PERFORMANCE IN RELATION TO WEANING RESPONSE
IN PRODUCTION TESTED BEEF CATTLE

by

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INTRODUCTION

The ever increasing demand for human food throughout the world calls not only for more production but also for the more efficient utilization of available resources. Basically we must be concerned with a nutritional economy--not a dollar economy. With livestock this will be achieved both through better husbandry and through the development of improved strains.

It is the object of production testing to identify animals of superior genetic worth with respect to the character(s) directly or indirectly responsible for maximum and efficient production.

In beef cattle it is generally agreed that in addition to desirable beef conformation, the outstanding qualities in this respect are rate of growth and the economy or efficiency with which the animal converts the available nutrients into edible beef. That individual animals vary in these characters is well known.

Fortunately, at least a portion of these variations is under genetic influence, thus justifying selection for them. The total variation in the phenotypic expression of a character (σ_{P^2}) equals the sum of the variance due to heredity (σ_{H^2}), the variance due to environment (σ_{E^2}), and the interaction between these (σ_{HE^2}),

$$\text{i.e., } \sigma_{P^2} = \sigma_{G^2} + \sigma_{E^2} + \sigma_{GE^2}.$$

Further, heritability (h^2) theoretically equals the ratio between the variance due to heredity and phenotypic variance, (18, pp.74-102),

$$\text{i.e., } h^2 = \sigma_{H^2}/\sigma_{P^2}.$$

Hence, for the best estimate of heritability, a character should be measured at a time when σ_{H^2} is at a maximum compared with σ_{E^2}.

Current production testing methods aim to achieve this by minimizing σ_{E^2}. This necessitates a study of all aspects and phases of growth and development and of their interrelations. It yet remains to more accurately delineate the optimum period and to increase the repeatability of the observations. This must be consistent with practicability and economy of the testing procedure.

REVIEW OF LITERATURE

Until recently the only records available to beef cattle breeders have been show ring winnings and subjective evaluations made by the individual breeder.

Sheets (24, pp.41-47) in 1932 devised one of the earliest record of performance tests for beef cattle. This was based on carcass quality and on efficiency, measured by pounds of cold carcass produced per 100 pounds of total digestible nutrients (T.D.N.) (including milk), consumed from birth to 365 days. Winters and McMahon (29, p.90) simplified this by proposing average daily gain to 365 days of age and a quality score based on slaughter grade.

On the basis of work conducted at the National Agricultural Research Center, Beltsville, Maryland, Black and Knapp (1, pp.72-77) recommended a test period following weaning on a weight constant basis from 500 to 900 pounds. The final evaluation was to be based on efficiency of gain during this period and on carcass grade.

They found a high correlation (r = .88) between rate and efficiency of gain on test during a comparable weight period. The faster gaining calves were the more efficient. However, in a <u>time</u>-constant population the correlation is not high as shown by Winters and McMahon (30

p. 28); Knapp, et al. (16, p.19), and Blackwell (2 , pp.23-27).

Kidwell (11, pp.54-60) studied the growth relations in range cattle for five periods (including two winters). Gains during succeeding periods were negative and significant. He concluded that environmental influences exert the greatest effect on the relation between gains at these different periods, but that heredity is also effective.

Koger and Knox (17, p.765) consider that a positive relationship between growth at different periods would be most in evidence where the environment is held uniform. A negative relationship would be expected when environmental variations are experienced during one period and later removed, allowing a compensation for over or under growth during the first period. The net result is a balance between the two influences.

Black and Knapp (1 , p.75) found no relation between efficiency of gain in the birth-to-weaning period and the efficiency of gain in the weaning-to-slaughter period. They conclude that the period prior to weaning is apparently of no value in predicting economy of gain after weaning.

These workers found a negative correlation ($r = -.36$) between average daily gains made in the birth-to-weaning and weaning-to-slaughter periods. This negative trend has been reported by other workers, but it lacked significance according to Blackwell (2 , p.34) and Dahmen and Bogart (5 , p.18).

This might be expected since weaning weight is largely a function of the dam's maternal ability (14, p.585). These authors give a heritability estimate for weaning weight of 28 per cent. Since σ_E^2 is such a large factor at the time, there are many possible interactions between inherent growth ability of the calves and milk production of the dams which tend to make weight at weaning the lowest point on the heritability curve.

A feeding period of 168 days was sufficient to indicate differences between progeny groups, providing the data were adjusted for differences in initial weight, Knapp, <u>et al</u>. (16, p.292). If the method of least squares were used to determine the regression of efficiency on mean weights, at least 5 or 6 twenty-eight-day periods were needed to determine the slope of the regression.

Knapp and Clark (13, p.180) found a progressively better measure of genetic growth as the feeding period progressed during a 252-day test. Eighty-four per cent of all the variation in gains was accounted for by genetic influences during the last third of the period, whereas only 10 per cent of the variation in the first third of the feeding period were due to genetic causes. In swine the first half of the feeding period following weaning gave the better measure of genetic growth, Hazel, et al. (10, pp.127-128) and Blunn, et al. (3 , p.49).

Clark, et al. (4, pp.10-12) compared steer progeny from several Hereford bulls. Because of the great sire differences they advocated the use of the progeny test in evaluating beef bulls. Stanley and McCall (26, p.51) found differences between sire groups of calves in the amount of gain made in the feed lot. Knapp, et al. (16, p.19) showed that inherited differences between the progeny from various sires existed in weaning weights, daily gain in the feed-lot, and weights of heifers at 18 and 30 months of age.

Knapp and Nordskog (12, p.69) reported estimates of heritability for some of the important productive characteristics in beef cattle. These were subsequently revised by Knapp and Clark (14, p.587) as follows: Birth weight, 53 per cent; weaning weight, 28 per cent; final feed lot weight at 15 months, 86 per cent; and gain on feed, 65 per cent.

Knapp and Clark (13, p.180) and Patterson, et al. (22, p.608) found that the ability to gain is highly inherited. Selection based on performance of the individual should prove the most effective in improving rate of gain in beef cattle. (The greatest rate of progress, at least in the initial stage, would be expected from mating superior performing animals irrespective of any predetermined lines.)

Weaning causes a transitory reduction in immediately subsequent gains as observed by Green and Buric (9 , p. 566). They assume that a calf weaned at a given age requires a preliminary feeding period of a certain length of time (T) prior to test feeding to eliminate preweaning influences. A test feeding period of duration (X) is then needed to evaluate comparative performance. The value (T) is theoretically the quotient of the accumulation of preweaning influences (A) divided by (R) the rate at which these influences are dissipated.

It is one of the aims of the present study to determine whether this postweaning reduction in gain and other features of the early test period are related to previous and, more importantly, to subsequent performance on test. Further, does this individual weaning response and adjustment to feed lot conditions vary in such a manner and to such an extent that it could be included or considered in the test period?

MATERIALS AND METHODS

The data used in this study are from 19 purebred Hereford bull calves at the Oregon Agricultural Experiment Station under the Western Regional Beef Cattle Improvement Project. All were produced at this station and dropped during the spring of 1953. They were weaned at approximately 400 pounds body weight, or on December 30, 1953, whichever came first, and placed under experimental conditions immediately.

a. Collection of Data

All calves were weighed at birth and then once weekly at a uniform time of day until 800 pounds body weight. In addition to these regular weighings, during the week following weaning each calf was weighed on the first, third and fifth days. In subsequent weeks, until a body weight of 500 pounds was reached, additional weight records were taken on the third day of each week.

Following weaning the animals were individually stall fed twice daily at regular times and remained tied by neck chains for a total of approximately eight hours. Mangers were constructed so that calves had access to water at all times through automatic drinking cups. Pens, in which wood shavings were used for bedding, housed the calves in monosexual groups of six.

The ration used has been described by Nelms, et al. (21, pp.1-2). It was composed of 2 parts chopped alfalfa and 1 part concentrate, mixed thoroughly and pelleted in a one-inch pellet about one and one-half inches long. This permitted accurate determination of feed consumption. All animals were full-fed so that there was some weighback after each feeding. Feed consumption was determined at every weighing.

Clinical observations were made of the animals during the early feeding period. Such conditions as scouring, fever, bloat, etc. were noted.

The dam's daily milk production was estimated at weaning. The cow was milked out in the evening immediately following removal of her calf. She was milked next morning and again in the afternoon. The twenty-four-hour production was based on the last two milkings. To insure complete let-down of milk 2 milliliters of oxytocin was injected into the jugular vein at the commencement of the first and third milkings. (6, pp.211-223)

b. Treatment of Data

Cumulative growth curves for all animals were plotted from birth to 800 pounds. The segment of the curve from approximately twenty-one days before weaning to seventy days after weaning was enlarged and plotted as a subset on the same graph paper. A smooth curve of best fit was drawn through these points to more accurately determine the time required for each animal to regain its weaning weight (Figure 1). Individual values and the mean were calculated.

The maximum loss of weight immediately following weaning was taken as the difference between weaning weight and the lowest weight recorded after weaning and before weaning weight was first regained. Individual values and the mean were calculated.

The time at which the growth rate assumed a constant rate of increase characteristic of the 500-to-800-pounds test period was calculated objectively as follows: The linear regression of weight on time during 500-to-800-pounds period was calculated by least squares analysis for each animal. The standard deviations for every third animal, starting with the first, were calculated. These were pooled to approximate the average standard deviation from the 19 regression lines. Each regression line was extrapolated below the test period. Individual differences between actual weight and estimated weight were calculated. When the sum of any two such differences were significantly different ($P = .05$) from zero, the growth curve was considered to have deviated from the regression line. The next weight above these was taken

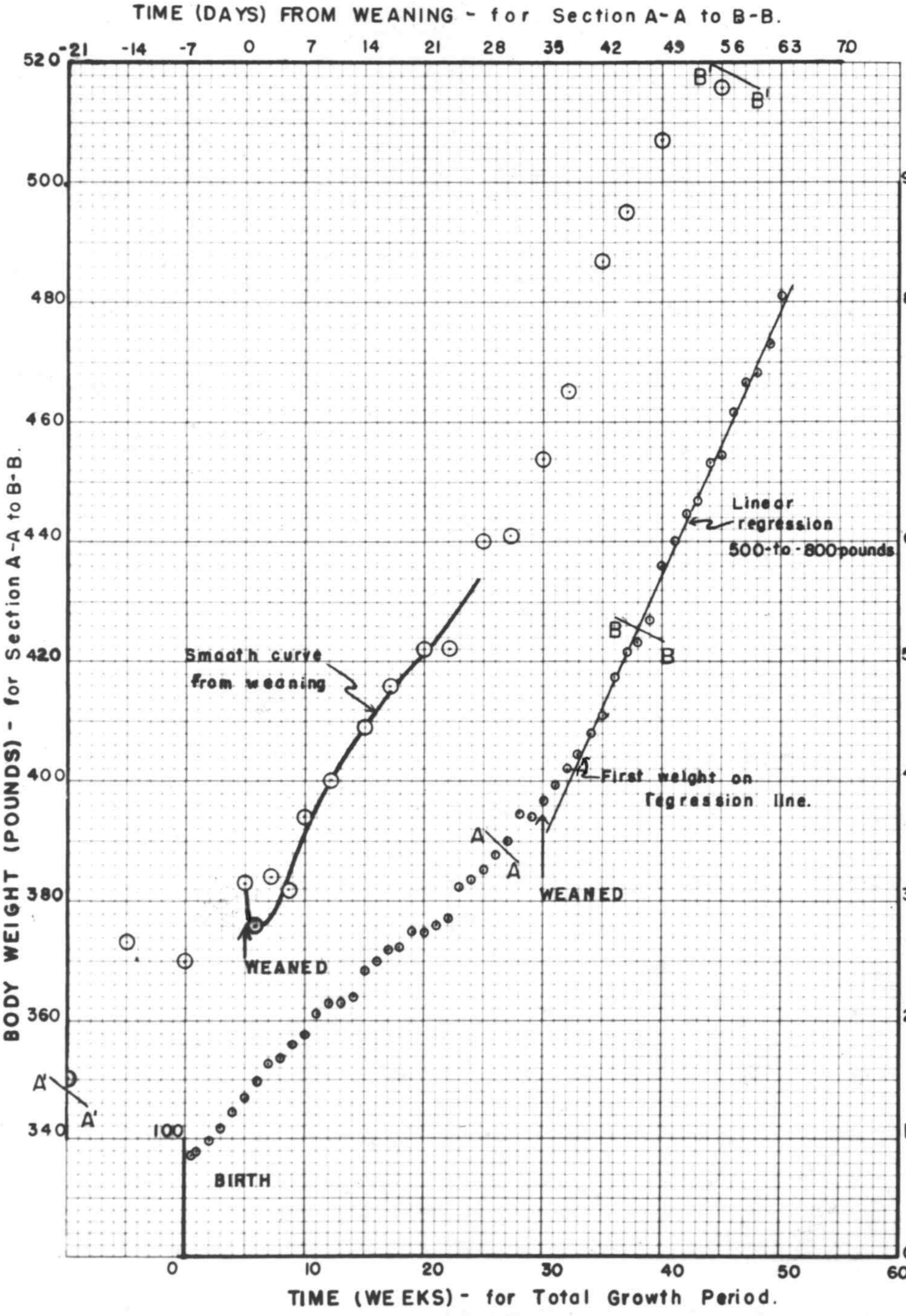

FIGURE I: GROWTH CURVE OF BULL NUMBER 34 WITH EXPANDED SECTION A-A TO B-B ABOUT WEANING.

as being the first time an animal was on constant rate of increase (Figure 1 and Appendix I). The number of weeks between this point and weaning was counted.

The time when 95 per cent of the animals can be expected to have reached such a point in growth was calculated as equalling $\bar{x} + t_{.05}\,s$.

The nutritive requirements for maintenance and for maintenance plus a gain of one pound a day were obtained from the recent publication by Winchester and Hendricks (28, pp.15-17). The corresponding amounts of ration were calculated from an estimated value of 65 pounds T.D.N. per 100 pounds of feed. Feed values used were from Morrison (20, pp.1086-1131).

Daily rate of gain was calculated for the following periods: birth to 300 pounds, birth to weaning, weaning to 500 pounds, weaning plus 200 pounds, weaning plus 300 pounds, and 500 to 800 pounds. Feed efficiency (pounds of feed consumed per 100 pounds liveweight gain) was calculated for the following periods: weaning to 500 pounds, weaning plus 200 pounds, weaning plus 300 pounds, and 500 to 800 pounds.

Initially, scatter diagrams were plotted to indicate trends and possible relationships between the measurements of immediate interest. In cases where more specific information was required regression and correlation coefficients were calculated as outlined by Snedecor (25, pp.214-239, pp.340-373). Unless otherwise stated, significance in this study refers to the 5 per cent level.

RESULTS

Calves varied considerably in their response to the joint effects of weaning and commencement of the feeding period. This was assessed by loss of weight, time to regain weaning weight, time to adjust to the rate of gain during test (500 to 800 pounds), and by their initial feed consumption. Individual and mean figures for the above are presented in Table 1.

The time when 95 per cent of the animals can be expected to have adjusted to rate of gain on test is 9.4 weeks postweaning.

There was a negative correlation which lacked significance between rate of gain from birth to weaning and rate of gain from 500 to 800 pounds (Table 2).

1. Relation of Response to Weaning to Preweaning Influences

The relation which previous suckling performance bears to this period of adjustment following weaning was considered. Scatter diagrams were plotted for these measurements against the rate of gain from birth to weaning. No definite correlations were detected. A regression for time to regain weaning weight on gains during the suckling period was not significant (Table 2).

Another measure of the preweaning performance was

TABLE 1

Factors Used to Appraise Weaning Response

Calf Number	Loss of Weight After Weaning (pounds)	Time to Regain Weaning Weight (days)	Time to Adjust to Rate of Gain During Test (weeks)	Feed Consumption During First Week After Weaning (pounds)
4	41	8	1	64.0
6	11	8	- 1	65.4
8	4	4	3	62.6
9	18	3	0	66.1
10	35	7	- 4	62.4
12	0	1	- 4	61.5
13	8	3	3	66.3
15	31	7	7	60.2
16	19	14	1	59.6
17	23	11	2	43.9
19	13	7	7	59.4
21	22	10	4	56.7
22	9	4	10	52.2
25	13	5	10	66.1
26	25	7	6	66.4
27	15	7	6	74.8
34	7	5	3	67.9
35	15	5	3	61.1
36	9	5	6	60.8
Mean	16.7	6.4	3.3	62.0

TABLE 2

Regression and Correlation Coefficients Between Rate of Gain, Weaning Responses, and Feed Efficiency

Variates	Regression Coefficient - b Correlation Coefficient - r
Rate of gain 500-to-800-pounds on rate of gain birth-to-weaning	b = -0.20 r = -0.29
Days to regain weaning weight on rate of gain birth-to-weaning	b = 2.15 r = 0.25
Days to regain weaning weight on suckling gain ratio: Birth-to-weaning / Birth to 200 pounds	b = -0.09 r = -0.02
Days to regain weaning weight on rate of gain 500-to-800-pounds	b = 1.05 r = 0.09
Rate of gain 500-to-800-pounds on weeks to adjust to rate of gain on test	b = -0.002 r = -0.02
Feed efficiency (Feed/100 pounds gain) 500-to-800 pounds on feed consumption during first week after weaning	b = -1.48 r = -0.15
Days to regain weaning weight on loss of weight after weaning (pounds)	b = 0.15* r = 0.53*
Days to regain weaning weight on feed consumption during first week after weaning	b = -0.16 r = -0.33

* Significant at 5 per cent level.

determined by dividing the daily rate of gain from birth to weaning (at approximately 400 pounds) by the daily rate of gain from birth to 300 pounds. This ratio was considered a more accurate indication of the immediate preweaning growth rate in relation to milk production of the dam, than would have been obtained with the rate of growth from 300 to 400 pounds alone. It will be realized that a value of more or less than unity indicates an increased or decreased growth rate during the last part of the suckling period. This ratio likewise bore no detectable relationship to postweaning loss of weight or to time required to regain weaning weight. It did, however, show a marked positive correlation with initial food consumption (first week). After the first week this relationship to food consumption declined.

Milk production at weaning was estimated quantitatively for eight cows (Table 3). The fact that these records showed no relation to the factors studied in the weaning response is not considered significant because of the limited number of observations made.

2. Interrelation of Factors During the Immediate Postweaning Period

There was a positive significant correlation between maximum loss of weight following weaning and the time taken to regain weaning weight (Table 2). When the time to regain weaning weight was regressed on feed consumption during the first week, a negative and non-significant correlation was revealed.

The animals taking the longer time to regain weaning weight were those which lost the most weight and had a tendency to consume the least feed immediately following weaning. However, there was no indication that loss of weight as a result of weaning and feed consumption during the first week following weaning were related. There might have been a more definite relationship here had the daily feed consumption from weaning to the time of maximum weight loss been used instead of the feed consumption for the whole of the first week.

Since the weaning weight varied from 368 to 458 pounds a further refinement would be to subtract the estimated maintenance requirement from the weekly food consumption. In other words the food intake above maintenance may be more closely related to weight changes at this time.

In no case was the feed consumption during the first week in the feed lot below calculated maintenance. (For a 400 pound animal calculated maintenance was 4.6 pounds of feed per day.) However, three out of the four instances in which feed intake is less than the calculated

TABLE 3

Daily Milk Production of Beef Cows at the Time the Calves Were Weaned

Calf Number	Cow Number	Length of Lactation	Milk Production		
			7 A.M.	5 P.M.	Total Daily
		days	gms	gms	gms
C 15	H 2	167	710	3070	3780
C 10	H 11-0	169	1360	1355	2615
C 59	A 37	169	1360	1995	3355
C 56	A 23	174	1815	720	2535
C 55	A 67	176	1360	2505	3865
C 4	H 4-0	185	625	2015	2640
C 53	A 36	185	720	2225	2945
C 52	A 111	187	580	3480	4060

requirements for maintenance plus one pound gain per day were also individuals taking considerably longer than the mean time to regain weaning weight.

3. Relation of Response to Weaning to Postweaning Performance

Rate of gain on test (500-to-800-pounds period) was not related to initial loss of weight following weaning, to time to regain weaning weight, or to time required for adjustment to rate of gain on test (Table 2).

Likewise feed efficiency during the test period (500-to-800-pounds) showed no correlation with any of the factors listed above. There was a non-significant correlation of feed efficiency on test with feed consumption during first week following weaning. There may be a tendency, therefore, for the animals coming on feed more readily to be the more efficient.

4. Interrelation of Performance During Different Periods of Weaning-to-800-Pound Period.

If immediate postweaning performance is not related to subsequent performance, as at present assayed from 500 to 800 pounds, then (providing individual variation is not too great) the inclusion of this postweaning period should not affect the results unduly.

To test this, growth rates and feed efficiencies were calculated for weaning plus 300 pounds, weaning plus 200 pounds, and weaning to 500 pounds. (Where weaning to 500 pounds was less than 100 pounds, weaning plus 100 pounds was used.) These figures were plotted against the growth rates and feed efficiencies from 500 to 800 pounds.

The animals are ranked for each of the above characteristics in Table 4 for growth rate and in Table 5 for efficiency. The animals which would be selected (or culled) on the criterion of rank in gains or efficiency appear in the upper (or lower) sections. The animals so designated in each column are compared with those in the corresponding section of the 500-to-800-pounds column as a basis. Animals common to both are marked in both columns. In the fifth column of Table 4 the animals are listed on the basis of the 500-to-800-pound period less one week. This was calculated to show the effects of the variation of one week on the repeatability of the values obtained from the 500-to-800-pound period as at present measured.

TABLE 4

Selection on the Basis of Rate of Gain

	500-to-800-Pound Period	Weaning-to-500-Pound Period	Weaning + 200-Pound Period	Weaning + 300-Pound Period	500-to-800-Pound Period Less 1 Week
	34 abc	12	26	22 c	22
	22 abc	26	9 b	10	34
Upper	16	22 a	34 b	26	16
Third	9 abc	9 a	21	34 c	35
	35	34 a	22 b	9 c	9
	27 X	10	10	21	21 X
	21	27	27	12	10
	10	21	6	27	36
	36	4	12	16	27
	26	6	36	17	8
	6	16	4	35	17
	8	8	17	6	6
	17	36	19	36	26
	15 abc	17	35	19 c	15
	12	25 a	15 b	8	12
Lower	4 c	19 a	16	15 c	4
Third	13 abc	13 a	8	4 c	19
	19 a c	15 a	13 b	13 c	13
	25 abc	35	25 b	25 c	25

a - indicates animal designated by both 500-to-800-pound and weaning-to-500-pound periods.

b - indicates animal designated by both 500-to-800-pound and weaning-plus-200-pound periods.

c - indicates animal designated by both 500-to-800-pound and weaning-plus-300-pound periods.

X - indicates animal designated either by the period of 500-to-800-pounds or by this period less one week but not selected by the other.

TABLE 5

Selection on the Basis of Feed Efficiency

	500-to-800-Pound Period	Weaning-to-500-Pound Period	Weaning + 200-Pound Period	Weaning + 300-Pound Period
Upper Third	12 abc	13 a	16	4 c
	13 abc	15 a	12 b	13 c
	4 abc	8	8	16
	19	16	13 b	8
	15 a c	4 a	4 b	12 c
	10 ab	10 a	10 b	15 c
	21	25	15	25
	8	6	25	6
	6	17	6	19
	17	36	19	10
	36	19	27	21
	25	35	35	36
	26	34	17	27
Lower Third	16	21	21	34 c
	9 abc	27 a	36	19
	35 c	12	22 b	35 c
	27 a	9 a	34 b	9 c
	22 abc	26	26	26
	34 bc	22 a	9 b	22 c

a - indicates animal designated by both 500-to-800-pound and weaning-to-500-pound periods.

b - indicates animal designated by both 500-to-800-pound and weaning-plus-200-pound periods.

c - indicates animal designated by both 500-to-800-pound and weaning-plus-300-pound periods.

DISCUSSION

Weaning is the process of accustoming a young animal to the loss of mother's milk. Implicit in this definition, and certainly under the present circumstance, there is the concurrent adjustment to a new environment. In nature this is gradually done with the declining milk production of the dam and increasing dependence of the young animal on its foraging ability. Under the conditions at this institution as with production testing of beef cattle in general, weaning results in the sudden loss of milk and is accompanied by placing the calf on *ad libitum* feed, under rather restricted and controlled conditions. The animal is called upon to make the necessary physiological and psychological adjustments for both of these changes at the same time. (This, of course, not only falls in with management practices but is desirable from the point of view of production testing.) However, it should be understood that the effects of one confound the effects of the other. Therefore, in the current study when reference is made to the "weaning response" or "period of adjustment" in the "immediate postweaning period", one is at the same time considering the effects of the "initial feed lot period".

Inspection of the individual accumulated growth curves of body weight on time in many cases revealed a marked change in rate of growth centered on weaning, (Figure 1). This leaves little doubt as to the wisdom of partitioning the growth curve at this point.

Another striking observation is the linearity of growth during each of these two periods from birth to weaning and from weaning to 800 pounds (the end of the test period). This is valuable since it means that during each period we are measuring growth slopes rather than the results being confounded by changing rates of growth. In the animals studied there was no plateauing before 800 pounds.

Beyond weaning there was a shift in such a way that the rate of growth approached the optimum. Usually growth rate during this change was less rapid but sometimes it was more rapid than the rate eventually established in the 500-to-800-pound period. The time taken to adjust to this rate varied considerably (Table 1).

The generally strong upward trend of the growth curve when animals are on full feed after weaning is considered to be due to the lower plane of nutrition in force during the suckling period. When these limitations are removed the animal usually grows at an increased rate more nearly approaching its genetic potential.

<u>Preweaning environmental influences</u> are varied and of relatively great magnitude. Outstanding among these is the dam's milk production as shown by many workers under varied conditions.

Knapp and Black (15, p.254) have shown that in beef calves 41 per cent of the variation in rate of gain during the suckling period was accounted for by differences in the amount of milk produced by the dam.

MacDowell, <u>et al</u>. (19, pp.529-545) emphasize that growth of the mouse is limited by the quantity of mother's milk available. As this limitation is removed the growth curve approaches a parabola, which is abruptly interrupted at the end of the second week when the natural process of weaning begins. They cite Robertson (23, pp. 373-374) who found no distortion of the curve at weaning (21 days) and hence no physiological disturbance in the young. MacDowell and co-workers found this true if the natural process of weaning has been completed before the mother is removed--but in certain cases especially good mothers continued to nurse their young and delay the complete shift to solid food.

Working with Yorkshire hogs Walden and Wood (27) found the energy intake became limiting on growth rate at or about the tenth day following birth. This was considered due to the physical limitations of the sow to continue to provide all of the milk energy required by her litter.

Gifford (7, p.605) found correlations of .60, .71, .52, and .35 between daily milk production of 57 Hereford cows and daily gain in weight of their calves during the first, second, third and fourth months respectively. After the fourth month there was no significant relationship between the two items. He concludes that the importance of high milk production in beef cows had been overestimated.

In a later study Gifford (8, p.29) confirmed these figures. He also noted that calves produced by low producing cows failed to make normal gains during the first three months, but from then on, during the decline of milk production on the part of their dams, they made normal gains until weaning. The calves from the highest producing dams gained very rapidly during the first three months, but followed a pattern of growth similar to that of the other group as their dams declined in milk production, and at a rate considerably lower than was initiated during the first three months.

The ratio of rate of gain from birth to weaning with the rate of gain from birth to 300 pounds was calculated to utilize this information.

If this ratio had reflected the milk consumption of the calf in the last 100 pounds of the suckling period then it might reasonably have indicated the milk consumption immediately prior to weaning. Whether this result was achieved is not known.

Since creep feeding was available before weaning the ratio might rather have been an indication of the degree to which the calves had availed themselves of the supplement in the latter part of the suckling period--the higher ratios being from those calves who had taken to the supplement. It might be expected that such individuals, being accustomed to the ration, would go on feed more readily in the feed lot. This could explain the positive (though non-significant) correlation of this ratio with feed consumption during the first week on feed.

The fact that the loss in weight following weaning and time to regain weaning weight were significantly correlated is not surprising. However, these factors might have been expected to be related to feed consumption during the first week. However, as pointed out in the results no animal consumed less than its estimated maintenance requirement during this time. Refinements of method were suggested. It is pointed out here that inaccuracies in assessing the actual maximum loss of weight and time taken to regain weaning weight may be important.

These changes immediately following weaning while interesting in themselves are of greatest value to us in a consideration of their effects on subsequent performance. Are these changes so related to subsequent performance and are they of such magnitude that the whole period on feed could or should be included in the test period?

If individually or in their combined effect on the initial rate of gain after weaning, they are positively or negatively correlated with subsequent gain on test, their inclusion would either increase or decrease the individual differences between animals. This would either aid or hinder selection as the case may be.

However, since none of these factors in the weaning response was significantly related to performance on test, the inclusion of this initial postweaning period in the test period would have no effect other than to increase variation. This added variation would most likely be environmental (σE^2) and so decrease the estimate of h^2.

It has to be decided whether such a loss is justified and compensated for in terms of economy and convenience.

When animals were ranked on the basis of growth rate and on feed efficiency calculated to include the whole period from weaning, a good agreement was obtained with the results from 500-to-800-pound period. It might be pointed out, however, that even the 500-to-800-pound period is not absolute as a selection criterion. When growth rate was assessed for a gain of 300 pounds only one week earlier than the present 500-to-800-pound period, results were sufficiently different in some animals to change their order of rank and hence of their chances of selection (Table 4).

These considerations suggest that under the relatively uniform conditions of this herd comparable selection can be achieved when the whole period from weaning is included. Further, a shorter gain period, even down to weaning plus 100 pounds, insures selection comparable with the present 500-to-800-pounds period. In most cases individual performance values are lower by these modifications. However, the magnitude does not matter so much as order. For purposes of selection we are mostly concerned with isolating the animals of superior worth within a herd. We cannot make valid comparisons between animals tested under different environments.

While the foregoing is of interest and of possible practical value under certain conditions, there is no doubt that for the more accurate results there should be a period of adjustment following weaning. It is during the first one or two weeks postweaning that the major variations in weaning response occur (Table 1). By starting the official test two weeks after weaning these chance variations would be largely eliminated. While this applies to conditions under which all animals had comparable pretest (preweaning) environment (such as at this institution) a longer time may be necessary when calves are from varied environments.

CONCLUSIONS

1. The animal's response to weaning as determined by initial loss of body weight, time to regain weaning weight, time to adjust to constant rate of increase in weight, and by the food consumption during the first week could not be demonstrated as being related to its subsequent feed lot rate of gain or feed efficiency as at present determined during the period from 500 to 800 pounds.

2. There is a marked individual variation in the ability of beef bull calves to adjust to weaning and to the beginning of stall feeding.

3. The rate of gain from birth to weaning was not related to weaning response.

4. There was no relationship of the different criteria used to assess the response to weaning with the exception of the time required to regain weaning weight and the amount of weight lost immediately following weaning. These factors were positively correlated.

5. The growth was linear both during the preweaning and the postweaning periods, but the slopes of the growth curves were not the same for the two periods.

6. Where calves have comparable preweaning conditions

a long period on feed prior to beginning the feed lot performance records is apparently unwarranted. Nevertheless, an adjustment period of two weeks is advisable.

7. A short 100 to 150 pound gain period taken from weaning may be of value when one is concerned not so much for individual accuracy of test but rather for selection of the best performing <u>group</u> of animals. Such a case may be a rancher who wishes to test out a number of young animals from his herd and who might not be prepared or able to run a more precise test.

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APPENDIX I

Example of calculation for time at which growth rate assumed a constant rate of increase characteristic of the 500-to-800-pounds test period. (See page 10, Figure 1 and Table 1.)

The average (pooled) standard deviation (s^2P) from the 19 regression lines is 105.54.

The least significant difference (for 2 observations) equals $t_{.05}\sqrt{2\ s^2P} = 29.0$.

The calculations for bull number 34 are as follows:

$b = 22.09$ $\quad\bar{Y} = 637$ $\quad\bar{X} = 7$

	$\bar{X}$-X	Y	Y-$\bar{Y}$
	5	516	-15
	6	507	3
	7	487	5
	8	454	- 6
	9	440	2
	10	422	6
	11	409	15
	12	394	22
Weaned:	13	383	33
	14	370	42

Where $\bar{X}$ is the mean of the number of weeks in 500-to-800-pound period.

X is the week for which the weight is being estimated (X = 1 at the first observation in the 500-to-800-pound period).

$\bar{Y}$ is the estimated weight at week X.

Y is actual weight at week X.

Y-$\bar{Y}$, then, is the deviation from the regression line. In the above example the first two deviations whose sum is greater than 29.0 are 15 and 22. The first weight above these, i.e., 422, was taken at the first time this was on constant rate of increase.