>JERSEY</u>			
Age	Number	Mean	Standard Deviation	Number	Mean	Standard Deviation	
Months		Pounds			Pounds		
Birth	67	94.5 ± 1.019	12.36 ± .721	32	55.4 ± .811	6.805 ± .573	
1	69	124.8		32	73.4		
2	70	161.5		30	99.1		
3	65	206.8		30	134.9		
4	62	253.4		30	174.5		
5	57	311.4		27	217.6		
6	53	369.3 ± 1.868	20.17 ± 1.321	24	264.8 ± 4.683	34.01 ± 3.311	
7	45	427.4		23	318.8		
8	35	487.2		21	363.0		
9	28	549.1		18	400.2		
10	19	604.5		17	443.8		
11	15	654.9		10	484.9		
12	10	688.2 ± 18.805	88.15 ± 13.297	8	548.4 ± 6.729	28.21 ± 4.758	

TABLE IV. AVERAGE HEIGHT OF DAIRY BULLS FROM BIRTH TO TWELVE MONTHS OF AGE

<u>AYRSHIRE</u>				<u>GUERNSEY</u>			
Age	Number	Mean	Standard Deviation	Number	Mean	Standard Deviation	
Birth	69	71.1 ± .223	2.74 ± .158	34	69.9 ± .309	2.67 ± .218	
1	61	75.2		33	74.8		
2	58	78.9		31	77.7		
3	53	83.3		27	82.3		
4	52	87.7		24	86.1		
5	49	91.7		24	90.9		
6	42	96.1 ± .414	3.98 ± .293	21	95.3 ± .432	2.93 ± .305	
7	37	100.1		20	98.9		
8	33	102.3		17	101.9		
9	30	104.8		14	105.1		
10	28	106.2		11	107.9		
11	21	108.6		8	109.5		
12	12	109.6 ± 1.365	7.01 ± .965	6	112.7 ± 1.874	6.81 ± 1.325	
<u>HOLSTEIN</u>				<u>JERSEY</u>			
Age	Number	Mean	Standard Deviation	Number	Mean	Standard Deviation	
Birth	63	72.2 ± .243	2.86 ± .172	32	65.2 ± .306	2.56 ± .216	
1	69	79.7		32	69.6		
2	70	83.7		30	73.6		
3	65	87.6		30	78.0		
4	62	91.7		30	83.1		
5	57	96.8		27	87.5		
6	53	100.7 ± .435	4.706 ± .308	24	91.7 ± .441	3.20 ± .312	
7	45	104.4		23	94.9		
8	35	107.5		21	97.9		
9	28	111.0		18	99.7		
10	19	113.3		17	103.0		
11	15	116.4		10	105.0		
12	10	118.5 ± .642	3.006 ± .454	8	108.2 ± .789	3.31 ± .558	

GROWTH CURVES OF DAIRY BULLS
 Average weight of Dairy bulls from birth to 12 months of age.

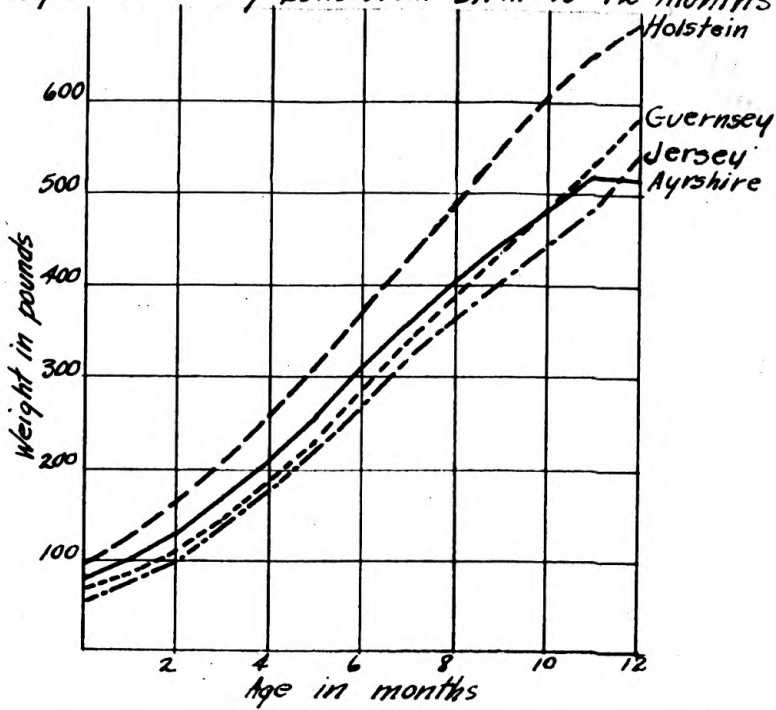


Figure III

Average Height of Dairy Bulls from birth to 12 months of age

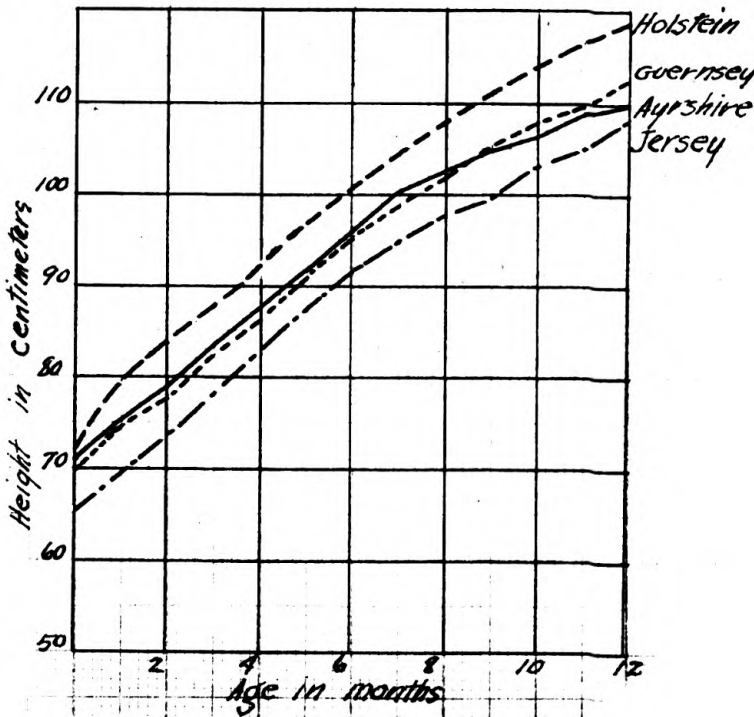


Figure IV

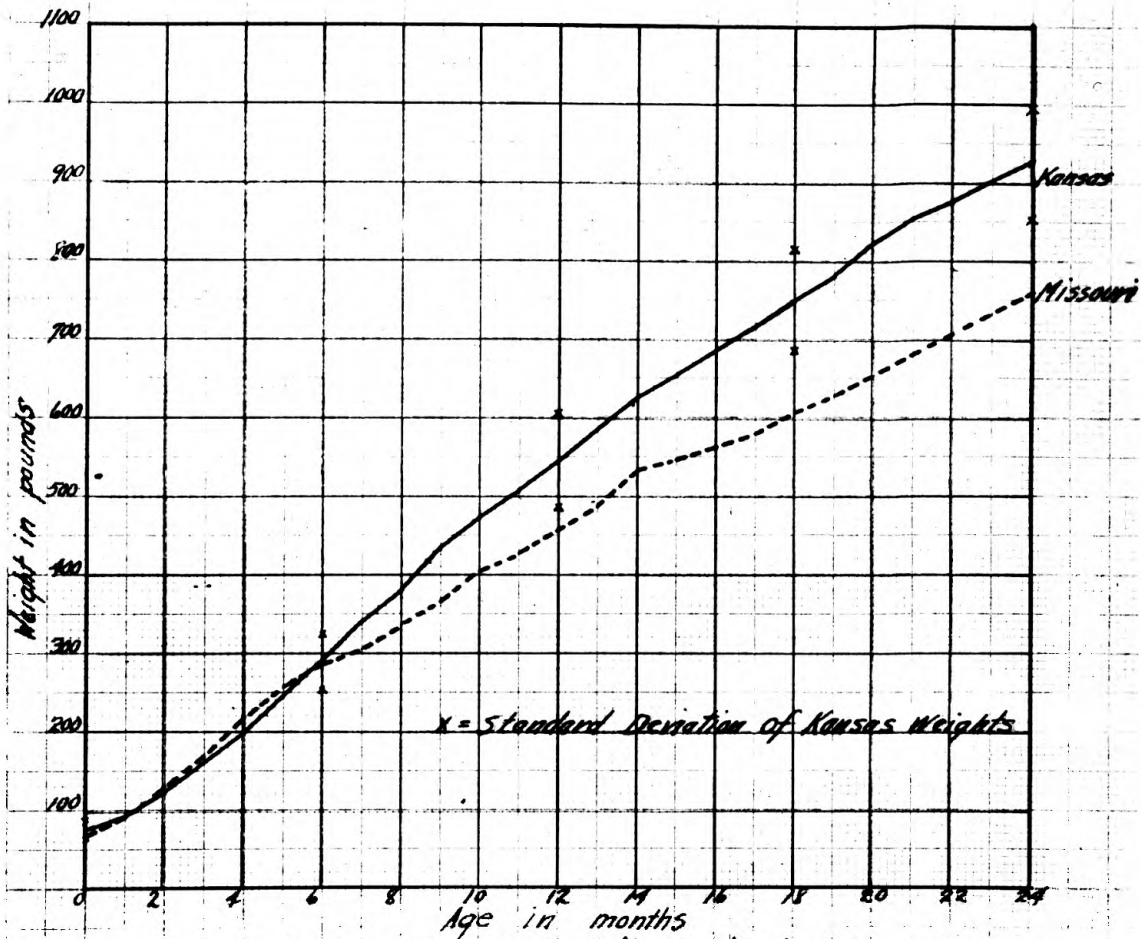
Figures III and IV show growth curves of dairy bulls in weight and height at withers using the data in Tables III and IV. Since curves could only be carried to 12 months of age, no decided differences between breeds appear.

Figure V presents comparisons between weight for normal growth at this station and those at Missouri for Ayrshire heifers from birth to 24 months. A difference of 6 per cent at birth and 18.1 per cent at 24 months was found in favor of the Kansas heifers.

Figure VI shows a similar comparison for Holsteins at this station and Missouri. Here we find that there is no difference in weight at birth but a difference of 22 per cent at 24 months in favor of the Kansas heifers.

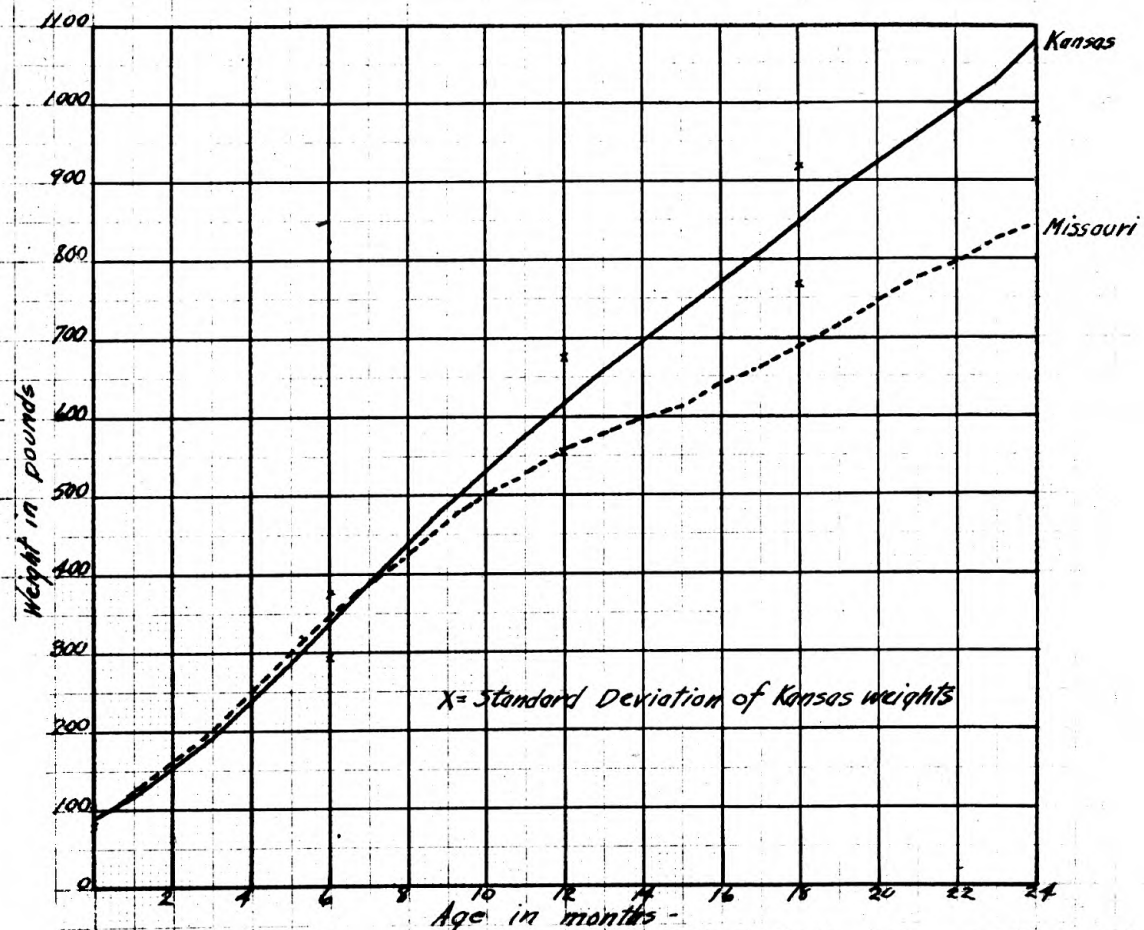
In Figure VII, comparison of the average monthly weights for the Jersey breed is made. A difference of 13 per cent in weight is found at birth and only 1.1 per cent at 24 months of age in favor of the Missouri heifers. These differences seem to indicate that the Kansas heifers were fed a little heavier and that the differences were not due to hereditary factors, since all breeds showed a greater increase in weight at this station than those at Missouri.

Figure VIII shows the growth curve of Guernsey heifers in weight from birth to 24 months of age. A comparison could not be made with this breed because Guernseys were not kept in the Missouri herd.



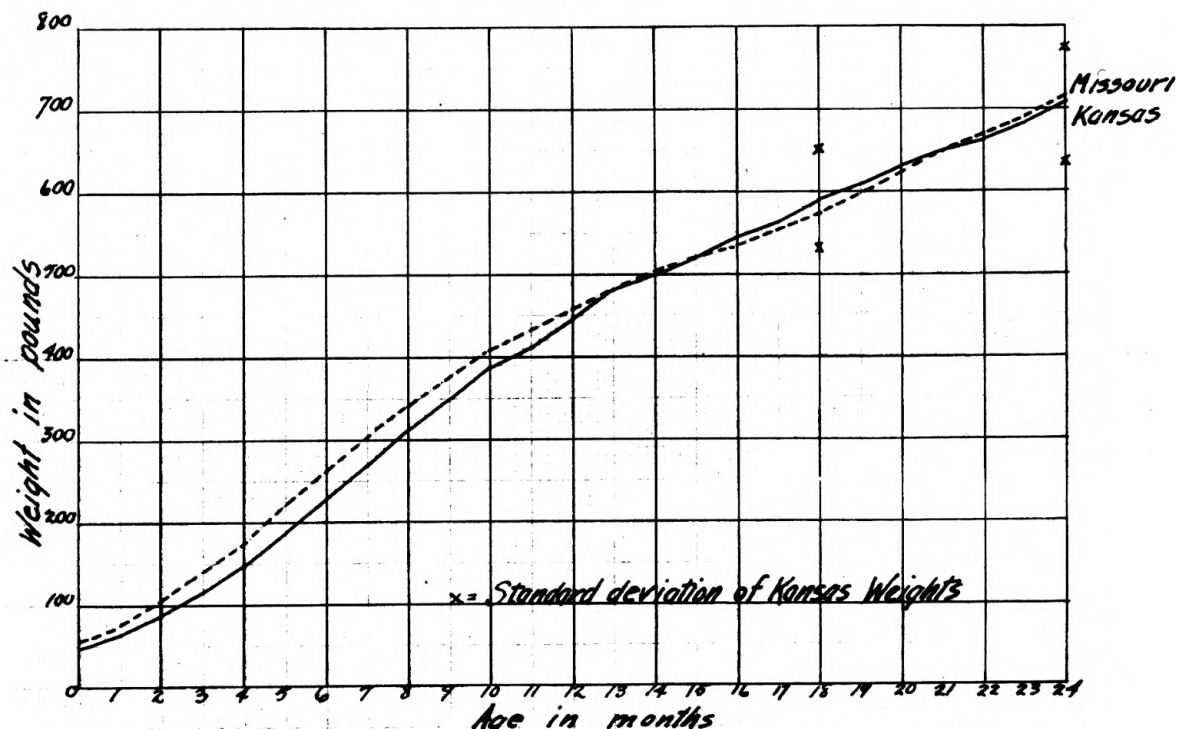
Comparison of the average weights of Ayshire Heifers from birth to 24 months of age of the Kansas and Missouri Experiment Stations.

Figure V



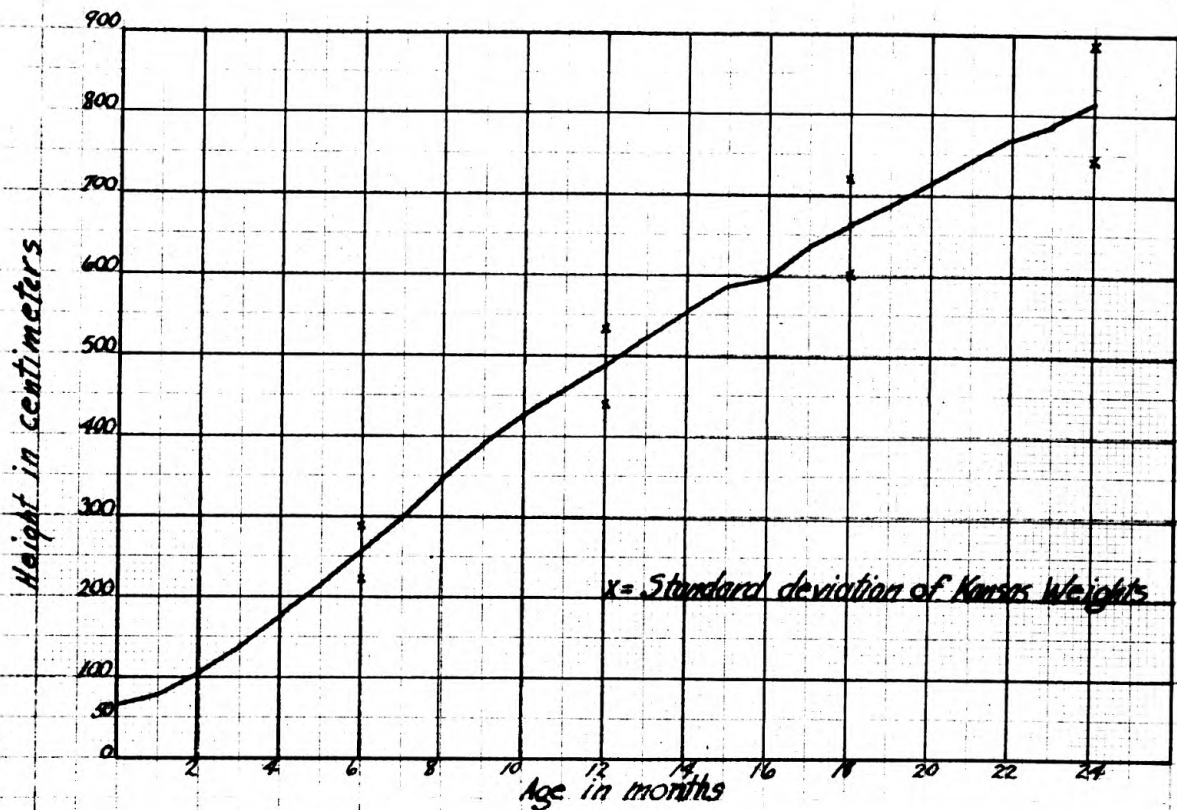
Comparison of average weights of Holstein Heifers from birth to 24 months of age at the Kansas and Missouri Experiment Stations.

Figure VI



Comparison of average weights of Jersey Heifers from birth to 24 months of age, at Kansas and Missouri Experiment Stations.

Figure VII



Growth Curve showing the average weight of Guernsey Heifers from birth to 24 months of age at the Kansas Experiment Station.

Figure VIII

SUMMARY AND CONCLUSIONS

1. In this study a total of 12,929 heights and measurements were obtained from the dairy animals of the four breeds represented.

2. The most rapid period of growth in weight for heifers was found to be between the third and twenty-fourth months.

3. The most rapid period of growth in height for heifers was found to be from birth to 10 months of age.

4. The most rapid period of growth in weight for bulls started at the second month and continued on through 12 months of age.

5. The most rapid period of growth in height for bulls appeared to be from birth to 10 months of age.

6. The standard deviation of weights from the mean for heifers and bulls increases as the animals grow older. In the case of heifers it increases from about 10 pounds at birth to about 100 pounds at 6 years of age. For bulls the average standard deviation for all breeds is 8.7 pounds at birth while at 12 months there is a range from 28 to 182 pounds.

7. The standard deviation from the mean in height is practically the same at birth as it is at 24 months of age in the case of heifers. In all breeds the average standard

deviation is 3.1 centimeters at birth and 3.5 centimeters at 24 months of age. In the case of bulls there is an increase from an average of 2.7 centimeters at birth to an average of 5 centimeters at 12 months of age for all breeds.

8. In a comparison of weights between dairy heifers at this station and Missouri, the animals at this station were found to gain more in weight as they increased in age. A marked difference was found between heifers in the Holstein and Ayrshire breeds. The Holsteins at this station averaged the same at birth, but were 22 per cent heavier than the Missouri animals at 24 months of age. The Ayrshires were found to be 6 per cent heavier at birth and 18 per cent heavier at 24 months. In the Jerseys the Missouri animals were found to be 13 per cent heavier at birth and 1.1 per cent heavier at 24 months of age.

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