QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
DIVISION OF ANIMAL INDUSTRY BULLETIN No. 131

# STUDIES ON FACTORS IN BEEF CATTLE PRODUCTION IN A SUBTROPICAL ENVIRONMENT. 3. GROWTH FROM WEANING TO YEARLING

By G. I. ALEXANDER, B.V.Sc., M.S., Ph.D., and A. W. BEATTIE, B.Sc.Agr.

SUMMARY

**Data from 806 calves from 306 cows during the years 1955-1962 at "Brian Pastures" Pasture Research Station in south-eastern Queensland were analysed. The inter-relationships between birth weight, weaning age, daily gain to weaning, weaning weight, weaning score, yearling weight, yearling score, gain from weaning to yearling and daily gain during four 3-monthly sub-periods of that time were studied. The effects of sex, year of birth, age of dam, weight of dam and time of birth on these characteristics were evaluated.**

**The mean birth weight of all calves was 66·7 lb, suckling gain 1·49 lb per day, weaning weight 340 lb, yearling weight 535 lb, and gain from weaning to yearling 194 lb. Year differences were observed in all variates. Sex differences were recorded in birth weight, suckling gain and weaning weight. Heifers' calves differed from calves from adult cows in suckling gain, weaning weight and yearling score. Cows not having a calf in the previous year were 41 lb heavier than cows having a calf in the previous year and produced calves with greater suckling gain, weaning weight and yearling weight.**

**The repeatabilities of birth weight, suckling gain, weaning weight, weaning score and yearling weight ranged from moderate to high.**

**Yearling weight was associated with all characteristics studied and yearling score was associated particularly with suckling gain, weaning weight, weaning score, yearling weight and gain from weaning to yearling. Gain from weaning to yearling was asssociated only with its component gains and yearling weight and yearling score.**

## I. INTRODUCTION

Investigations into the growth rate of beef cattle under Queensland conditions have been reviewed by Sutherland (1959) and have dealt almost exclusively with the description of growth after weaning. Previous papers in this series (Alexander

*et al.* 1960; Alexander, Beattie, and Sutherland 1964) have considered performance up to weaning. It is proposed in this paper to examine performance during the period for 12 months after weaning and its relationship to performance prior to weaning.

## II. EXPERIMENTAL PROCEDURE

The data studied in this paper were based on the growth rate of 806 calves from 306 cows over the 8 years 1955 to 1962," at "Brian Pastures" Pasture Research Station in south-eastern Queensland. Owned by the Australian Meat Board, the station is operated by the Queensland Department of Primary Industries as a pasture research station with emphasis on beef cattle production. The property is situated about 10 miles from Gayndah in latitude 25° 40'S. and has an average rainfall of 29 in., mainly of summer incidence. The property consists of ridges of varying slopes and broken areas of river bank and flood plain regions along the small creeks flowing into Barambah Creek. The vegetation was originally open forest and the pasture grasses now are *Heteropogon contortus* and species of *Dichanthium* and *Bothriochloa.*

The cattle on the property are grade Poll Hereford cows of known age seasonally mated to Poll Hereford bulls, so that the calving is extended over approximately 10 weeks from late October to early January. Weaning is usually practised at an average age of 6 months and is associated with a settling-down period of 10 days, during which the calves are fed a hay ration in yards. After this, they are released into a paddock of native pasture.

Regression and correlation methods were used to estimate the inter-relationships among birth weight of calf, weight of dam, weaning age of calf, daily gain in weight of calf from birth to weaning (suckling gain), weaning weight, weaning score, yearling weight, yearling score, daily gain in weight from weaning to yearling and four 3-monthly sub-periods of this time. Yearling weight was taken on the weighing date approximating most closely 12 months after weaning.

The weight of the dam was taken to be that at the time of weaning of the calf, while the weaning and yearling scores were the average of scores placed on each animal by four independent scorers. Two scorers were beef cattle producers and two were Departmental officers; the scoring method used was that described by Wagnon, Albaugh, and Hart (1960). The gains from weaning to yearling were divided into four 3-monthly periods, namely May to August, August to November, November to February and February to May, to observe any relationships between sub-period gains and the other critera.

Preliminary analyses of the data indicated that interactions were unimportant and regressions could be regarded as homogeneous from year to year. An additive linear model was therefore fitted by least squares, constants being years, sex, previous history of cow (i.e. calved or did not calve in previous year), and cows. The computational techniques of Rao (1955) were used. The data from all 806 calves were used for all variates except yearling score, for which only data for 727 calvings from 288 cows were available.

**TABLE 1**

MEAN VALUES FOR THE VARIOUS PREWEANING AND POST-WEANING PERFORMANCE CHARACTERISTICS

| Item | Overall Mean and Standard Deviation | Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 | 1962 |
| Birth weight (lb) .. .. .. .. | 66·7 ± 9·5 | 67·8 | 68·7 | 72·1 | 64·5 | 70·0 | 68·2 | 55·7 | 71·6 |
| Weight of dam (lb) .. .. .. .. | 898 ± 107 | 896 | 897 | 809 | 897 | 927 | 844 | 926 | 939 |
| Weaning age (days) .. .. .. .. | 183 ± 18·0 | 186 | 186 | 185 | 187 | 187 | 190 | 197 | 192 |
| Suckling gain (birth to weaning) (lb per day) | 1·49 ± 0·23 | 1·50 | 1·55 | 1·35 | 1·60 | 1·51 | 1·38 | 1·49 | 1·42 |
| Weaning weight (lb) .. .. .. .. | 340 ± 51 | 345 | 356 | 321 | 369 | 354 | 330 | 349 | 343 |
| Weaning score .. .. .. .. | 74·9 ± 3·3 | 71·3 | 74·4 | 74·3 | 75·2 | 76·1 | 74·9 | 75·8 | 77·3 |
| Yearling weight (lb) .. .. .. .. | 535 ± 70 | 505 | 473 | 546 | 587 | 509 | 558 | 551 | 587 |
| Yearling score .. .. .. .. | 75·0 ± 2·5 | 72·7 | 72·8 | 74·8 | 74·7 | 75·1 | 76·4 | 75·8 | 76·8 |
| Gain (weaning to yearling) (lb) .. .. | 194 ± 50·7 | 160 | 115 | 225 | 219 | 155 | 228 | 202 | 244 |
| Gain (May to August) Period I (lb) .. | 2 ± 29·5 | 13 | 0·4 | −28 | 15 | −23 | −17 | −28 | 71 |
| Gain (August to November) Period II (lb) | 33 ± 23·9 | 13 | 15 | 20 | 57 | 25 | 34 | 94 | −0·3 |
| Gain (November to February) Period III (lb) | 110 ± 27·0 | 76 | 103 | 99 | 100 | 144 | 133 | 101 | 141 |
| Gain (February to May) Period IV (lb) .. | 49 ± 33·1 | 58 | −3 | 134 | 47 | 9 | 77 | 34 | 33 |

## III. RESULTS

*Pre-weaning Performance.*—The criteria of pre-weaning performance—namely birth weight, weight of dam, weaning age, suckling gain, weaning weight and weaning score—are presented in Tables 1–3. Year differences were observed for all characters ($P < 0{\cdot}001$) except weaning age. These differences remained when the influence of weaning age was removed.

TABLE 2

EFFECT OF SEX AND HISTORY OF DAM ON THE PREWEANING AND POST-WEANING PERFORMANCE CHARACTERISTICS

| Item | Male-Female (Mean Difference and Standard Error) | Difference Adult without Calf Previous Year—Adult | Adult—Heifer |
|---|---|---|---|
| Birth weight (lb) | 4·86 ± 0·74‡ | 1·47 ± 1·14 | −0·49 ± 1·22 |
| Weight of dam (lb) | 2·46 ± 4·66 | 41·0 ± 7·2‡ | 58·0 ± 7·6‡ |
| Weaning age (days) | −1·01 ± 1·54 | 8·02 ± 2·37‡ | −8·61 ± 2·52‡ |
| Rate of gain (birth to weaning) (lb per day) | 0·032 ± 0·015* | 0·082 ± 0·023‡ | 0·139 ± 0·025‡ |
| Weaning weight (lb) | 9·94 ± 3·37† | 28·1 ± 5·18‡ | 11·0 ± 5·5* |
| Weaning score | 0·327 ± 0·251 | 0·626 ± 0·386 | 0·643 ± 0·411 |
| Yearling weight (lb) | 5·75 ± 5·43 | 22·6 ± 8·4† | 7·5 ± 8·9 |
| Yearling score | −0·390 ± 0·224 | 0·375 ± 0·342 | 0·761 ± 0·373* |
| Gain (weaning to yearling) (lb) | −4·59 ± 4·43 | −5·7 ± 6·8 | −3·1 ± 7·3 |
| Gain (Period I) (lb) | 2·05 ± 2·52 | −5·9 ± 3·9 | −0·16 ± 4·1 |
| Gain (Period II) (lb) | 2·22 ± 2·06 | −4·8 ± 3·2 | −3·5 ± 3·4 |
| Gain (Period III) (lb) | −3·62 ± 2·32 | 4·6 ± 3·6 | −2·2 ± 3·8 |
| Gain (Period IV) (lb) | −5·23 ± 2·88 | −0·4 ± 4·4 | 2·8 ± 4·7 |

* = Significantly different at 5% probability level.

† = Significantly different at 1% probability level.

‡ = Significantly different at 0·1% probability level.

TABLE 3

REPEATABILITY OF THE VARIOUS FACTORS

| Item | Repeatability | 95% Fiducial Intervals |
|---|---|---|
| Birth weight | 0·25 | +0·17 to +0·33 |
| Dam weight | 0·77 | +0·72 to +0·80 |
| Weaning age | 0·11 | −0·03 to +0·19 |
| Rate of gain (birth to weaning) | 0·48 | +0·41 to +0·55 |
| Weaning weight | 0·47 | +0·40 to +0·54 |
| Weaning score | 0·30 | +0·22 to +0·38 |
| Yearling weight | 0·25 | +0·17 to +0·33 |
| Yearling score | 0·12 | +0·04 to +0·21 |
| Gain (weaning to yearling) | 0·07 | −0·01 to +0·15 |
| Gain (May to August) | 0·10 | −0·02 to +0·18 |
| Gain (August to November) | 0·09 | −0·01 to +0·17 |
| Gain (November to February) | 0·09 | −0·01 to +0·18 |
| Gain (February to May) | 0·08 | −0·00 to +0·16 |

Sex differences were apparent in birth weight ($P<0\cdot001$), suckling gain ($P<0\cdot05$) and weaning weight ($P<0\cdot01$) and were not influenced when the effect of weaning age was removed.

Appreciable differences were demonstrated in weight of dam, weaning age and suckling gain between calves from adult cows and heifers ($P<0\cdot001$), while the difference between the weaning weight of calves from adults and from heifers was significant at the 5% level of probability (Table 2). These differences remained when the effect of weaning age was eliminated. In the comparison between calves from cows which did not calve in the previous year and from cows which did, differences were demonstrated in weight of dam, weaning age, suckling gain and weaning weight ($P<0\cdot01$). When the effect of age at weaning was removed, these differences still remained and weaning score differences were demonstrated ($P<0\cdot05$).

*Yearling weight.*—The mean yearling weight of all calves was 535 lb based on the production of the dam as an adult and averaged over years, sexes and cows (Table 1). There were highly significant year differences in yearling weight. There was no sex difference nor any difference between calves from heifers and those from adult cows, but a significant difference was demonstrated between calves from cows which did not have a calf the previous year and those which did (Table 2). The repeatability of yearling weight was significant at $0\cdot25$, which was comparable to that of many of the preweaning performance characteristics.

*Yearling score.*—Yearling score did not vary as much as the other characteristics studied (Table 1), having a coefficient of variation of only $3\cdot3\%$. Year differences were significant and appeared to indicate a trend for score to increase with time. The score of yearlings from adult cows was significantly higher than the score of heifers' offspring ($P<0\cdot05$), but no sex difference nor one between offspring from adults without a calf the previous year and those from adults having a calf the previous year was detected. A significant repeatability of $0\cdot12$ was recorded for yearling score.

*Gain (weaning to yearling).*—The gain over this 12-month period, averaging 194 lb, was particularly variable (Table 1), the coefficient of variation being $26\cdot1\%$. The marked year differences ($P<0\cdot001$) confirmed that the variation was strongly influenced by seasonal effects. No effects from either sex or type of dam were observed.

The partitioning of this gain into four separate 3-monthly periods of liveweight change indicated that gains were recorded on the average in each period. The period November to February showed the greatest mean gain and the period May to August the least. The latter period showed the greatest variation in weight change and the former period the least. The other two periods were intermediate in the magnitude of gain and variability, with the mean gain over the August to November period being 33 lb and that for February to May being 49 lb. Repeatability estimates for post-weaning gain and its components were low and not significant.

**TABLE 4**

PHENOTYPIC CORRELATION COEFFICIENTS BETWEEN PREWEANING AND POST-WEANING PERFORMANCE CHARACTERISTICS

| Item | Birth Weight | Weight of Dam | Weaning Age | Suckling Gain | Weaning Weight | Weaning Score |
|---|---|---|---|---|---|---|
| Yearling weight .. .. .. | +0·33† (+0·38)‡ | +0·23† (+0·23)† | +0·24† | +0·57‡ (+0·62)‡ | +0·68‡ (+0·66)‡ | +0·46‡ (+0·44)‡ |
| Yearling score .. .. .. | +0·12 (+0·14)* | +0·08 (+0·07) | +0·18* | +0·28† (+0·31)† | +0·35† (+0·31)† | +0·43‡ (+0·41)‡ |
| Gain (weaning to yearling) .. | +0·08 (+0·08) | +0·107 (+0·108) | −0·02 | −0·02 (−0·02) | −0·07 (−0·06) | +0·05 (+0·05) |
| Gain (May to August) .. .. | +0·07 (+0·05) | +0·05 (+0·05) | −0·14* | +0·01 (−0·007) | −0·12* (−0·08) | +0·05 (+0·07) |
| Gain (August to November) .. | −0·06 (−0·06) | −0·02 (−0·02) | +0·02 | −0·17† (−0·17)† | −0·14† (−0·16)† | −0·08 (−0·08) |
| Gain (November to February) .. | +0·08 (+0·08) | +0·11* (+0·11)* | +0·05 | +0·07 (+0·07) | +0·08 (+0·07) | +0·07 (+0·07) |
| Gain (February to May) .. .. | +0·05 (+0·06) | +0·04 (+0·04) | +0·03 | +0·03 (+0·04) | +0·04 (+0·03) | +0·02 (+0·02) |

Figures in parentheses are those after weaning age is eliminated.

* = Significantly correlated at 5% probability level.

† = Significantly correlated at 1% probability level.

‡ = Significantly correlated at 0·1% probability level.

*Phenotypic correlations and regressions.*—The effects of the preweaning performance characteristics upon post-weaning characteristics were variable. Yearling weight was significantly influenced by birth weight, weight of dam, weaning age, suckling gain, weaning weight and weaning score (Tables 4–6). Yearling score was influenced by weaning age, suckling gain, weaning weight and weaning score but to a much less degree than yearling weight.

**TABLE 5**

PHENOTYPIC CORRELATION COEFFICIENTS BETWEEN THE VARIOUS POST-WEANING PERFORMANCE CHARACTERISTICS

| Item | Yearling Weight | Yearling Score | Gain Weaning to Yearling | Gain | | | |
|---|---|---|---|---|---|---|---|
| | | | | Period I | Period II | Period III | Period IV |
| Yearling weight .. | .. | 0·52‡ | +0·67‡ | +0·16† | +0·07 | +0·42† | +0·49‡ |
| Yearling score .. | (+0·50)‡ | .. | +0·39‡ | +0·10 | +0·06 | +0·30† | +0·21* |
| Gain (weaning to yearling) .. .. | (+0·70)‡ | (+0·40)‡ | .. | +0·35‡ | +0·25† | +0·50‡ | +0·63‡ |
| Gain (Period I) .. | (+0·20)† | (+0·13)* | (+0·35)‡ | .. | −0·29† | −0·04 | −0·11 |
| Gain (Period II) .. | (+0·07) | (+0·06) | (+0·25)† | (−0·29)† | .. | −0·11* | +0·11 |
| Gain (Period III) .. | (+0·43)‡ | (+0·30)* | (+0·50)‡ | (−0·04) | (−0·12)* | .. | +0·07 |
| Gain (Period IV) .. | (+0·50)‡ | (+0·21)† | (+0·64)‡ | (+0·11) | (+0·01) | (+0·07) | .. |

* = Significantly correlated at 5% probability level.

† = Significantly correlated at 1% probability level.

‡ = Significantly correlated at 0·1% probability level.

Gain from weaning to yearling was not influenced by preweaning performance and there was little relationship between the weight changes in the 3-month periods and preweaning performance. There was, however, a slight tendency for a negative relationship between early post-weaning weight changes and suckling gain and weaning weight (Table 4).

Among the post-weaning performance characteristics, the relationships were more marked. Yearling weight was highly correlated with yearling score, with gain from weaning to yearling and with the sub-period gains with the exception of the second period from August to November. Yearling score was similarly highly influenced by gain from weaning to yearling and was correlated with the gains during the first, third and fourth periods, with coefficients of 0·13, 0·30 and 0·21 respectively after a correction was applied for weaning age. The gain from weaning to yearling was well correlated with gains during all sub-periods but was more closely associated with the gains during the second half of the period. The weight changes in the first sub-period from May to August were negatively correlated ($r = -0.29$) with those in the second period (August to November). The weight changes in the second sub-period were negatively related to those from November to February. No relationships were detected between the weight changes of the other sub-periods.

## TABLE 6

REGRESSION COEFFICIENTS BETWEEN THE PREWEANING AND POST-WEANING PERFORMANCE CHARACTERISTICS

| — | Standard Error of Estimate | Regression Coefficient and Standard Error | 95% Fiducial Interval for Regression Coefficient |
|---|---|---|---|
| Yearling weight on:— | | | |
| Birth weight .. .. | ±59·4 (±56·3) | + 1·15 ± 0·33‡ (+ 1·55 ± 0·31)‡ | + 0·51 to + 1·80 (+ 0·94 to + 2·17) |
| Weight of dam .. .. | ±59·6 (±57·1) | + 0·154 ± 0·052† (+ 0·167 ± 0·050)‡ | + 0·051 to + 0·256 (+ 0·069 to + 0·265) |
| Weaning age .. .. | ±57·7 | + 1·01 ± 0·15‡ | + 0·70 to + 1·31 |
| Suckling gain .. .. | ±54·7 (±50·3) | +149 ±15‡ (+170 ±14)‡ | +120 to +177 (+144 to +197) |
| Yearling score on:— | | | |
| Birth weight .. .. | ± 2·32 (± 2·26) | + 0·0095 ± 0·0134* (+ 0·019 ± 0·0132) | − 0·017 to + 0·036 (− 0·007 to + 0·045) |
| Weight of dam .. .. | ± 2·30 (± 2·25) | + 0·0053 ± 0·0022* (+ 0·0058 ± 0·0022) | + 0·0009 to + 0·0097 (− 0·0015 to + 0·0101) |
| Weaning age .. .. | ± 2·26 | + 0·030 ± 0·0065‡ | + 0·017 to + 0·042 |
| Gain (yearling-weaning) on:— | | | |
| Birth weight .. .. | ±49·0 (±49·1) | + 0·090 ± 0·270 (+ 0·081 ± 0·274) | − 0·44 to + 0·62 (− 0·46 to + 0·62) |
| Weight of dam .. .. | ±49·0 (±49·0) | − 0·059 ± 0·043 (− 0·059 ± 0·043) | − 0·142 to + 0·025 (− 0·143 to + 0·025) |
| Weaning age .. .. | ±49·0 | − 0·032 ± 0·130 | − 0·29 to + 0·22 |
| Gain (Period I) on:— | | | |
| Birth weight .. .. | ±27·9 (±27·6) | + 0·062 ± 0·154 (− 0·030 ± 0·154) | − 0·24 to + 0·36 (− 0·33 to + 0·27) |
| Weight of dam .. .. | ±27·9 (±27·6) | − 0·012 ± 0·024 (− 0·015 ± 0·024) | − 0·060 to + 0·036 (− 0·062 to + 0·032) |
| Weaning age .. .. | ±27·6 | − 0·260 ± 0·073‡ | − 0·40 to − 0·12 |
| Gain (Period II) on:— | | | |
| Birth weight .. .. | ±22·8 (±22·8) | − 0·16 ± 0·13 (− 0·14 ± 0·13) | − 0·41 to + 0·09 (− 0·39 to + 0·11) |
| Weight of dam .. .. | ±22·7 (±22·7) | − 0·050 ± 0·020* (− 0·050 ± 0·020)* | − 0·089 to − 0·011 (− 0·089 to − 0·011) |
| Weaning age .. .. | ±22·8 | + 0·069 ± 0·061 | − 0·050 to + 0·188 |
| Gain (Period III) on:— | | | |
| Birth Weight .. .. | ±25·7 (±25·6) | + 0·19 ± 0·14 (+ 0·22 ± 0·14) | − 0·09 to + 0·47 (− 0·06 to + 0·51) |
| Weight of dam .. .. | ±25·7 (±25·7) | + 0·029 ± 0·022 (+ 0·031 ± 0·022) | − 0·015 to + 0·074 (− 0·013 to + 0·075) |
| Weaning age .. .. | ±25·7 | + 0·086 ± 0·068 | (− 0·048 to + 0·220) |
| Gain (Period IV) on:— | | | |
| Birth weight .. .. | ±31·8 (±31·8) | − 0·003 ± 0·1754 (+ 0·026 ± 0·178) | − 0·34 to + 0·34 (− 0·32 to + 0·37) |
| Weight of dam .. .. | ±31·8 (±31·8) | − 0·026 ± 0·028 (− 0·025 ± 0·028) | − 0·081 to + 0·029 (− 0·080 to + 0·030) |
| Weaning age .. .. | ±31·8 | ± 0·072 ± 0·085 | − 0·094 to + 0·238 |

* = Significant relationship at 5% probability level.

† = Significant relationship at 1% probability level.

‡ = Significant relationship at 0·1% probability level.

## IV. DISCUSSION

The preweaning performance characteristics of birth weight, suckling gain and weaning weight were influenced by sex, previous history of the dam and year-to-year variation, and in general the findings agree with those of Dawson, Phillips, and Black (1947), Nelms and Bogart (1956), Koch and Clark (1955), Clark *et al.* (1958) and Alexander *et al.* (1964).

The initial period of 3 months after weaning includes a period of adjustment for the calf, which has to adjust to a new behaviour pattern without any maternal influence period. It also has to adjust to a lack of any milk supplement to the pasture diet at a period when pasture productivity is not increasing. Under North American performance testing conditions, this period of adjustment has varied considerably. Bogart (1959) found a 2-week period of adjustment satisfactory where animals are handled frequently but considered that calves handled less frequently prior to weaning might need a month or 6 weeks to adjust. Since the animals on "Brian Pastures" are handled quite frequently, it is considered that this factor should not have influenced the weight changes recorded.

The change of diet from the younger pasture supplemented with milk from the dam to the more mature pasture after weaning would be expected to produce a negative correlation between suckling gain and the first sub-period weight changes. This was not borne out by the results reported in this study, which suggests that the growth rate of the calves during the immediate post-weaning period of 3 months was not adversely affected by the withdrawal of milk from the diet of the calf. There was, furthermore, a highly significant negative regression of gain on weaning age during the May to August period, suggesting that the younger calves which were lighter at weaning but growing faster than the older calves gained more weight during this period than did the older calves. When weaning weight was corrected for weaning age, there was no association between weaning weight and gain during the first period from May to August.

It is quite likely that the seasonal variations between the May to August periods of different years masked any of the other influences discussed above. During the second sub-period between August and November, there was much less variation in performance, the coefficient of variation declining from 1,228% for the first sub-period to 73% for the second sub-period. This period was generally marked by positive gains and could be expected to demonstrate some elements of compensatory gain after the performance during the first sub-period. There was a negative correlation coefficient of -0·17 between gain during this period and suckling gain and of -0·16 with weaning weight when weaning age is eliminated. Similarly, there was a negative correlation of -0·29 between the gains from May to August and from August to November. This would suggest that the lighter, slower gaining calves to weaning and the calves which performed poorly during the immediate post-weaning period tended to be superior in growth rate during this period to the remaining calves. The growth depression of these effects could be compensated for during this period of moderate gains and was not of the magnitude reported by Black, Quesenberry, and Baker (1940) and Bohman (1955).

Gains during the subsequent two periods of November to February and February to May averaged 0·8 lb/day. There was a slight tendency for poorer gaining animals during the period from August to November to make up this deficiency during the period from November to February. The gains during this period exerted a considerable influence on the overall weaning to yearling gain and on yearling weight and yearling score but showed little association with other performance characteristics.

These data have implications in the selection of beef cattle breeding stock. The moderately high repeatability of suckling gain, weaning weight and weaning score indicate that they would be useful as an aid to mass selection. Since it is usual to select stock for their post-weaning performance as well as their pre-weaning performance, it is desirable to select characteristics measuring this performance which possess a reasonable level of repeatability. The only post-weaning characteristics showing a suitable level of repeatability is yearling weight. However, because of the extremely great influences of birth weight, and suckling gain on this characteristic, it is probable that its repeatability is a reflection of these influences rather than of its value as a measure of post-weaning performance. Therefore, it is reasonable to expect that selection for suckling gain, a much more repeatable characteristic, may be more effective in influencing yearling weight than selection for yearling weight itself.

The lack of repeatability of gain from weaning to yearling or of its components is disappointing. A number of workers have stressed the need for the selection of stock under the environmental conditions for which they are to be used, particularly because of the need to select animals which can withstand seasonal fluctuations in diet (MacDonald 1956; French and Ledger 1957; Wilson and Osbourn 1960; Butterfield 1966). The data in this study would suggest that, within a population such as reported here, there would be little chance of making genetic gains by selection based on these post-weaning performance criteria. It may be that genetically correlated criteria may provide a more efficient means of selecting for genetically superior post-weaning performance, such as by the use of coat type (Turner and Schleger 1960) or other physiological trait. Selection directly on performance criteria may be effective in a more variable population such as that derived from crosses between Brahman and British cattle.

## V. ACKNOWLEDGEMENTS

The authors wish to acknowledge indebtedness to the following officers of the Queensland Department of Primary Industries: Messrs. M. A. Burns, P. J. Round, J. J. Daly and P. F. Wall for assistance in the collection of the data, and Misses H. I. Usher and P. M. Pepper for assistance in the statistical analyses.

## REFERENCES

ALEXANDER, G. I., SUTHERLAND, D. N., DAVEY, Gillian P., and BURNS, M. A. (1960).—Studies on factors in beef cattle production in a subtropical environment. 1. Birth weight. *Qd J. Agric. Sci.* 17:123-34.

ALEXANDER, G. I., BEATTIE, A. W., and SUTHERLAND, D. N. (1964).—Studies on factors in beef cattle production in a subtropical environment. 2. Growth to weaning. *Qd J. Agric. Sci.* 21:25-32.

BLACK, W. H., QUESENBERRY, J. R., and BAKER, A. L. (1940).—Wintering beef steers on different planes of nutrition from weaning to 2½ years of age. *Tech. Bull. U.S. Dep. Agric.* No. 667.

BOGART, R. (1959).—"Improvement of Livestock". (Macmillan:New York).

BOHMAN, V. R. (1955).—Compensatory growth of beef cattle. The effect of hay maturity. *J. Anim. Sci.* 14:249-55.

BUTTERFIELD, R. M. (1966).—The effect of nutritional stress and recovery on the body composition of cattle. *Res. Vet. Sci.* 7:168-79.

CLARK, R. T., SHELBY, C. E., QUESENBERRY, J. R., WOODWARD, R. R., and WILLSON, F. S. (1958).—Production factors in range cattle under northern Great Plains conditions. *Tech. Bull. U.S. Dep. Agric.* No. 1181.

DAWSON, W. M., PHILLIPS, R. W., and BLACK, W. H. (1947).—Birth weight as a criterion of selection in beef cattle. *J. Anim. Sci.* 6:247-57.

FRENCH, M. H., and LEDGER, H. P. (1957).—Live-weight changes of cattle in East Africa. *Emp. J. Exp. Agric.* 25:10-18.

KOCH, R. M., and CLARK, R. T. (1955).—Influence of sex, season of birth and age of dam on economic traits in range beef cattle. *J. Anim. Sci.* 14:386-97.

MACDONALD, M. A. (1956).—Evaluation and selection of beef cattle. *Proc. Aust. Soc. Anim. Prod.* 1:145-54.

NELMS, G. E., and BOGART, R. (1956).—The effect of birth weight, age of dam and time of birth on suckling gains of beef calves. *J. Anim. Sci.* 15:662-6.

RAO, C. R. (1955).—Analyses of dispersion for multiple classified data with unequal numbers in cells. *Sankhya* 15:253-80.

SUTHERLAND, D. N. (1959).—Factors affecting the performance of beef cattle on unimproved pastures in Queensland. *Aust. Vet. J.* 35:129-34.

TURNER, H. G., and SCHLEGER, A. V. (1960).—The significance of coat type in cattle. *Aust. J. Agric. Res.* 11:645-63.

WAGNON, K. A., ALBAUGH, R., and HART, G. H. (1960).—"Beef Cattle Production." (Macmillan:New York).

WILSON, P. N., and OSBOURN, D. F. (1960).—Compensatory growth after under-nutrition in mammals and birds. *Biol. Rev.* 35:324-63.

(Received for publication February 14, 1967)

Dr. Alexander is Director, Cattle Husbandry Branch, Division of Animal Industry, Department of Primary Industries. Mr. Beattie was previously an officer of the Department. His present address is University of Queensland, Brisbane.