

## STUDIES ON FACTORS IN BEEF CATTLE PRODUCTION IN A SUBTROPICAL ENVIRONMENT. 2. GROWTH TO WEANING

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### SUMMARY

Data from 973 calves from 259 cows during the years 1955-1960 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 and weaning score were studied and the effects of sex, year of birth, age of dam, weight of dam and time of birth on them were evaluated.

The mean birth weight of all calves was 72.3 lb, with very significant sex and year differences. The mean suckling gain was 1.52 lb per day but was the most variable character studied, year differences, age and precalving history of the cow having significant effects. The repeatability of suckling gain was high. Weaning weight averaged 339 lb at 172 days, with significant year, sex and dam influences. Weaning score was not nearly so variable as the other characters measured and was only influenced by whether a cow had had a calf the previous year or not.

Birth weight exerted its major effect on weaning weight, which in turn was closely associated with suckling gain and weaning score.

### I. INTRODUCTION

The seasonal nature of the growth curve of beef cattle under Queensland conditions has been studied quite extensively (Chester 1952; Alexander and Chester 1956; Shelton 1956; Sutherland 1959). However, these investigations have been devoted almost exclusively to the description of growth after weaning. Very little information is available on the performance of beef animals prior to weaning. The first paper in this series (Alexander *et al.* 1960) dealt with birth weight of beef calves. In this paper, it is proposed to examine the period from birth to weaning.

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## II. EXPERIMENTAL PROCEDURE

The investigation recorded in this paper was based on the growth rates of 793 calves from 259 cows during the years 1955 to 1960, inclusive, 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 about 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, which forms the eastern boundary of the property. Originally the vegetation was open eucalypt forest and the pasture grasses now are *Heteropogon contortus* and species of *Dichanthium* and *Bothriochloa*.

Seasonal mating is practised on the property, so the calving usually extended over approximately 10 weeks from late October to early January. The cows were either Hereford or Poll Hereford cows of known age mated to Poll Hereford bulls.

The inter-relationships between birth weight of calf, weight of dam, weaning age of calf, daily gain in weight of calf from birth to weaning, weaning weight, and weaning score were studied. Weaning was considered to be the weighing date nearest to the time when the average age of the calves was six months. The actual weaning dates were somewhat variable; they were close to eight months during the early years but since 1957 have been standardized at six months of age.

Preliminary analyses 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 weight of the dam was taken to be that at the time of weaning of the calf, while the weaning score was the average of scores placed on each calf at weaning 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).

## III. RESULTS

*Birth Weight.*—The mean birth weight based on the dam as an adult having a calf in the previous year and averaged over years, sexes and cows was 72.3 lb. There were very significant year and sex differences in birth weight (Tables 1 and 2). Differences in the birth weights of calves from heifers, cows not having calves in the previous year and cows which did, were not significant (Table 2). The repeatability of birth weight was significant but of relatively small magnitude (Table 3).

**TABLE 1**  
MEAN VALUES FOR BIRTH WEIGHT, WEIGHT OF DAM, WEANING AGE, GAIN, WEANING WEIGHT AND WEANING SCORE

| —                                | Overall Mean and Standard Deviation | Coeff. of Variation (%) | Year |      |      |      |      |      |
|----------------------------------|-------------------------------------|-------------------------|------|------|------|------|------|------|
|                                  |                                     |                         | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 |
| Birth weight (lb) ..             | 72.3 ± 9.4                          | 13.0                    | 71.7 | 72.3 | 75.8 | 68.4 | 73.9 | 71.7 |
| Weight of dam (lb) ..            | 883 ± 105                           | 11.9                    | 879  | 895  | 824  | 912  | 933  | 855  |
| Weaning age (days) ..            | 172 ± 17.7                          | 10.3                    | 172  | 169  | 168  | 174  | 171  | 178  |
| Daily gain to weaning (lb) .. .. | 1.54 ± 0.22                         | 14.6                    | 1.50 | 1.60 | 1.38 | 1.66 | 1.55 | 1.43 |
| Weaning weight (lb) ..           | 339 ± 48                            | 14.2                    | 331  | 345  | 311  | 386  | 338  | 323  |
| Weaning score ..                 | 72.6 ± 3.4                          | 4.6                     | 69.4 | 72.4 | 72.6 | 73.9 | 74.0 | 73.3 |

**TABLE 2**  
EFFECT OF SEX AND HISTORY OF DAM ON THE PREWEANING AND WEANING PERFORMANCE OF THE CALF

| —                          | Male-Female (Mean difference and Standard Error) | Difference Adult without Calf Previous Year—Adult | Adult-Heifer     |
|----------------------------|--|---|------------------|
| Birth weight (lb) .. ..    | 4.94 ± 0.70***                                   | + 1.08 ± 0.99                                     | 2.58 ± 1.35      |
| Weight of dam (lb) ..      | 2.70 ± 3.69                                      | 52.3 ± 5.3***                                     | 57.3 ± 7.19***   |
| Weaning age (days) ..      | -0.11 ± 1.47                                     | 8.15 ± 2.10***                                    | -10.5 ± 2.86***  |
| Daily gain to weaning (lb) | 0.025 ± 0.013***                                 | 0.095 ± 0.019***                                  | 0.149 ± 0.026*** |
| Weaning weight (lb) ..     | 10.52 ± 2.96                                     | 32.0 ± 4.2***                                     | +20.4 ± 5.8***   |
| Weaning score .. ..        | 0.173 ± 0.227                                    | 1.40 ± 0.32***                                    | +0.629 ± 0.442   |

\*\*\* Significant at the 0.1 per cent. level of probability.

**TABLE 3**  
REPEATABILITY OF VARIOUS FACTORS

| —                           | Repeatability | 95% Fiducial Intervals |
|-----------------------------|---------------|------------------------|
| Birth weight .. ..          | 0.23          | +0.15 to +0.31         |
| Weight of dam .. ..         | 0.83          | +0.79 to +0.85         |
| Weaning age .. ..           | 0.02          | -0.05 to +0.09         |
| Daily gain to weaning .. .. | 0.51          | +0.43 to +0.57         |
| Weaning weight .. ..        | 0.47          | +0.39 to +0.54         |
| Weaning score .. ..         | 0.35          | +0.27 to +0.43         |

*Weight of Dam.*—Very significant year differences around the mean of 883 lb were recorded in the weights of the cows, due particularly to the lower weights in the drought years of 1957 and 1960 (Table 1). No effect of sex of calf on weight of dam at weaning was recorded but significant differences were obtained in the different classes of cow. Heifers were significantly lighter than cows which had a calf the previous year ( $P < 0.001$ ) and the difference in body-weight between cows calving the previous year and those which did not was also significant at the 0.1 per cent. level (Table 2). On eliminating weaning age, these differences were still significant at the 0.1 per cent. level. The repeatability of body-weight of cows was high (0.83).

*Daily Gain to Weaning or Suckling Gain.*—The suckling gain of the calves was among the most variable of the characteristics studied, having a coefficient of variation of 14.6 per cent. Year differences were very significant ( $P < 0.001$ ) but no significant effect of sex on preweaning gain was observed (Tables 1 and 2). Differences significant at the 0.1 per cent. level were recorded between heifers and adult cows and between adult cows and those which did not have a calf in the previous year. The repeatability of suckling gain was 0.51, which was significant and of a reasonably high order (Table 3).

*Weaning Weight.*—Weaning weight varied similarly with suckling gain and had a similar order of coefficient of variation (Table 1). Year differences were also very significant ( $P < 0.001$ ). There was a very significant sex difference in weaning weight although the sex difference in gain did not quite attain significance (Table 2). The three classes of dam had calves with significantly different weaning weights (Table 2) and the significance increased with the elimination of weaning age. Weaning weight had very nearly as high a repeatability as suckling gain (Table 3).

*Weaning Score.*—Weaning score was not nearly so variable as the other characteristics measured, the coefficient of variation being only 4.6 per cent. (Table 1). Significant year differences in weaning score appeared to show a time trend, with an increase in value with time. While no significance was observed in the score of heifer calves and cows which had a calf in the previous year, there was a significant difference in the score of calves from cows which did and did not have a calf the previous year.

*Phenotypic Correlations and Regressions.*—The phenotypic correlations between the five characters were not markedly affected by weaning age, so there was little change in the order of the correlations and regressions when weaning age was eliminated (Tables 4 and 5). Birth weight exerted its major effect on weaning weight, while weight of dam was most closely associated with the birth weight of the calf. Suckling gain was markedly associated with weaning weight and score, which were inter-related.

TABLE 4

PHENOTYPIC CORRELATION COEFFICIENTS BETWEEN BIRTH WEIGHT, WEIGHT OF DAM, WEANING AGE, GAIN, WEANING WEIGHT AND WEANING SCORE OF THE CALVES

|                          | Birth Weight | Weight of Dam | Weaning Age | Gain       | Weaning Weight | Weaning Score |
|--------------------------|--------------|---------------|-------------|------------|----------------|---------------|
| Birth weight ..          |              | +0.26***      | -0.14*      | +0.27***   | +0.35***       | +0.19**       |
| Weight of dam ..         | (+0.26)***   |               | -0.003      | +0.09      | +0.13*         | -0.01         |
| Weaning age ..           |              |               |             | -0.18**    | +0.29***       | +0.13*        |
| Daily gain to weaning .. | (+0.20)***   | (+0.10)       |             |            | +0.78***       | +0.56***      |
| Weaning weight ..        | (+0.42)***   | (+0.14)*      |             | (+0.89)*** |                | +0.61***      |
| Weaning score ..         | (+0.21)***   | (-0.01)       |             | (+0.72)*** | (+0.60)***     |               |

Values in parentheses are partial correlation coefficients with weaning age eliminated.

\* Significant at 5 per cent. level.

\*\* Significant at 1 per cent. level.

\*\*\* Significant at 0.1 per cent. level.

TABLE 5

REGRESSION COEFFICIENTS BETWEEN BIRTH WEIGHT, SUCKLING GAIN AND OTHER CHARACTERS

|                          | Standard Error of Estimate | Regression Coefficient and Standard Error | 95% Fiducial Interval for Regression Coefficient |
|--------------------------|----------------------------|---|--|
| <i>Birth weight on—</i>  |                            |   |  |
| Weight of dam .. ..      | $\pm 8.3$                  | $+0.0059 \pm 0.008$                       | $-0.010$ to $+0.022$                             |
| (Weight of dam) .. ..    | $(\pm 8.2)$                | $(+0.0034 \pm 0.0083)$                    | $(-0.013$ to $+0.020)$                           |
| Weaning age .. ..        | $\pm 8.2$                  | $-0.049 \pm 0.021$                        | $-0.089$ to $-0.008$                             |
| <i>Suckling gain on—</i> |                            |   |  |
| Birth weight .. ..       | $\pm 0.156$                | $+0.0017 \pm 0.0082$                      | $+0.0001$ to $+0.0033$                           |
| (Birth weight) .. ..     | $(\pm 0.150)$              | $(+0.0013 \pm 0.00079)$                   | $(-0.0003$ to $+0.0029)$                         |
| Weight of dam .. ..      | $\pm 0.145$                | $+0.0013 \pm 0.00014$                     | $+0.0010$ to $0.0016$                            |
| (Weight of dam) .. ..    | $(\pm 0.143)$              | $(+0.0013 \pm 0.00014)$                   | $(+0.0010$ to $0.0016)$                          |
| Weaning age .. ..        | $-0.153$                   | $-0.0017 \pm 0.00038$                     | $-0.0024$ to $-0.0010$                           |

Figures in parentheses are those after weaning age is eliminated.

The regression of weaning age on each characteristic is taken to indicate the effect of time of birth on performance of the calf. The regression of birth weight on weaning age was  $-0.05 \pm 0.021$  lb per day. Those calves born later in the calving season were slightly heavier at birth. They also appeared to gain faster prior to weaning, but had lower weaning weights and scores (Tables 4-6).

TABLE 6

REGRESSION COEFFICIENTS BETWEEN WEANING WEIGHT AND WEANING SCORE AND THE OTHER CHARACTERS

|                            | Standard Error of Estimate | Regression Coefficient and Standard Error | 95% Fiducial Interval for Regression Coefficient |
|----------------------------|----------------------------|---|--|
| <i>Weaning weight on—</i>  |                            |   |  |
| Birth weight .. ..         | $\pm 34.5$                 | $+0.85 \pm 0.18$                          | $+0.50$ to $1.21$                                |
| (Birth weight) .. ..       | $(\pm 30.0)$               | $(+1.07 \pm 0.16)$                        | $(+0.75$ to $1.38)$                              |
| Weight of dam .. ..        | $\pm 34.2$                 | $+0.19 \pm 0.033$                         | $+0.13$ to $+0.26$                               |
| (Weight of dam) .. ..      | $(\pm 29.4)$               | $(+0.25 \pm 0.030)$                       | $(+0.19$ to $+0.30)$                             |
| Weaning age .. ..          | $\pm 31.3$                 | $+0.93 \pm 0.077$                         | $+0.78$ to $+1.08$                               |
| Daily gain to weaning ..   | $\pm 28.2$                 | $+136 \pm 7.9$                            | $+120$ to $+151$                                 |
| (Daily gain to weaning) .. | $(\pm 19.1)$               | $(+162 \pm 5.4)$                          | $(+151$ to $+172)$                               |
| <i>Weaning score on—</i>   |                            |   |  |
| Birth weight .. ..         | $\pm 2.70$                 | $+0.018 \pm 0.014$                        | $-0.010$ to $+0.046$                             |
| (Birth weight) .. ..       | $(\pm 2.65)$               | $(+0.024 \pm 0.014)$                      | $(-1.003$ to $+0.052)$                           |
| Weight of dam .. ..        | $\pm 2.69$                 | $+0.0054 \pm 0.0027$                      | $+0.0001$ to $+0.0107$                           |
| (Weight of dam) .. ..      | $(\pm 2.64)$               | $(+0.0070 \pm 0.0026)$                    | $(+0.0019$ to $+0.0121)$                         |
| Weaning age .. ..          | $\pm 2.66$                 | $+0.0279 \pm 0.0066$                      | $+0.0149$ to $+0.0409$                           |
| Daily gain to weaning ..   | $\pm 2.52$                 | $6.21 \pm 0.71$                           | $+4.83$ to $+2.06$                               |
| (Daily gain to weaning) .. | $(+ 2.43)$                 | $(7.07 \pm 0.69)$                         | $(5.71$ to $8.43)$                               |

Figures in parentheses are those after weaning age is eliminated.

#### IV. DISCUSSION

In a previous study of this herd, Alexander *et al.* (1960) reported a mean birth weight of 70.4 lb. The figure of 72.3 lb in this study is based on a much larger number of calves and over a greater number of years. Both these figures are generally in accord with those reported by Dawson, Phillips, and Black (1947), Nelms and Bogart (1956), Koch and Clark (1955) and Clark *et al.* (1958). A significant sex effect was observed in the birth weight of the calf and is of similar order to those reported in the literature. Knapp, Lambert, and Black (1940) considered that 25-35 per cent. of the variation in birth weight between the sexes was accounted for by differences in the length of the gestation period. The gestation length of male calves is generally slightly longer than that of female calves (Dawson, Phillips, and Black 1947; Joubert and Bonsma 1959).

While the birth weights of calves from heifers and adults in this study were not significantly different, significant differences have usually been reported in the literature. These have been associated with shorter pregnancies in heifers. Indirect evidence of the shorter pregnancy in heifers is obtained in this study by the older weaning age of heifers' calves, although it may be merely an indication that heifers did not come into oestrus and conceive as quickly as cows in the mating season. Another factor influencing the birth weight of the calf is the time of birth. Calves born late in the season are generally heavier than calves born early (Koch and Clark 1955; Davenport and Neil 1958; Alexander *et al.* 1960). This is due to the combined influences of better conditions later in the calving season and of longer gestations. Condition of the dam has also been shown to influence the birth weight of the calf (Blaxter 1957; Ryley 1961; Ryley and Gartner 1962; Neville 1962; Wiltbank *et al.* 1962).

Gain during the suckling period is a reflection of the milk production of the cow and the ability of the calf to utilize the available nutrients. This gain has a greater influence on weaning weight than does birth weight and is more variable than birth weight (Clark *et al.* 1958; Knapp and Black 1941). The repeatability of suckling gain of 0.51 in this study is supported by the observation of Botkin and Whatley (1953) and Knapp and Black (1941) that the milk production of the cow exerts a major influence on suckling gain. The gains reported in this study were of similar order to those reported by Clark *et al.* (1958) and Heyns (1960).

Weaning weight in turn is strongly influenced by suckling gain and birth weight. The latter influence would appear to be responsible for the sex difference in weaning weight, since these are the only two performance criteria showing sex differences. Sex and year-to-year differences in weaning weight have also been reported by other workers (Clark *et al.* 1958; Knapp *et al.* 1942).

The influence of time of calving on suckling gain and weaning weight presents some interesting possibilities in interpretation. The regression of suckling gain on weaning age is  $-0.0017 \pm 0.00038$ , while that of weaning weight on weaning age is  $+0.93 \pm 0.077$ . This indicates that the younger calves at weaning were growing faster but the older calves at weaning were heavier. An examination

of the preweaning growth curve for the calves on this property as reported by Burns and Alexander (1956) shows that the growth rate tends to slow down about weaning. Thus, if the older calves at weaning were gaining more slowly at weaning than the younger calves, this would explain the relationships.

Weaning score has been used in this study as an attempt to reproduce a commercial evaluation of the calves. If it can be presumed that this was successful, then an assessment can be made of the relationship the more objective criteria bear to the weaning score. Calves with high suckling gains and weaning weights scored well (suckling gain  $b = 6.21 \pm 0.71$ ). When weaning age is eliminated, approximately 50 per cent. of the variation in weaning score is associated with suckling gain and 36 per cent. with weaning weight. Only about 4 per cent. of this variation was associated with birth weight. Since weaning weight and suckling gain are very closely associated ( $r = 0.89$ , weaning age eliminated), it may be inferred that much of the other half of the variation in weaning score is associated with conformation evaluation. These relationships are of similar magnitude to those reported by Koch and Clark (1955), who concluded from a genetic analysis of their data that selection of calves on the basis of their weaning score would lead to increased genic value affecting weaning score directly and to a lesser extent genic value for maternal environment affecting weaning score. This conclusion could also hold for the present study.

In the selection of beef cattle on performance to weaning it seems desirable that emphasis should be placed upon the milking ability of the cow, growth rate of the calf and conformation grade of the calf. The inter-relationships between the performance criteria describing these three features are important in deciding which should be used and the relative stress to be placed on each. The information presented in this study provides some basic information which can assist in this decision.

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