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BELTSVILLE GROWTH STANDARDS FOR JERSEY CATTLE
MATTHEWS, C A. FOHRMAN, M H 1 OF 1

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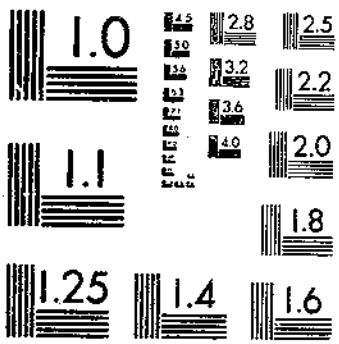

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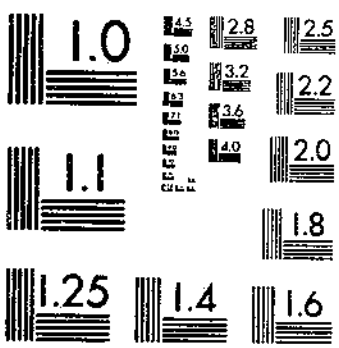

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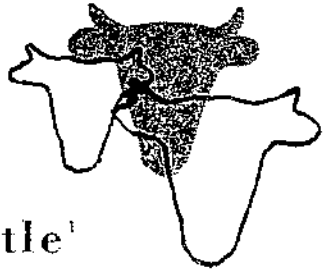
Beltsville Growth Standards for Cattle[1]



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INTRODUCTION

Normal growth by dairy cattle, as measured by weight, depends on a mixture of the effects of three kinds of conditions, which may be expressed as: (1) The inherent maximum capacity for growth; (2) the plane of nutrition and environment; and (3) the weight changes associated with recurring cycles of pregnancy and lactation.

Included in maximum capacity for growth are the effects of sex, breed, inheritance from nearby ancestors, breeding pattern, and chance variation between individuals. It is generally agreed that maximum growth in weight represents a degree of fatness that is undesirable in dairy cattle and a departure from a profitable feeding program. Consequently, good, accepted feeding practices produce a standard rate of growth that is somewhat less than maximum.

When a given set of weights is used to establish a standard for measuring normal growth, it must be assumed that each of the three kinds of conditions that may have affected the weights was normal. The usefulness of such a standard will depend on the degree of similarity, in respect to these conditions, between the standard and the groups of data that are to be compared with the standard. The effect of differences in a particular condition can be studied most effectively when other conditions are nearly alike. For example, the relative effects of outbreeding, linebreeding, and inbreeding on growth and size might be measured when the conditions of feeding and environment and pregnancy and lactation are nearly alike.

Naturally, a growth standard is more suitable for use in the herd in which it was developed than in another herd. Its use in another herd will depend on an accurate measure and description of the three kinds of conditions that affect weight and rate of growth, and on the degree of similarity between the two herds in respect to these conditions.

Since 1921, when a breeding experiment with Jersey cattle was begun at Beltsville, Md., the Dairy Husbandry Research Branch has collected an unusually large volume of weight data on the herd as a part of the experimental work. Weights are available on nearly all animals from birth to maturity and it is possible to tabulate weights by stages of pregnancy and lactation.

[1] Submitted for publication May 13, 1954.

Because certain conditions have been maintained rather constant from the beginning of the experiment, the Beltsville weight data are well adapted for use as growth standards for Jerseys. For example, the herd has been maintained for a study of the laws of inheritance for milk and butterfat production and, therefore, an attempt has been made to use good, practical methods of feeding and management and to keep them constant throughout all the years of the experiment. This has been accomplished with a high degree of success and makes it possible to describe the conditions of feeding and environment involved. Also, no new females have been added to the herd except descendants of the foundation cows and no culling of female offspring has been practiced.

Efforts to establish Jersey breed standards for growth in weight are complicated by the existence within the breed of the smaller, more refined, Island Type Jerseys and the larger, more rugged, American Type Jerseys. Probably, a large number of Island Type Jerseys were included in the data from which Ragsdale (*7*),[2] Espe (*2*), and Turner (*10*) prepared their growth standards. Their standards show average weights of about 950 to 980 pounds for mature Jersey cows. It frequently happens that the average weight of Jersey cattle in some herds, particularly herds of American Type Jerseys, is well above the weight shown in these three standards. For example, the average weight for 7-year-old cows in the Beltsville Jersey herd is about 1,090 pounds. A large proportion of the cows in the Beltsville herd trace to three or more prominent American Type Jersey families. Therefore, the data from the Beltsville herd fill a need for a growth standard for the larger, American Type Jerseys, particularly for use in the Beltsville herd itself.

Although the Beltsville data furnish a needed standard for larger, American Type Jerseys, several new methods are used here in presenting the weight data in order to increase their usefulness as standards of normal growth for all Jerseys. Some of the innovations are attempts to control or measure variation in various environmental conditions affecting the weights of the animals, the calculation of smooth curves of standard weights from the average weights, and the use of a system of grades based on the standard deviations for evaluating the differences between the weights of individual animals and the standard weights.

SOURCES OF DATA AND CONDITIONS AFFECTING THEM

If these standards were to be considered as representing only one segment of the Jersey population of this country, that segment might be defined as the merging of the 3 families represented by the 9 proved sires that were brought into the Beltsville herd. Sires representing the Owl-Interest family, in order of their use in the Beltsville herd were The Moose O'Fernwood 137024, Oxford May's Interested Owl 205447, and Marston's Interested Owl 234782. Sires representing the Sophie-Tormentor family, in order of their use, were Hood's Sophie's Tormentor 145709, Sophie's Torono 23d 167335, and Sophie's Phoenix 222930. Sires representing the Raleigh family, in order of their use, were Karnak's Noble 4th 115589, Tiddledywink's Raleigh 158391, and

[2] Italic numbers in parentheses refer to Literature Cited, p. 46.

Raleigh's Dorothy's Senator 203000. Approximately two-thirds of the females whose weights are used in this study were sired by sons and by grandsons of the nine proved sires and were out of Beltsville cows. Most of these females can be grouped according to the same three families. A small group of females, sired by Golden Glow Fauvic Prince 289458, traces to the Golden Glow and Fauvic's Prince families.

Although weights on foundation cows were not used in these studies, the foundation cows (as dams of some of the cows and sires bred at Beltsville) brought a slight relationship to the Sophie-Tormentor, Majesty, Owl-Interest, Golden Glow, St. Mawes, St. Lambert, Nobles, and Fauvic's Prince families. However, it may be estimated that as much as 95 percent of the ancestry of the animals used in this study is in the Owl-Interest, Sophie-Tormentor, and Raleigh families—with a little more than a third of the animals being in the first family and a little less than a third in the last.

In an effort to reduce the number of different factors that cause variations between individuals in their maximum capacity for growth, weights from twins and inbred animals were omitted from the data for the growth standards. Rates of growth for these groups, in relation to the growth standards, may be the subject of later studies.

A further limitation on the data to be used in these studies was the requirement that the average weights for all ages, in the period of time for which a rate of growth was studied, be based on the weights from the same animals. In this way the change in average weight from one age to the next was the average gain or loss in weight and was not confused with the effect of dropping the weights of light or heavy individuals from the averages between one age and the next. This requirement is important for comparative studies on rates of growth.

Since there were fewer cows to be weighed at older ages than at younger ages, the adoption of this requirement made it necessary to calculate rates of growth for a number of groups with different age limits for each. These are referred to as age-limit groups. The 9 groups adopted had upper age limits of 12, 21, 35, 53, 71, 89, 107, 125, and 139 months, respectively.

It occasionally happened that some weights were not obtained. Such missing weights were estimated in order to avoid the effect on the average weights of dropping or adding individuals between one age and another. Usually, these estimated weights were an average of the weights before and after the omission. A few estimates that involved calving periods were adjusted according to average changes at other calving periods in the cow's life.

A comparison of the number of animals in each age-limit group may make it appear that cows in the Beltsville herd had shorter productive lives than Jersey cows usually do, even though there was no culling of inferior animals. Although the Beltsville herd was no exception to the hazards of accidents, disease, or epidemics, the plan of the breeding experiment and the limitation placed on the size of the herd by Government appropriations tended to reduce the number of cows reaching an advanced age. Because the primary objective in the breeding experiment was to obtain data on the producing ability of as many different cows as possible, some cows were disposed

of by slaughter or transfer to other herds as soon as the required data had been obtained.

Calves and heifers were rarely used in feeding experiments. The practice was to separate calves from their dams shortly after birth and feed whole milk to 4 weeks of age, then to continue with skim milk up to 6 months of age. Whole milk was fed at the rate of 5 to 8 pounds daily, and skim milk was fed in quantities up to 12 pounds daily. Animals lacking in vigor or retarded by sickness were given whole milk a little longer. Hay and grain were offered as soon as the calves would eat these feeds. Grain feeding was gradually increased to 3 pounds of grain daily at 6 months of age or later, and then continued at that rate to 24 months of age. Calves and heifers were given all the alfalfa or mixed hay they would eat. After the heifers were a year old, they were moved into herd barns and silage or pasture in season was added to their rations. Some hay was fed to Jersey and Holstein heifers herded together in pens, and at times some of the Jersey heifers may have suffered from too much competition with larger animals. However, monthly gains in weight were kept under close observation at all times, and if conditions appeared to be unfavorable for good growth in some animals measures were taken to correct them.

There was greater variation in the feeding and management of cows than in the feeding and management of calves and heifers, because the cows were on test for Register of Merit production records during some lactations and not during others. Usually the cows were on test during the first lactation and also during a lactation beginning after they were 5½ years old. Frequently a cow was on test during her second lactation. Cows on test were kept in box stalls, milked three times a day, exercised daily in a dry lot, and never allowed on pasture. They were encouraged to eat all the alfalfa hay and corn silage they would. Then they were fed enough of a 15.5-percent-protein grain mixture to bring their net energy intake up to approximately 10 percent above their requirements.

Cows not on official test were milked twice a day, housed in stanchion barns, and turned on pasture in season. As a rule they were not fed as liberally as cows on test. Frequently, during lactations when they were not on test, they were used on special feeding experiments. Occasionally these feeding experiments resulted in lower weights. Tabulations comparing the relative number of cows on test at each age with the number not on test are presented with the average weights in an effort to describe this condition, which varied with age and had some effect on average weights.

It was the plan to breed heifers to calve at 2 years of age, and to breed again for a calving interval of 14 months following lactations on test and for a calving interval of 12 months following other lactations. This plan was only approached in practice. However, this plan and its degree of accomplishment are offered as two of the normals involved in producing a standard for normal growth in Jersey females.

Calves were weighed at birth and every 10 days thereafter during their first year. Every 30 days an average was obtained from 3 consecutive daily weights, centering on the date for the third 10-day weighing. All cows and heifers 1 year old and over were weighed

on 3 consecutive days at the beginning of each calendar month and the average was used as the weight for their nearest age in months. Calves and cows on test were weighed after feeding. Heifers over a year old and cows not on test were weighed before feeding. All animals had access to water before they were weighed.

No body measurements were taken to accompany these weights. Detailed sets of measurements were taken on many of the animals, but not at monthly intervals. Such data will be used in other studies to determine relative size and form at specified ages.

GROWTH STANDARDS FOR JERSEY FEMALES BY AGE-LIMIT GROUPS

From Birth to 365 Days of Age

The age limit for the first group was set at birth to 365 days to correspond to the period when calves were weighed at 10-day intervals. There are times when reference to a growth standard by 10-day intervals will be useful. The average actual weights, the variations in these weights, and the estimated weights and gains in weight for 378 Jersey heifer calves are shown in table 1. The 5-percent fiducial limits are included to demonstrate the unimportance of slight deviations from a growth standard or table of average weights.

The coefficient of variation decreased gradually after 70 days of age in spite of increases in standard deviation values with age. Espe (*2*) found changes of a similar nature in Jersey calves, although his data showed higher coefficients at all ages. The average of the coefficients of variation for the eleven 30-day periods, when averages of 3 consecutive daily weights for each calf were used, was 10.86 percent. The average of the coefficients of variation for 22 preceding and subsequent periods, when the calves were weighed on 1 day only, was 11.00 percent. Apparently, the gain in reduced variation from weighing calves on 3 consecutive days was slight.

The standard or estimated weights shown in table 1 are the result of an effort to smooth out of the growth curve some of the irregularities in the average weights for successive 10-day periods. Most of the estimated weights are within the 5-percent fiducial limits for the average weights.

The method used for producing a smooth curve from the average weights was the fitting of fourth-degree orthogonal polynomials as described by Snedecor (*9*). This method produces a flexible curve with the properties of a regression line and a possibility of testing the success of fitting terms of higher and higher degree through the statistical significance of reduction in the sums of squares for the differences between observed and estimated values. The first-degree term produces a straight line; the second-degree term produces a parabola; and higher degree terms produce the sigmoid and more complicated curves. The F-values for the first-, second-, third-, and fourth-degree terms in this set of data were 8,276.11, 0.21, 367.41, and 253.69, respectively. The second-degree term representing a parabola was not significant, but all the others were highly significant.

The estimated daily gain in weight, as shown in table 1, increased to 1.59 pounds at 150 days of age and gradually declined after 6 months of age. Although the age of 6 months coincides with the end of the

TABLE 1.—*Average and estimated weights and gains, and variations in weight, for 378 Jersey heifer calves by 10-day periods from birth to 365 days of age*

Age	Average actual weight	5-percent fiducial limits	Standard deviation	Coefficient of variation	Estimated standards	
					Weight	Daily gain
Days	*Pounds*	*Pounds*	*Pounds*	*Percent*	*Pounds*	*Pounds*
At birth	56	54.8–56.4	7.7	13.9	56.4	
10	59	57.9–59.5	7.7	13.2	59.8	0.33
20	64	63.4–65.1	8.4	13.1	64.9	.51
30	72	71.3–73.1	9.1	12.6	71.6	.68
40	81	80.3–82.6	11.2	13.8	79.9	.82
50	91	90.2–92.7	12.4	13.6	89.4	.96
60	102	100.2–103.0	14.2	14.0	100.2	1.07
70	113	111.3–114.5	15.8	14.0	111.9	1.16
80	125	123.2–126.7	17.3	13.8	124.7	1.27
90	138	136.1–139.8	18.1	13.1	138.1	1.35
100	151	149.4–153.3	19.3	12.8	152.2	1.41
110	165	163.4–167.6	20.6	12.5	166.9	1.47
120	181	178.3–182.8	22.0	12.2	182.1	1.51
130	196	193.0–198.6	23.3	11.9	197.5	1.55
140	212	209.2–214.1	24.3	11.5	213.2	1.57
150	228	225.2–230.3	25.4	11.1	229.1	1.59
160	244	241.5–246.9	26.4	10.8	244.9	1.59
170	261	258.0–263.6	27.6	10.6	260.9	1.59
180	277	274.1–279.8	28.2	10.2	276.8	1.59
190	293	290.3–296.4	30.3	10.3	292.5	1.57
200	309	306.0–312.3	31.3	10.1	308.1	1.56
210	325	321.8–328.3	32.0	9.9	323.4	1.53
220	340	336.6–343.4	33.2	9.8	338.5	1.51
230	354	350.9–357.9	34.5	9.7	353.2	1.48
240	369	365.0–372.3	35.7	9.7	367.7	1.44
250	382	378.4–385.9	37.2	9.7	381.7	1.41
260	395	391.2–398.8	37.5	9.5	395.4	1.37
270	408	404.6–412.3	37.8	9.2	408.8	1.33
280	421	417.0–424.9	38.6	9.2	421.7	1.29
290	431	429.0–437.0	39.3	9.1	434.3	1.26
300	445	441.3–449.3	39.7	8.9	446.5	1.22
310	458	453.7–461.8	40.3	8.8	458.3	1.19
320	470	465.4–473.7	40.7	8.7	469.9	1.16
330	481	476.7–485.1	41.6	8.6	481.1	1.12
340	492	487.0–496.6	43.0	8.7	492.1	1.10
350	503	498.2–507.1	44.1	8.8	502.9	1.08
360	514	509.5–518.6	44.7	8.7	513.5	1.06
365	519	514.7–523.8	44.9	8.7	518.8	1.05

milk-feeding period, the average actual weights show no sudden change in daily gains in weight at any point between 120 and 240 days of age. Although a gain in weight is shown for the first 10-day period by both the average and estimated weights, there may have been a decline in weight for 2 or 3 days after birth. Many individual calves weighed less at 10 days of age than at birth.

The usefulness of any growth standard can be increased greatly by having some method of interpreting the importance of the difference between the weight of an individual heifer and the standard weight. Obviously, small differences are unimportant, but the problem is in knowing when the differences cease to be small. The answer appeared to be in using the standard deviation as a measure of normal variation in heifer weights, in the same manner that the mean or average is used as a normal or standard weight. Then the standard deviation for any age could be multiplied by appropriate factors and the resulting products added to the mean or subtracted from it to obtain boundary weights for dividing the theoretical array of weights into 10 or any number of equal parts. These 10 parts or classes could be numbered consecutively and the numbers called percentile grades or grades for weight at a given age.

There was considerable advantage in using smooth curves for increases in weight with age and for changes in the standard deviation with age. The standard or estimated weights in table 1 furnished a smooth curve for weight and the fitting of a fourth-degree polynomial to successive standard deviations produced a smooth curve for standard deviation.

In preparing the boundary weights shown in table 2, the estimated weight for each age was used as the boundary between grades 5 and 6. In calculating the other boundaries, factors were adapted from a table by Fisher (*3*) that could be used with the standard deviation to divide a normally distributed array of data into 10 classes with an equal number of items in each class. The estimated weight minus the estimated standard deviation multiplied by 1.28155, 0.84162, 0.52440, or 0.25335 produced the boundaries between grades 1 and 2, 2 and 3, 3 and 4, and 4 and 5, respectively. The addition of the same products in reverse order produced the boundaries between grades 6 and 7, 7 and 8, 8 and 9, and 9 and 10, respectively.

There are no lower limits to grade 1, nor upper limits to grade 10. All boundary weights carry decimal fractions in order to avoid borderline cases among individual weights when using this table.

The first line for weights at birth in table 2 is based on the average birth weight and the standard deviation instead of the values obtained from the curve-fitting procedures. This furnished a standard for grading birth weights that is independent of the effect of later weights that occurs when values from a fitted curve are used.

To use the boundary weights in table 2, simply locate, on the line for the heifer's age, the boundary weights between which her weight occurs and then give her weight the grade shown at the top of the space between these two columns. For example, a Jersey heifer weighing 320 pounds at 180 days of age would be given the grade 10, indicating that she was in a class heavier than 90 percent of the Beltsville Jersey heifers at that age. Another heifer weighing 530 pounds at 365 days of age would be given the grade 6, indicating that her weight was in a class higher than 50 percent and lower than 40 percent of the Beltsville Jersey heifers of that age. Although she weighed 11 pounds more than the standard, her weight was in one of the two middle classes or grades. Thus, these grades show directly the rank of each heifer's weight in relation to the weights of other heifers.

Theoretically, this grading procedure makes 10 classes of heifers with an equal number of heifers in each class. For example, the theoretical distribution of grades for the weights of 390 Jersey heifers at 180 days of age would have been 39 heifer weights for each grade or class from 1 to 10. Actually, the number of heifer weights in each of the 10 classes was 45, 29, 35, 34, 31, 55, 45, 43, 47, and 26, respectively.

If a heifer were weighed at some other age than one of the 10-day intervals shown in table 2, it would be well to adjust her weight back to the last 10-day interval. This would be done by subtracting the product of the number of days beyond the even 10-day interval multiplied by the estimated daily gain for the incompleted 10-day interval found in table 1. For example, if a heifer weighed 372 pounds at 216 days of age, subtract 6 times 1.51 pounds (the estimated daily gain in weight from 210 to 220 days of age) from 372 pounds. This gives an adjusted weight of 363 pounds at 210 days of age, which would be grade 9 as shown in table 2.

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TABLE 2.—*Boundary weights by 10-day periods between grades for the weights of Jersey heifers*

Age	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Days	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	
At birth [1]	45.7	49.1	51.5	53.6	55.6	57.5	59.6	62.1	65.5	
At birth	47.7	50.7	52.9	54.7	56.4	58.2	60.1	62.2	65.2	
10	49.7	53.1	55.6	57.8	59.8	61.8	63.9	66.4	69.9	
20	53.4	57.3	60.2	62.6	64.9	67.2	69.6	72.5	76.4	
30	58.6	63.1	66.3	69.1	71.6	74.2	76.9	80.2	84.7	
40	65.3	70.3	73.9	77.0	79.9	82.8	85.9	89.5	94.5	
50	73.3	78.8	82.8	86.3	89.4	92.6	96.1	100.1	105.6	
60	82.4	88.5	92.9	96.7	100.2	103.7	107.5	111.9	118.1	
70	92.5	99.2	103.9	108.1	111.9	115.8	119.9	124.8	131.5	
80	103.5	110.8	115.9	120.5	124.7	128.9	133.3	138.6	145.8	
90	115.2	123.1	128.8	133.6	138.1	142.6	147.5	153.2	161.1	
100	127.7	136.1	142.2	147.4	152.2	157.1	162.3	168.4	176.8	
110	140.6	149.7	156.2	161.7	166.9	172.1	177.7	184.2	193.2	
120	154.1	163.8	170.6	176.5	182.1	187.6	193.5	200.4	209.9	
130	167.9	178.1	185.4	191.6	197.5	203.3	209.6	216.9	227.1	
140	181.9	192.7	200.4	207.1	213.2	219.3	225.9	233.7	244.4	
150	196.2	207.5	215.6	222.5	229.1	235.5	242.5	250.6	261.9	
160	210.6	222.4	230.9	238.2	244.9	251.8	259.1	267.5	279.3	
170	224.9	237.3	246.2	253.8	260.9	267.9	275.6	284.5	296.8	
180	239.4	252.2	261.5	269.4	276.8	284.2	292.1	301.3	314.1	
190	253.7	267.1	276.6	284.8	292.5	300.2	308.4	317.9	331.3	
200	267.9	281.7	291.6	300.1	308.1	316.1	324.5	334.4	348.2	
210	281.9	296.2	306.4	315.2	323.4	331.6	340.4	350.6	364.9	
220	295.7	310.4	320.9	330.1	338.5	346.9	355.9	366.5	381.2	
230	309.3	324.4	335.3	344.5	353.2	361.9	371.2	382.1	397.2	
240	322.5	338.1	349.2	358.7	367.7	376.6	386.1	397.3	412.8	
250	335.5	351.4	362.8	372.6	381.7	390.9	400.7	412.1	427.9	
260	348.1	364.4	376.1	386.1	395.4	404.8	414.8	426.5	442.8	
270	360.4	377.1	388.9	399.2	408.8	418.3	428.6	440.5	457.1	
280	372.4	389.3	401.5	411.9	421.7	431.5	441.9	454.1	471.1	
290	383.9	401.2	413.7	424.3	434.3	444.2	454.9	467.3	484.6	
300	395.2	412.8	425.5	436.4	446.5	456.6	467.5	480.2	497.8	
310	406.2	424.1	436.9	448.1	458.3	468.7	479.7	492.6	510.5	
320	416.8	435.1	448.2	459.4	469.9	480.4	491.6	504.8	522.9	
330	427.1	445.7	459.1	470.4	481.1	491.8	503.2	516.6	535.1	
340	437.2	456.1	469.6	481.3	492.1	502.9	514.6	528.2	547.0	
350	447.1	466.2	480.1	491.8	502.9	513.9	525.7	539.5	558.7	
360	456.7	476.2	490.3	502.3	513.5	524.7	536.7	550.8	570.2	
365	461.6	481.3	495.4	507.5	518.8	530.2	542.3	556.4	576.1	

[1] Based on average instead of estimated birth weights.

If average weights of other groups of Jersey heifers, instead of the weights of individual heifers, are to be compared with the Beltsville standard, the estimated weights in table 1 might be used, and the usual tests of the significance of deviation from a standard applied.

Although the grades obtained from table 2 have statistical limitations arising from the use of an unequal number of pounds in the various class intervals, much information might be gained from combining the grades obtained from the weights of different heifers at different ages. The grades on heifer calves might be combined irrespective of age: (1) To obtain an early indication of the relative size of the offspring of a certain sire; (2) to discover some conditions in the feeding and management program which have caused a general retarding of normal growth in weight; and (3) to observe by differences in the grades for different periods how some calves tend to overcome early handicaps in size or recover from the retarding influence of sickness.

From Birth to 21 Months of Age

The weights of 360 of the Jersey heifers included in the previous age-limit group were available for studies on normal growth in weight from birth to 21 months of age. After 21 months of age, and possibly before, the average weights are so influenced by advanced pregnancy or parturition that special methods are needed to estimate the effect of variations in these conditions. The average actual weights, the variations in weight, and the estimated weights by months or 30-day periods are shown in table 3.

TABLE 3.—*Average and estimated weights and gains, and variations in weight, for 360 Jersey heifers by months from birth to 21 months of age* [1]

Age	Average actual weight	5-percent fiducial limits	Standard deviation	Coefficient of variation	Estimated standards	
					Weight	Daily gain
Months	*Pounds*	*Pounds*	*Pounds*	*Percent*	*Pounds*	*Pounds*
At birth	56	54.9–56.5	7.8	14.0	57.3	
1	72	71.4–73.3	9.1	12.6	71.1	0.45
2	102	100.3–103.2	14.1	13.9	99.9	.95
3	138	136.4–140.1	17.9	13.0	130.2	1.26
4	181	178.6–183.1	21.8	12.1	184.6	1.40
5	228	225.4–230.6	25.3	11.1	233.1	1.59
6	277	274.2–280.0	28.1	10.1	281.8	1.60
7	326	321.8–328.4	31.5	9.8	329.2	1.55
8	389	385.0–372.4	35.7	9.7	373.7	1.46
9	409	404.7–412.5	37.9	9.3	414.7	1.35
10	446	441.5–449.7	39.9	8.9	451.8	1.22
11	481	476.8–485.4	41.6	8.7	484.9	1.09
12	520	515.0–524.4	45.2	8.7	514.7	.98
13	540	535.4–545.2	47.2	8.7	541.5	.88
14	505	560.2–570.1	48.2	8.5	566.1	.81
15	585	579.7–590.6	52.6	9.0	589.2	.76
16	611	605.0–616.3	54.6	8.9	611.9	.75
17	635	628.9–640.9	58.1	9.2	634.9	.76
18	659	653.8–666.4	60.9	9.2	659.1	.70
19	687	680.2–693.3	63.2	9.2	684.6	.84
20	712	705.7–719.3	65.7	9.2	712.1	.90
21	740	732.8–748.9	67.7	9.2	741.2	.90

[1] All data for the period between birth and 12 months of age, except the estimated standards, are for 30-day periods instead of calendar months.

The average weights and measures of variation for the first 11 months, shown in table 3, are actually the average values at corresponding 30-day periods. Before the estimated weights were calculated by the fitting of orthogonal polynomials, the average 30-day weights were adjusted to the basis of a calendar month of 30.4375 days by adding the product of difference in days multiplied by the corresponding estimated daily gains shown in table 1.

Average weights and measures of variation to 12 months of age were practically the same as those shown in table 1. Differences in the average weights showed monthly gains of about 37 pounds for the period from 9 to 12 months of age, and only about 22 pounds for the period from 12 to 15 months of age. This may have been due in part to the practice of transferring heifers to a herd barn after they were 1 year old, where they had to compete with older and larger heifers in the pen feeding of some of the roughages in their rations. However, animals from 15 to 18 months of age, with monthly gains in weight of about 25 pounds, failed to show any gains that could be interpreted as an indication of recovery from unfavorable conditions prior to 15 months of age.

There was no sudden increase in the coefficients of variation after 12 months of age, in spite of the fact that these older heifers were weighed on the first 3 days of each calendar month and of the possibility that the actual ages for some heifers may have been as much as 15 days over or under the ages for which their weights were tabulated.

The series of the average weights by months for this period of 21 months had irregularities that were reproduced in a better manner, especially at either end of the curve, by fitting a fifth-degree polynomial taken by the fourth-degree polynomial. The adjustment of weights by 30-day periods to weights by calendar months accounts for some of the differences between average and estimated weights shown by the values from 4 to 11 months of age. The F-values for the first-, second-, third-, fourth-, and fifth-degree terms of orthogonal polynomial were 1,100.42, 70.69, 1.53, 170.30, and 56.72, respectively, showing highly significant reductions in the sums of squares with each step except for the third-degree term.

Beltsville standard weights for Jersey heifers are definitely higher than those published by other investigators. The weights at 3, 6, 12, and 18 months of age are higher than the Ragsdale (*7*) standards from 167 to 123 heifers by 15.0, 16.0, 14.4, and 9.7 percent, respectively; higher than the Espe (*2*) standards from 56 to 63 heifers by 22.1, 19.9, 14.1, and 8.6 percent, respectively; higher than the average weights from 18 to 13 heifers in the Kansas station herd (*8*) by 8.8, 11.3, 10.2, and 10.8 percent, respectively; and higher than the standard published by Eckles (*1*) in 1920 by −0.6, 8.4, 12.9, and 15.2 percent, respectively. Also, the Beltsville standard weights at 6, 12, and 18 months of age are 16.9, 23.4 and 19.8 percent higher than the average weights of 55 to 57 Jersey heifers in a herd at Lewisburg, Tenn. (*4*), and 19.4, 22.3, and 16.2 percent higher than the average weights of 59 Jersey heifers in a herd at Jeanerette, La.

Differences in the relative rates of growth shown by Beltsville and other standards may be measured by calculating the percentages of the maximum mature weight for weights at different ages in each standard. Applying these percentages to the maximum weight in

the Beltsville standard will give equivalent weights that may be compared directly or graded according to the boundary weights in table 4. The equivalent weights from the Ragsdale (7) data at birth and at 3, 6, 12, and 18 months of age are 59, 134, 269, 499, and 666 pounds, respectively. Those from the Espe (2) data are 56, 128, 265, 508, and 684 pounds, respectively. The corresponding grades of 7, 4, 4, 4, and 6 for the Ragsdale data and 6, 3, 3, 5, and 7 for the Espe data show that the Beltsville Jersey standards are relatively higher as well as actually higher than these other two standards during the first 12 months of life, and that the Espe data were relatively higher after 12 months of age.

The estimated daily gains in weight show a continuous decline in the rate of growth to about 17 or 18 months of age, when increases in the number of pregnant heifers coincided with increases in the estimated daily gains in weight. At 17 and 18 months of age, 35 and 53 percent of the heifers, respectively, were pregnant more than 45 days, but fewer than 1 percent at either age were pregnant more than 165 days. At 20 and 21 months of age, 73 and 79 percent of the heifers, respectively, were pregnant more than 45 days, and 10 and 33 percent, respectively, were pregnant more than 165 days.

An analysis of variance between four 60-day stages of pregnancy, omitting the first 45 days, was made on the average data for each of several months of age for the 360 Jersey heifers whose weights were reported in table 3. The variance ratios at 15, 16, 17, 18, 19, 20, and 21 months of age were 1.16, 2.73, 1.02, 4.71, 3.28, 10.97, and 10.88, respectively. The effects of pregnancy were highly significant at 18 months and later ages, but they were not significant at earlier ages.

The boundary weights for assigning grades to the monthly weights of individual Jersey heifers are shown in table 4. The values in this table are based on the standard or estimated weights shown in table 3 and on the results of fitting a fourth-degree orthogonal polynomial to the standard deviations in the same table. In all other respects the calculations were the same as those for table 2. The boundary weights for calendar months in table 4 are slightly higher at most ages than those for corresponding 10-day periods in table 2, because there are differences of a few days in age. Curve-fitting procedures involving adversely affected weights at 13 and 14 months of age caused the boundary weights at 12 months of age in table 4 to be lower than those at 365 days of age in table 2.

With a greater number of days in the age intervals for table 4 than for table 2, it becomes increasingly important to make adjustments for weights that are obtained at several days over or under the ages listed in table 4. For example, a heifer weighing 593 pounds at 15 months and 12 days of age should have gained 9 pounds (12 times 0.75) in the last 12 days, making an adjusted weight of 584. The adjusted weight would be graded 5, while the original weight would have been graded 6.

From 12 to 35 Months of Age

There were 278 Jersey cows that reached 35 months of age in the Beltsville herd. The average actual weights, the measures of variation, and the estimated weights from 1 year to 2 years 11 months of age are shown in table 5. This age-limit group was intended to show the trends in average weight during ages that include the periods of

TABLE 4.—*Boundary weights by calendar months between grades for the weights of Jersey heifers*

Age	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Months	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
At birth [1]	45.7	49.1	51.6	53.7	55.7	57.7	59.8	62.2	65.7	
At birth	49.1	51.9	53.9	55.7	57.3	58.9	60.6	62.7	65.5	
1	57.4	62.1	65.4	68.3	71.1	73.7	76.6	79.9	84.6	
2	81.2	87.6	92.3	96.3	99.9	103.7	107.6	112.3	118.7	
3	115.6	123.7	129.5	134.5	139.2	143.9	148.9	154.7	162.8	
4	156.4	166.1	173.1	179.1	184.6	190.2	196.2	203.2	212.9	
5	200.4	211.6	219.7	226.6	233.1	239.5	246.4	254.5	265.7	
6	245.1	257.7	266.8	274.6	281.8	289.1	296.9	305.9	318.6	
7	288.5	302.4	312.5	321.1	329.2	337.2	345.8	355.9	369.9	
8	329.3	344.5	355.5	364.9	373.7	382.5	391.9	402.9	418.2	
9	366.7	383.2	395.1	405.2	414.7	424.2	434.3	446.2	462.7	
10	400.4	418.1	430.7	441.6	451.8	461.9	472.8	485.6	503.2	
11	430.3	449.1	462.6	474.2	484.9	495.8	507.4	520.9	539.7	
12	456.8	476.7	490.9	503.3	514.7	526.2	538.4	552.7	572.6	
13	480.4	501.4	516.8	529.4	541.5	553.5	566.1	581.5	602.5	
14	501.9	523.9	539.8	553.3	566.1	578.7	592.3	608.1	630.2	
15	521.9	545.1	561.7	575.9	589.2	602.5	616.7	633.4	656.5	
16	541.6	565.7	583.1	598.1	611.9	625.8	640.7	658.1	682.3	
17	561.4	586.6	604.8	620.4	634.9	649.5	665.1	683.3	708.5	
18	582.1	608.5	627.6	643.8	659.1	674.2	690.5	709.5	735.9	
19	604.3	631.9	651.7	668.7	684.6	700.5	717.5	737.3	764.9	
20	628.1	656.9	677.7	695.4	712.1	728.6	746.4	767.2	795.9	
21	653.4	683.5	705.3	723.8	741.2	758.6	777.1	798.9	829.1	

[1] Based on average instead of estimated birth weights.

first pregnancy and parturition for most cows. Also, it follows the general plan to have each age-limit group include some of the ages covered by the previous age-limit group in order to present continuous growth curves at all ages and to determine differences in the average weights of animals in different groups.

TABLE 5.—*Growth in weight for 278 Jersey cows from 12 to 35 months of age*

Age	Pregnancy score	Cows on test	Average actual weight	5-percent fiducial limits	Standard deviation	Coefficient of variation	Estimated standards	
							Weight	Daily gain
Year–Month		*Percent*	*Pounds*	*Pounds*	*Pounds*	*Percent*	*Pounds*	*Pounds*
1 0			519	514–525	47.4	9.1	521.0	
1 1			539	534–545	49.3	9.1	538.5	0.544
1 2			565	559–570	49.7	8.6	559.5	.690
1 3			585	579–591	53.7	9.2	583.7	.797
1 4			612	605–618	55.8	9.1	610.1	.867
1 5			636	629–643	59.3	9.3	637.7	.906
1 6	2		661	654–669	62.5	9.4	665.6	.917
1 7	7		689	681–696	63.7	9.3	693.1	.904
1 8	12		714	706–722	66.2	9.3	710.6	.871
1 9	19		742	734–750	68.6	9.2	744.6	.821
1 10	26		772	764–780	70.2	9.1	767.7	.759
1 11	33	2	799	791–808	73.5	9.2	788.7	.689
2 0	30	17	818	810–827	73.5	9.0	807.4	.615
2 1	21	36	826	818–835	73.2	8.9	823.8	.549
2 2	16	48	835	825–844	80.1	9.6	838.0	.468
2 3	12	57	843	833–853	84.9	10.1	850.3	.404
2 4	8	67	852	842–862	82.1	9.6	861.6	.351
2 5	7	71	867	857–877	84.9	9.8	870.6	.304
2 6	5	74	878	868–889	87.5	10.0	879.5	.295
2 7	5	76	891	880–901	87.2	9.8	888.7	.309
2 8	5	79	903	893–913	85.0	9.4	898.8	.332
2 9	8	80	915	905–925	84.9	9.3	910.8	.395
2 10	11	80	929	919–939	85.6	9.2	925.8	.482
2 11	14	81	939	929–950	83.8	8.9	944.9	.629

The average weights in early life for this group of 278 Jersey cows differed only a pound or two from the average 30-day weights for calves listed in table 1, or from the average weights of heifers from 12 to 21 months of age listed in table 3. The average weights for this group of cows are well within the 5-percent fiducial limits presented in tables 1 and 3.

Ages are expressed in terms of years and months in table 5 and several later tables for ease in locating average or estimated values according to the usual method of figuring the ages of cows. In discussions on the data in these tables, many statements are made in a simpler manner when months alone are used for expressing age.

Two columns in table 5 are presented as an attempt to measure or describe variations in conditions that may have affected the average weights at different ages. It was observed from other tabulations that cows in the Beltsville herd tended to carry more weight during lactations when they were liberally fed for Register of Merit testing than during other lactations. A greater number of cows on test at certain ages may have contributed to higher average weights for the group at those ages. The numbers on test are expressed as percentages of the total number of cows in the group. This permits direct comparisons with corresponding data in the tables for other age-limit groups.

The mixed effects from variations in some of these conditions are illustrated in table 6. The data from these 278 cows were sorted into four 60-day stages of pregnancy, the first 90 days of a lactation, and the first 90 days after an early abortion. Another group consisted of the data from heifers and cows not pregnant more than 45 days nor within 90 days after calving or abortion. Most of the data for this last group, prior to 26 months of age, were obtained from heifers not pregnant or pregnant less than 45 days. Most of the data for this group, after 26 months of age, were obtained from cows more than 90 days in milk but not more than 45 days pregnant. One heifer was bred and calved at a very early age.

Differences in the characteristic weights of individual cows or groups of cows caused much variation in the trends for regular increases with advancing age in the average weights for all stages of pregnancy and lactation. At most ages the average weights for cows and heifers pregnant 166 days or more were higher than the average weights for all 278 cows. The average weights for cows and heifers pregnant less than 106 days and for cows not pregnant within 90 days after calving were lower than the average weights for all data. Average weights from data obtained within 90 days after calving were lower than the average weights for all data for ages under 30 months and higher than the average weights for all data for all ages over 29 months. Possibly the greater than average weights developed in heifers with delayed pregnancy persisted even after calving. Heifers and cows which aborted after a gestation period of less than 226 days were definitely underweight during the following 90 days.

A reduction in the number of cows in advanced pregnancy and an increase in the number of cows in milk are undoubtedly the reasons that gains in the average weights after 2 years of age dropped to a third of what they were in previous months. If there had been less variation in the age at calving, there may have been greater differences in the monthly gains in weight, or even a decrease for some months.

The estimated standard weights, calculated by the fitting of a fourth-degree orthogonal polynomial to the average weights, spread out the effect of differences in the number of animals in advanced pregnancy; but the effect is still evident in the decline in daily gains to 30 months of age and an increase thereafter. Nearly all of the estimated weights are within the 5-percent fiducial limits of the average weights.

From 12 to 53 Months of Age

The average actual weights, the measures of variation, and the estimated weights for 206 Jersey cows from 12 to 53 months of age are shown in table 7. At the ages included in this table, most cows were well into their second lactation, and many of them in their third lactation. The estimated weights make a continuous growth curve for the weights of young cows from ages prior to their first pregnancies.

The average weights of these cows at birth and at 90, 180, and 270 days of age were well within the 5-percent fiducial limits for the average weights of calves listed in table 1. The average weights of these cows at 12, 13, and 14 months of age were slightly below the 5-percent fiducial limits shown in table 3, but they recovered to equal the average weights in table 3 after a few more months in age. All

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TABLE 6.—*Effects of pregnancy and calving on the average weights of Jersey cows in the 35-month age-limit group*

Age	Average weight for all 278 cows	Stage of pregnancy								1 to 90 days after calving		1 to 90 days after an abortion under 226 days		Not pregnant over 45 days or within 90 days after calving	
		46 to 105 days		106 to 165 days		166 to 225 days		226 days or over							
		Animals	Average weight	Animals	Average weight	Animals	Average weight	Animals	Average weight	Animals	Average weight	Animals	Average weight	Animals	Average weight
Year-Month	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1 2	565					1	620							277	564
1 3	585	2	583			1	605							275	585
1 4	612	20	625					1	709					248	610
1 5	636	90	640	2	632					1	685			185	634
1 6	661	112	657	20	687					1	642			136	651
1 7	689	83	689	90	702	2	709			1	649			102	677
1 8	714	63	707	112	726	20	754							74	688
1 9	742	48	726	82	746	87	765	2	770			3	692	50	714
1 10	772	36	736	62	763	106	786	31	828			5	699	38	746
1 11	799	25	703	46	788	81	808	83	836	4	724	8	717	31	758
2 0	818	18	784	35	797	62	829	87	851	47	798	6	753	23	782
2 1	826	15	805	24	821	44	856	61	861	106	808	7	773	21	796
2 2	835	7	805	15	844	31	871	47	895	142	816	8	748	25	796
2 3	843	11	826	15	877	21	889	36	925	126	817	7	721	62	843
2 4	852	15	809	7	919	17	909	24	930	94	836	5	731	116	847
2 5	867	16	837	11	861	15	931	17	956	67	862	2	812	150	857
2 6	878	29	857	16	849	6	979	15	980	52	887	2	822	158	870
2 7	891	54	875	16	876	10	930	11	1,095	32	906	3	802	152	885
2 8	903	63	895	29	887	14	908	6	1,057	27	915	3	815	136	903
2 9	915	55	912	54	909	15	913	9	996	18	942	2	832	125	912
2 10	929	52	934	63	932	29	921	12	969	15	936	2	907	105	922
2 11	939	49	940	54	937	52	940	13	961	14	941	4	902	92	937

TABLE 7.—*Growth in weight for 205 Jersey cows from 12 to 53 months of age*

Age	Pregnancy score	Cows on test	Average actual weight	5-percent fiducial limits	Standard deviation	Coefficient of variation	Estimated standards	
							Weight	Daily gain
Year-Month		*Percent*	*Pounds*	*Pounds*	*Pounds*	*Percent*	*Pounds*	*Pounds*
1 0			514	508– 520	45.6	8.9	501.6	
1 1			535	528– 542	48.9	9.1	532.5	1.016
1 2			560	553– 567	49.8	8.9	562.2	.974
1 3			583	575– 590	54.1	9.3	590.8	.947
1 4			610	602– 618	56.1	9.2	618.3	.900
1 5			634	626– 642	59.2	9.3	644.7	.863
1 6	2		660	651– 668	63.2	9.6	660.9	.829
1 7	7		688	679– 697	65.2	9.5	694.1	.792
1 8	13		713	704– 722	67.9	9.5	717.0	.755
1 9	19		742	732– 752	70.6	9.5	738.9	.719
1 10	27		773	763– 783	73.4	9.5	760.7	.682
1 11	34	1	801	791– 812	75.9	9.5	779.4	.647
2 0	30	19	820	810– 830	73.7	9.0	798.0	.611
2 1	21	37	828	818– 838	72.9	8.8	815.5	.576
2 2	16	49	836	825– 847	79.2	9.5	832.0	.542
2 3	11	61	842	831– 853	82.0	9.7	847.5	.509
2 4	8	69	850	840– 861	78.5	9.2	862.0	.477
2 5	7	72	868	857– 879	82.0	9.4	875.6	.445
2 6	5	78	876	865– 887	82.4	9.4	888.2	.414
2 7	6	79	890	877– 901	85.1	9.6	899.9	.385
2 8	6	82	903	892– 914	82.5	9.1	910.8	.357
2 9	9	83	915	903– 926	82.6	9.0	920.8	.330
2 10	12	83	926	915– 938	82.1	8.9	930.1	.304
2 11	15	84	937	925– 948	81.8	8.7	938.6	.280
3 0	19	76	950	938– 961	81.5	8.6	946.4	.257
3 1	23	55	961	950– 973	86.6	9.0	953.6	.236
3 2	23	50	970	958– 983	91.8	9.5	960.2	.217
3 3	20	50	973	960– 985	93.7	9.6	966.3	.198
3 4	17	50	977	964– 990	94.0	9.7	971.8	.183
3 5	15	50	982	968– 995	98.1	10.0	977.0	.170
3 6	13	48	984	970– 998	100.7	10.2	981.8	.158
3 7	11	40	983	969– 998	105.5	10.7	986.3	.148
3 8	9	50	985	970– 999	105.9	10.8	990.6	.141
3 9	7	51	986	972–1,001	105.8	10.7	994.7	.135
3 10	9	51	991	976–1,007	113.1	11.4	998.7	.133
3 11	10	50	1,002	987–1,017	112.2	11.1	1,002.8	.132
4 0	13	47	1,009	994–1,024	109.8	10.9	1,006.9	.134
4 1	14	46	1,015	1,000–1,031	112.8	11.1	1,011.1	.139
4 2	17	40	1,021	1,005–1,036	112.5	11.0	1,015.5	.146
4 3	19	31	1,026	1,010–1,042	115.4	11.2	1,020.3	.157
4 4	19	24	1,025	1,009–1,041	115.7	11.4	1,025.5	.170
4 5	19	20	1,025	1,009–1,040	114.7	11.2	1,031.1	.186

other average weights were in close agreement with those in table 5. In fact, all of these first four age-limit groups have very similar average weights.

Monthly gains in the average weights to 35 months of age followed the same trend as those in table 5. At 42 months of age and again at 52 months of age, there were practically no gains in average weights. Relatively few cows were on test in these last two periods.

Variations in the conditions represented by the pregnancy scores seemed to have little relationship to the gains in average weights. The average pregnancy score for all ages above 19 months was 15.1.

The data in table 7 show increases in the coefficients of variation after 3 years of age. This may have been because, at each of the older ages, there were fewer cows in any one stage of pregnancy or lactation.

The estimated weights, calculated by the same methods as those in table 5, show a gradual increase in weight over a period of 42

months that is little affected by the relative number of cows in advanced pregnancy. These estimated weights are outside of the 5-percent fiducial limits of the average weights at several ages, particularly at those points concerned in flattening out the curve at the ages of first pregnancy and parturition.

The estimated daily gains in weight showed a gradual decrease to 4 years of age. The increases during the short period after 4 years of age may have been due in part to conditions of herd management and in part to the characteristic shape of the ends of a curve produced by a fourth-degree orthogonal polynomial.

One result of flattening out the curve for growth in weight at the ages covering first pregnancy was to produce estimated daily gains in weight definitely higher than those shown in table 3 for heifers during the period from 12 to 18 months of age. It is a normal herd practice to try to have heifers calve at about a certain age. Any attempt to separate the effects of such procedures from a standard based on data assembled in the present manner results in a considerable degree of artificiality.

From 30 to 71 Months of Age

The growth data presented in table 8, for cows from 30 to 71 months of age, are for the group of 126 Jersey cows that reached 71 months of age. This period covered the growth of young cows after most of them had calved for the first time and were approaching the age for mature weights.

It seems like a high mortality rate, in spite of management policies peculiar to the Beltsville herd, that out of 378 heifers at 12 months of age only 33 percent of them reached the age of 71 months. However, corresponding ratios from the number of Jersey cows reported in the Ragsdale (7) and Espe (2) standards are only 25 and 40 percent, respectively.

This was the first age-limit group that showed an appreciable difference in average weights from the previous groups. While the average weight at birth for these cows was practically the same as for those shown in tables 1 and 3, their average weights as heifers from 90 days through 18 months of age were below the 5-percent fiducial limits shown in tables 1 and 3. The average weight for this age-limit group at 12 months of age was 13 pounds less than the average in table 3. The averages for this group from 30 to 53 months of age were consistently lower than those in tables 5 and 7, although they were rarely below the 5-percent fiducial limits in these tables. The average weight of the cows in the 71-month age-limit group during a period of 18 months beginning at 3 years of age was 983 pounds. The corresponding average weight for cows in the 53-month age-limit group was 993 pounds. The 80 cows, out of the 206 in table 7, whose weights were not available for the data in table 8, had an average weight during this period of 18 months beginning at 3 years of age that was 24 pounds higher than that for the 126 cows included in table 8.

The average weights shown in table 8 increased to 51 months of age. From 54 to 59 months of age there were actual decreases in average weights. Relatively few cows were on official test at these ages.

TABLE 8.—*Growth in weight for 126 Jersey cows from 30 to 71 months of age*

Age	Pregnancy score	Cows on test	Average actual weight	5-percent fiducial limits	Standard deviation	Coefficient of variation	Estimated standards	
							Weight	Daily gain
Year–Month		*Percent*	*Pounds*	*Pounds*	*Pounds*	*Percent*	*Pounds*	*Pounds*
2 6	7	74	868	854– 882	79.8	9.2	868.8	
2 7	6	76	882	867– 896	82.3	9.3	883.2	0.471
2 8	6	80	894	880– 908	80.4	9.0	896.3	.431
2 9	7	83	905	891– 918	77.9	8.6	908.3	.394
2 10	10	83	918	904– 931	77.9	8.5	919.2	.359
2 11	12	84	929	915– 943	80.3	8.6	929.1	.327
3 0	17	75	945	931– 959	79.3	8.4	938.2	.296
3 1	21	56	955	940– 970	83.6	8.8	946.3	.269
3 2	23	48	963	947– 978	88.2	9.2	953.7	.243
3 3	19	50	964	948– 981	92.4	9.6	960.4	.219
3 4	17	48	967	951– 983	91.0	9.4	966.4	.197
3 5	15	47	973	956– 989	93.4	9.6	971.8	.178
3 6	14	40	977	960– 995	98.7	10.1	976.7	.160
3 7	11	40	974	955– 993	106.7	11.0	981.0	.144
3 8	9	40	972	953– 991	107.6	11.1	985.0	.129
3 9	7	41	971	952– 990	107.2	11.0	988.5	.116
3 10	10	40	978	958– 997	111.5	11.4	991.7	.105
3 11	10	39	987	968–1, 006	106.3	10.8	994.6	.095
4 0	13	38	996	978–1, 015	106.0	10.6	997.3	.087
4 1	15	38	1, 003	984–1, 022	108.3	10.8	999.7	.080
4 2	17	34	1, 012	993–1, 030	106.3	10.5	1, 001.9	.074
4 3	20	25	1, 021	1, 002–1, 040	108.9	10.7	1, 004.0	.069
4 4	20	22	1, 021	1, 001–1, 040	110.5	10.8	1, 006.0	.065
4 5	20	17	1, 010	1, 000–1, 030	100.0	10.7	1, 007.9	.063
4 6	19	17	1, 020	1, 000–1, 040	111.2	10.9	1, 009.8	.061
4 7	14	13	1, 012	994–1, 031	106.5	10.5	1, 011.6	.060
4 8	13	11	1, 009	990–1, 027	106.2	10.5	1, 013.5	.060
4 9	15	10	1, 009	991–1, 028	104.5	10.4	1, 015.3	.061
4 10	16	10	1, 012	994–1, 031	105.5	10.4	1, 017.2	.062
4 11	16	9	1, 011	992–1, 030	107.9	10.7	1, 019.1	.063
5 0	14	10	1, 013	995–1, 032	105.2	10.4	1, 021.1	.066
5 1	15	11	1, 014	996–1, 033	102.8	10.1	1, 023.2	.068
5 2	17	14	1, 025	1, 009–1, 042	106.8	10.4	1, 025.3	.071
5 3	16	12	1, 028	1, 010–1, 046	104.8	10.2	1, 027.6	.074
5 4	15	13	1, 033	1, 014–1, 052	106.0	10.3	1, 029.9	.077
5 5	18	12	1, 035	1, 016–1, 054	106.6	10.6	1, 032.4	.081
5 6	15	15	1, 037	1, 019–1, 055	102.6	9.9	1, 034.9	.084
5 7	14	16	1, 038	1, 020–1, 056	104.3	10.0	1, 037.6	.087
5 8	16	19	1, 043	1, 024–1, 062	106.9	10.2	1, 040.3	.090
5 9	15	20	1, 044	1, 025–1, 063	106.4	10.2	1, 043.2	.093
5 10	16	21	1, 044	1, 025–1, 063	107.8	10.3	1, 046.1	.095
5 11	12	20	1, 049	1, 030–1, 068	107.7	10.3	1, 049.0	.097

The fewer numbers in this age-limit group are responsible for the greater range of values in the 5-percent fiducial limits. The standard deviations and the coefficients of variation were lower at most ages than those in the previous age-limit group.

The estimated weights showed gradual increases through all ages covered in table 8. The estimated daily gains gradually decreased to 55 months of age and then gradually increased for the rest of the period. Evidently, the effects of variations in herd management were not entirely removed.

The smooth curves for the estimated weights and the estimated daily gains demonstrate how slight are the weight changes that may be attributed to the effect of age at older ages. The monthly gains shown by the estimated weights at 3, 4, and 5 years of age were 0.1, 2.7, and 2.0 pounds, respectively. Many other environmental conditions could have made greater changes than these.

From 30 to 89 Months of Age

The data from 77 Jersey cows presented in table 9 furnish an opportunity for studying growth in weight on the same animals from shortly after the age of first calving through the age of maximum size.

TABLE 9.—*Growth in weight for 77 Jersey cows from 30 to 89 months of age*

Age	Pregnancy score	Cows on test	Average actual weight	5-percent fiducial limits	Standard deviation	Coefficient of variation	Estimated standards	
							Weight	Daily gain
Year–Month		*Percent*	*Pounds*	*Pounds*	*Pounds*	*Percent*	*Pounds*	*Pounds*
2 6	6	78	857	838– 876	83.6	9.8	855.7	
2 7	5	81	869	849– 889	86.9	10.0	869.9	0.467
2 8	5	84	883	864– 902	84.4	9.6	882.8	.424
2 9	7	86	889	871– 908	81.6	9.2	894.5	.384
2 10	10	87	903	885– 921	80.5	8.9	905.1	.347
2 11	12	87	915	896– 934	84.3	9.2	914.6	.313
3 0	18	77	928	910– 947	81.8	8.8	923.2	.282
3 1	21	55	939	920– 958	83.7	8.9	930.9	.254
3 2	22	45	946	926– 966	87.6	9.3	937.8	.227
3 3	19	48	950	928– 972	96.2	10.1	944.0	.203
3 4	16	45	951	930– 972	94.5	9.9	949.6	.182
3 5	15	43	956	935– 977	92.8	9.7	954.5	.163
3 6	14	36	961	939– 983	98.7	10.3	958.9	.145
3 7	10	35	953	929– 97	105.3	11.1	962.9	.130
3 8	9	32	950	926– 974	106.5	11.2	966.5	.117
3 9	7	34	949	925– 973	105.8	11.1	969.7	.106
3 10	10	34	955	930– 980	110.2	11.5	972.6	.097
3 11	10	35	965	942– 989	101.6	10.5	975.3	.089
4 0	14	34	976	953– 999	101.4	10.4	977.8	.082
4 1	15	34	981	958–1,004	101.8	10.4	980.2	.077
4 2	19	31	995	972–1,018	99.6	10.0	982.5	.074
4 3	21	23	1,004	981–1,027	101.8	10.1	984.6	.072
4 4	19	21	1,001	978–1,029	109.4	10.9	986.8	.070
4 5	18	18	1,000	976–1,025	108.6	10.9	988.9	.070
4 6	16	17	1,004	977–1,030	117.9	11.7	991.1	.071
4 7	10	14	994	969–1,018	107.9	10.8	993.3	.073
4 8	11	13	985	959–1,021	113.3	11.4	995.6	.075
4 9	14	13	996	972–1,021	108.7	10.9	998.0	.079
4 10	16	13	1,001	975–1,027	114.7	11.5	1,000.5	.082
4 11	18	10	1,001	976–1,026	116.7	11.7	1,003.1	.087
5 0	16	12	1,003	977–1,028	112.1	11.2	1,005.9	.091
5 1	17	12	1,005	981–1,029	105.3	10.5	1,008.8	.096
5 2	18	10	1,017	993–1,041	106.0	10.4	1,011.9	.101
5 3	16	9	1,018	995–1,042	103.1	10.1	1,015.1	.106
5 4	15	10	1,019	995–1,043	105.0	10.3	1,018.5	.111
5 5	17	10	1,019	995–1,043	106.1	10.4	1,022.0	.116
5 6	16	12	1,023	999–1,046	101.5	10.2	1,025.7	.121
5 7	15	13	1,025	1,002–1,049	103.5	10.1	1,029.5	.125
5 8	16	18	1,030	1,005–1,055	111.2	10.8	1,033.4	.129
5 9	15	17	1,027	1,001–1,053	113.7	11.1	1,037.4	.132
5 10	18	18	1,032	1,005–1,059	110.1	11.5	1,041.5	.135
5 11	14	26	1,040	1,012–1,067	120.8	11.6	1,045.7	.137
6 0	16	33	1,040	1,014–1,067	117.5	11.3	1,049.9	.138
6 1	17	36	1,054	1,026–1,081	120.5	11.4	1,054.1	.139
6 2	15	36	1,059	1,031–1,084	109.2	10.3	1,058.3	.138
6 3	18	42	1,071	1,040–1,096	111.0	10.4	1,062.5	.136
6 4	16	51	1,066	1,042–1,090	105.6	9.9	1,066.5	.133
6 5	14	48	1,080	1,055–1,104	107.3	9.9	1,070.4	.129
6 6	15	52	1,086	1,062–1,111	107.7	9.9	1,074.2	.123
6 7	12	53	1,080	1,055–1,105	110.2	10.2	1,077.7	.116
6 8	15	48	1,083	1,058–1,108	111.0	10.2	1,081.0	.107
6 9	14	52	1,082	1,057–1,107	108.8	10.1	1,083.9	.096
6 10	15	52	1,087	1,061–1,113	114.6	10.5	1,086.5	.084
6 11	11	49	1,085	1,057–1,114	121.9	11.5	1,088.6	.070
7 0	16	47	1,092	1,063–1,120	124.2	11.4	1,090.2	.054
7 1	15	47	1,097	1,069–1,121	120.9	11.0	1,091.3	.036
7 2	14	44	1,092	1,066–1,118	113.3	10.4	1,091.8	.015
7 3	13	42	1,089	1,062–1,116	117.8	10.8	1,091.5	−.008
7 4	13	35	1,085	1,059–1,111	115.5	10.6	1,089.5	−.033
7 5	12	35	1,088	1,061–1,114	115.6	10.6	1,088.7	−.061

The cows in this 89-month age-limit group were definitely smaller than those in the previous groups. While their average weights at birth and at 90 days of age were little different from those in table 1, their average weights at 180 days of age and over were definitely below the 5-percent fiducial limits listed in tables 1 and 3. The average weight of this group at 12 months of age was 21 pounds below that shown in table 3. The average weight of this group for an 18-month period beginning at 3 years of age was 965 pounds, compared to 983 pounds for cows in table 8 and 993 pounds for those in table 7. During this period of 18 months, the average weights of these cows in table 9 were well below the 5-percent fiducial limits for the average weights in table 7 and slightly below those in table 8.

Although the average weights of these 77 cows from 54 to 71 months of age were within the fiducial limits listed in table 8, the average of the weights during this period of 18 months was 1,014 pounds, or 13 pounds less than that for the data in table 8, and 33 pounds less than a corresponding weight for the 49 cows represented in table 8 whose weights were not available for use in table 9. The gradual dropping of the weights for such heavier animals from successive monthly totals would have given an inaccurate description of normal rates of growth at these ages.

It must not be concluded from these comparisons that lighter weight Jersey cows have a longer useful life than heavier ones. Preliminary surveys showed that earlier generations of Jersey cows in the Beltsville herd were lighter than the later ones. More calves were needed from some of the cows in the earlier generations in order to fill up some of the groups in the breeding experiments, and these cows were kept longer in the herd. A disease epidemic about 18 years after the herd was assembled caused the removal of some of the larger cows at early ages. Also, some of the cows in later generations were living and not at an advanced age when these data were assembled.

The estimated weights in table 9, although lower than those in table 8, show the same general trend. The highest weights, a little over 1,091 pounds, were reached at a little past 7 years of age. Cows with weights at earlier ages equal to those in table 8 might have reached a maximum weight of 1,100 pounds.

The estimated daily gains in weight were low at 52 months of age, gradually increased again to the age of 6 years, and then declined to 87 months of age, after which there were losses in weight. Undoubtedly, the relative number of cows on official test had considerable to do with the lower daily gains of 4-year-old cows. However, such irregularities are by no means uncommon. In the average Jersey cow weights reported by Espe (*2*), there was a period from 54 to 69 months of age when there were no apparent gains in weight. There are indications in the Ragsdale (*7*) data of periods of lower gains in weight centering at 45 and 60 months of age.

For 107-, 125-, and 139-Month Age-Limit Groups

Data available on a number of older Jersey cows made it possible to test again the age at which maximum weight occurs and to study the changes of weight in cows of more advanced age. The data for three age-limit groups were condensed and combined in table 10. Beginning at 5 years of age, the weights are recorded in intervals of 3 months. As a result, no data are shown for the last 2 months of each

age-limit group. The data for average actual weight, pregnancy score, and relative number of cows on test are averages of the values for 3 consecutive months. The estimated weights were calculated in the same manner as those for other age-limit groups, but only the values for the specified months are used in table 10. Also, the estimated daily gains in weight are for the month stated instead of an average for a 3-month interval. The 125- and 139-month age-limit groups include weights for some cows without records of weights from birth, and these cows were not included in the previous age-limit groups.

The measures of variation are not reported in table 10, although they were calculated for the 107- and 125-month age-limit groups. The average coefficients of variation during the last 3 years for these 2 groups were 10.6 and 11.5, respectively.

TABLE 10.—*Growth in weight for three groups of older Jersey cows*

Age	Pregnancy score	Cows on test	Average actual weight	Estimated standards	
				Weight	Daily gain
Year Month		*Percent*	*Pounds*	*Pounds*	*Pounds*
107-MONTH AGE-LIMIT GROUP (28 COWS)					
5 0	13	13	1,010	1,025.2	
5 3	17	11	1,033	1,030.2	0.076
5 6	22	14	1,040	1,040.5	.127
5 9	14	23	1,046	1,053.7	.151
6 0	17	26	1,065	1,067.8	.154
6 3	20	34	1,074	1,081.1	.140
6 6	15	50	1,087	1,092.2	.112
6 9	18	44	1,096	1,100.2	.074
7 0	14	56	1,113	1,104.4	.031
7 3	11	48	1,115	1,104.5	−.014
7 6	14	38	1,100	1,100.6	−.057
7 9	18	32	1,087	1,093.0	−.095
8 0	17	18	1,086	1,082.4	−.124
8 3	11	17	1,070	1,070.1	−.139
8 6	15	12	1,055	1,057.4	−.137
8 9	19	8	1,048	1,046.1	−.115
125-MONTH AGE-LIMIT GROUP (26 COWS)					
5 0	17	4	994		
5 3	16	12	1,011		
5 6	19	19	1,019	1,009.6	0.334
5 9	12	35	1,027	1,034.9	.249
6 0	15	40	1,052	1,053.2	.178
6 3	12	55	1,056	1,065.8	.119
6 6	15	60	1,064	1,073.6	.070
6 9	17	47	1,081	1,077.6	.032
7 0	8	55	1,087	1,078.7	.002
7 3	12	38	1,083	1,077.6	−.019
7 6	18	29	1,087	1,075.0	−.033
7 9	20	27	1,072	1,071.5	−.040
8 0	16	12	1,067	1,067.7	−.042
8 3	11	14	1,050	1,063.9	−.040
8 6	17	14	1,060	1,060.6	−.034
8 9	20	14	1,050	1,057.9	−.026
9 0	22	12	1,067	1,056.2	−.015
9 3	12	8	1,059	1,055.5	−.004
9 6	15	3	1,062	1,055.7	.007
9 9	16	0	1,054	1,057.0	.017
10 0	16	0	1,057	1,059.0	.024
10 3	14	0	1,061	1,061.5	.030

TABLE 10.—*Growth in weight for three groups of older Jersey cows*—Continued

139-MONTH AGE-LIMIT GROUP (9 COWS)

5 0	13	11	1,011		
5 3	24	10	1,050		
5 6	25	33	1,051	1,046.8	0.107
5 9	13	48	1,047	1,049.6	.090
6 0	7	44	1,059	1,056.8	.074
6 3	7	48	1,044	1,052.5	.058
6 6	21	33	1,053	1,066.9	.043
6 9	24	15	1,072	1,070.0	.029
7 0	7	33	1,074	1,071.9	.017
7 3	7	33	1,083	1,072.7	.005
7 6	21	33	1,087	1,072.5	−.006
7 9	25	30	1,087	1,071.4	−.015
8 0	16	11	1,076	1,069.6	−.023
8 3	15	15	1,067	1,067.1	−.029
8 6	23	22	1,048	1,064.2	−.035
8 9	16	19	1,053	1,060.9	−.037
9 0	10	11	1,012	1,057.5	−.038
9 3	26	4	1,052	1,054.1	−.037
9 6	18	0	1,050	1,050.8	−.035
9 9	15	0	1,038	1,047.0	−.030
10 0	24	0	1,054	1,045.6	−.023
10 3	25	0	1,038	1,044.0	−.014
10 6	21	0	1,060	1,043.4	−.002
10 9	10	0	1,035	1,044.0	.012
11 0	11	0	1,022	1,046.1	.028
11 3	17	0	1,050	1,049.8	.047
11 6	18	0	1,057	1,055.4	.069

Average weights at younger ages for the 28 cows in the 107-month age-limit group were similar to those in the previous tables. Average weights for the cows in the 125- and 139-month age-limit groups, for which weights were available as heifers and young cows, were considerably below those shown in previous tables at these ages. By using the average of the weights in table 9 from 59 to 88 months of age as a basis for comparisons at older ages, it was found that the cows in the 107-month age-limit group were 15.9 pounds heavier than, and therefore comparable to, those listed in table 7 and earlier tables. The cows in the 125-month age-limit group were 4.5 pounds lighter than those listed in table 9, and the cows in the 139-month age-limit group were 1.5 pounds heavier.

The estimated weights for all groups in table 10 show the age of maximum weight in Jersey cows to be a little past 7 years. The 125- and 139-month age-limit groups show that the subsequent losses in weight continue for only 2 or 3 years. Reduction in the relative number of cows on test may be the explanation for some of this loss in weight. However, most of the gains or losses in table 10 are small.

INFORMATION FROM ALL AGE-LIMIT GROUPS

There was no satisfactory method of joining the several curves for estimated weights from this series of tables into one continuous growth standard from birth to old age. Comparisons may be made to whichever table covers the desired range of ages. Preference should be given, with the exception of the lighter weights in table 9, to the standard or estimated weights based on average weights from the larger number of cows.

However, a summarization of the average weights of Jersey females in the Beltsville herd is given in table 11. Data for this table include weights that were omitted in the tabulations by age-limit groups and also weights that were acquired after the standards were calculated. Weights from twins or inbred animals were not used. Weight standards from tables 1, 3, 5, 7, 8, 9, and 10 are included for comparison.

TABLE 11.—*Average weights of Jersey cows and heifers in the Beltsville herd without regard to age-limit groups*

Age	Jersey females	Average actual weight	Estimated standard weight	Age	Jersey females	Average actual weight	Estimated standard weight
	Number	*Pounds*	*Pounds*		*Number*	*Pounds*	*Pounds*
At birth	397	56	56.4	*Years*			
Days				1	407	529	518.8
30	407	72	71.6	1½	396	660	659.1
60	407	102	100.2	2	337	815	807.4
90	407	138	138.1	2½	337	874	879.5
180	407	277	276.8	3	309	950	946.4
270	407	409	408.8	4	257	1,008	1,006.9
				5	186	1,007	1,021.1
				6	147	1,043	1,040.9
				7	106	1,037	1,060.2
				8	66	1,064	1,082.4

At most ages, particularly for heifers, the average actual weights of these larger groups were in close agreement with the estimated standard weights. The noticeable exceptions were the average weights at 5 and 8 years of age. The added data caused a reduction from the average values given for 5 years of age in table 8 and for 8 years of age in table 10. In comparison with average weights at younger and older ages, it would seem that the deviations of these average weights from the estimated standards at 5 and 8 years of age were largely the result of an unusual combination of environmental conditions.

An analysis of variance between the average monthly weights, over successive periods of 18 months in age was made, in an effort to estimate at what ages growth in weight with age was insignificant. The variance ratios for the period from birth to 17 months of age were 10,697.31 and 7,224.07 for the 21- and 35-month age-limit groups. For the period from 18 to 35 months of age, the variance ratios were 312.22 and 235.63 for the 35- and 53-month age-limit groups. For the period from 36 to 53 months of age, the variance ratios were 10.27, 6.80, 4.18, and 2.24, respectively, for the 53-, 71-, 89-, and 107-month age-limit groups. All of these values showed highly significant relationships between age and weight. It was only natural that higher weight variance ratios would be obtained from age-limit groups representing larger numbers of cows.

The variance ratios for the period from 54 to 71 months of age were 2.22, 1.26, and 0.72, respectively, for the 71-, 89.- and 107-month age-limit groups. The first variance ratio indicated highly significant differences between the different months of age, but those from smaller groups did not. In no groups were there significant differences between the average monthly weights at ages above 71 months. The variance ratios were 1.32, 0.66, and 0.52, respectively, for the period from 72 to 89 months of age in the 89-, 107-, and 125-month age-limit groups. The variance ratios were even less for older periods.

STANDARD FOR ASSIGNING GRADES TO THE WEIGHTS OF JERSEY COWS

A standard for assigning grades to the weights of Jersey cows was produced by combining the results of a number of different tabulations and computations. The estimated standard weights in tables 5 to 10 were not used because they provided no satisfactory way of measuring the effects, on individual weights or on a standard itself, of (1) differences in the number and size of cows at different ages, (2) the relative number of cows in various stages of gestation or lactation, and (3) the number of cows being fed for official testing. Therefore, the data were tabulated on an entirely different basis. The results of various steps in these tabulations are shown in table 12.

TABLE 12.—*Data used in calculating estimated standards for average weight of Jersey cows during the first 10 months of a lactation*

Age at time of first monthly weight		Average of first 10 monthly weights after calving		Weight changes between lactations					Estimated values	
				Average values						
		Cows	Weight	Cows	Gains	Interval	Gain per month	Cumulative gains	Cumulative gains	Standard weights
	Year-Month	*Number*	*Pounds*	*Number*	*Pounds*	*Months*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1	11	5	862						−1.9	825.3
2	0	44	870					9.0	8.5	835.7
2	1	59	867					18.0	18.7	845.8
2	2	49	857					27.1	28.5	855.6
2	3	27	871					36.1	38.0	865.1
2	4	27	916					44.6	47.2	874.3
2	5	13	944					53.2	56.1	883.3
2	6	12	929					61.8	64.7	891.9
2	7	7	990					70.4	73.0	900.2
2	8	6	958					78.9	81.3	908.3
2	9	5	986					87.5	88.9	916.1
2	10	3	1,004					96.1	96.4	923.6
2	11	7	955					104.6	103.7	930.9
3	0	5	973					113.2	110.7	937.9
3	1	6	952					121.8	117.5	944.7
3	2	23	972					130.3	124.1	951.3
3	3	20	984	57	128.18	14.21	9.02	138.2	130.4	957.6
3	4	22	975					139.0	136.5	963.7
3	5	10	983					145.6	142.3	969.5
3	6	16	1,005					152.3	148.0	975.2
3	7	17	981					158.9	153.4	980.6
3	8	15	1,017					164.6	158.7	985.8
3	9	13	993	36	139.47	16.53	7.89	164.4	163.7	990.9
3	10	6	949					168.4	168.5	995.7
3	11	5	1,026					172.5	173.2	1,000.4
4	0	6	997					176.5	177.6	1,004.8
4	1	11	1,002					180.5	181.9	1,009.1
4	2	7	1,014					184.3	186.0	1,013.2
4	3	7	971	22	58.05	12.81	4.53	188.1	190.0	1,017.2
4	4	13	989					191.2	193.8	1,020.9
4	5	13	983					194.7	197.4	1,024.6
4	6	12	995					198.3	200.8	1,028.0
4	7	18	996					201.8	204.1	1,031.3
4	8	10	988					205.0	207.3	1,034.5
4	9	5	1,053	20	48.00	13.21	3.63	207.2	210.3	1,037.5
4	10	7	1,066					210.2	213.2	1,040.4
4	11	10	971					213.1	215.9	1,043.1
5	0	13	984					216.0	218.6	1,045.7
5	1	7	1,056					218.9	221.0	1,048.2
5	2	4	1,023					221.8	223.4	1,050.6
5	3	11	1,022	20	46.00	13.45	3.42	224.6	225.7	1,052.9
5	4	7	1,040					224.6	227.8	1,055.0
5	5	5	1,004					226.5	229.8	1,057.0
5	6	12	1,017					228.9	231.8	1,058.9
5	7	9	1,004					231.4	233.6	1,060.8
5	8	6	992					233.8	235.3	1,062.5
5	9	8	1,070	23	28.00	12.48	2.32	236.3	236.9	1,064.1
5	10	6	1,040					240.4	238.5	1,065.6
5	11	11	1,110					242.5	239.9	1,067.1

TABLE 12.—*Data used in calculating estimated standards for average weight of Jersey cows during the first 10 months of a lactation*—Continued

Age at time of first monthly weight	Average of first 10 monthly weights after calving		Weight changes between lactations					Estimated values	
			Cows	Average values					
	Cows	Weight		Gains	Interval	Gain per month	Cumulative gains	Cumulative gains	Standard weights
Year-Month	*Number*	*Pounds*	*Number*	*Pounds*	*Months*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
6 0	5	1,058					244.4	241.3	1,069.5
6 1	6	1,066					246.2	242.5	1,069.7
6 2	8	1,067					248.1	243.7	1,070.9
6 3	5	1,100	11	36.36	13.45	2.70	243.8	244.9	1,072.1
6 4	11	1,074					244.9	245.9	1,073.1
6 5							246.0	246.9	1,074.1
6 6	4	1,010					247.0	247.8	1,075.0
6 7	7	1,076					248.4	248.7	1,075.9
6 8	1	1,080					249.7	249.5	1,076.6
6 9	5	1,056	7	16.71	14.00	1.19	251.0	250.2	1,077.4
6 10	4	999					252.4	250.9	1,078.0
6 11	6	1,021					253.2	251.5	1,078.7
7 0	2	1,166					256.3	252.1	1,079.2
7 1	3	1,130					257.0	252.6	1,079.8
7 2	5	1,088					257.8	253.0	1,080.2
7 3	5	1,021	5	13.00	14.20	.92	259.2	253.5	1,080.7
7 4	1	1,076					259.8	253.9	1,081.0
7 5	1	915					260.5	254.2	1,081.4
7 6	4	1,139					261.1	254.5	1,081.7
7 7	4	1,020					261.8	254.8	1,082.0
7 8	1	1,144					262.5	255.0	1,082.2
7 9	2	850	7	25.56	14.28	1.79	255.6	255.2	1,082.4
7 10	3	1,106					254.4	255.4	1,082.6
7 11	3	974					253.2	255.5	1,082.7
8 0	3	988					252.0	255.7	1,082.8
8 1	1	1,192					250.8	255.7	1,082.8
8 2	3	1,054					249.6	255.8	1,083.0
8 3	3	1,036	5	−13.20	14.40	−.92	252.6	255.8	1,083.0
8 4	1	1,132					251.2	255.9	1,083.0
8 5	1	1,066					250.7	255.9	1,083.0
8 6	1	979					250.2	255.8	1,083.0
8 7							249.7	255.8	1,083.0
8 8	2	951					249.2	255.7	1,082.9
8 9	3	1,077	7	−18.43	13.14	−1.40	248.7	255.6	1,082.8
8 10	2	909					254.1	255.5	1,082.7
8 11	1	964					254.6	255.4	1,082.6
9 0							255.0	255.3	1,082.5
9 1	1	1,055					255.5	255.2	1,082.3
9 2	3	1,038					256.0	255.0	1,082.2
9 3	3	1,053					256.5	254.8	1,082.0
9 4							256.9	254.6	1,081.8
9 5	2	1,037					257.4	254.4	1,081.6
9 6			13	6.00	12.62	.48	257.9	254.2	1,081.4
9 7	1	951					257.2	254.0	1,081.2
9 8	2	965					256.4	253.8	1,081.0
9 9							255.7	253.5	1,080.7
9 10	3	1,047					254.9	253.3	1,080.4
9 11							254.2	253.0	1,080.2
10 0							253.5	252.7	1,079.9
10 1	1	1,073					252.7	252.4	1,079.6
10 2	1	1,240					252.0	252.1	1,079.3
10 3	1	1,055					251.3	252.0	1,078.9
10 4	1	1,009					250.5	251.4	1,078.6
10 5	1	957					249.8	251.1	1,078.2
10 6			9	−8.78	11.89	−.74	249.0	250.7	1,077.9

The first step was to adopt the average of the first 10 monthly weights in a lactation as the basic measure of a cow's weight. The effects of different stages of pregnancy and lactation were controlled in this way, except for minor effects resulting from variations in the time from calving to the next conception. The averages of 786 such basic weights for cows calving at different ages are listed in table 12. The age of a cow at the time of the first 10 monthly weights was used

as the basis for expressing the cow's age. The average ages at calving may have been 15 days less. The irregular changes between average weights for successive ages and the realization that a larger percentage of the cows were on official test at some ages than others demonstrated the need for finding some other method of measuring the effects of age.

The effects of age were measured by the differences in the average 10-month weights of the same cows in two consecutive lactations, when the cows were on test for both lactations or not on test for both lactations. For convenience the data were grouped according to the ages of the cows in the later lactation. Data from these tabulations are shown in table 12 at ages marking the midpoints of the range in age for each group. The average interval for each group was the difference between the average ages for the two lactations. Data were obtained from 262 sets of paired lactations.

In combining the respective average monthly gains into a single cumulative average of gains, the average monthly gains for each group except the first were applied to a range of ages extending from the age in months below the average age for the previous lactation through the age in months above the average of the later lactation. Average monthly gains for the first group were applied by assigning a value of zero for the weight at 23 months of age and adding the average monthly gain (9.02 pounds) cumulatively through the age of 39 months. Corresponding values for the second group began at 27 months of age with a value equal to the cumulative weight at that age for the preceding group, and continued by the cumulative addition of the average monthly gain (7.893 pounds) through 44 months of age. The same procedure was followed for the other groups. If the age for the first weight was covered by the cumulative gains from 2 preceding groups, as it was in most cases, the first weight was established as the weighted average from the 2 preceding groups.

The averages of cumulative gains shown in table 12 are the averages of the values from the various groups weighted according to the number of cows represented in each group.

This series of average cumulative gains had irregularities that were smoothed out by the fitting of a fourth-degree orthogonal polynomial to produce the estimated cumulative gains shown in table 12. In this series of values the estimated daily gains at 2, 3, 4, 5, 6, 7, 8, 9, and 10 years of age were 0.343, 0.231, 0.147, 0.086, 0.045, 0.019, 0.004, −0.004, and −0.009 pounds, respectively. In contrast to the estimated daily gains in tables 5 to 10, these daily gains show little relationship with the number of cows in the herd that were on test at different ages.

The average of the 786 basic 10-month average weights at all ages in this study was 972.995 pounds. The average of the estimated cumulative gains weighted by the same number of cows at each age was 145.812 pounds. The difference (827.183 pounds) added to the estimated cumulative gains gave estimates of standard weights for the averages of 10 monthly weights after calving. The weighted average of all estimated standard weights was 973 pounds. By these procedures a growth curve, little affected by changes in the relative number of cows on official test or by the relative number of light or heavy cows from which weights were obtained, was fitted on basic data that were little affected by differences in the stages o pregnancy and lactation.

Variation in this group of data was measured by the sum of the squares of the deviations of the 786 basic 10-month weights from the estimated standard weights for the same age. The result was a mean square of 8821.1983 and a standard deviation from the estimated values of 93.9212 pounds.

Average deviations at different ages were of little use in determining the normal effect of age on the standard deviation from the estimated values. The effects of age were mixed with the results of wider differences associated with the relative number of cows on official test and the relative number of light or heavy cows in the groups at each age. Data in tables 5 to 10 show that the coefficients of variation were nearly alike for all ages after 3½ years of age. It is reasonable to believe that the coefficients were lower at ages below 3½ years because most cows were in similar stages of pregnancy or lactation and on official test at the same ages. Therefore, it was decided to adjust this standard deviation for age in a manner that would give the same coefficient of variation at all ages. The coefficient of variation was 9.6538 percent for these data.

Since the coefficient of variation was assumed to be the same at all ages, the factors, 0.25335, 0.52440, 0.84162, and 1.28155, which were taken from tables by Fisher (*3*) to use in establishing the boundaries between 10 grades for weight, could be used with the coefficient of variation in calculating constants to apply directly to the standard weights for the first 10 months of lactation. The constants for calculating the boundaries between grades 1 and 2, 2 and 3, and so on, were 0.876295, 0.918760, 0.949381, 0.975545, 1.000000, 1.024455, 1.050619, 1.081240, and 1.123705. The standard weight, represented by the constant 1.000000, is the boundary between grades 5 and 6. Table 13 shows the boundary weights calculated in this manner.

The constants used in calculating the boundary weights may also be considered as percentages. For example, a weight more than 8.1240 percent above any standard weight would be equivalent to a weight graded 9 or 10, and theoretically heavier than 80 percent of the Jerseys judged by such a standard. Such percentage values may be of some use in interpreting comparisons of individual weights with other standards besides this one constructed from data obtained in the Beltsville Jersey herd.

Variations in Weight Due to Stages of Pregnancy and Lactation

There may be times when weights on a cow for the first 10 months after calving are not available. In such cases it would be convenient to know the normal relationship between the average of 10 monthly weights and whatever single weight or group of weights may be available. Table 14 was prepared to furnish such information and also to show the normal changes in weight throughout the months of pregnancy and the following lactation. The data were grouped according to the ages of the cows at the first monthly weight after calving. Two groups were included for a comparison between lactations when cows were on official test and when they were not. Stages of pregnancy are represented in reverse order by the number of months before calving. On the average, the last monthly weight before calving would be equivalent to 264 days of pregnancy, the preceding monthly weight, 234 days of pregnancy, and so on; but wide deviations are possible.

TABLE 13.—*Boundary weights between grades for the average weights of Jersey cows during the first 10 months of a lactation*

Age at time of first monthly weight	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Year–Month	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1 11	723.2	758.2	783.5	805.1	825.3	845.5	867.0	892.3	927.4	
2 0	732.3	767.8	793.4	815.3	835.7	856.1	878.0	903.6	939.1	
2 1	742.0	777.1	803.0	825.1	845.8	866.5	888.6	914.5	950.5	
2 2	749.8	786.1	812.3	834.7	855.6	876.6	898.9	925.2	961.5	
2 3	758.1	794.9	821.3	844.0	865.1	886.3	908.9	935.4	972.2	
2 4	766.2	803.3	830.1	853.0	874.3	895.7	918.6	945.4	982.5	
2 5	774.0	811.5	838.5	861.7	883.3	904.8	928.0	955.0	992.5	
2 6	781.5	819.4	846.7	870.1	891.9	913.7	937.0	964.3	1,002.2	
2 7	788.8	827.1	854.6	878.2	900.2	922.2	945.8	973.3	1,011.6	
2 8	795.9	834.5	862.3	886.1	908.3	930.5	954.3	982.1	1,020.6	
2 9	802.8	841.7	869.7	893.7	916.1	938.5	962.5	990.5	1,029.4	
2 10	809.4	848.6	876.9	901.0	923.6	946.2	970.4	998.7	1,037.9	
2 11	815.8	855.3	883.8	908.2	930.9	953.7	978.0	1,006.5	1,046.1	
3 0	821.9	861.7	890.4	915.0	937.9	960.9	985.4	1,014.1	1,053.9	
3 1	827.8	868.0	896.9	921.6	944.7	967.8	992.5	1,021.5	1,061.6	
3 2	833.6	874.0	903.1	928.0	951.3	974.5	999.4	1,028.5	1,068.9	
3 3	839.1	879.8	909.1	934.2	957.6	981.0	1,006.0	1,035.4	1,076.0	
3 4	844.5	885.4	914.9	940.1	963.7	987.2	1,012.4	1,041.9	1,082.9	
3 5	849.6	890.8	920.4	945.8	969.5	993.2	1,018.6	1,048.3	1,089.5	
3 6	854.5	895.9	925.8	951.3	975.2	999.0	1,024.5	1,054.4	1,095.8	
3 7	859.3	900.9	931.0	956.6	980.6	1,004.6	1,030.2	1,060.3	1,101.9	
3 8	863.9	905.8	935.9	961.7	985.8	1,009.9	1,035.7	1,065.9	1,107.8	
3 9	868.3	910.4	940.7	966.6	990.9	1,015.1	1,041.0	1,071.4	1,113.5	
3 10	872.5	914.8	945.3	971.4	995.7	1,020.1	1,046.1	1,076.6	1,118.9	
3 11	876.6	919.1	949.7	975.9	1,000.4	1,024.8	1,051.0	1,081.6	1,124.1	
4 0	880.5	923.2	954.0	980.3	1,004.8	1,029.4	1,055.7	1,086.5	1,129.1	
4 1	884.3	927.1	958.0	984.4	1,009.1	1,033.8	1,060.2	1,091.1	1,133.9	
4 2	887.9	930.9	961.9	988.4	1,013.2	1,038.0	1,064.5	1,095.5	1,138.6	
4 3	891.3	934.5	965.7	992.3	1,017.2	1,042.0	1,068.6	1,099.8	1,143.0	
4 4	894.6	938.0	969.3	996.0	1,020.9	1,045.9	1,072.6	1,103.9	1,147.2	
4 5	897.8	941.3	972.7	999.5	1,024.6	1,049.6	1,076.4	1,107.8	1,151.3	
4 6	900.8	944.5	976.0	1,002.9	1,028.0	1,053.1	1,080.0	1,111.5	1,155.2	
4 7	903.7	947.5	979.1	1,006.1	1,031.3	1,056.5	1,083.5	1,115.1	1,158.9	
4 8	906.5	950.4	982.1	1,009.2	1,034.5	1,059.8	1,086.8	1,118.5	1,162.5	
4 9	909.2	953.2	985.0	1,012.1	1,037.5	1,062.9	1,090.0	1,121.8	1,165.8	
4 10	911.7	955.9	987.7	1,014.9	1,040.4	1,065.8	1,093.0	1,124.9	1,169.1	
4 11	914.1	958.4	990.3	1,017.6	1,043.1	1,068.6	1,095.9	1,127.9	1,172.2	

5 0	916.4	960.8	992.8	1,020.2	1,045.7	1,071.3	1,098.7	1,130.7	1,175.1
5 1	918.6	963.1	995.2	1,022.6	1,048.2	1,073.9	1,101.3	1,133.4	1,177.9
5 2	920.6	965.2	997.4	1,024.9	1,050.6	1,076.3	1,103.8	1,135.9	1,180.6
5 3	922.6	967.3	999.6	1,027.1	1,052.9	1,078.6	1,106.1	1,138.4	1,183.1
5 4	924.5	969.3	1,001.6	1,029.2	1,055.0	1,080.8	1,108.4	1,140.7	1,185.5
5 5	926.3	971.1	1,003.5	1,031.2	1,057.0	1,082.9	1,110.5	1,142.9	1,187.8
5 6	927.9	972.9	1,005.3	1,033.0	1,058.9	1,084.8	1,112.5	1,145.0	1,189.9
5 7	929.5	974.6	1,007.1	1,034.8	1,060.8	1,086.7	1,114.5	1,146.9	1,192.0
5 8	931.1	976.2	1,008.7	1,036.5	1,062.5	1,088.5	1,116.3	1,148.8	1,193.9
5 9	932.5	977.7	1,010.2	1,038.1	1,064.1	1,090.1	1,118.0	1,150.6	1,195.6
5 10	933.8	979.1	1,011.7	1,039.6	1,065.6	1,091.7	1,119.6	1,152.2	1,197.5
5 11	935.1	980.4	1,013.1	1,041.0	1,067.1	1,093.2	1,121.1	1,153.8	1,199.1
6 0	936.3	981.6	1,014.4	1,042.3	1,068.5	1,094.6	1,122.5	1,155.3	1,200.2
6 1	937.4	982.8	1,015.6	1,043.6	1,069.7	1,095.9	1,123.9	1,156.6	1,202.1
6 2	938.5	983.9	1,016.7	1,044.7	1,070.9	1,097.1	1,125.1	1,157.9	1,203.4
6 3	939.4	985.0	1,017.8	1,045.8	1,072.1	1,098.3	1,126.3	1,159.1	1,204.7
6 4	940.4	985.9	1,018.8	1,046.9	1,073.1	1,099.4	1,127.4	1,160.3	1,205.9
6 5	941.2	986.8	1,019.7	1,047.8	1,074.1	1,100.4	1,128.5	1,161.3	1,207.0
6 6	942.0	987.7	1,020.6	1,048.7	1,075.0	1,101.3	1,129.4	1,162.3	1,208.0
6 7	942.8	988.4	1,021.4	1,049.5	1,075.9	1,102.2	1,130.3	1,163.3	1,208.9
6 8	943.5	989.2	1,022.1	1,050.3	1,076.6	1,103.0	1,131.1	1,164.1	1,209.8
6 9	944.1	989.8	1,022.8	1,051.0	1,077.4	1,103.7	1,131.9	1,164.9	1,210.6
6 10	944.7	990.5	1,023.5	1,051.7	1,078.0	1,104.4	1,132.6	1,165.6	1,211.4
6 11	945.2	991.0	1,024.1	1,052.3	1,078.7	1,105.0	1,133.3	1,166.3	1,212.1
7 0	945.7	991.6	1,024.6	1,052.8	1,079.2	1,105.6	1,133.9	1,166.9	1,212.7
7 3	947.0	992.9	1,026.0	1,054.2	1,080.7	1,107.1	1,135.4	1,168.5	1,214.3
7 6	947.9	993.8	1,026.9	1,055.2	1,081.7	1,108.2	1,136.5	1,169.6	1,215.5
7 9	948.5	994.5	1,027.6	1,055.9	1,082.4	1,108.9	1,137.2	1,170.3	1,216.3
8 0	948.9	994.9	1,028.0	1,056.4	1,082.8	1,109.3	1,137.7	1,170.8	1,216.8
8 3	949.1	995.0	1,028.2	1,056.5	1,083.0	1,109.5	1,137.9	1,171.0	1,217.0
8 6	949.0	995.0	1,028.2	1,056.5	1,083.0	1,109.5	1,137.8	1,171.0	1,217.0
8 9	948.9	994.9	1,028.0	1,056.3	1,082.8	1,109.3	1,137.6	1,170.8	1,216.8
9 0	948.6	994.5	1,027.7	1,056.0	1,082.5	1,109.0	1,137.3	1,170.4	1,216.4
9 3	948.2	994.1	1,027.2	1,055.6	1,082.0	1,108.5	1,136.8	1,169.9	1,215.9
9 6	947.6	993.6	1,026.7	1,055.0	1,081.4	1,107.9	1,136.2	1,169.3	1,215.2
9 9	947.0	992.9	1,026.0	1,054.3	1,080.7	1,107.1	1,135.4	1,168.5	1,214.4
10 0	946.3	992.2	1,025.2	1,053.5	1,079.9	1,106.3	1,134.6	1,167.6	1,213.5
10 3	945.5	991.3	1,024.3	1,052.6	1,078.9	1,105.3	1,133.6	1,166.6	1,212.4
10 6	944.5	990.3	1,023.3	1,051.5	1,077.9	1,104.2	1,132.4	1,165.4	1,211.2

TABLE 14.—*Average weights and deviations from the average of the first 10 monthly weights after calving for Jersey cows at various months before and after calving*

Period weighed	Age groups [1]															
	23 to 35 months		36 to 47 months		48 to 59 months		60 to 71 months		72 to 83 months		84 to 125 months		36 to 125 months			
													On test		Not on test	
	Weight	Deviation	Weight	Deviation	Weight	Deviation	Weight	Deviation	Weight	Deviation	Weight	Deviation	Weight	Deviation	Weight	Deviation
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Months before calving:																
10	631	−259	885	−100	955	−37	982	−49	988	−76	990	−37	937	−116	968	−18
9	655	−235	901	−84	962	−30	987	−44	991	−73	996	−31	948	−105	976	−10
8	670	−211	908	−77	970	−22	986	−45	1,000	−64	1,001	−26	954	−99	980	−6
7	703	−187	919	−66	980	−12	996	−35	998	−66	1,007	−20	964	−89	988	2
6	730	−160	935	−50	993	1	1,003	−28	1,010	−54	1,017	−10	977	−76	998	12
5	764	−126	955	−30	1,009	17	1,021	−10	1,029	−35	1,034	7	996	−57	1,015	29
4	794	−96	968	−17	1,025	33	1,038	7	1,050	−14	1,051	24	1,011	−42	1,032	46
3	825	−65	985	0	1,046	54	1,057	26	1,079	15	1,072	45	1,034	−19	1,049	63
2	860	−30	1,005	20	1,059	67	1,082	51	1,111	47	1,094	67	1,062	9	1,066	80
1	895	5	1,035	50	1,077	85	1,117	86	1,152	88	1,122	95	1,098	45	1,089	103
Months after calving:																
1	832	−58	956	−20	988	−4	1,034	3	1,061	−3	1,031	−4	1,020	−33	996	10
2	839	−51	953	−32	973	−19	1,014	−17	1,052	−12	1,012	−15	1,019	−34	975	−11
3	854	−36	959	−26	971	−21	1,017	−14	1,055	−9	1,013	−14	1,029	−24	972	−14
4	870	−20	967	−18	976	−16	1,015	−16	1,060	−4	1,015	−12	1,040	−13	971	−15
5	883	−7	976	−9	978	−14	1,013	−18	1,059	−5	1,012	−15	1,048	−5	968	−18
6	898	8	985	0	984	−8	1,018	−13	1,057	−7	1,016	−11	1,057	4	971	−15
7	910	20	995	10	993	1	1,031	0	1,062	−2	1,025	−2	1,066	13	980	−6
8	925	35	1,006	21	1,007	15	1,040	9	1,070	6	1,035	8	1,074	21	993	7
9	936	46	1,018	33	1,021	29	1,056	25	1,076	12	1,047	20	1,081	28	1,008	22
10	954	64	1,034	49	1,036	44	1,070	39	1,085	21	1,062	35	1,091	38	1,026	40
1 to 5	856	−34	962	−23	977	−15	1,019	−12	1,057	−7	1,017	−10	1,033	−20	975	−11
3 to 5	869	−21	968	−17	975	−17	1,015	−16	1,058	−6	1,013	−14	1,039	−14	970	−16
6 to 10	924	34	1,008	23	1,008	16	1,043	12	1,071	7	1,037	10	1,073	20	997	11
1 to 10	890	0	985	0	992	0	1,031	0	1,064	0	1,027	0	1,053	0	986	0
Number of records	255		176		110		99		62		355		215		316	

[1] Cows are arranged in groups according to their ages at first weighing after calving.

The average lactation weights on which the deviations in table 14 were based were 890 pounds for the 23- to 35-month-old group, 985 pounds for the 36- to 47-month-old group, 992 pounds for the 48- to 59-month-old group, 1,031 pounds for the 60- to 71-month-old group, 1,064 pounds for the 72- to 83-month-old group, 1,027 pounds for the 48- to 125-month-old group, 1,053 pounds for the cows on test, and 986 pounds for cows not on test.

Weights at monthly intervals previous to calving showed average gains during periods of 9 months of 264 pounds for 2-year-old cows, 150 pounds for 3-year-old cows, and 132 pounds for 4-year-old cows. Morgan and Davis (*6*) found total gains in Jersey cows for the first of 9 monthly weights to the time of calving of 231 pounds for the first gestation, 160 pounds for the second gestation, and 157 pounds for the third and later gestations. The data in table 14 show that for cows 3 years old and over, the average 9-month gains were 161 pounds for cows that went on official test after calving, and 121 pounds for cows that did not. Monthly gains were greater during the later months of pregnancy in all groups, and these differences between the gains made during earlier and later months of pregnancy were greater for older cows than for younger ones.

Since the last weight before calving and the first weight after calving were a month apart, no measure of abrupt changes in weight at calving time was possible. However, the losses in weight during this month were 63 pounds for 2-year-old cows, 79 pounds for 3-year-old cows, 89 pounds for 4- and 5-year-old cows, and 91 pounds for 6-year-old cows. While 2-year-old cows began gaining in weight immediately after the first month, groups of older cows continued to lose weight for another month or two. This continued loss in weight was slight for cows on official test, but it was several months before cows not on test began to gain in weight.

The columns of deviations in table 14 may be used to provide a means of adjusting single weights or certain series of weights on an individual cow to an equivalent 10-month average weight, which is the basis of the table of boundary weights for Jersey cow grades. However, there is no way of accounting for differences between different cows in this relationship. In using the deviations in table 14, minus deviations are added to the cow's weight at a certain month or group of months and plus deviations are subtracted from it to give an adjusted weight that can be used in comparison with the boundary weights in table 13. Two- and three-year-old cows should be treated as separate groups. All other values could be obtained from the columns headed 48 to 125 months of age. For example, suppose that a cow 57 months of age weighed 975 pounds at 3 months after calving. Table 14 shows the deviation to be −14 pounds. Adding 14 to 975 gives a weight of 989 pounds, which at 57 months of age (table 13) would be given a grade of 4.

Grades were assigned to the 786 basic 10-month average weights used in preparing these standards as a test of the actual distribution of these grades. Theoretically, there should have been the same number of weights for each grade. Actually, the number of weights for each grade from 1 to 10 was 62, 96, 78, 82, 86, 76, 86, 68, 65, and 87, respectively. Corresponding numbers for the 447 lactations for cows on test were 11, 30, 23, 42, 45, 48, 67, 49, 52, and 80. Similar numbers

for 339 lactations of cows not on test were 51, 66, 55, 40, 41, 28, 19, 19, 13, and 7. Proportionally fewer of the higher grades went to the cows not on test.

TIME TRENDS IN THE AVERAGE WEIGHTS OF JERSEY FEMALES AT BELTSVILLE

The possibility of a time trend in the average weights within a herd was indicated by occasional observations and supported by the known existence of a time trend toward higher levels of producing ability as a result of a successful breeding program. For purposes of a study on such a question, these data on the weights of Jersey females have the advantage that they are based on adequate numbers of females in a herd that was maintained (1) under relatively uniform environment over a considerable number of years and (2) without culling for production or adding purchased females.

The weights at various ages of the Jersey females used in the previous studies were tabulated according to the year of birth. The average weights from such tabulations are shown in table 15. The average weights on each line are from the same group of females, minus those that left the herd.

The environmental years, as distinguished from the year of birth, can be determined for some average weights by adding the age to the year of birth. For example, the environmental years for females born in 1930 were from January 1930 to December 1930 for weights at birth, from July 1930 to June 1931 for weights at 180 days of age, from January 1931 to December 1931 for weights at 12 months of age, from July 1931 to June 1932 for weights at 18 months of age, and from January 1934 to December 1934 for weights at 4 years of age.

For the same group of females, the environmental period for most of the first-lactation weights, each of which was an average of 10 monthly weights, would have been from January 1932 to April 1934. The environmental period for mature-lactation weights would have been spread over a greater number of years, because lactations beginning at any age between 4 and 8 years were used in order to base these values as far as possible on weights obtained during lactations on test.

All first-lactation weights were adjusted to a calving age of 26 months by multiplying the standard lactation weight for 26 months of age by the ratio of the cow's lactation weight divided by the standard lactation weight for cows of her age. All mature-lactation weights were adjusted to a calving age of 7 years in the same manner. The adjusted values at 7 years of age are a good representation of each cow's maximum weight while in milking condition.

Some of the differences in the average weights from a sorting according to the year of birth may have been due to inherited differences from the sires that were used. Therefore, letter symbols are used in table 15 to indicate the bulls siring one-sixth or more of the heifers whose weights are tabulated from birth to 12 months of age. This may or may not have represented the proportion of offspring that remained in the herd to older ages. Letters *a* to *h*, inclusive, represent sires that were brought in from other herds. Letters *j* to *u*, inclusive, represent sires originating in the Beltsville herd and frequently used for linebred matings.

For all ages there appears to have been a trend toward higher weights for the first 10 to 12 years and then a leveling off, or possibly a decline, for the next 21 or 23 years. There were numerous up-and-down changes from one year to another. Similar trends were found in Holstein weights at Beltsville (*5*). The parabolic nature of the trend was demonstrated from the Holstein data by the greater reduction in errors of estimate from using this type of a curve in regression studies.

On the basis of these findings, it was decided to use the data from calves born in 1920 to 1930, inclusive, for a study of the ascending trend in weights and the data from animals born from 1928 to 1951, inclusive, for a study of the leveling-off period. Average weights for all ages were lower during the ascending period.

A summary section of table 15 shows the results of tests of the significance of differences in the average weights for different years of birth. The ratios of the mean squares between years to the mean squares within years were highly significant for weights at nearly all ages except at birth. Weights at birth were distinctly different from other weights, in that they were little affected by the years in which they were obtained.

Linear regression coefficients were calculated to show the possible trends from one year to another. The regression coefficients at the bottom of table 15 show a general trend for slightly higher weights throughout the 33-year period as a whole. The first-lactation weights and the mature-lactation weights were exceptions to this trend.

When the 33 years were divided into 2 periods, there were highly significant yearly increases in weight for all ages except birth during the period from 1920 through 1930. On the other hand, there was a trend toward lower weights during the period from 1928 through 1951. The decreases became significant and highly significant at older ages. Weights at birth were an exception to this trend.

There is no easy explanation of these trends. Considering the efforts made to maintain a uniform environment and the fact that calves, older heifers, and cows were fed in different barns and that different methods were used in calculating their requirements, it does not seem likely that feeding or environment would have resulted in similar trends at all ages.

Frequently the average weights of a group of animals born in a certain year were higher or lower at all ages than those for animals born in other years. Animals born in 1932, 1935, or 1946 are such examples. This suggests that some of the differences in the average weights of various groups were inherited. It may also be observed in table 15 that average weights were high for animals born in the years 1932 through 1935, when the offspring of sires *f*, *g*, and *h* were predominant, and that average weights were considerably lower after 1935, when the offspring of various Beltsville-raised family sires were predominant. In this respect the management of the Holstein herd at Beltsville differed from that of the Jersey herd. The use of sires brought in from outside was continuous in the Holstein herd. The average yearly weights in the Holstein herd showed no definite downward trend during the years 1928 through 1951.

TABLE 15.—*Yearly trends in the average weights of Jersey females sorted according to the year of birth* [1]

Year of birth	Sires of various percentages of the heifers, from birth to 12 months of age. [2]			Number of females, and average weights, from birth to 12 months of age—						Number of females, and average weights, from 18 months through mature lactation—							
	50 percent	33.3 to 49.9 percent	[illegible] to 33.2 percent	At birth		At 180 days		At 12 months		At 18 months		At 4 years		At first lactation		At mature lactation	
				Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1919												1	1,023				
1920												2	856	2	787	2	956
1921	*a, b*			4	52.5	4	247	4	410	4	561	3	803	3	820	2	974
1922	*b*			2	55.0	2	259	2	493	2	622	2	860	2	835	1	972
1923	*b*		*a*	8	58.0	8	253	8	477	8	612	8	967	8	803	8	1,063
1924		*c*	*a, j*	23	54.7	23	258	23	466	23	606	18	912	19	795	16	1,059
1925		*d*	*a, c*	12	56.5	12	263	12	474	10	635	8	913	8	846	8	1,092
1926		*c, d*	*d*	7	60.0	7	266	7	489	7	628	6	955	6	865	5	1,131
1927		*d*	*a*	10	56.4	10	271	10	503	10	620	8	969	9	883	4	1,113
1928			*c, k*	13	51.0	13	264	13	508	13	640	8	960	13	894	6	1,084
1929			*e*	13	54.8	13	277	13	545	13	703	4	1,067	10	896	4	1,164
1930		*e*		17	53.2	17	270	17	528	17	668	12	1,068	13	928	9	1,147
1931			*e, f, g*	18	55.4	18	284	18	545	16	688	12	1,072	12	933	7	1,155
1932		*g*		15	54.0	15	303	15	555	15	691	7	1,097	13	955	3	1,214
1933			*f, g, h*	13	57.8	13	292	13	534	12	684	6	1,049	6	932	4	1,147
1934		*g*	*f, h*	17	54.2	17	279	17	535	15	689	7	1,029	7	929	6	1,094
1935	*h*	*g*		11	56.0	11	297	11	543	11	715	6	1,062	7	938	6	1,176
1936			*h, q, r*	8	54.6	8	287	8	554	9	701	9	1,043	8	917	4	1,096
1937		*s*	*q, r*	17	53.6	17	272	17	541	14	721	14	1,075	14	924	5	1,084
1938		*q*	*r, s*	16	57.8	16	276	16	541	16	712	10	1,054	11	921	4	1,046
1939		*l*	*n, s*	18	57.1	18	279	18	507	16	654	12	1,019	12	876	8	1,068
1940	*m*		*n*	19	56.6	19	282	19	520	19	666	13	1,023	15	872	7	1,035
1941	*o*		*n*	22	55.6	22	278	22	532	21	670	15	1,083	17	857	6	1,034
1942		*o, p*	*r*	12	56.0	12	288	12	523	12	644	10	984	12	848	9	1,064
1943		*p*	*o, r*	28	55.9	28	279	28	512	27	646	19	959	21	843	7	989
1944		*o*	*n, r*	16	55.6	16	272	16	520	16	630	10	987	13	848	3	997
1945		*p*	*n, o*	13	58.6	13	293	13	539	13	667	5	1,107	10	865	3	1,151
1946	*r*			13	50.5	13	262	13	514	13	613	7	931	8	796	5	975
1947	*p*	*r*		15	57.9	15	278	15	512	15	637	10	984	12	819	9	1,100
1948	*r*			9	52.3	9	273	9	519	9	628	3	987	5	837	3	1,054

1946	*t*			7	59.1	7	278	7	526	7	661	2	1,107	5	873		
1950	*t*	*u*		11	60.7	11	279	11	534	10	681			8	878		
1951	*t*			3	63.7	3	331	[2]	608	3	737						
Averages:																	
1919–51				407	55.8	407	277	407	520	396	661	257	1,008	309	875	164	1,082
1919–30				109	54.9	109	265	109	495	107	636	80	960	93	863	65	1,086
1928–51				341	55.7	341	280	341	529	332	670	201	1,030	252	884	118	1,087
Mean squares between years:																	
1919–51					71.2		2,010**		8,792**		15,695**		32,558**		20,170**		18,533**
1919–30					82.0		711		10,091**		14,073**		27,643**		27,014**		15,944
1928–51					64.8		1,581**		3,691**		12,371**		21,517**		19,487**		21,021**
Mean squares within years:																	
1919–51					59.9		702		1,524		2,701		9,301		4,291		7,877
1919–30					61.1		775		1,720		2,901		8,710		3,550		8,225
1928–51					51.8		686		1,523		2,626		9,350		4,445		7,453
Regression of weight on years:																	
1919–51					.070		.61**		1.43**		.65		2.62**		−.79		−1.35
1919–30					−.319		2.58**		11.13**		11.13**		17.31**		14.03**		16.14**
1928–51					.163*		−.06		−.71*		−2.12**		−3.68**		−5.03**		−6.22**

[1] 1 asterisk indicates significance at the 5-percent level; 2 asterisks indicate significance at the 1-percent level.

[2] The 21 individual sires are represented by the letters *a*, *b*, *c*, etc. Two or more letters in the same column indicate that 2 or more bulls sired a similar proportion of the heifers born in that year.

All of these observations lead to the suggestion that in a breeding program of outcrossing to sires proved for high production, the average weights in an assembled herd will increase for 2 or 3 generations and then level off. Then, if the degree of relationship between mates is increased again by closing the herd to outside blood lines, a trend toward lower weights may be expected.

RELATIONSHIPS BETWEEN EARLY AND MATURE WEIGHTS

The weight data from the Jersey breeding experiments provide an excellent opportunity for a study of the relationships between early weights and mature weights, because of the efforts that were made in the experiments to maintain uniform environmental conditions and provide a liberal plane of feeding for growth and milk production. By using a number of weights obtained since the standards were calculated, data were made available from birth to maturity or near maturity on 161 Jersey cows. The weights of inbred cows and twins were not used.

The preferred measure of a cow's mature weight would be the average of the first 10 monthly weights during a lactation on test beginning at 7 years of age. Such weights would be close to the maximum weights of cows in milking condition, when on careful feeding. Naturally, few lactations of cows on test began at exactly 7 years of age. Although table 12 shows relatively minor changes in the standard weights after 6½ years of age, many cows were started on official test at earlier ages, but under mature-test conditions. Therefore, all weights obtained during lactations at mature or nearly mature ages were converted to a 7-year-old equivalent, by using the ratio of each cow's lactation weight divided by the standard weight for cows of her age.

Adjusting the lactation weights for age made it possible to include data from a number of cows calving after 4 years of age but without later lactations on test. However, in spite of the efforts to obtain the data from cows on official test, nearly a third of the mature-lactation weights in this study were not obtained under test conditions.

First-lactation weights were adjusted to a calving age of 26 months, in the manner previously described. More than 91 percent of these first-lactation weights were obtained from cows on official test.

The results of these studies on the relationships between weights at earlier ages and mature-lactation weights are shown in table 16. Additional studies were made of the relationships between weights at birth and at 6 months of age, and between weights at 12 months of age and during the first lactation.

All correlation coefficients were highly significant, showing a definite relationship between early weights and later weights. The successive increases in the correlation coefficients, from 0.3254 for birth and mature-lactation weights to 0.7519 for first- and mature-lactation weights, demonstrate the greater reliability of each older age in predicting mature-lactation weights.

Another demonstration of the relative values of early weights in predicting mature-lactation weights is shown in the proportion of the sum of squares for mature-lactation weights (Sy^2) that was attributable to regression on earlier weights. They are shown in table 16 as percentage values calculated as $r^2(100)$. The relatively low

TABLE 16.—*Relationships between weights at different ages in the same Jersey females*

Earlier weights			Later weights						
Age	Average weight	Standard deviation	Age	Average weight	Standard deviation	Correlation coefficient [1]	Reduction in S_y^2 due to regression	Regression coefficient	Standard deviation from regression
	Pounds	*Pounds*		*Pounds*	*Pounds*		*Percent*	*Pounds*	*Pounds*
At birth	56	7.8	Mature lactation	1,084	91.4	0.3254	10.6	3.83	86.7
90 days	138	17.8	do	1,084	91.4	.4421	19.5	2.27	82.3
180 days	274	29.5	do	1,084	91.4	.5124	26.3	1.59	78.8
12 months	510	44.7	do	1,084	91.4	.5608	31.4	1.15	76.0
18 months	650	58.7	do	1,084	91.4	.5772	33.3	.90	74.9
First lactation	870	70.6	do	1,084	91.4	.7519	56.5	.97	60.5
At birth	56	7.8	180 days	274	29.5	.4817	23.2	1.53	25.9
12 months	510	44.7	First lactation	870	70.6	.6110	37.3	.97	56.1

[1] All correlation coefficients are highly significant.

correlation coefficient of 0.3254 between birth weights and mature-lactation weights accounted for only 10.6 percent of the sum of squares for mature-lactation weights. On the other hand, the correlation of 0.7519 between first- and mature-lactation weights accounted for 56.5 percent of the sum of squares for mature-lactation weights.

The standard deviations from regression, or standard errors of estimate for mature-lactation weights, were successively lower for each older age that the earlier weights were obtained. This value for estimates from weights at birth was 4.7 pounds less than the standard deviation for mature-lactation weights. The value for estimates for first-lactation weights was 30.9 pounds less than the standard deviation for mature-lactation weights.

The data for many individual cows gave the impression that there was little relationship between weights of calves at birth and their weights at older ages. A correlation coefficient of 0.4817 showed a considerably higher relationship between weights at birth and at 180 days of age than between birth weights and mature-lactation weights. On the other hand, the slightly higher correlation coefficient of 0.5124 showed that weights at 6 months of age were more closely associated with mature-lactation weights than with birth weights.

The values in table 16 also show that weights at 12 months of age produced more reliable estimates of first-lactation weights than of mature-lactation weights. However, the differences in the correlation coefficients were not great considering the differences in intervening time. In parallel studies on weight data from the Holstein breeding experiments at Beltsville (*5*), first-lactation weights were obtained with considerably greater reliability than mature-lactation weights. In all other respects the results on Holstein weight data were almost identical with the results on Jersey weight data.

GROWTH STANDARDS FOR BULL CALVES

Weights from birth were available on a limited number of the bull calves born in the Jersey herd at Beltsville. Many bulls were transferred to another herd soon after birth, and many of them were loaned and placed in cooperating herds before they were 10 or 12 months old. Nevertheless, weights were obtained regularly from birth to

270 days of age on 184 bulls, from birth to 12 months of age on 127 bulls, and from birth to 15 months of age on 55 bulls.

The feeding and management of these Jersey bull calves was much like that of the heifer calves, except that the bulls were moved out of the calf barn at an earlier age. Of the 127 bull calves that reached 12 months of age, 37 percent were in the bull barn at 270 days of age, 47 percent at 300 days, 80 percent at 330 days, and 90 percent at 360 days. No silage was fed in the bull barn, but pasture was available for young bulls some of the time.

The average weights for four groups of Jersey bulls are shown in table 17. Standard deviations are shown for 184 bulls to 270 days of age and for 55 bulls to 15 months of age. The coefficients of variation were generally higher than those shown for Jersey heifers, particularly after 120 days of age. Averages of the coefficients of variation for the 184 bulls that reached 270 days of age were 13.8, 12.7, and 11.3 percent, respectively, during the first, second, and third 3-month periods after birth. Corresponding values for 378 Jersey heifers were 13.5, 11.7, and 9.8 percent. The coefficients for the group of bulls reaching 15 months of age were also higher than those for heifers.

By some chance the average weights for the groups of bull calves that remained longer in the herd were higher than the average weights for groups of bulls that left the herd at earlier ages. At 270 days of age, for example, the average weights for the groups that remained in the herd until they reached 12, 15, and 18 months of age were 6, 21, and 34 pounds heavier, respectively, than the average weights for all the bulls at 270 days of age.

Estimated weights for 10-day periods were calculated by fourth-degree orthogonal polynomial regression from the average weights of the 184 bull calves that reached 270 days of age. Average weights from the groups reaching 11 and 12 months of age were used in calculating the estimated values from 280 to 365 days of age, in order to make a calculated curve of estimated weights with the same length as the standard for heifer calves. There was but little difference in the average weights from these three groups at corresponding ages. Estimated weights by 10-day periods are not presented in table 14 beyond 300 days of age because such values might be considerably affected by data coming from different age-limit groups and by environmental changes involved in the transfer of a large percentage of the calves to the bull barn.

Estimated weights by months, like the estimated weights for heifers, were calculated, by fifth-degree orthogonal polynomial regression from the average weights of 55 bulls that reached 15 months of age and from adjusted values from the groups that reached 18 and 21 months of age, to obtain the average weights beyond 15 months of age. Average weights from the last 2 groups were adjusted downward in proportion to the amounts that the average weights from these groups exceeded those from the group that reached 15 months of age at corresponding ages. The average weights for 30-day periods were adjusted to a calendar-month basis in the manner described for heifers.

Neither of the curves for estimated values closely duplicated the abrupt changes in weight following birth. As a result, the estimated values for weight at birth appear to be too high in the series by 10-day periods and too low in the series by months.

A comparison of the estimated weights of Jersey bull and heifer calves shows higher weights for the bull calves at all ages. Because the average weights of the bulls that remained in the herd 15 months or longer were higher than those for the bulls that left the herd at an earlier age, the standard of estimated weights by months is definitely higher than the standard by 10-day periods. Consequently, the greatest difference between bull and heifer calf weights is shown by comparisons using the estimated weights by months. For example, at 270 days, or 9 months of age, the weights of bull calves exceeded the weights of heifer calves by 71.7 pounds, or 17.5 percent, according to the estimated weights by 10-day periods, and by 84.3 pounds, or 20.3 percent, according to the estimated weights by months.

The difference between Jersey bull and heifer weights increased with age after about 6 months of age. According to the monthly estimated weights, the bulls were 53.1 pounds, or 18.8 percent, heavier at 6 months of age; 84.3 pounds, or 20.3 percent, heavier at 9 months of age; 128.1 pounds, or 24.9 percent, heavier at 12 months of age; 180.4 pounds, or 30.6 percent, heavier at 15 months of age; and 225.6 pounds, or 34.2 percent, heavier at 18 months of age. Differences between the rates of growth for Jersey bulls and heifers are also shown by the percentages of the estimated weights at 6 months of age attained at other ages. The percentages for Jersey heifers at 2, 4, 6, 9, 12, 15, and 18 months of age were 35, 66, 100, 147, 183, 209, and 234 percent, whereas those for the bulls were 36, 66, 100, 149, 192, 230, and 264 percent.

Also, the bulls did not fall off in daily gains as rapidly as the heifers. Daily gains for the heifers at 9, 12, 15, and 18 months of age were only 84.4, 61.3, 47.5, and 49.4 percent, respectively, of their gains at 6 months of age, when daily gains were highest for both bulls and heifers. Corresponding values for the bulls were 92.5, 80.2, 71.7, and 64.7 percent.

The boundary weights for assigning grades to the weights of Jersey bull calves are shown by 10-day periods in table 18 and by months in table 19. The variations in weights by 10-day periods were based on the standard deviations for the group of bull calves that reached 270 days of age. The variations by months were based on the standard deviations for the bull calves that reached 15 months of age. The calculations were made in the same manner as described for Jersey heifers. These tables can be used in the same way as those for the heifers.

Since the standards by 10-day periods were calculated from lighter average-weight data, the weights of the same bulls would tend to be graded higher by the standards for 10-day periods than by the standards by months. Also, the weights at birth could be graded more accurately by boundary weights, which were calculated from the average weights and the standard deviations at birth, than by the estimated values.

TABLE 17.—*Average weights and standard deviations, and estimated weights and gains, for Jersey bull calves*

Age	184 calves to 9 months of age		Weights of 127 calves to 12 months	55 calves to 15 months of age		Weights of 28 calves to 18 months	Estimated values			
							By 10-day periods		By months [1]	
	Weight	Standard deviation		Weight	Standard deviation		Weight	Daily gain	Weight	Daily gain
Days	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
At birth	61	7.6	61	63	8.2	63	63.5		58.1	
10	64	7.9	64				65.8	9.23		
20	70	9.0	70				70.5	.47		
30	78	11.1	79	82	13.4	84	77.3	.68	82.9	0.82
40	89	12.6	89				86.1	.88		
50	100	14.4	102				96.7	1.06		
60	112	16.3	114	119	19.0	120	108.9	1.21	121.2	1.26
70	125	18.8	127				122.4	1.35		
80	138	19.2	141				137.1	1.47		
90	153	20.9	155	160	23.0	162	152.9	1.58	168.6	1.56
100	169	22.2	171				169.6	1.67		
110	185	24.0	188				187.0	1.74		
120	202	25.9	204	212	26.9	214	205.0	1.80	221.7	1.75
130	220	28.4	223				223.4	1.85		
140	238	30.3	240				242.3	1.88		
150	259	32.9	262	271	32.8	277	261.3	1.90	277.8	1.84
160	278	34.0	280				280.5	1.92		
170	297	36.1	300				299.7	1.92		
180	318	37.0	321	332	39.7	339	318.9	1.92	334.9	1.87
190	339	39.2	342				338.9	1.91		
200	361	41.1	363				356.8	1.89		
210	379	42.4	382	393	46.6	404	375.5	1.86	391.4	1.86
220	398	45.2	402				393.9	1.84		
230	416	45.8	420				411.9	1.80		
240	435	47.2	438	450	51.6	463	429.6	1.77	446.3	1.80
250	450	48.4	455				446.9	1.73		
260	468	54.8	475				463.9	1.70		
270	478	54.8	484	499	57.4	512	480.5	1.66	499.0	1.73

Months										
10			534	549	57.0	565	528.1	1.56	549.3	1.65
11			578	590	68.8	606			597.2	1.57
12			626	636	71.4	649			642.8	1.50
13				676	69.6	689			686.6	1.44
14				725	77.9	733			728.7	1.38
15				769	79.3	787			769.6	1.34
16						830			809.3	1.30
17						862			847.8	1.26
18						903			884.7	1.21

[1] These values are for calendar months instead of 30-day periods.

TABLE 18.—*Boundary weights by 10-day periods between grades for the weights of Jersey bull calves*

Age	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Days	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
At birth [1]	51.1	54.4	56.9	58.9	60.8	62.8	64.8	67.2	70.6	
At birth	54.5	57.6	59.9	61.7	63.5	65.3	67.2	69.4	72.5	
10	55.1	58.8	61.4	63.7	65.8	67.9	70.2	72.8	76.4	
20	58.1	62.3	65.4	68.1	70.5	72.9	75.5	78.6	82.9	
30	63.1	67.9	71.5	74.5	77.3	80.1	83.2	86.7	91.6	
40	69.9	75.5	79.5	82.9	86.1	89.3	92.8	96.8	102.4	
50	78.4	84.7	89.2	93.1	96.7	100.5	104.2	108.7	114.9	
60	88.5	95.5	100.5	104.8	108.9	112.9	117.2	122.2	129.2	
70	99.9	107.6	113.2	117.9	122.4	126.8	131.6	137.2	144.9	
80	112.4	120.9	127.1	132.2	137.1	142.1	147.3	153.4	161.9	
90	125.9	135.2	141.9	147.6	152.9	158.2	163.9	170.6	179.9	
100	140.3	150.4	157.6	163.8	169.6	175.4	181.6	188.8	198.8	
110	155.4	166.2	174.1	180.7	186.9	193.2	199.9	207.7	218.6	
120	171.1	182.7	191.1	198.3	204.9	211.7	218.9	227.3	238.9	
130	187.2	199.6	208.6	216.3	223.4	230.6	238.3	247.3	259.7	
140	203.6	216.9	226.4	234.6	242.3	249.9	258.1	267.7	280.9	
150	220.3	234.4	244.5	252.2	261.3	270.4	278.1	288.2	302.3	
160	237.1	251.9	262.7	271.9	280.5	289.1	298.2	308.9	323.9	
170	253.9	269.7	280.9	290.7	299.7	308.8	318.4	329.8	345.4	
180	270.8	287.3	299.2	309.4	318.9	328.4	338.6	350.5	366.9	
190	287.6	304.9	317.3	327.9	337.9	347.9	358.6	371.1	388.4	
200	304.2	322.2	335.3	346.4	356.8	367.3	378.4	391.4	409.5	
210	320.6	339.4	353.1	364.6	375.5	386.4	397.9	411.6	430.4	
220	336.7	356.3	370.5	382.6	393.9	405.2	417.3	431.4	451.1	
230	352.5	372.9	387.6	400.2	411.9	423.6	436.2	450.9	471.3	
240	368.1	389.2	404.4	417.4	429.6	441.8	454.8	470.1	491.1	
250	383.3	405.2	420.9	434.4	446.9	459.5	472.9	488.7	510.6	
260	398.2	420.8	437.1	450.9	463.9	476.9	490.8	507.1	529.6	
270	412.8	436.1	452.8	467.1	480.5	493.9	508.2	524.9	548.2	
280	427.1	450.9	468.2	482.9	496.7	510.5	525.2	542.5	566.4	
290	441.1	465.6	483.3	498.4	512.6	526.7	541.9	559.6	584.1	
300	454.7	479.9	498.1	513.6	528.1	542.6	558.2	576.3	601.5	

[1] Based on the observed mean and standard deviation.

TABLE 19.—*Boundary weights by calendar months between grades for the weights of Jersey bull calves*

Age	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
Months	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
At birth [1]	52.4	55.9	58.5	60.8	62.8	64.9	67.1	69.7	73.3	
At birth	47.4	51.1	53.7	55.9	58.1	60.2	62.5	65.1	68.8	
1	66.2	71.0	76.1	79.6	82.9	86.2	89.8	93.9	99.6	
2	98.1	106.1	111.7	116.6	121.2	125.8	130.6	136.4	144.3	
3	138.8	149.1	156.4	162.7	168.6	174.5	180.8	188.2	198.4	
4	184.9	197.6	206.7	214.5	221.7	228.9	236.8	245.8	258.4	
5	234.1	249.1	259.9	269.2	277.8	286.5	295.7	306.6	321.6	
6	284.1	301.5	314.1	324.9	334.9	344.9	355.7	368.3	385.7	
7	333.6	353.4	367.7	379.9	391.4	402.8	415.1	429.3	449.2	
8	381.7	403.8	419.8	433.5	446.3	459.1	472.7	488.7	510.9	
9	427.7	452.2	469.8	484.9	498.9	513.1	528.2	545.8	570.3	
10	471.6	498.3	517.5	533.9	549.3	564.7	581.1	600.3	626.9	
11	513.5	542.2	562.9	580.6	597.2	613.7	631.5	652.2	680.9	
12	553.4	584.1	606.2	625.2	642.8	660.5	679.5	701.6	732.3	
13	591.8	624.3	647.8	667.9	686.6	705.2	725.4	748.8	781.4	
14	629.1	663.3	687.9	709.1	728.7	748.5	769.5	794.2	828.4	
15	665.5	701.2	726.9	749.1	769.6	790.2	812.2	837.9	873.7	
16	701.2	738.3	765.1	787.9	809.3	830.7	853.5	880.3	917.4	
17	736.2	774.5	802.1	825.7	847.8	869.8	892.4	921.1	959.4	
18	770.1	809.5	837.8	862.1	884.7	907.4	931.6	960.1	999.4	

[1] Based on the observed mean and standard deviation.

Not enough weights were available for a study of growth in weight by older bulls. However, some indication of the size of mature Jersey bulls in the Beltsville herd may be obtained by calculating for each bull the averages of 10 consecutive monthly weights beginning after 4 years of age and designating the highest of these average weights as the bull's maximum weight. Calculated in this manner, the average of the maximum weights of 8 Jersey bulls brought in from outside the herd was 1,501 pounds at an average age of 105 months. Similarly, the average maximum weight of 21 bulls born at Beltsville was 1,566 pounds at an average age of 93 months.

SUMMARY

Studies of growth by Jersey cattle, as measured by changes in weight from birth to maturity, have been made by the Dairy Husbandry Research Branch from the weights of cows, heifers, and bulls that were born and raised in the experimental breeding herd of Jerseys at Beltsville, Md., during the past 30 years. Twins and inbred animals were not included in the studies. The ancestry of the Beltsville Jerseys was mostly in three well-known families—the Owl-Interest, Sophie-Tormentor, and Raleigh families.

Because certain conditions have been maintained rather constant from the beginning, the Beltsville weight data are well suited for use as standards of normal growth. For example, good, practical methods of feeding and management have been used and an effort has been made to keep them as uniform as possible throughout the years of the experimental work. These conditions are described in detail, and their effects represent a part of the normal included in these standards.

Tabulations of the weight data for Jersey females were made by dividing the data into nine age-limit groups, so that measures of the rates of growth covering a certain range in age could be based on successive weights from the same animals.

The average weights of 378 heifer calves were 56 pounds at birth, 277 pounds at 180 days of age, and 519 pounds at 12 months of age. Other average weights were 878 pounds for 278 cows at 30 months of age, 1,000 pounds for 206 cows at about 4 years of age, and a maximum of nearly 1,100 pounds for 77 cows between 7 and 7½ years of age.

Coefficients of variation in the average weight of females decreased from 14.0 percent at 60 days of age to 8.7 percent between 11 and 14 months of age, increased gradually during ages affected by pregnancy and lactation, and ranged from 10 to 12 percent for cows over 42 months of age.

The portions of the growth curves represented by the data from birth for heifers, and by the data for the last 2 to 5 years of age for cows in the several age-limit groups, were smoothed by fitting fourth- or fifth-degree orthogonal polynomials to a series of average weights. The differences between successive estimated weights calculated in this way gave rates of gain that were nearly free from month to month variations, but still showed the long range trends due to age and some environmental conditions. These estimated weights and gains are presented as Beltsville standards for normal growth.

A system of grades for heifers by 10-day periods to 365 days of age or by months to 21 months of age was produced from the smoothed curves of the estimated weights and the estimated standard deviations, in order to have some method of interpreting the importance of the difference between the weight of an individual heifer and the standard weight. Grades from 1 to 10 were set up with the probability that in the Beltsville herd each grade would represent 10 percent of all weights at that age.

Tabulations of weights during the ages covering the first pregnancy and the beginning of lactation showed that at each age the average weights of heifers pregnant more than 165 days were definitely higher than those for heifers not pregant, or for heifers in earlier stages of pregnancy, or for heifers recently fresh.

Tabulations showed some relationship in this herd between the number of cows on official production test, when they were on higher levels of feeding, and the average or estimated weights. This was particularly noticeable at 72 and 92 months of age, when relatively more cows were on test than at the preceding or following ages. Average weights tended to be higher when larger numbers of cows were in advanced stages of pregnancy, as at 21 to 26 months of age.

Analyses of variance for the differences between the average weights for these pregnancy groups, in the data for 360 heifers, showed that these conditions had a highly significant effect at the ages of 18 months and older.

Analyses of variance for the differences between average weights in various age-limit groups, over successive periods of 18 months in age, demonstrated how much greater was the influence of age on weights at younger ages. It was doubtful that age was a significant factor in the weights after 54 months of age, and certainly not in weights after 72 months of age.

Special tabulations and calculations were made in order to obtain a standard for assigning grades to the weights of individual cows. The average of the first 10 monthly weights after calving was used as the basic weight during lactation for this standard. Age was expressed as the cow's age at the time of the first monthly weight after calving. This standard was based on data obtained from 786 basic weights during lactation, with 262 comparisons between the weights of cows in 2 successive lactations under like conditions of feeding and management, as the measure of growth with age. A smooth curve for growth was obtained by fitting a fourth-degree orthogonal polynomial to the data. Deviations of the observed basic weights during lactation from the standard or estimated weights were taken as the measure of variation and apportioned in a way that would give the same coefficient of variation for all ages. These were used in establishing boundary weights between grades for the observed 10-month basic weights.

A table was prepared showing the relationships between the basic weights during lactation and weights obtained at various times during the lactation or in the preceding gestation period.

There were time trends in the Beltsville Jersey herd, in yearly average weights at various ages. The trends were characterized by rapid increases in average weights for the first 10 or 12 years of the breeding experiment and by a slow decline in average weights during the remaining 18 or 20 years.

Correlation studies showed that mature-lactation weights were definitely related to weights at all earlier ages, but relationships were progressively higher when the differences in age were smaller.

Standards similar to those for the heifers were developed for measuring the growth of Jersey bulls by 10-day periods from birth to 300 days of age and by months from birth to 18 months of age. It was found that bulls were heavier than heifers by 18.8 percent at 6 months of age, 24.9 percent at 12 months, and 34.2 percent at 18 months.

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