

THE INFLUENCE OF EXCESSIVE BODY FATNESS/
ON THE PERFORMANCE OF BEEF FEMALES

by

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TABLE OF CONTENTS

	Page
INTRODUCTION	1
REVIEW OF LITERATURE	2
PHASE I	
EXPERIMENTAL PROCEDURE	7
RESULTS AND DISCUSSION	12
Body Weight and Reproductive Performance	12
Milk Production	19
A Comparison of Methods of Estimating Milk Production .	39
Milk Fat and Total Solids	40
Body Temperature	43
Blood Composition	45
PHASE II	
EXPERIMENTAL PROCEDURE	48
RESULTS AND DISCUSSION	50
SUMMARY	53

LIST OF TABLES AND FIGURES

Table	Page
1. Date of birth, breed, and results of the blood-antigen test	8
2. Average daily rations and intakes of T.D.N. and digestible protein by twin heifers prior to and during lactation	9
3. Composition of calf ration	10
4. Average age and weight of heifers at the beginning of the trial and at first mating	13
5. Age and weight of heifers at the beginning of the trial, at first mating, and at first calving	14
6. Average number of matings required for conception	15
7. Average age and weight of heifers at first calving	16
8. Number of heifers calving, heifers requiring assistance, heifers lost, and calves lost	17
9. Average birth weight of calves	19
10. Birth date, sex, birth weight, 112-day weight, and 210-day weight of calves	20
11. Average 112-day milk production of 10 sets of twins during their first lactation	22
12. Total and average daily milk production for 112 and 210 days of lactation, and average daily gains of calves from birth to 112 and birth to 210 days of age	23
13. Average 210-day milk production of six sets of twins during their first lactation	25
14. Average 210-day milk production of eight sets of twins with complete lactation records	26

Table	Page
15. 112 and 210-day milk production and average daily gains of calves from birth to 112 and birth to 210 days of age	37
16. Simple correlation coefficients of three estimates of milk production	40
17. Means and standard deviations of estimates of milk production by three different methods	41
18. Average total fat and average percent fat of milk produced during a 210-day lactation period	41
19. Average total and percent total-solids of milk produced during a 210-day lactation period	43
20. Average hematocrit, red blood cell, white blood cell, hemoglobin, and plasma protein values	45
21. Average hematocrit, red blood cell count, white blood cell count, hemoglobin, and plasma protein content of blood	47
22. Average weight of cows at five intervals of the trial	50
23. Average weight of calves at birth, 112, and 210 days of age	51
24. Number of cows lost from the experiment and number of cows and calves lost from causes other than loss of the dam	52

Figure

1. Average daily milk production of eight sets of twin cows during 30 weeks of lactation	27
2. Average daily milk production of cows 13 and 14 during 30 weeks of their first lactation	28
3. Average daily milk production of cows 15 and 16 during 30 weeks of their first lactation	29
4. Average daily milk production of cows 17 and 18 during 30 weeks of their first lactation	30

5. Average daily milk production of cows 19 and 20 during 30 weeks of their first lactation	31
6. Average daily milk production of cows 21 and 22 during 30 weeks of their first lactation	32
7. Average daily milk production of cows 23 and 24 during 30 weeks of their first lactation	33
8. Average daily milk production of cows 3 and 4 during 30 weeks of their second lactation	34
9. Average daily milk production of cows 7 and 8 during 30 weeks of their second lactation	35
10. Average daily milk production of individual sets of twin cows and the corresponding gains of their calves during the first 112 days of lactation	38
11. Average daily milk-fat production during 30 weeks of lactation	42
12. Average daily milk total-solids during 30 weeks of lactation	44

INTRODUCTION

In recent years much attention has been focused on the effect of plane of nutrition on the reproductive performance of various species of domestic animals. Most of these studies have been concerned with nutritional levels below those commonly recommended for maximum productivity. In order to fully evaluate nutritional levels within economically practical ranges, basic information is needed concerning the effect of energy intakes in excess of those normally fed breeding animals in commercial herds. It would seem that maximum information would be obtained by first studying the results of extremely high levels of energy intake compared to recommended levels. Such information would aid in interpretation of results from research in which much smaller differences, within more practical nutritional ranges, were compared. Only a few controlled experiments have been conducted with beef females to study the effect of energy intakes at levels sufficient to produce maximum body weight and fatness.

The specific objective of this experiment was to determine the influence of excessive body fat on the performance of beef females by inducing a high degree of fatness at two different stages of the life cycle: (1) In the heifer during the period of growth and development after weaning (Phase I), and (2) in the mature cow that has completed growth and attained full body size (Phase II).

REVIEW OF LITERATURE

Most of the literature pertaining to the effects of plane of nutrition on the performance of beef cows has been concerned with lower levels of nutrition than those studied in this experiment. This review is limited primarily to those studies in which definite attempts to induce body fatness are reported.

Swanson (1960) studied the effects of rapid growth with fattening upon the lactation of dairy heifers. Seven pairs of identical twin heifers were separated at ages varying from 4 to 12 months. Prior to first parturition one heifer of each pair was fed a normal control ration and her mate a high concentrate ration. After calving a schedule of concentrate allowance was set for each pair of twins so that at comparable stages of their lactations they were fed the same amount. At 24 months of age the fattened heifers weighed an average of 899 pounds compared to an average weight of 683 pounds for the control group.

Only one of the fattened twins produced more milk than her mate in these comparisons. Four of the control twins produced considerably more milk than their mates. The fat content of milk produced by the fattened twins averaged slightly higher than that produced by the controls but total butterfat yields and fat-corrected milk followed milk yields closely. The average fat-corrected milk yield of the fattened heifers in the first lactation was 84.8 percent of that of the controls but large differences in within-twin performance indicated that the effects of fattening were

possibly more serious in some heifers than others. A gross inspection of the udders following slaughter showed areas of incomplete development in three of four fattened heifers. The udders of the lean heifers and one fattened heifer were normal.

Hansson (1959) conducted studies with identical twin dairy heifers fed at levels ranging from 40 to 140 percent of standard levels. An increase in feeding level from 100 to 140 percent of the standard resulted in a very slight decrease in milk yield during the first lactation, a marked decrease in the second lactation, and decreased the average age at first calving from 27.0 to 26.4 months.

Bratton (1957) reported studies with dairy heifers fed at levels 60 to 70 (low), 100 (medium), and 140 to 160 (high) percent of the upper limits of Morrison's recommended allowances for growing dairy heifers, beginning at a few days of age. Data available on 25 trios show the average age at first estrus was 36, 44, and 61 weeks for the heifers on the high, medium, and low levels, respectively. The average number of services was generally about the same for the three feeding levels. The milk yield of high level cows was slightly lower than moderate level cows during the first three lactations and slightly higher during the fourth and fifth lactations.

Zimmerman et al. (1959) studied the effects of three levels of winter feeding on the performance of beef cows which grazed year-long on native grass pastures. The average calving date was about eight days later for low level cows than for medium and high level cows. The percent calf crop weaned was 94.3, 87.4, and 86.7 for the low, medium and high levels of supplement, respectively. Survival rates were inversely related

to the level of winter feeding. Of the 30 cows started on each level of feeding there were 27, 21, and 18 cows remaining on the low, medium, and high levels, respectively, at the time the cows were 10.5 years of age.

Zimmerman (1960) reported the effects of four levels of winter feeding on the growth, development, and reproductive performance of beef heifers. With each increase in level of supplement above the low level the average calving date was 7-10 days earlier, accompanied by a trend towards increased calving difficulty. There was little difference between medium and high level lots in the average birth weight of the calves or in percent calf crop weaned. In one trial a very high level of wintering did not increase the weaning weight of the calf crop and decreased the percent calf crop weaned.

Three different feeding systems were used by Herman and Ragsdale (1946) in rearing Holstein heifers from birth to first parturition. Heifers full fed a "rapid growth" ration containing 72 percent T.D.N. yielded less milk than those fed a normal control ration consisting primarily of roughages after nine months of age. The full fed group was characterized by a heavy, coarse build with a large amount of fat deposition in the udder before freshening.

Swanson and Spann (1954) conducted an experiment with white rats in which lactation was measured by growth of equalized litters of 11 young per rat. Rats raised by ad libitum feeding raised only 59 percent of their young with an average litter gain of 136 grams whereas rats fed 80 percent of ad libitum to parturition raised 93 percent of their young with an average litter gain of 235 grams. In the second lactation the rapid-

growth rats had litter gains only 60 percent as great as the restricted rats. The mammary glands of the fattened animals were not fully developed.

Sykes et al. (1948) in a similar experiment fed two groups of 60 white rats each at 100 and 70 percent of ad libitum feeding with protein intake adjusted to approximately equal amounts. At parturition, slaughter of half the rats in each group revealed that mammary glands of the full fed group were 80 percent heavier than those of the restricted group. The gain per litter, the average weight of the young, and the survival of the young at the 14th and 21st days of lactation were greater in the case of the mother which had been subjected to reduced feed intake.

Fuller (1959) conducted a trial with 900 White Leghorn pullets. The pullets were fed either a high efficiency or a low efficiency diet for the first 10 weeks. The pullets were then divided into three growing treatments and either full fed, semi-restricted, or fully restricted based upon feeding time allowed. Where the high efficiency starting diets were used egg production was higher in the restricted group, followed by the semi-restricted group and lowest in the full fed group. In the case of the low efficiency diets egg production was higher in the full fed and semi-restricted groups and lowest in the restricted group.

Singsen et al. (1958) full fed a high energy ration to meat-type White Plymouth Rocks which resulted in a marked increase in body weight (obesity). Obesity did not reduce egg production when calculated on a hen-day basis but mortality was increased markedly. While the fat birds lived they laid eggs at a rate normal for the strain. The obesity and subsequent increase in mortality appeared to be a direct result of excessive calorie intake and unrelated to the feeding of high levels of corn and animal fat

per se, since control-feeding of the high energy ration eliminated excessive body weight gains and reduced mortality to the same low level obtained when a lower energy feed was full-fed.

EXPERIMENTAL PROCEDURE

Phase I

A study was initiated in July, 1956, to determine the effect of excessive body fatness induced in beef heifers beginning prior to their first gestation. Four sets of twin heifers (numbered 1-8) were initially started on trial but both heifers of one set (1, 2) were found to be sterile and removed from the experiment. In January of 1958 eight additional sets of twins (9-24) were included in the experiment. A blood-antigen test conducted by the Bacteriology Department of Ohio State University revealed that two of the 11 sets of twins were non-identical. In this test detection of vascular anastomosis is considered positive proof that twins are not identical, and failure to detect this phenomena is considered a highly reliable but not positive indication that the twins are identical. Results of the blood-antigen tests together with the breed and date of birth of all twins are shown in Table 1.

The heifers were kept in drylot and fed individually in stanchions. One heifer of each set of twins was fed at a level sufficient to maintain good thrifty condition and a gain of one-half to two-thirds pound per day previous to first parturition, while the other heifer of each twin pair was fed for maximum possible gain. The rations which were fed prior to parturition and during lactation are given in Table 2. All heifers received identical amounts of protein supplement, bonemeal, salt, and alfalfa pellets. The desired difference in fatness between moderate and

TABLE 1. DATE OF BIRTH, BREED, AND RESULTS OF THE BLOOD-ANTIGEN TEST

Heifer Number	Date of Birth	Breed	Blood-Antigen Test ¹
3,4	2-1-55 ²	Hereford X Brahman	+
5,6	2-1-55 ²	Hereford	+
7,8	2-1-55 ²	Angus	+
9,10	12-24-56	Shorthorn	+
11,12	7-15-56	Hereford X Shorthorn	-
13,14	5-1-57	Hereford X Santa Gertrudis	-
15,16	10-30-56	Polled Hereford	+
17,18	3-15-57	Hereford X Angus	+
19,20	12-1-56	Hereford	+
21,22	10-20-56	Angus	+
23,24	3-5-57	Angus	+

¹ Negative sign indicates that the twins are non-identical; positive sign indicates that the twins could be identical.

² Approximate date.

high level heifers was induced by the proportion of corn and cottonseed hulls fed. Prior to parturition the moderate level ration was composed primarily of cottonseed hulls with corn added only when necessary in order to maintain desired gains. During lactation corn was added at a level sufficient to maintain small but constant gains in weight. This level of feeding was considered adequate to allow full expression of the milk producing potential of the cow. High level heifers received a full feed of corn and a minimum amount of cottonseed hulls at all times.

Heifers were hand mated to a purebred Angus bull and with the exception of the first year's matings of cows 3-8 the same bull was mated to all heifers. The bull mated to cows 3-8 the first year was apparently of low fertility and was replaced by a half-sib bull that was used for all subsequent matings. Heifers were exposed to the bull during the morning and evening feeding periods and at other periods when observed in heat. First parturition was at approximately three years of age.

TABLE 2. AVERAGE DAILY RATIONS AND INTAKES OF T.D.N. AND DIGESTIBLE PROTEIN BY TWIN HEIFERS PRIOR TO AND DURING LACTATION

Treatment Level	Supplement ¹ lbs.	Alfalfa Pellets lbs.	Cottonseed Hulls lbs.	Cracked Corn lbs.	T.D.N. lbs.	Dig. Prot. lbs.
----- Prior to Parturition -----						
Moderate	2.0	2.0	10	0	6.85	0.95
High	2.0	2.0	7	8	11.95	1.48
----- During Lactation -----						
Moderate	2.0	4.0	16	4	13.77	1.46
High	2.0	4.0	6	10	14.20	1.86

¹Supplement composition: Cottonseed Meal, 47.0%; Soybean meal, 46.1%; Bonemeal, 4.6%; Salt, 2.3%.

Calves were separated from their dams at seven to ten days of age, placed in individual drylot pens, and received no supplemental feed until they reached 112 days of age. With milk as the only nutrient source the gain of the calf should be a good estimate of treatment effect upon milk production of the dam on a within-twin basis. During the period of 112 to 210 days of age the calves were hand fed a mixed ration (Table 3). Feed intakes were adjusted bi-weekly to amounts calculated by the method of Winchester (1953) to satisfy maintenance requirements. With the maintenance requirements thus satisfied, differences in calf gain should estimate differences in milk production of dams on a within-twin basis. In order to minimize risk of loss the calves were not dehorned or castrated.

The following data were collected:

1. Weights of cows at 28 day intervals.
2. Individual feed records for each cow.
3. Services required per conception.

TABLE 3. COMPOSITION OF CALF RATION

Ingredient	Percent of Total
Cottonseed Hulls	20
Cracked Corn	30
Cottonseed Meal	10
Alfalfa Leaf Meal	10
Rolled Oats	20
Molasses	10

4. Notes concerning gross examinations of the reproductive tract and results of pregnancy checks conducted at approximately the third and seventh months of gestation.
5. Notes concerning calving difficulty and the general health of cows at calving.
6. Weights of calves at birth, 70 days, 112 days, and 210 days of age. Birth weights of heifer calves were adjusted to a bull equivalent using the factors calculated by Botkin (1952). Weaning weights (210-day) of heifer calves were adjusted to a bull equivalent using the methods suggested by Koch et al. (1959).
7. Milk production, estimated by the following methods:
 - a. Hand-milking the cows during the morning and evening feeding period each week. Milk was drawn from one half of the udder while the calf was suckling the opposite side. The opposite udder half was milked the following week.
 - b. Weighing the calves before and after morning and evening nursings each day. This procedure was not initiated

until January 1960 and data for complete lactations with this method are not available.

c. Calf weights at 112 and 210 days of age.

8. Partial milk composition. Composite samples were taken of the weekly morning and evening milkings and the butterfat content and total solids content determined by the standard Babcock and Mojonnier methods, respectively.
9. Rectal temperature of cows. (Temperatures were taken during four periods of 10 consecutive days each during March, May, and July, 1959, and March 1960.)
10. Determinations of hematocrit, red blood cell count, white blood cell count, plasma protein, and hemoglobin content of blood samples taken from the cows at monthly intervals over a period of 12 months. An International micro-hematocrit centrifuge was used for hemotacrit determinations. The standard counting procedure using Hayem's diluting fluid was used for red blood cell determinations. White blood cell counts were taken using Turk's diluting fluid. The Spencer Hemoglobin Meter was used for hemoglobin determinations with plasma protein determinations made by the standard copper sulphate method.

RESULTS AND DISCUSSION

Phase I

The data collected prior to and including the summer of 1960 are included in this thesis. Data of individual heifers and average of treatment groups are presented and discussed. Due to the large genetic variation between sets of twins treatment averages include data only of those sets of twins in which complete records of both members were available.

Body Weight and Reproductive Performance

Table 4 summarizes by treatment the average age and weight of the heifers at the beginning of the trial and at first mating. More detailed information involving individual sets of twins is given in Table 5. Mating of each set of twins was initiated during the first estrus following a date determined at the beginning of the trial. Most of the sets of twins were maintained on the trial rations for a minimum period of 12 months before breeding, and in no case was the pre-breeding experimental period less than nine months. The maximum within-twin weight difference was 50 pounds and exceeded 15 pounds in only 3 of the 11 sets of twins at the beginning of the trial.

The age at first mating ranged from 21 to 30 months with an over-all average of 26 months. Body weight differences between twin mates varied from minimum of 180 to a maximum of 400 pounds with high level heifers weighing an average of 320 pounds more than their twin mates at first

TABLE 4. AVERAGE AGE AND WEIGHT OF HEIFERS AT THE BEGINNING OF THE TRIAL AND AT FIRST MATING

Treatment Level	Av. Heifers 3-8		Av. Heifers 9-24		Overall Average	
	Age	Wt.	Age	Wt.	Age	Wt.
	Months	lbs.	Months	lbs.	Months	lbs.
----- Beginning of Trial -----						
Moderate	18	578	12.5	421	14	464
High	18	577	12.5	416	14	460
----- First Mating -----						
Moderate	30	712	24	667	26	679
High	30	988	24	1003	26	999

mating. Heifers 9-24 were started on experiment at a younger age and had a larger within-twin weight difference than heifers 3-8.

Table 6 contains a summary of the average number of matings required for conception among heifers of each treatment group. Averages are presented for heifers 3-8, 9-24, and the two groups combined (3-24). Poor conception rates were observed when heifers 3-8 were first mated, especially in the high level group. Heifers in the moderate level group conceived with a maximum of two matings but high level heifers failed to conceive after several matings. Observations indicated that the libido of the bull was below normal, and a possible low level of fertility of the bull may have also contributed to the poor reproductive efficiency of the heifers. Therefore, the bull in use was replaced by a bull of similar breeding and all future matings made to this bull. Two of the three high level heifers (6, 8) required more than one mating for conception when mated to the second bull, but this may have been caused by the prolonged period of mating and advancing age of the heifers. The studies of Sorensen et al. (1959) indicated that there is a tendency toward increased numbers of abnormalities of the ovaries and estrus cycles in heifers allowed to have many cycles before being bred.

TABLE 5. AGE AND WEIGHT OF HEIFERS AT THE BEGINNING OF THE TRIAL, AT FIRST MATING, AND AT FIRST CALVING

Level	Cow No.	Beginning of Trial		First Mating		First Calving	
		Age	Weight	Age	Weight	Age	Weight
		Months	Pounds	Months	Pounds	Months	Pounds
Moderate	3	18	655	30	800	42.0	955
High	4	18	670	30	1060	45.5	1410
Moderate	5	18	535	30	670	41.2	800
High	6	18	520	30	1060	51.0	1500
Moderate	7	18	545	30	665	39.6	730
High	8	18	540	30	845	44.3	1100
Moderate	9	12	475	24	715	35.4	830
High	10	12	490	24	1100	34.6	1340
Moderate	11	18	575	27	785	37.9	880
High	12	18	585	27	1110	37.4	1430
Moderate	13	8	345	21	625	32.8	800
High	14	8	330	21	1000	31.1	1360
Moderate	15	14	460	24	665	36.8	840
High	16	14	450	24	970	33.8	1290
Moderate	17	10	295	22	535	34.6	845
High	18	10	305	22	935	32.4	1325
Moderate	19	13	360	25	635	35.1	750
High	20	13	385	25	890	35.7	1205
Moderate	21	15	485	27	720	38.3	920
High	22	15	465	27	1060	37.8	1420
Moderate	23	10	370	22	655	32.4	745
High	24	10	320	22	950	32.9	1290

TABLE 6. AVERAGE NUMBER OF MATINGS REQUIRED FOR CONCEPTION

Treatment Level	Heifers 3-8	Heifers 9-24	Overall Average
Moderate	1.34	1.25	1.27
High	3.67	1.13	1.91

Excellent breeding efficiency is evident in both treatment levels of heifers 9-24 and with three exceptions all heifers of this group conceived with one mating. Two moderate level heifers (11, 15) and one high level heifer (22) required two matings for conception. Bratton (1957) similarly reported that there was no difference in number of services required for conception between groups of heifers fed at 100 or 140 percent of the upper limits of Morrison's recommended allowances for growing dairy heifers.

Considering the comparable breeding efficiency of the two treatment levels of heifers 9-24 and the possible consequences of the delay in mating of heifers 3-8 previously discussed, it would seem that the breeding data of heifers 3-8 should not be considered significant. However, it is possible that excessive body fatness could exert more detrimental influence on reproductive efficiency with increasing age of the heifers.

Within-twin body weight differences at first calving ranged from a minimum of 370 pounds to a maximum of 700 pounds (Table 5) with high level heifers weighing an average of 507 pounds more than their moderate level mates (Table 7). Average body weights of heifers 3-8 were almost identical to those of heifers 9-24 at first calving.

High level heifers of group 3-8 calved an average of six months later than their moderate level mates. However, as previously explained, heifers

TABLE 7. AVERAGE AGE AND WEIGHT OF HEIFERS AT FIRST CALVING

Treatment Level	Av. Heifers 3-8		Av. Heifers 9-24		Overall Average	
	Age.	Wt.	Age	Wt.	Age	Wt.
	Months	lbs.	Months	lbs.	Months	lbs.
Moderate	40.9	828	35.4	826	36.9	827
High	46.9	1337	34.5	1333	37.9	1334

of this group were initially mated to a bull of probable lowered libido and fertility and data from this group are of questionable value in evaluating the effect of treatment level upon calving date.

In contrast to the results in group 3-8, high level heifers of group 9-24 calved an average of 0.9 months earlier than their moderate level mates. Both treatment levels conceived with a near minimum number of matings; therefore, the earlier calving date indicates an earlier or more regular estrus in the high level heifers. Other workers have reported that higher feeding levels resulted in earlier calving dates ranging from 7-18 days with first-calving heifers (Zimmerman, 1960; Hansson, 1959) and mature cows (Zimmerman, 1958). Bratton (1957) reported the average ages of dairy heifers at first estrus to be 36 and 44 weeks for groups fed 140 and 100 percent of Morrison's standards, respectively.

Cows were observed closely at calving time and veterinarians were called to assist when it became apparent a heifer would be unable to calve normally. High level heifers had more calving difficulty and sustained more calf losses and cow losses than the moderate level group (Table 8). Six of eleven high level heifers required assistance at first calving with two high level heifers requiring cesarean sections and two others calving by malpresentation (posterior longitudinal presentation,

dorso-tubic position). With one exception all moderate level heifers calved normally and unaided. Zimmerman (1960) recorded calving difficulty scores of two-year-old heifers fed four levels of winter supplement and noted a slight trend toward more difficult calving with each increase in level of supplement above the low level.

TABLE 8. NUMBER OF HEIFERS CALVING, HEIFERS REQUIRING ASSISTANCE, HEIFERS LOST, AND CALVES LOST

Treatment Level	Heifers Calving	Requiring Assistance	Heifers Lost	Calves Lost
Moderate	11	1	0	1
High	11	6 ¹	2	3 ²

¹Includes two high level heifers (4, 22) requiring caesarean sections.

²The failure of one high level heifer to produce a calf the first year after mating is included here as a calf loss.

An autopsy of the only calf lost from the moderate level group indicated that the calf was normal and may have died at birth due to placental membranes covering the mouth and nostrils. One high level calf was born dead due to unknown causes and another died 10 days after caesarean delivery apparently as a result of intestinal infection. The third loss was assessed against the high level group due to the first-year calving failure of one high level heifer (No. 6). Frequent pregnancy checks indicated the heifer conceived but reabsorbed her fetus at approximately seven months of gestation. The heifer was rebred and calved almost one year later than her twin. Chambers et al. (1960) reported that heifers full fed during a five month post-weaning gain test sustained more fetal death losses than heifers grazed on native pasture the same period.

Two high level cows were lost from the experiment during their first lactations. One high level cow (No. 12) died approximately a month after calving as a result of an acute mastitis infection. The other high level cow (No. 10) was removed from the experiment after 112 days of lactation due to a partial prolapse and stricture of the rectum which may have been a result of calving difficulty. Zimmerman et al. (1959) studied the effects of three levels of winter supplement on the performance of beef cows and reported survival rates inversely related to the level of feeding. Ad libitum feeding of a high energy ration to meat-type White Plymouth Rock pullets resulted in a marked increase in body weight (obesity) and in mortality (Singsen et al., 1959).

Table 9 shows a summary of the average birth weights of calves produced by cows at first and second calving, and a combined average of these groups. The first calves of high level cows were 3.7 pounds heavier at birth than calves of moderate level cows. Eight of 11 high level cows produced heavier calves at first calving than their moderate level mates (Table 10) and this trend continued in three sets of twins which produced their second calves. Errors introduced by the sex correction factor should be minimized by the near equal sex ratio (moderate level - seven males, six females; high level - nine males, five females) of calves within the combined first and second calving treatment groups. There thus appears to be a definite trend for heavier calves at birth as a result of the high level feeding of cows in this trial. Zimmerman (1960) compared high and medium levels of winter feeding and reported that calves of high level heifers were 2.5 and 0.6 pounds heavier at birth during the first and second calving periods but were 0.6 pounds lighter than medium level calves

the following year. In one limited trial heifers fed at a "very high" level produced calves two pounds lighter at birth than heifers fed a "medium" level of winter supplement.

TABLE 9. AVERAGE BIRTH WEIGHT¹ OF CALVES

Treatment Level	Overall Average ² lbs.	First Calving ³ lbs.	Second Calving ⁴ lbs.
Moderate	60.4	60.4	60.3
High	65.4	64.1	70.3

¹Heifer birth weights corrected to a bull equivalent by the methods of Botkin (1952).

²Average of 14 calves per treatment group.

³Average of 11 calves per treatment group.

⁴Average of three calves per treatment group.

Milk Production

Moderate level cows produced an average of 35 percent more milk than high level cows during the first 112 days of their first lactation (Table 11). This trend was not consistent within sets of twins as 3 of 10 high level cows (cows 6, 8, and 16) produced more milk than their moderate level mates (Table 12). It should be noted that cow 6 calved approximately one year later than cow 5 and perhaps should have been considered in her second lactation. Comparing the first lactation of cow 6 with the second lactation of cow 5, there is an even greater difference in the milk production of the two groups. The effects of age on the lactation records of dairy cows have been reported by several investigators and are summarized by Gowen (1929) and Searle and Henderson (1959). There seems to be general agreement that milk production increases during the period from two to six years of age.

TABLE 10. BIRTH DATE, SEX, BIRTH WEIGHT, 112-DAY WEIGHT, AND 210-DAY WEIGHT
OF CALVES BORN TO TWIN COWS

Treatment Level	Cow No.	Birth Date	Calf Sex	Corrected ¹		112-Day Wt.	210-Day Wt.	Corrected ² 210-Day Wt.
				Birth Wt.	Birth Wt.			
				lbs.	lbs.			
First Parturition								
Moderate	3	7-17-58	M	46	46	--- ⁴	--- ⁴	--- ⁴
High	4	10-30-58 ³	M	64	64	180	375	375
Moderate	5	3-20-58	F	69	74	245	410	456
High	6	4-10-59	M	86	86	--- ⁴	--- ⁴	--- ⁴
Moderate	7	5-5-58	M	59	59	287	470	470
High	8	9-22-58	M	30	30	170	360	360
Moderate	9	11-20-59	F	58	63	175	277	308
High	10	10-27-59	M	78	78	221	--- ⁵	--- ⁵
Moderate	11	8-26-59	F	66	71	192	374	416
High	12	8-12-59	F	64	69	--- ⁶	--- ⁶	--- ⁶
Moderate	13	1-10-60	M	64	64	207	338	338
High	14	11-21-59	M	73	73	173	250	250
Moderate	15	11-7-59	F	49	54	175	286	318
High	16	8-11-59	M	70	70	228	422	422
Moderate	17	1-17-60	M	65	65	213	357	357
High	18	11-13-59	F	63	68	209	313	348
Moderate	19	10-19-59	M	57	57	211	389	389
High	20	11-8-59	F	60	65	184	277	308
Moderate	21	12-13-59	M	54	54	245 ¹	400	400
High	22	11-28-59 ³	F	57	62	--- ⁷	--- ⁷	--- ⁷
Moderate	23	11-2-59	M	57	57	233	418	418
High	24	11-16-59	M	40	40	--- ⁴	--- ⁴	--- ⁴
Continued								

TABLE 10 (Continued)

Treatment Level	Cow No.	Birth Date	Calf Sex	Corrected ¹					Corrected ²
				Birth Wt.	Birth Wt.	112-Day Wt.	210-Day Wt.	210-Day Wt.	
				lbs.	lbs.	lbs.	lbs.	lbs.	
Second Parturition									
Moderate	3	12-16-59	M	44	44	222	386	386	
High	4	11-3-59	F	68	73	249	372	413	
Moderate	5	7-10-59	F	66	71	183	334	371	
High	6	5-3-60	M	78	78	---8	---8	---8	
Moderate	7	7-11-59	F	61	66	224	374	416	
High	8	8-6-59	M	60	60	---4	---4	---4	

¹ Heifer birth weights corrected to bull equivalent by the methods of Botkin (1952).

² Heifer 210-day weights corrected to bull equivalent by the methods of Koch et al. (1959).

³ Caesarean birth.

⁴ Calf born dead.

⁵ Cow removed from experiment after 112 days due to prolapse.

⁶ Cow died approximately one month after calving as a result of mastitis infection.

⁷ Calf died at 10 days of age apparently as a result of intestinal disorders.

⁸ Calf had not reached 210 days of age at the time of this report.

TABLE 11. AVERAGE 112-DAY MILK PRODUCTION OF 10 SETS OF TWINS DURING THEIR FIRST LACTATION¹

Treatment Level	112-Day Total lbs.	112-Day Daily Average lbs.
Moderate	1026	9.2
High	761	6.8

¹Data of one set of twins (cows 11 and 12) not included due to loss of high level cow.

Limited numbers of twins of any one breed prevent definite conclusions regarding breed-treatment interactions. However, much of the difference in milk production between treatment levels is due to an extremely low milk production by three high level Angus cows (cows 8, 22, and 24). Two of the cows (cows 22 and 24) lost their calves at birth or shortly thereafter and were nursed by foster calves. The effect of foster calves upon milk production is not known.

Table 13 shows the average milk production of six sets of twins during a complete 210-day lactation period. The remaining five sets of twins in this trial are not included in the 210-day summary because cow 12 died shortly after calving and milk production records for cows 3-8 were obtained for a period of only 112 days during the first lactation.

The trend previously observed during the 112 day period was also evident throughout the complete 210 day lactation. Moderate level cows produced 78 percent more milk than their high level mates during the 210 day period, but again much of the difference between treatment level was due to the extremely low milk production of two high level Angus cows (cows 22 and 24). However, omitting the data of these cows does not alter the established trend of greater milk production in the moderate level group.

TABLE 12. TOTAL AND AVERAGE DAILY MILK PRODUCTION FOR 112 AND 210 DAYS OF LACTATION, AND AVERAGE DAILY GAINS OF CALVES FROM BIRTH TO 112 AND BIRTH TO 210 DAYS OF AGE

Treatment Level	Cow No.	Calf Sex	112-Day Milk Production		Calf 112-Day A.D.G. ¹	210-Day Milk Production		Calf 210-Day A.D.G. ²
			Total	Daily Ave.		Total	Daily Ave.	
			lbs.	lbs.		lbs.	lbs.	
First Lactation								
Moderate	3	M	997	8.9	----3	----4	----4	----3
High	4	M	801	7.2	1.04	----4	----4	1.48
Moderate	5	F	1016	9.1	1.57	----4	----4	1.62
High	6	M	1145	10.2	----3	----4	----4	----3
Moderate	7	M	1239	11.1	2.04	----4	----4	1.96
High	8	M	633	5.7	1.25	----4	----4	1.57
Moderate	9	F	585	5.2	1.04	1242	5.9	1.16
High	10	M	852	7.6	1.28	----5	----5	----5
Moderate	11	F	821	7.3	1.13	1514	7.2	1.64
High	12	F	----6	----6	----6	----6	----6	----6
Moderate	13	M	999	8.9	1.28	1833	8.7	1.30
High	14	M	769	6.9	0.89	977	4.7	0.84
Moderate	15	F	913	8.2	1.13	1473	7.0	1.25
High	16	M	1265	11.3	1.41	1910	9.1	1.67
Moderate	17	M	970	8.7	1.32	1764	8.4	1.39
High	18	F	944	8.4	1.30	1668	7.9	1.33
Moderate	19	M	955	8.5	1.38	1588	7.6	1.58
High	20	F	875	7.8	1.11	1296	6.2	1.16
Moderate	21	M	1285	11.5	1.73	2213	10.5	1.65
High	22	F	210	1.9	----3	317	1.5	----3
Moderate	23	M	1309	11.7	1.57	2338	11.1	1.72
High	24	M	125	1.2	----3	125	0.6	----7
(Continued)								

TABLE 12 (Continued)

Treatment Level	Cow No.	Calf Sex	112-Day Milk Production		Calf 112-Day	210-Day Milk Production		Calf 210-Day
			Total	Daily Ave.	A.D.G. ¹	Total	Daily Ave.	A.D.G. ²
			lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Second Lactation								
Moderate	3	M	1578	14.1	1.59	2649	12.6	1.63
High	4	F	2113	18.9	1.62	3075	14.6	1.62
Moderate	5	F	1220	10.9	1.05	1779	8.5	1.43
High	6	M	----- ⁸	----- ⁸	----- ⁸	----- ⁸	----- ⁸	----- ⁸
Moderate	7	F	1565	14.0	1.46	2624	12.5	1.67
High	8	M	190	1.7	----- ³	262	1.2	----- ³

¹ Gain obtained using uncorrected birth and 112-day weight (Table 11).

² Gain obtained using corrected birth and 210-day weight (Table 11).

³ Calf born dead.

⁴ Cow was not milked the entire 210-day period.

⁵ Cow was removed from experiment after 112-days of first lactation due to partial prolapse.

⁶ Cow died approximately one month after calving as a result of mastitis infection.

⁷ Calf died at 10 days of age apparently as a result of intestinal infection.

⁸ Cow had not completed lactation at the time of this report.

TABLE 13. AVERAGE 210-DAY MILK PRODUCTION OF SIX SETS¹
OF TWINS DURING THEIR FIRST LACTATION

Treatment Level	210-Day Total lbs.	210-Day Daily Average lbs.
Moderate	1868	8.8
High	1049	5.0

¹ Complete 210-day first-lactation records were available for only six sets of twins (cows 13-24).

Table 14 includes data of all twin sets having 210-day lactation records. This includes in addition to the first lactation records summarized in Table 13 (cows 13-24) the second-lactation records of cows 3, 4, 7, and 8. Pooling the data in this manner (to obtain maximum observations for statistical analysis) results in only a slight alteration of the trend shown in Table 13. An analysis of variance by the methods of Snedecor (1956) revealed that milk production of moderate level cows was significantly greater ($P < .09$) than milk production of high level cows.

Swanson (1959) fed identical twin dairy heifers in a manner similar to that reported in this trial and obtained a similar trend towards greater milk production in the normal control group. Only one of the seven fattened heifers produced more milk than her mate in the first lactation but there was a wide range in within-twin milk production difference similar to those observed in this trial. Bratton (1959) compared milk yields of high and medium fed dairy heifers and noted a slightly higher milk production in the medium fed heifers in their first three lactations but this situation was reversed in the fourth and fifth lactations. Other observations confirming the inverse relationship of high feeding levels and milk yield were reported by Herman and Ragsdale (1946) with non-twin dairy

heifers and Hansson (1959) with identical twin dairy heifers. The growth rates of litters from fat and lean rats have indicated a reduced lactating ability as a result of high feeding levels (Swanson and Spann, 1954; Sykes *et al.*, 1948).

TABLE 14. AVERAGE 210-DAY MILK PRODUCTION OF EIGHT SETS¹ OF TWINS WITH COMPLETE LACTATION RECORDS

Treatment Level	210-Day Total lbs.	210-Day Daily Average lbs.
Moderate	2060	9.8
High	1204	5.7

¹Includes first-lactation records of cows 13-24 and second-lactation records of cows 3, 4, 7, and 8.

Average daily milk production during 30 weekly periods is shown graphically in figures 1-9. Figure 1 shows the average milk production of the eight sets of twins which were represented in Table 14 and includes first lactation records of cows 13-24 and second lactation records of cows 3, 4, 7, and 8. Individual lactation curves of these cows are shown in figures 2-9.

The milk yield of moderate level cows reached a peak between four and six weeks following parturition and declined at an almost constant rate throughout the remaining weeks of the lactation, which agrees closely with the normal lactation curve of dairy cows (Maynard and Loosli, 1956). In contrast, the yield of high level cows did not show the characteristic rapid increase during the first weeks of lactation but, after the initial six weeks of lactation, roughly paralleled that of the moderate level group at a much lower level.

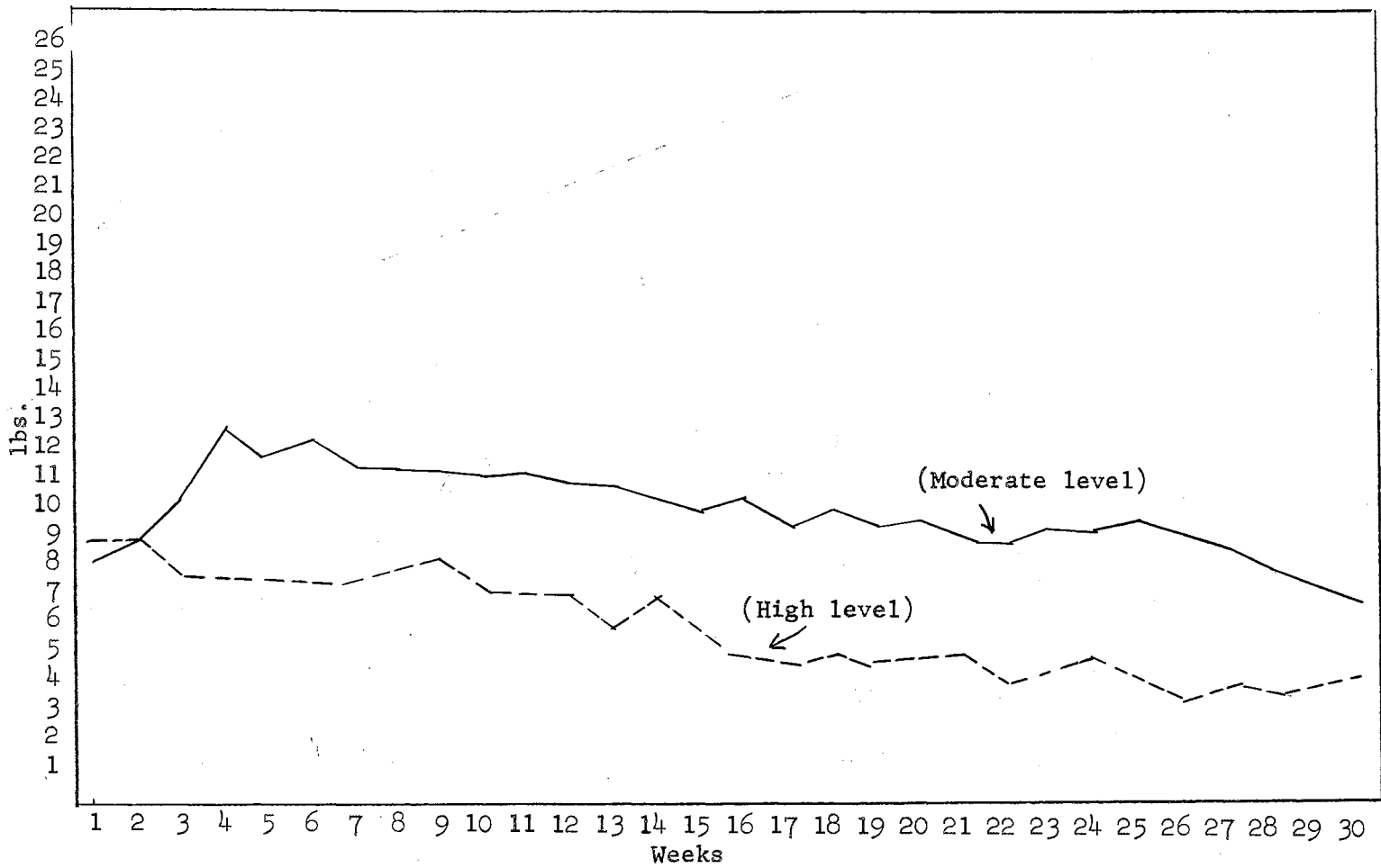


FIGURE 1. AVERAGE DAILY MILK PRODUCTION OF EIGHT SETS OF TWIN COWS DURING 30 WEEKS OF LACTATION

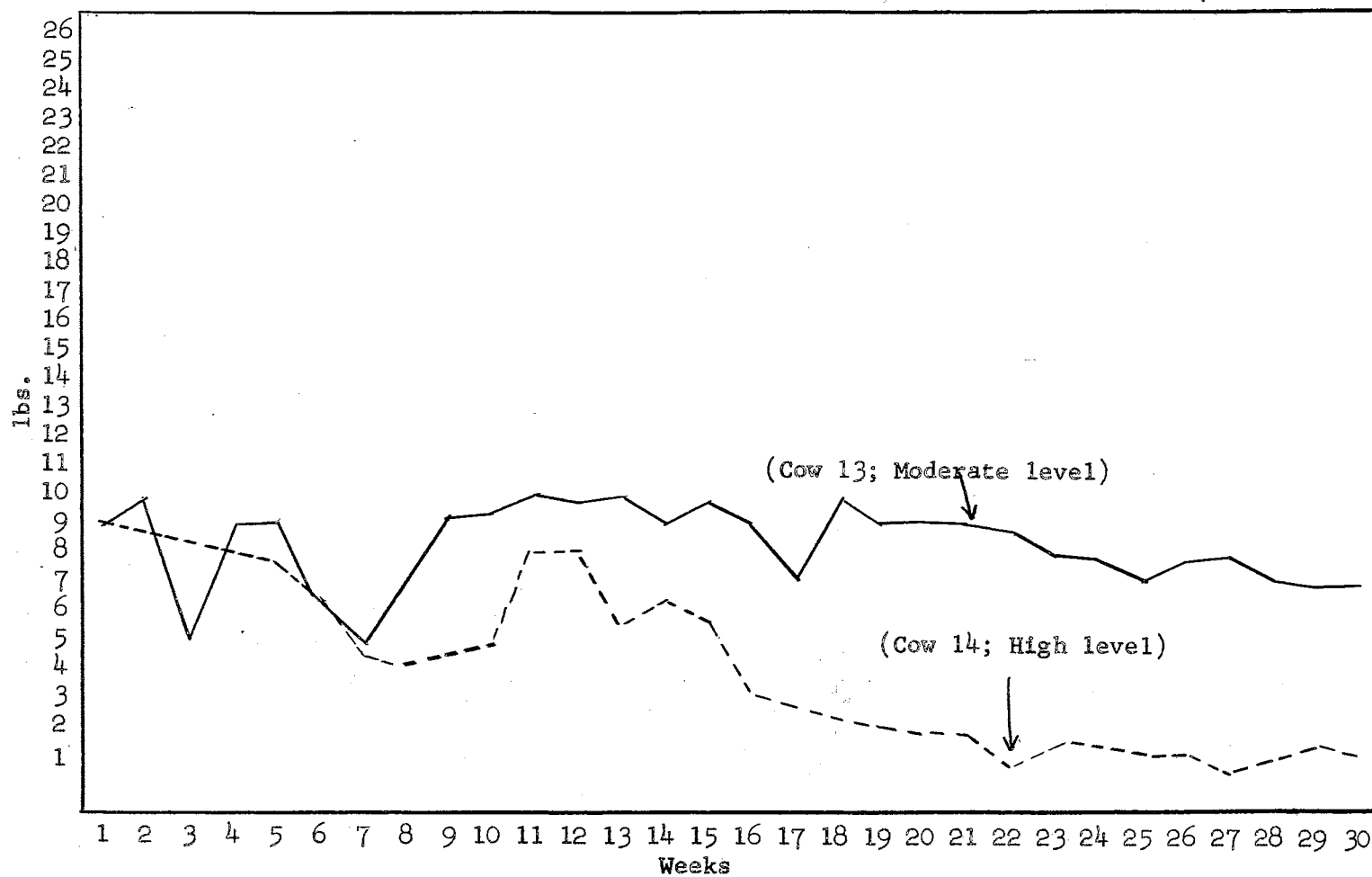


FIGURE 2. AVERAGE DAILY MILK PRODUCTION OF COWS 13 AND 14 DURING 30 WEEKS OF THEIR FIRST LACTATION

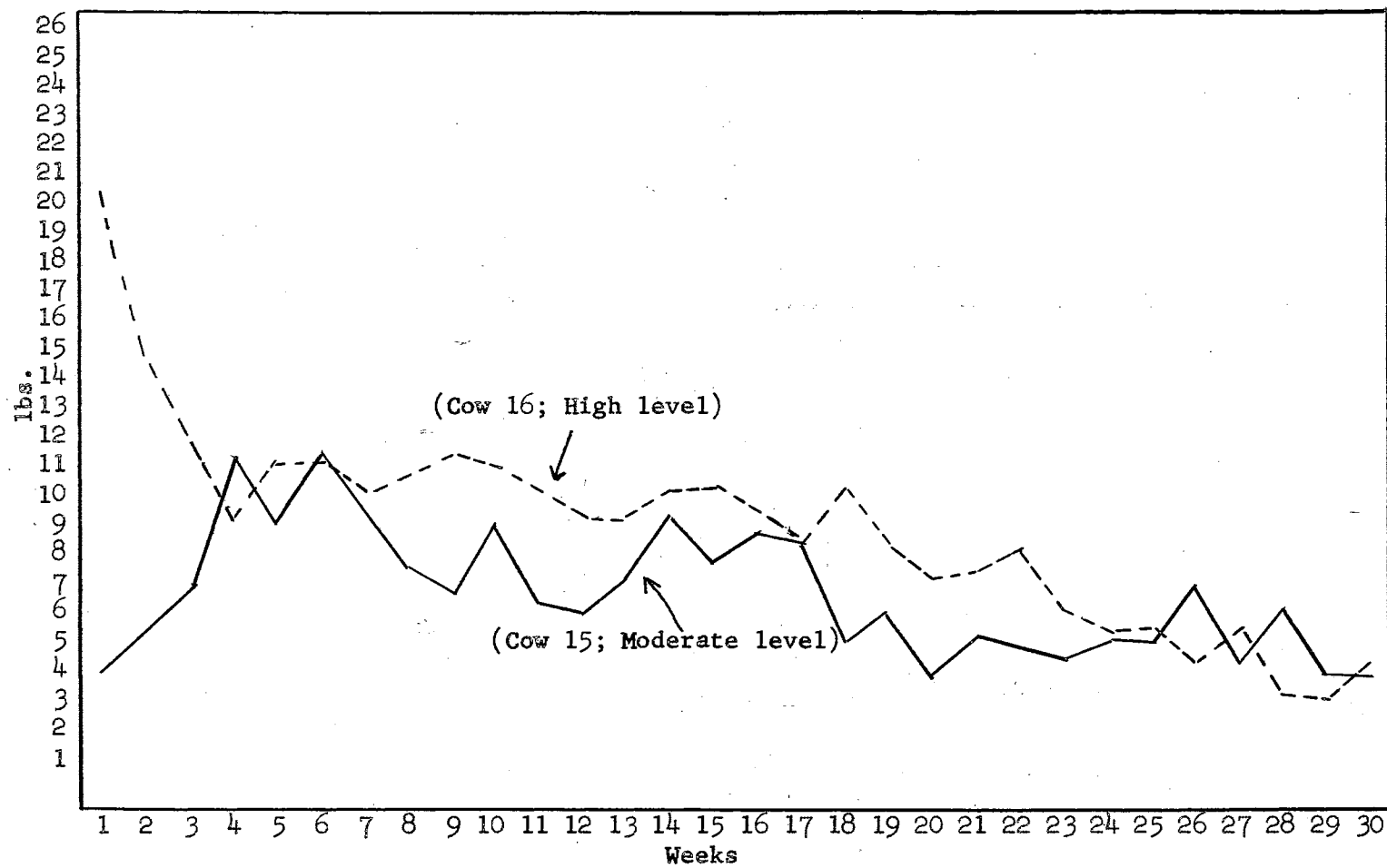


FIGURE 3. AVERAGE DAILY MILK PRODUCTION OF COWS 15 AND 16 DURING 30 WEEKS OF THEIR FIRST LACTATION

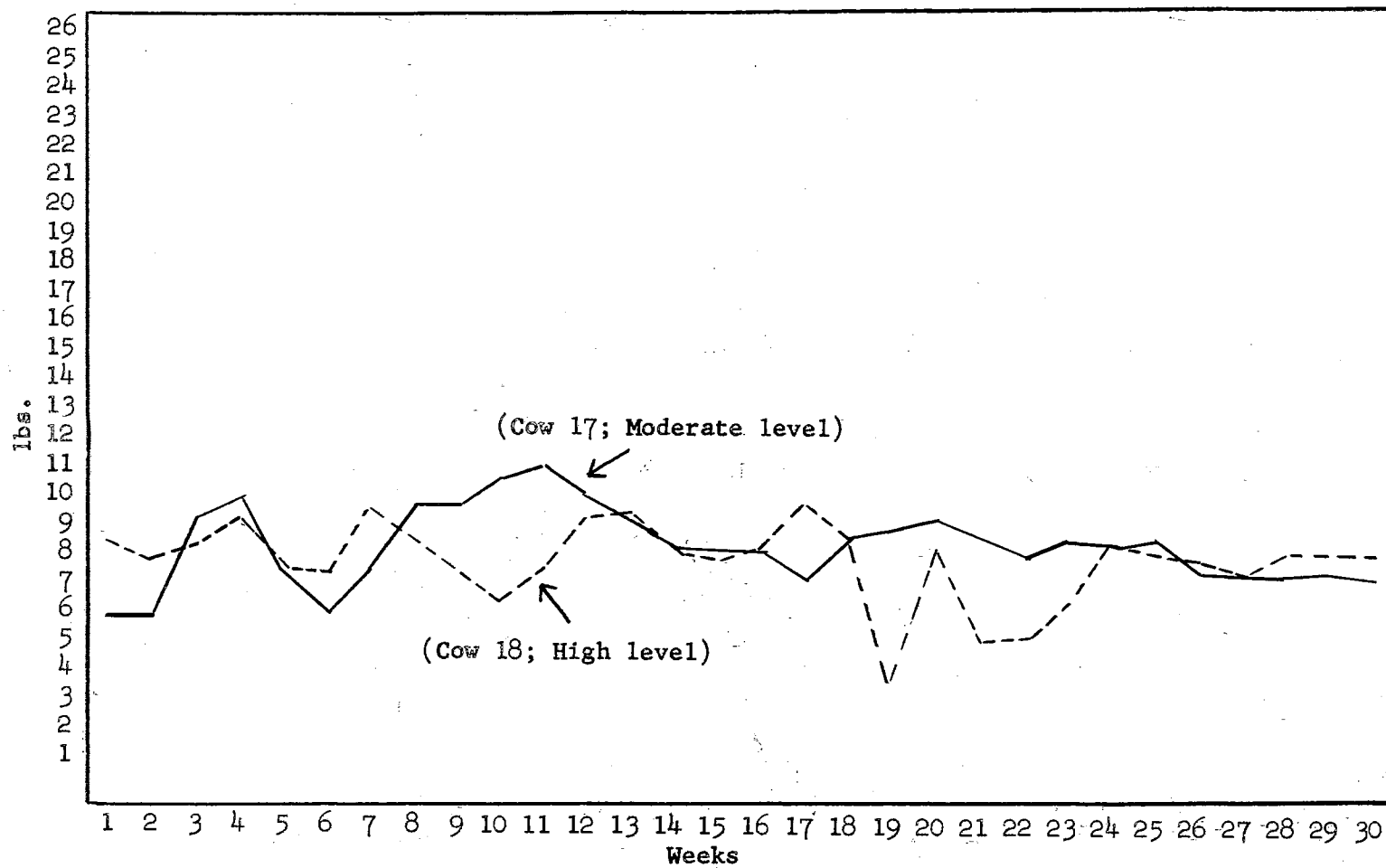


FIGURE 4. AVERAGE DAILY MILK PRODUCTION OF COWS 17 AND 18 DURING 30 WEEKS OF THEIR FIRST LACTATION

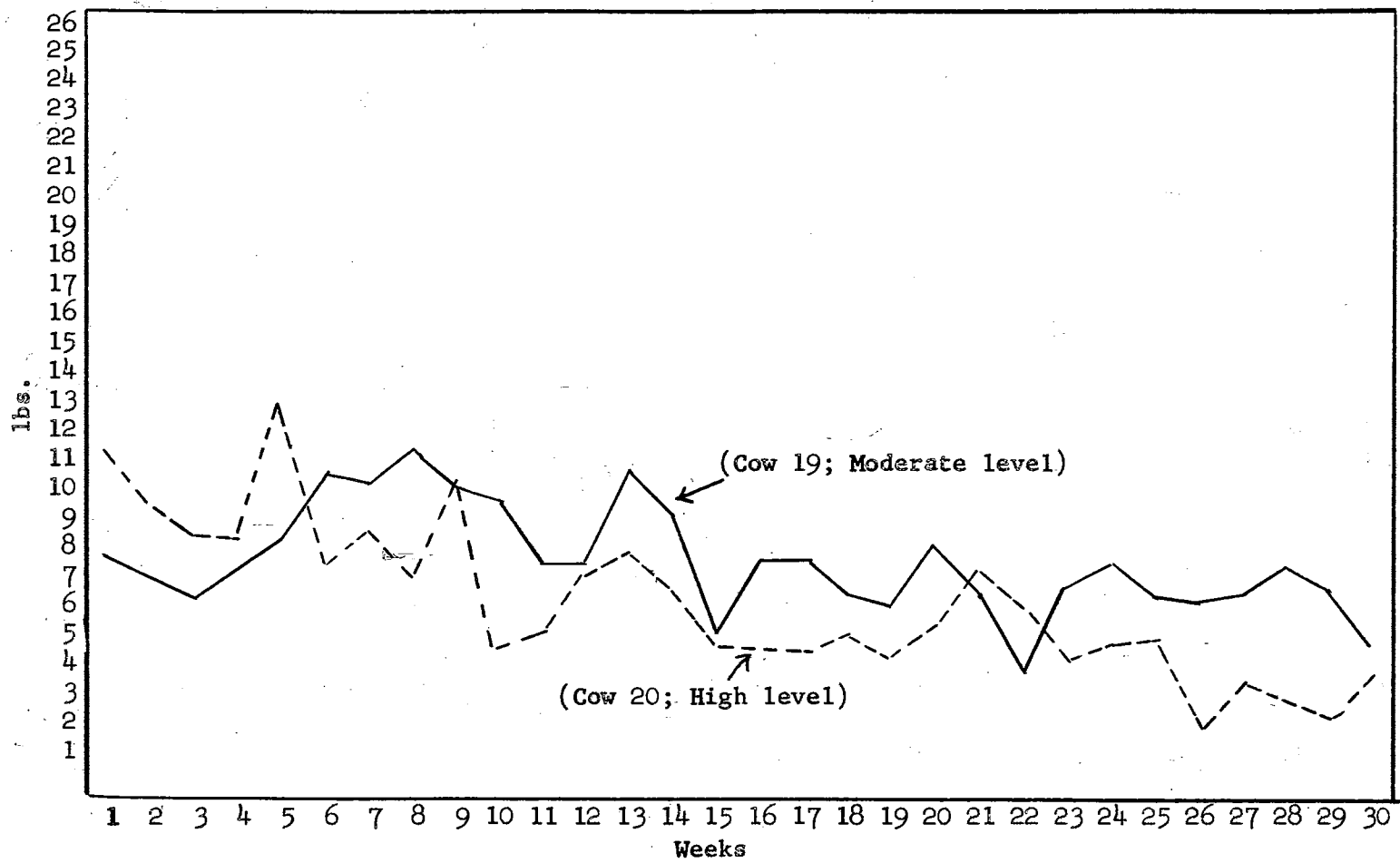


FIGURE 5. AVERAGE DAILY MILK PRODUCTION OF COWS 19 AND 20 DURING 30 WEEKS OF THEIR FIRST LACTATION

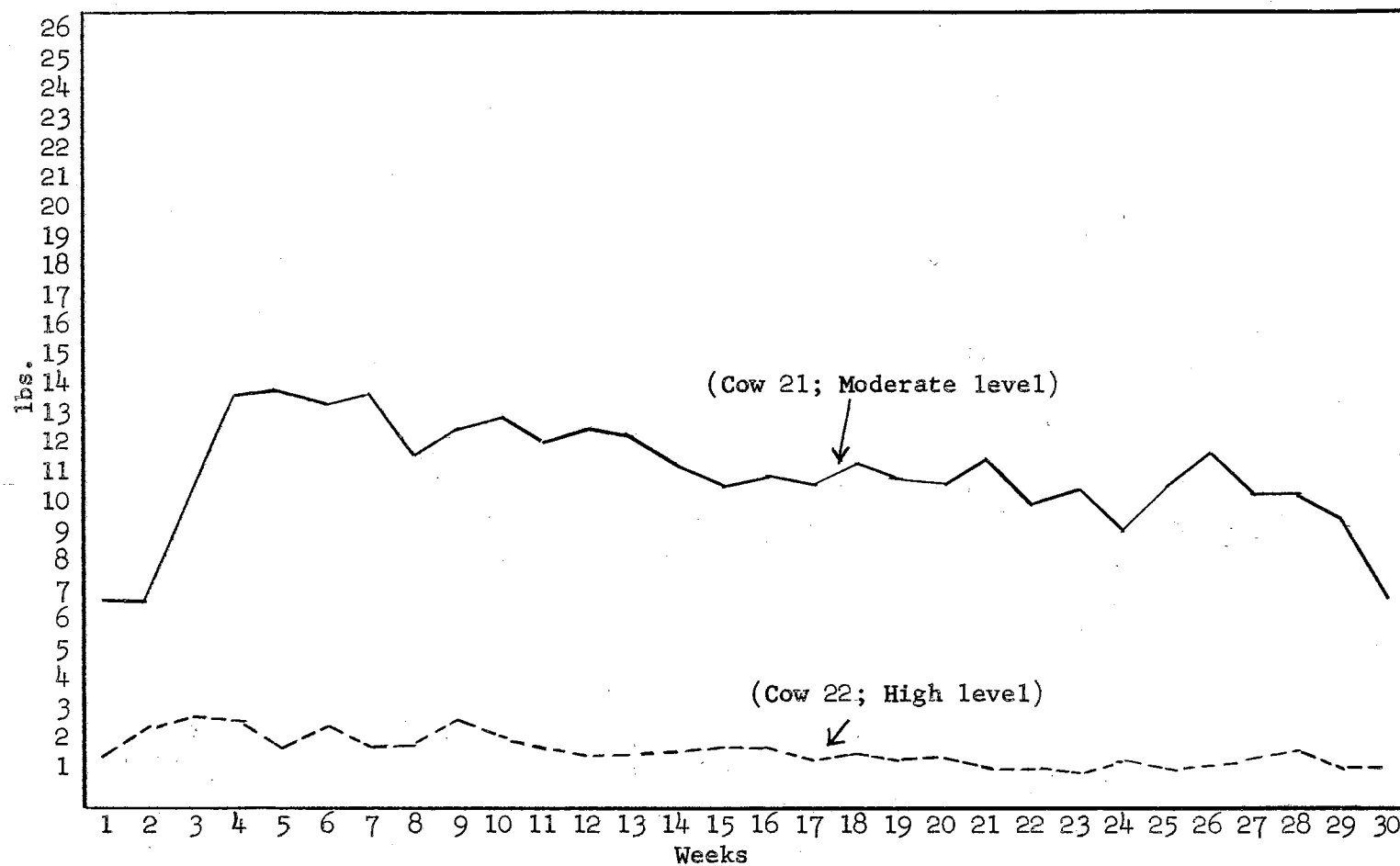


FIGURE 6. AVERAGE DAILY MILK PRODUCTION OF COWS 21 AND 22 DURING 30 WEEKS OF THEIR FIRST LACTATION

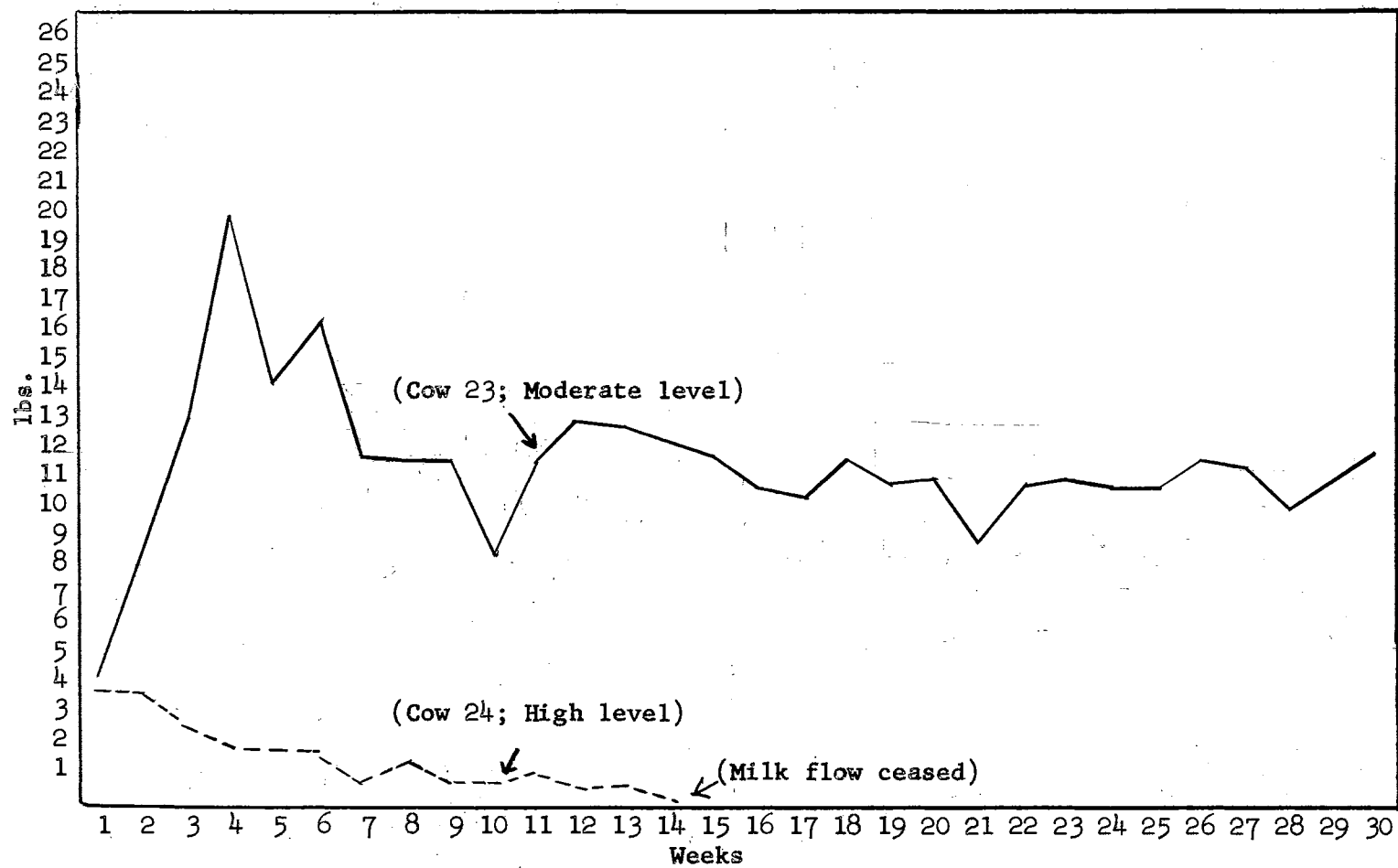


FIGURE 7. AVERAGE DAILY MILK PRODUCTION OF COWS 23 AND 24 DURING 30 WEEKS OF THEIR FIRST LACTATION

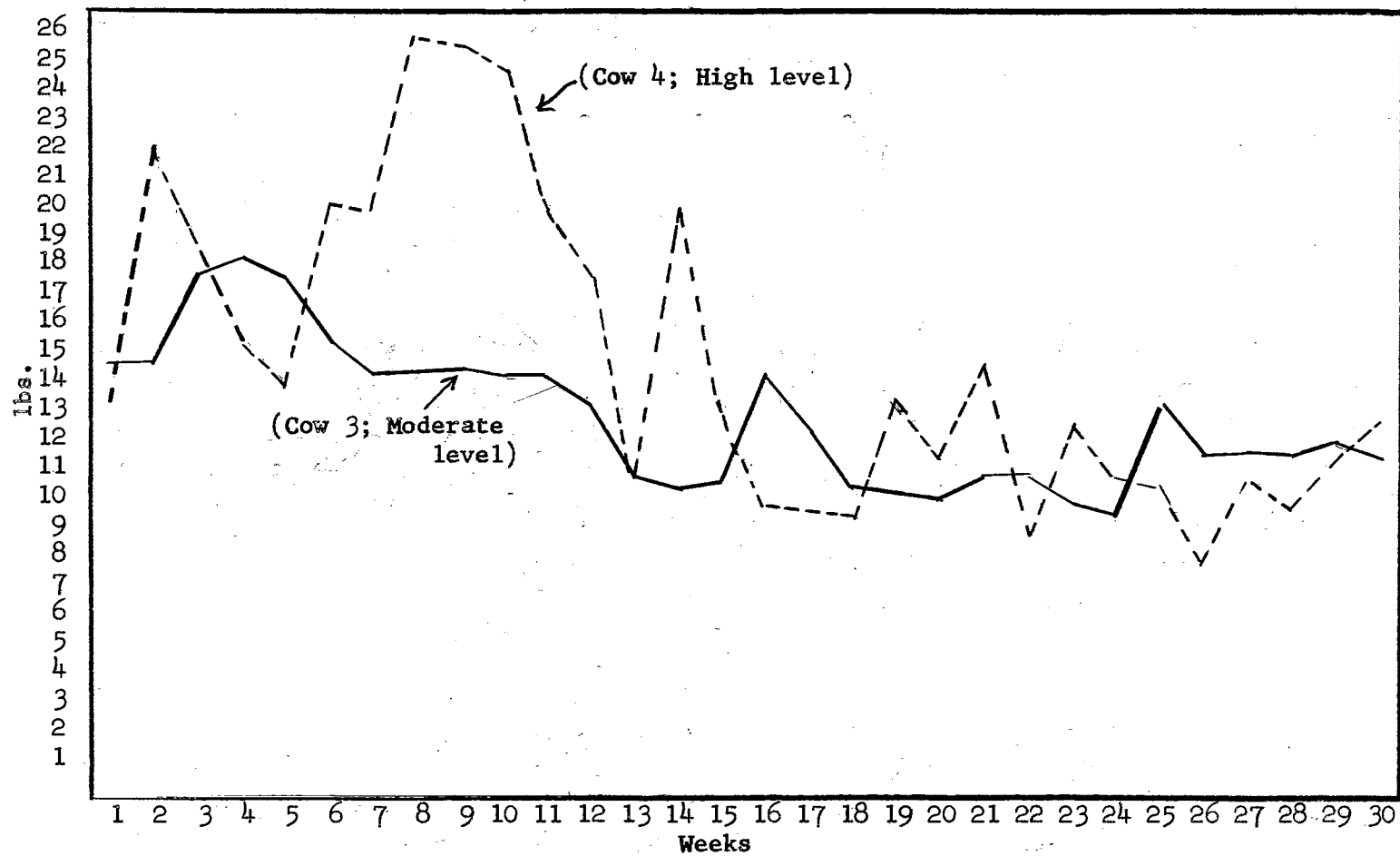


FIGURE 8. AVERAGE DAILY MILK PRODUCTION OF COWS 3 AND 4 DURING 30 WEEKS OF THEIR SECOND LACTATION

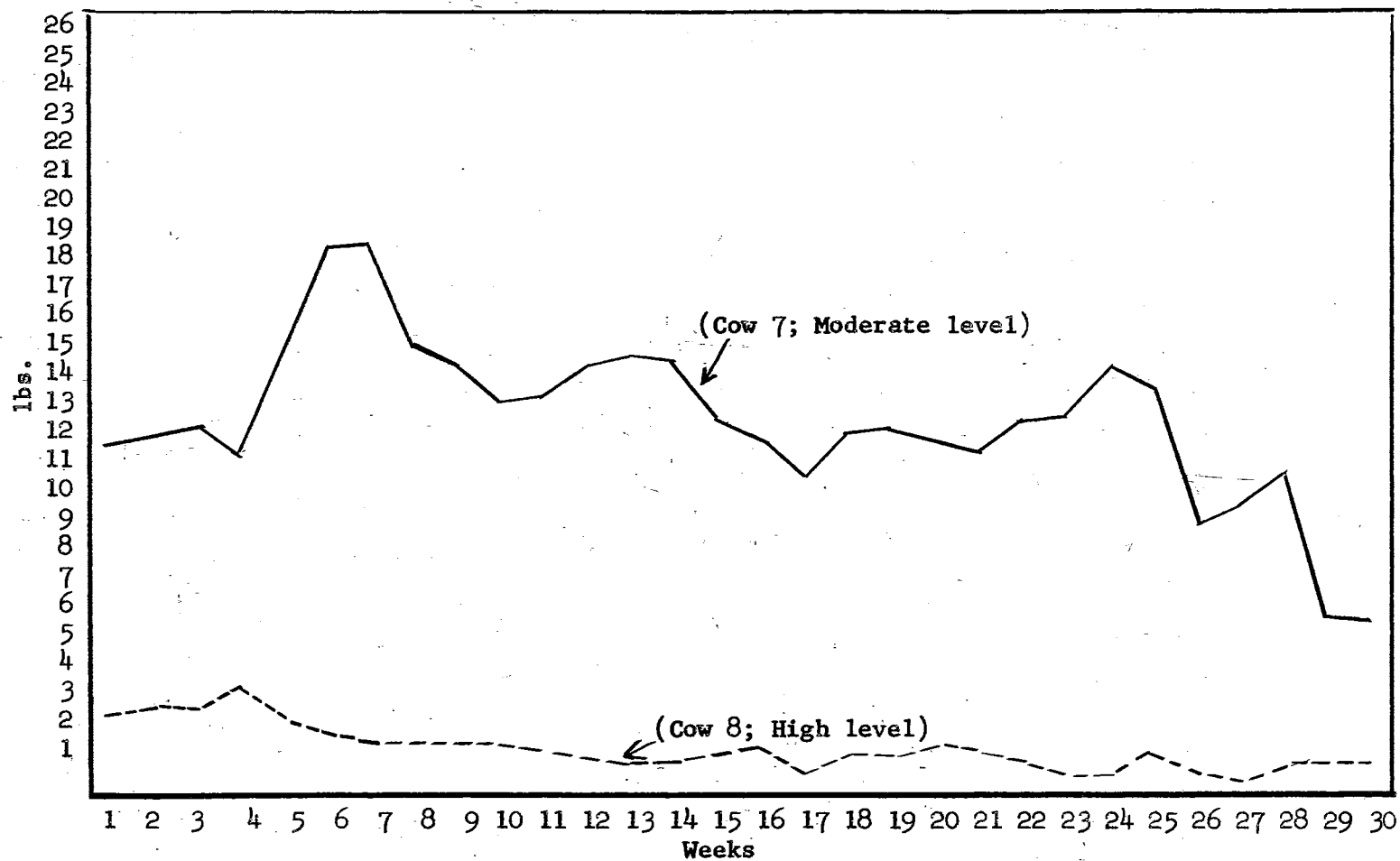


FIGURE 9. AVERAGE DAILY MILK PRODUCTION OF COWS 7 AND 8 DURING 30 WEEKS OF THEIR SECOND LACTATION

The data of those sets of twins in which both individuals raised their own calves and had complete 112-day lactation records are shown in both tabular (Table 15) and graphic (Figure 10) form. The lower portion of Figure 10 indicates the cows' average daily milk production and the upper portion the corresponding average daily gains of their calves. Dotted lines connect the two members of each set of twins in the lower portion of the figure, with the calves of twin sets similarly joined in the upper portion of the figure.

The units of gain in the upper portion of Figure 10 were purposely scaled so that the lines connecting the points representing milk production of twin sets were roughly parallel to lines connecting the points which represent gains of their calves. This technique serves to illustrate the high correlation (.75) between total 112-day milk production and calf gain on a within-twin basis. The data represented in Figure 10 (and Table 15) should be compared only on a within-twin basis due to the extremely varied genotype of the sets of twins. With this consideration it will be noted that with but one exception (cows 3 and 4) the faster gaining calf received the larger milk supply. The greater milk production of cow 4 compared to cow 3 is not reflected in the calf gain data but can be explained in part by referring to Figure 8 and noting the extremely high and variable milk yield of cow 4 during early portions of the lactation. The capacity of the calf to efficiently utilize all of the milk was possibly exceeded during peak periods of production.

TABLE 15. 112 AND 210 DAY MILK PRODUCTION AND AVERAGE DAILY GAINS OF CALVES
FROM BIRTH TO 112 AND BIRTH TO 210 DAYS OF AGE¹

Treatment Level	Cow No.	Calf Sex	112-Day		Calf	210-Day		Calf
			Milk Production		112-Day	Milk Production		210-Day
			Total	Daily Ave.	A.D.G. ²	Total	Daily Ave.	A.D.G. ³
			lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
First Lactation								
Moderate	7	M	1239	11.1	2.04	----- ⁴	--- ⁴	1.96
High	8	M	633	5.7	1.25	----- ⁴	--- ⁴	1.57
Moderate	9	F	585	5.2	1.04	----- ⁵	--- ⁵	----- ⁵
High	10	M	852	7.6	1.28	----- ⁵	--- ⁵	----- ⁵
Moderate	13	M	999	8.9	1.28	1833	8.7	1.30
High	14	M	769	6.9	0.89	9.77	4.7	0.84
Moderate	15	F	913	8.2	1.13	1473	7.0	1.25
High	16	M	1265	11.3	1.41	1910	9.1	1.67
Moderate	17	M	970	8.7	1.32	1764	8.4	1.39
High	18	F	944	8.4	1.30	1668	7.9	1.33
Moderate	19	M	955	8.5	1.38	1588	7.6	1.58
High	20	F	875	7.8	1.11	1296	6.2	1.16
Second Lactation								
Moderate	3	F	1578	14.1	1.59	2649	12.6	1.63
High	4	M	2113	18.9	1.62	3075	14.6	1.62

¹Includes data of those sets of twins raising their own calves and having complete 112 or 210 day lactation records.

²Gain calculated using uncorrected birth and uncorrected 112 day weight (Table 10).

³Gain calculated using corrected birth and corrected 210 day weight (Table 10).

⁴Complete 210-day lactation record was not available.

⁵The high level cow was removed from the experiment after 112 days of lactation.

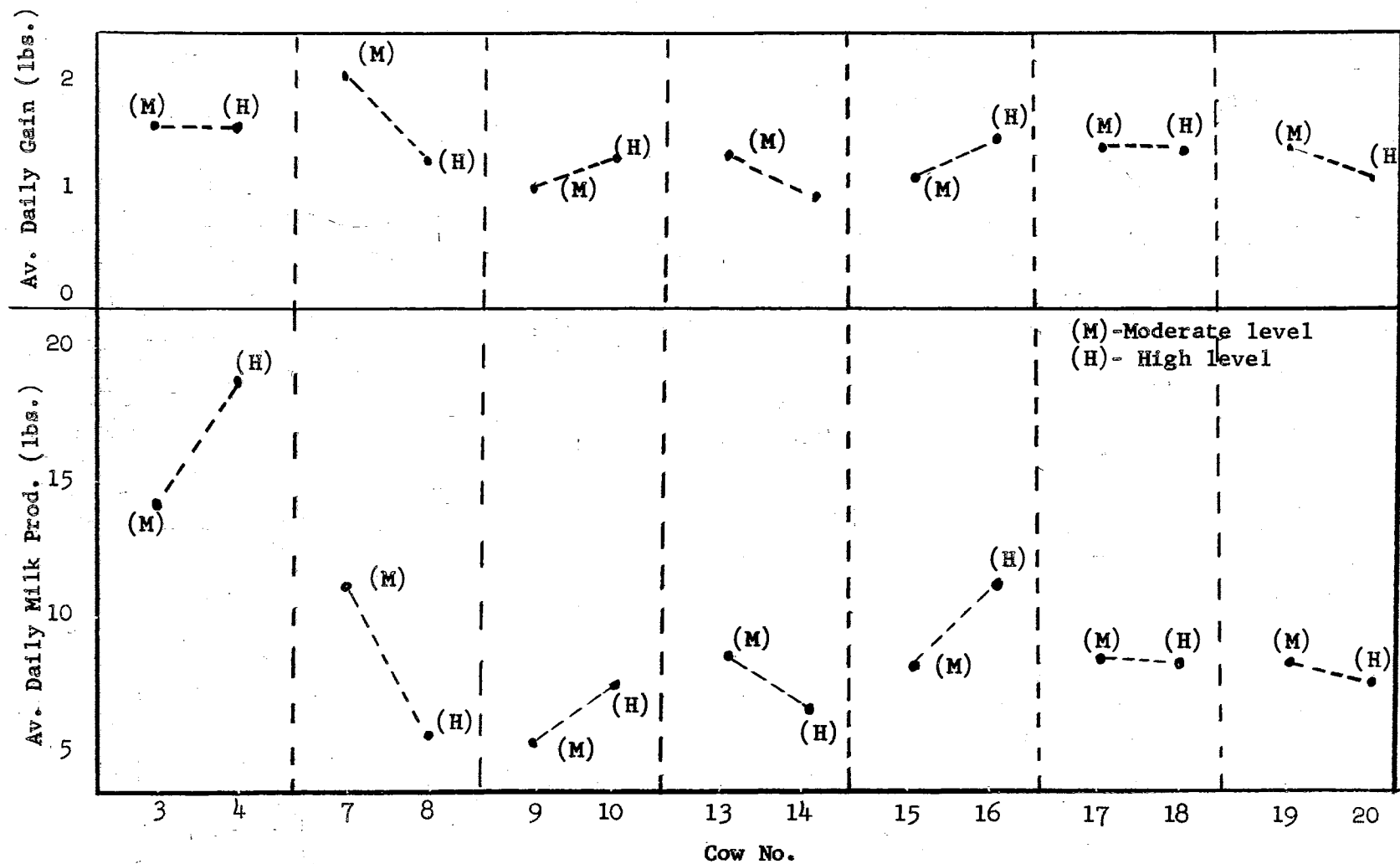


FIGURE 10. AVERAGE DAILY MILK PRODUCTION OF INDIVIDUAL SETS OF TWIN COWS AND THE CORRESPONDING GAINS OF THEIR CALVES DURING THE FIRST 112 DAYS OF LACTATION (First lactations of cows 7-20, second lactation of cows 3 and 4)

A Comparison of Methods of Estimating Milk Production

In addition to the hand-milking method used in previous milk production estimates, a second method was initiated in January 1960. Each calf was weighed immediately before and after morning and evening nursing periods and the difference in these weights was assumed to represent the actual weight of milk consumed by the calf. The calves were weighed on a beam-type scale capable of weighing with an accuracy of ± 0.5 pound. Complete 210-day lactation records by the calf-weight method were available for only a few cows at the time of this report; however, a pooled total of 202 cow-weeks of data was available for comparisons of estimates of milk production on a within-cow basis. Before pooling the data correlations of the milk production estimates by individual cows were obtained in order to determine that no large differences existed between cows.

The following data were compared:

- (1) An estimate of milk production by hand milking the cow one day each week in the manner explained in Experimental Procedure.
- (2) An average of six daily estimates per week by the calf weight-change method described above. The seventh day of each week on which the cows were milked was omitted from the average in order to eliminate any possible bias resulting from a slightly different weighing procedure on this day.
- (3) A milk production estimate by the calf weight-change method using only one day per week. Milk production estimates obtained on the day preceding the day of hand milking were used for this comparison.

Simple correlation coefficients were calculated between the estimates of milk production and are presented in Table 16. All estimates of milk production were highly correlated but there was no basis for predicting which method gave the most accurate measure of milk production. The data available did not permit valid correlations of calf-weight-change estimates of milk production with gain in weight of calves.

TABLE 16. SIMPLE CORRELATION COEFFICIENTS OF THREE ESTIMATES OF MILK PRODUCTION¹

Milk Production Estimated by:	Av. 6 Days Per Week Calf Wt.-Change	1 Day Per Week Hand Milking
One day per week Calf wt.-change	.84	.66
Av. 6 days per week Calf wt.-change		.74

¹Based on 202 cow-weeks of data.

The means and standard deviations of the three estimates of milk production are shown in Table 17. The absolute values of the estimates of milk production by the calf weight-change method are almost three pounds larger than the estimate by hand milking. A trend in this direction was expected because the cows could not be completely stripped by the hand milking method.

Milk Fat and Total Solids

The 210-day total milk fat production and the percent fat content of milk during this period are shown by treatment average in Table 18 and includes data from the first lactation of cows 13-24 and the second lactation of cows 3, 4, 7, and 8. The milk of high level cows was

TABLE 17. MEANS AND STANDARD DEVIATIONS OF ESTIMATES OF MILK PRODUCTION BY THREE DIFFERENT METHODS

Method	Means	Standard Deviation
	lbs.	lbs.
One day per week Calf wt.-change	12.5	4.2
Av. 6 days per week Calf wt.-change	12.4	3.5
One day per week Hand milking	9.6	3.9

slightly higher in fat content than that of moderate cows but due to the large difference in milk production the total milk fat production of moderate level cows was significantly greater ($P < .12$) than that of high level cows.

TABLE 18. AVERAGE TOTAL FAT AND AVERAGE PERCENT FAT OF MILK PRODUCED DURING A 210-DAY LACTATION PERIOD¹

Treatment Level	Total Fat	Av. Fat Content
	lbs.	lbs.
Moderate	75	3.6
High	46	3.8

¹ Includes data of the first lactation of cows 13-24 and second lactation of cows 3, 4, 7, and 8.

The fat production curves of both treatment levels (Figure 11) are almost identical to the milk production curves (Figure 1), with the exception of fat production of the high level cows during the second week. The fat production of high level cows increased during the second week of lactation whereas milk production remained relatively constant.

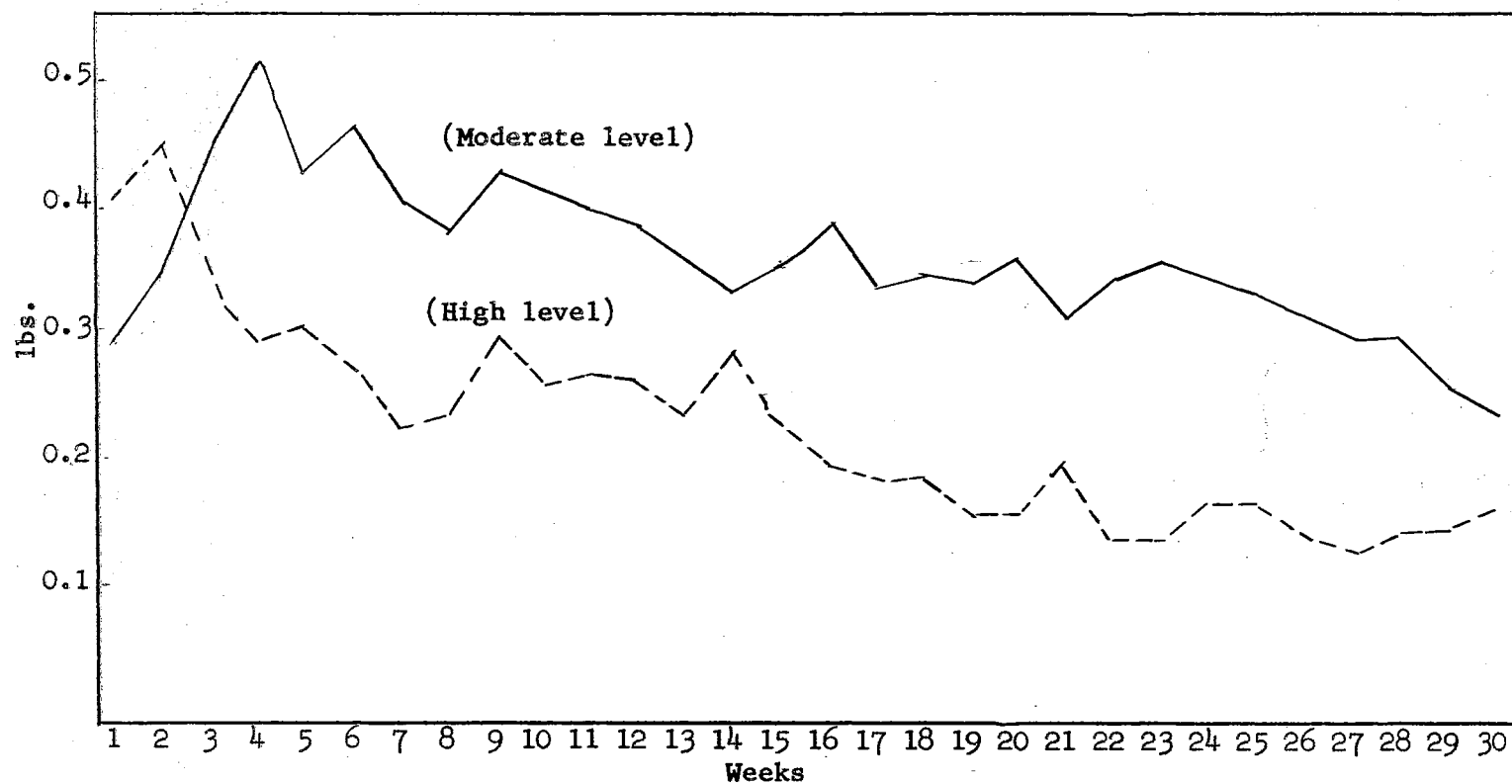


FIGURE 11. AVERAGE DAILY MILK-FAT PRODUCTION DURING 30 WEEKS OF LACTATION (Data obtained during first lactations of cows 13-24 and second lactations of cows 3, 4, 7, and 8)

The relationship of milk-total-solids production between treatment levels is very similar to milk-fat production. The total-solids content of high level cows was 0.4 percent greater than milk of moderate level cows (Table 19), but the greater milk production of the moderate level group more than compensated for the lower percentage total-solids to give moderate level cows a larger over-all total-solids production. The total-solids production curves (Figure 12) have a similar relationship between treatment levels as that of milk fat with only minor deviations from the milk production curves.

TABLE 19. AVERAGE TOTAL AND PERCENT TOTAL-SOLIDS OF MILK PRODUCED DURING A 210-DAY LACTATION PERIOD¹

Treatment Level	Pounds Total-Solids	Percent Total-Solids
Moderate	263	12.8
High	159	13.2

¹ Includes data of the first lactation of cows 13-24 and second lactation of cows 3, 4, 7, and 8.

Body Temperature

Rectal temperatures taken during four 10-day periods showed high level cows to have an average body temperature of 102.37° F compared to 102.21° F for moderate level cows. This difference of only 0.16° F was shown by an analysis of variance to be significant ($P < .05$); however, such a small variation in body temperature may not be of any physiological importance. Butt and Bush (1955) recorded the rectal temperatures of breeding ewes kept in rooms ranging in air temperatures from 45° F to 88° F and noted that the average body temperature of ewes in the warm room was 1.4° F higher than ewes in the cool room. The ewes in the

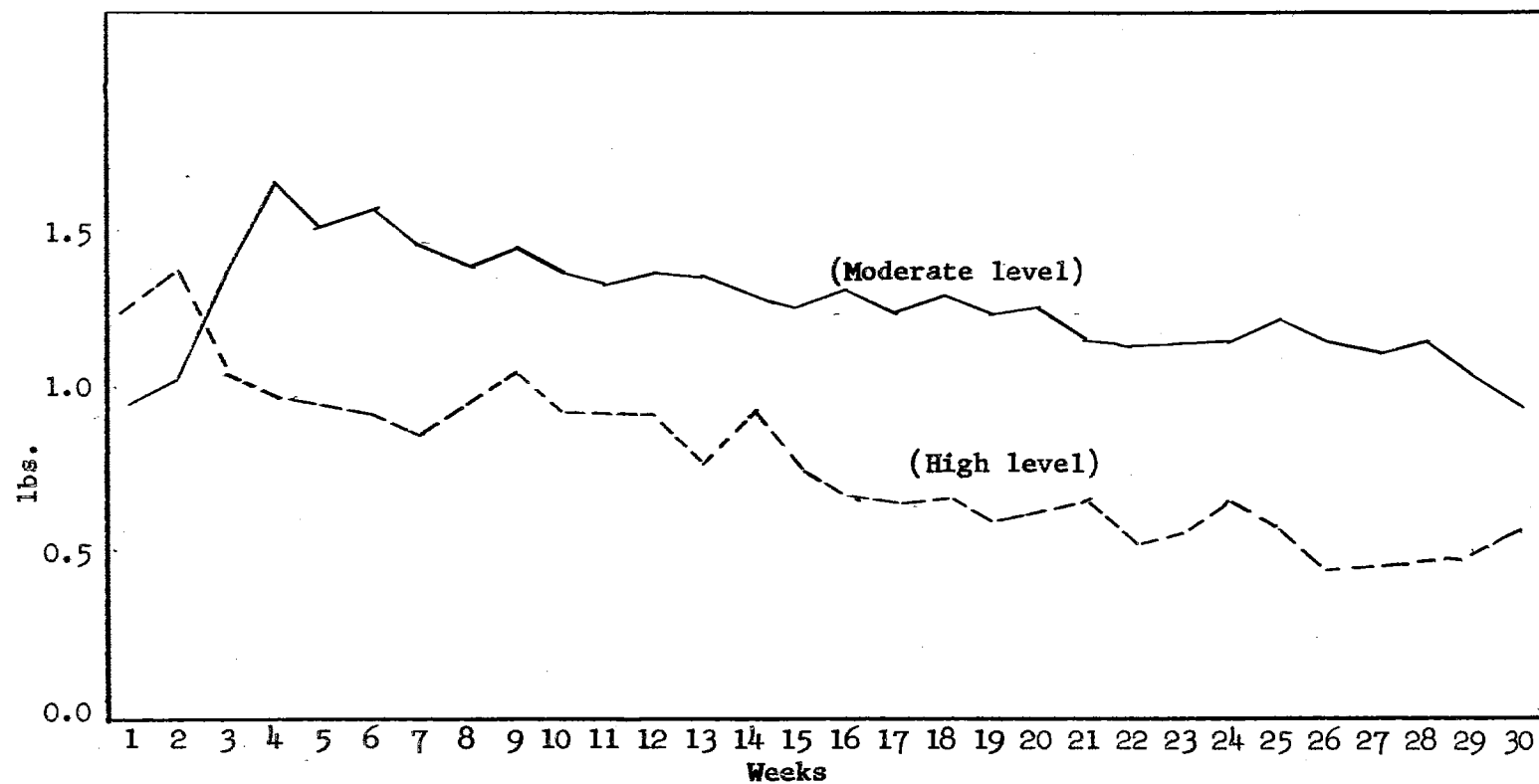


FIGURE 12. AVERAGE DAILY MILK TOTAL-SOLIDS DURING 30 WEEKS OF LACTATION (Data obtained during first lactations of cows 13-24 and second lactations of cows 3, 4, 7, and 8)

cooler environment had an earlier estrus and required fewer services per conception which may have been a direct result of the lower body temperature.

Blood Composition

Hematocrit, hemoglobin, and plasma protein values of high level cows were significantly ($P < .05$) higher than values of moderate level cows. The higher feeding level promoted higher mean values of all blood constituents determined (Table 20) but values within both feeding levels were within the reported normal ranges (Albritton, 1952; Dukes, 1956). There is no basis for attributing differences in performance of cows on the different feeding levels to differences in blood constituents of the magnitude shown in Table 20. Higher blood constituent levels within normal ranges might be assumed to indicate a better state of health in the high level group, but the performance of this group was inferior to the moderate fed cows in most production phases.

TABLE 20. AVERAGE HEMATOCRIT, RED BLOOD CELL, WHITE BLOOD CELL, HEMOGLOBIN, AND PLASMA PROTEIN VALUES

Treatment Level	Hematocrit ¹	Red Blood Cells ²	White Blood Cells ³	Hemoglobin ⁴	Plasma Protein ⁵
Moderate	36.5	7.25	8.99	13.8	7.19
High	39.3	7.63	9.08	14.6	7.50

¹ Percent

² Millions per cubic millimeter of blood.

³ Thousands per cubic millimeter of blood.

⁴ Grams per 100 milliliters of blood.

⁵ Grams per 100 milliliters of plasma.

Blood constituent values of individual cows are within the normal range with the exception of white blood cell values of cows 15 and 16 which are slightly higher than normal (Table 21). This may be due in part to a mild infection of the reproductive tract occurring shortly after calving and during the period blood samples were collected.

TABLE 21. AVERAGE HEMATOCRIT, RED BLOOD CELL COUNT, WHITE BLOOD CELL COUNT, HEMOGLOBIN, AND PLASMA PROTEIN CONTENT OF BLOOD

Treatment Level	Cow No.	Hematocrit ¹	Red Blood Cells ²	White Blood Cells ³	Hemoglobin ⁴	Plasma Protein ⁵
Moderate	3	40.4	8.21	8.93	15.4	7.08
High	4	42.6	8.43	8.22	15.1	7.37
Moderate	5	32.6	5.35	7.72	12.7	7.54
High	6	35.8	6.53	7.62	13.6	7.64
Moderate	7	37.7	7.07	7.97	14.1	7.78
High	8	40.8	7.55	8.53	15.1	7.78
Moderate	13	36.3	7.96	8.62	13.9	7.26
High	14	41.3	7.64	9.70	14.9	7.39
Moderate	15	33.6	6.60	12.37	12.4	6.57
High	16	32.0	6.90	13.49	12.0	7.26
Moderate	17	35.5	7.30	10.08	13.8	7.15
High	18	37.6	8.32	8.68	14.8	7.40
Moderate	19	39.7	7.78	7.39	15.0	7.14
High	20	40.8	7.66	8.16	15.1	7.44
Moderate	21	34.5	7.66	8.28	12.7	7.05
High	22	37.7	7.16	7.96	14.0	7.60
Moderate	23	38.4	7.36	9.55	14.2	7.23
High	24	45.8	8.45	9.37	16.4	7.61

¹Percent.

²Millions per cubic millimeter blood.

³Thousands per cubic millimeter blood.

⁴Grams per 100 milliliters blood.

⁵Grams per 100 milliliters plasma.

EXPERIMENTAL PROCEDURE

Phase II

The second phase of the experiment was initiated in August, 1957. Thirty 8-year-old cows were allotted to two groups on the basis of five years production records. The two groups were kept in adjacent five-acre traps from late summer until spring. During this period one group (moderate level) was fed prairie hay and 2.5 pounds of cottonseed cake per head daily. The other group of cows (high level) was fed the same ration and in addition was allowed free access to a self-feeder of ground milo. The high level cows consumed an average of 23.5 pounds of milo per head daily. As each high level cow calved she was moved to the trap with the moderate level cows and fed the moderate ration. The high level cows were not fed the high-grain ration following calving because: (1) it would be impractical under range conditions to hand milk the cows should a temporary excessive milk flow be produced by the high-grain ration, (2) calves could not be prevented from consuming the grain if it were fed during lactation, and (3) it was desired to determine influence of excessive feeding during gestation on subsequent lactation. The combined cow-groups were grazed on native range during the spring and early summer. At mid-summer the cows were separated into the original groups and the feeding procedure repeated the second year. All cows were pasture-mated to purebred Hereford bulls between April 15 and

July 15 each year. Bull calves were castrated at 8 to 10 weeks of age and all calves were dehorned and vaccinated for blackleg.

The following data were collected:

- (1) Weight of all cows at monthly intervals.
- (2) Feed consumption of cows.
- (3) Pregnancy check of cows approximately five months after close of breeding season.
- (4) Record of calving difficulty.
- (5) Date of calving.
- (6) Birth, 112, and 210-day weights of calves. Birth weights of heifer calves were adjusted to a bull equivalent and weaning weights to a 210-day steer equivalent using the factors calculated by Botkin (1952).
- (7) Gross examination of reproductive tracts of all cows after slaughter at conclusion of experiment.

RESULTS AND DISCUSSION

The high level cows were 248 pounds heavier and appeared much fatter than moderate level cows before calving (1-31-58, Table 22). During the spring and summer grazing periods the high level cows lost weight rapidly and were only 73 pounds heavier than moderate level cows at the start of the second feeding period (7-12-58). At the last weighing before the 1959 calving period the high level cows were 323 pounds heavier than moderate level cows (1-16-59). No grain was fed the high level cows after calving (1959) and the weight difference between groups was reduced to 42 pounds at the conclusion of the experiment (10-16-59). It will be noted that the average weight of moderate level cows fluctuated only 76 pounds between the lightest and heaviest weights reported in Table 22. The weight differential between moderate and high cows was not as great as differences in phase I.

TABLE 22. AVERAGE WEIGHT OF COWS AT FIVE INTERVALS OF THE TRIAL

Treatment Level	Initial Weight 8-8-57 lbs.	Before Calving 1-31-58 lbs.	Summer 7-12-58 lbs.	Before Calving 1-16-59 lbs.	End of Trial 10-16-59 lbs.
Moderate	1046	1078	1080	1122	1077
High	1061	1326	1153	1445	1119
<hr/>					
Difference Wt. High <u>minus</u> Mod. 15		248	73	323	42

The cows were bred before the start of the trial. No differences in breeding efficiency were noted during the trial. Calves were dropped in February and March of 1958 and 1959. No differences in calving difficulty were noted. The average birth, 112, and 210-day weights of both calf crops are shown in Table 23. Calves of high level cows were heavier at birth than calves of moderate level cows in both 1958 and 1959. Although the difference was small the trend is similar to that observed in phase I. Calves of high level cows were also heavier than calves of moderate level cows at 112 and 210 days of age in both years. The differences in weight at 112 and 210 days of age are in contrast to results reported at these periods of phase I. The results indicate that the mature cow is not as easily injured by excessive fatness as the developing heifer. The estimate of milk production obtained by a comparison of calf weights suggests that high level cows made very inefficient use of body fat reserves during the lactation period.

TABLE 23. AVERAGE WEIGHT OF CALVES AT BIRTH, 112, AND 210 DAYS OF AGE

Treatment Level	1958 Calves			1959 Calves		
	Birth ¹	112 Days	210 Days ²	Birth ¹	112 Days	210 Days ²
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Moderate	81	266	466	76	266	480
High	82	277	482	81	283	497

¹Weight of heifer calves corrected to a bull equivalent by the method of Botkin (1952).

²Weight of heifer calves corrected to a steer equivalent by the method of Botkin (1952).

Table 24 shows the number of cows lost and the number of calves lost from causes other than loss of the dam during the two years.

of the trial. Four high level and three moderate level cows were lost from the experiment. It should be noted that two of the moderate level cows were removed due to eye cancer, a condition quite common in aged Hereford cattle. Any of the conditions listed as a cause of loss from the high level group could logically have resulted from the high level of feeding. Although numbers were small and no definite conclusions can be drawn, the data suggest that the high level of feeding may have been detrimental to the general health of the cows.

TABLE 24. NUMBER OF COWS LOST FROM THE EXPERIMENT AND NUMBER OF CALVES LOST FROM CAUSES OTHER THAN LOSS OF THE DAM

Treatment Level	No. Cows Lost	No. Calves Lost
Moderate	3 ¹	1 ³
High	4 ²	2 ⁴

¹Two cows removed from the experiment due to eye cancer; one cow died of unknown causes.

²One cow removed due to lameness (apparently foundered), one cow removed due to prolapse, one cow removed due to a split udder, one cow removed because of failure to breed.

³Born dead.

⁴One calf died of unknown causes; one cow did not calve.

No important differences were noted in the number of calves lost from the experiment from causes other than loss of the dam. A gross examination of the reproductive tracts of the cows following slaughter at the conclusion of the experiment revealed no apparent differences due to treatment.

SUMMARY

Eleven sets of twin heifers and 30 mature cows were used to study the performance of beef females as influenced by an excessive body fatness induced at two stages of the life cycle. One heifer of each twin pair was full fed a high energy ration beginning not less than eight months prior to first mating. The twin-mates of these heifers were fed a moderately-low energy ration at levels required to maintain the heifers in thrifty condition. These treatments resulted in the highly fed heifers weighing an average of 320 and 507 pounds more than their moderately fed twin-mates at first mating and first parturition, respectively.

The fattening of heifers beginning prior to first parturition resulted in an earlier calving date, increased calving difficulty, heavier calf birth weights, lower milk yields, and decreased survival rates of both heifers and calves. The hematocrit, plasma protein, and hemoglobin content of blood of high level heifers was significantly higher ($P < .05$) but levels of both treatment groups were within the reported normal ranges. High level heifers also had significantly higher ($P < .05$) body temperatures than moderate level heifers but the mean difference of only 0.17°F may not be of physiological importance.

The mature cows were grazed on native pasture during the spring and summer months and were wintered in a small trap. In addition to the standard protein and roughage winter supplements fed all cows, one group

of 15 cows received a full feed of ground milo from mid-summer until calving. The full fed cows weighed an average of 248 and 323 pounds more at parturition than the control cows during the first and second years of the trial, respectively. High levels of feeding resulted in heavier birth, 112, and 210-day calf weights, indicating that the mature cow is not as easily injured by excessive fatness as the developing heifer.

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