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INFLUENCE OF BIRTH DATE AND DAM'S AGE ON EARLY GROWTH IN BEEF CATTLE

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SUMMARY

This paper reports age of dam, sex and regression-on-age effects for calf liveweight data from birth to 12 months of age or older from two experimental beef breeding locations. The magnitudes of all effects varied significantly both over years and between locations. Age-of-dam effects declined with calf age but remained important through to 18 to 20 months. Age-regression coefficients were consistently higher for males than females. The results are discussed in relation to current methods of correcting weaning and yearling weights for age of dam and birth date used by the N.Z. National Beef Recording Scheme (BeefPlan). It is concluded that present methods require re-examination, and in particular that correction factors should be calculated separately for each herd-year wherever adequate data are available.

INTRODUCTION

The accuracy of ranking animals on their breeding values and hence the effectiveness of selection is increased when allowance is made for non-genetic sources of variation among individuals. A recent New Zealand Society of Animal Production Study Group on beef cattle improvement through performance recording and selection (N.Z.S.A.P., 1972; Baker, 1973) stressed the need for re-evaluation of presently-used adjustment factors for environmental and particularly age-of-dam effects.

This paper reports age-of-dam, sex and regression-on-age effects on liveweight data from experimental beef breeding herds at two separate locations. The results are discussed in relation to the methods of correcting weaning and yearling weights for differences in age of dam and birth date currently used by the N.Z. National Beef Recording Scheme BeefPlan).

MATERIALS AND METHODS

SOURCES OF DATA

Breeding experiments with Angus cattle at Waikeria, a Justice Department farm located about 40 km south of Hamilton, have been described by Carter (1971). The experiments currently comprise two closed selection lines of about 125 cows each of which are normally run together and will be called Herd 1 and a progeny-test herd of about 180 cows designated as Herd 2. Replacement heifers, chosen on the basis of their own growth performance but subject to approximately equal sire representation, are joined as yearlings (14 to 15 months) in all herds. Apart from removal of barren cows, females are culled primarily on age ($5\frac{1}{2}$ years) in Herd 1 and on lifetime calf-weaning performance without regard to age in Herd 2. Males are kept entire in the selection herds, apart from some screening of bulls after weaning and again in early winter; non-selected animals are castrated. Five yearling bulls per line are mated annually following selection based on growth rate information up to about 14 months of age. Selection is for corrected final (October) weight in one line and weaning to October gain in the other. Six bulls of those previously mated as yearlings in the selection herds are progeny tested annually in Herd 2. Male calves are castrated at or prior to weaning and carried through to slaughter at 20 to 22 months of age.

The present analysis relates to nine calf crops, born 1964-72. Calves were weighed at birth, at the beginning of mating (November), at bull removal (January) and then at weaning in February at an average age of 154 days in Herd 1 and 161 days in Herd 2. A double weight was recorded in March and monthly weights recorded through to October. A high proportion (80 to 90%) of the yearling heifers available each year were selected for breeding.

The experimental programme at Waikite, a Lands and Survey block 30 km south of Rotorua, commenced in 1968 and the analysis covers calves born 1969-72. The herd comprises both Angus and Hereford females which have been mated to bulls of the same two breeds to generate purebred and crossbred progeny. About 28 bulls, approximately one-half each Angus and Hereford, were mated each year to about 800 cows. Replacement heifers were mated as yearlings (14 to 15 months of age) in all years except 1970. In the years 1969-71 male calves were kept entire until weaning (at an average age of 149 days) when all crossbred and a balanced sample of the purebred Angus and Hereford bull calves were castrated. The male calves born 1972 in the crossbreeding herd were castrated at birth. All steers born 1970-72 were off-grazed on another Lands and Survey block from 9 to 12 months of age through to slaughter at about 20 months of age. Weights were recorded at 4 to 6 weekly intervals from birth to about 15 months of age or to slaughter in the case of the steers. For purposes of present analysis the experiment comprises two lines, a crossbreeding line with purebred and reciprocal crossbred heifer and steer calves, and a selection line with purebred Angus or Hereford heifers and bulls.

Climatic and physical conditions at the two locations were described by Carter and Cox (1973) who concluded that Waikeria could be considered representative of well-developed stud breeding or fattening properties whereas Waikite was a harsher environment more typical of commercial beef breeding farms.

METHODS OF ANALYSIS

Analyses of variance and covariance were carried out within locations by least squares to allow for unequal subclass numbers. Preliminary analyses were undertaken on a within-year basis testing the main effects of age of dam, sex, herd or line, regression on age and (Waikite only) breed of dam and their first-order interactions, together with sire main effects. In the combined analyses across years, sires were ignored but interactions included as shown in Tables 2 and 3 for the Waikeria and Waikite data, respectively. Components of variance were not estimated directly, the approximate partitioning of the total variation among the several factors being derived simply from the corresponding sums of squares in the analyses. In most analyses no distinction has been made between bulls and steers, both being classified as males. Dams five years or older are designated as mature. At Waikeria the June and September weights were analysed and at Waikite the July and October weights. The March (6-month) weight at Waikeria is the average of two weights usually recorded on the same day. Only animals with complete records through to the final weights shown were included in the analyses, total numbers being indicated in Tables 1 and 6.

RESULTS

The means and residual standard deviation for the herds at the two locations are shown in Table 1. The average birth date at Waikeria was September 10 and at Waikite September 16. The average age at the March weight was 175 days at Waikeria and 180 days at Waikite.

As compared with Waikeria the harder environment at Waikite was reflected in lower mean weights at all ages. The residual standard deviations were substantially similar among herds and locations. In the Waikite analyses Hereford calves were heavier than Angus calves at all ages. Hereford calves were born on average one week later than Angus calves. Crossbred calves were consistently heavier than the average of the

TABLE 1: LEAST SQUARES MEANS (kg)[1]

Herd	No.	Weight Birth	March (6 months)	June/July (10 months)	Sept./Oct. (13 months)
Waikeria					
Herd 1	1 617	30.5 (4.1)	175.1 (19.6)	198.8 (18.5)	236.3 (22.6)
Herd 2	1 248	30.4 (4.0)	180.3 (19.3)	208.3 (19.5)	243.0 (22.5)
Waikite	2 028	26.8 (3.7)	144.6 (18.2)	175.2 (20.1)	189.9 (24.0)
Angus calves	1 014	24.6	138.7	164.8	178.0
Hereford calves	531	28.1	142.4	173.2	187.1
Crossbred calves	483	27.2	148.7	180.8	197.3

[1] Residual standard deviations shown in parentheses.

purebreds and after weaning were heavier than either the Angus or Hereford calves.

The analyses of variance for the March and September weights are shown in Table 2 for Waikeria and Table 3 for Waikite, substantially similar conclusions applying to the other weights analysed. Year, sex and age of dam were highly significant ($P < 0.01$) sources of variation in all analyses at both locations. As the calves grew older the relative contribution of the age-of-dam effects declined while that due to sex differences increased. The most important single source of variation was that due to regression on age, and this contribution also declined proportionately as the calves grew older. The partial confounding of sex and herd or line effects in these analyses should be noted.

There were a number of significant interactions. In the Waikeria analyses age of dam, sex and herd differences varied from year to year. Paddock differences in feed availability could account in part for the interactions between years and herds, which were not always grazed together, and between years and sexes, which were separated after weaning. The age of dam by sex interaction was significant at the 5% level for March weight. Separate analyses within herds 1 and 2 (*i.e.*, separating bulls and steers) showed no significant interaction in either herd. In the Waikite analyses year by age of dam, year by sex and sex by age of dam interactions were significant. For males, calves from 2-year-old dams were 31 kg (23%) lighter in March than those from mature dams, the corresponding difference for female calves being 17 kg (14%). In this case this interaction was significant for both bulls and steers. The significant line-by-year and line-by-sex interactions are likely to be due largely to differential management of bulls and steers, particularly where the steers (crossbreeding line only) were off-grazed in some years.

TABLE 2: ANALYSES OF VARIANCE FOR THE WAIKERIA HERDS

		Weight			
		March		*Sept.*	
Source of Variation	*df*	*Mean Squares*	*% S.S.*[1]	*Mean Squares*	*% S.S.*
Age of dam (AOD)	3	67 196**	9.8	29 154**	2.5
Sex (S)	1	152 046**	7.3	399 069**	11.3
Years (Y)	8	12 648**	4.9	38 700**	8.8
Herd (H)	1	566	0.0	4	0.0
Y × AOD	24	1 595**	1.9	1 657**	1.1
Y × S	8	776*	0.3	18 954*	4.3
Y × H	8	2 481**	1.0	13 946*	3.2
S × AOD	3	1 118*	0.2	2 246	0.2
H × AOD	3	330	0.1	75	0.0
H × S	1	541	0.0	12 549**	0.4
Regression on age	1	476 167**	23.0	503 828**	14.3
Error	2 803	380	51.5	677	53.9

[1] The sums of squares as a percentage of the total of individual sums of squares.

TABLE 3: ANALYSES OF VARIANCE FOR THE WAIKITE HERD

		Weight			
		March		*Oct.*	
Source of Variation	*df*	*Mean Squares*	*% S.S.*[1]	*Mean Squares*	*% S.S.*
Age of dam (AOD)	3	23 992**	6.0	11 590**	1.4
Sex (S)	1	47 028**	3.9	25 919**	1.0
Line (L)	1	3 864**	0.3	69 365**	2.7
Dam breed (DB)	1	67	0.0	3 480*	0.1
Years (Y)	3	3 032**	0.8	170 310**	20.2
Sire breed (SB)	1	5 993**	0.5	11 973**	0.5
Y × AOD	8	1 799**	1.2	2 051**	0.6
Y × S	3	2 829*	0.7	37 049**	4.4
Y × L	3	230	0.1	19 293**	2.3
Y × DB	3	1 039*	0.3	2 809**	0.3
L × S	1	1 128	0.1	88 464**	3.5
L × AOD	3	265	0.1	103	0.0
S × AOD	3	1 727**	0.4	2 820**	0.3
SB × DB	1	15 599**	1.3	50 384**	2.0
Regression on age	1	340 479**	28.5	379 435**	15.0
Error	1 991	333	55.8	577	45.5

[1] The sums of squares as a percentage of the total of individual sums of squares.

TABLE 4: AVERAGE AGE OF DAM EFFECTS

			Weight							
			Birth		*March*		*Jun./Jul.*		*Sept./Oct.*	
Location	*Effects*[1]	*n*[2]	*kg*	*%*[3]	*kg*	*%*	*kg*	*%*	*kg*	*%*
Waikeria										
Herd 1	M-2	399	4.0	14.2	24.2	15.1	18.1	9.6	15.0	6.6
	M-3	385	2.0	6.5	10.4	6.0	6.3	3.2	3.6	1.5
	M-4	343	0.4	1.3	3.8	2.1	1.8	0.9	0.9	0.4
	M	490	32.1	—	184.7	—	205.6	—	241.3	—
Herd 2	M-2	240	4.9	17.9	23.0	13.8	18.5	9.4	15.9	6.8
	M-3	222	2.0	6.6	8.2	4.5	5.4	2.6	4.5	1.8
	M-4	192	1.0	3.3	5.3	2.9	3.3	1.6	2.2	0.9
	M	594	32.3	—	189.4	—	215.1	—	248.6	—
Waikite	M-2	138	4.4	18.2	23.9	18.4	19.9	12.2	16.0	8.8
	M-3	469	1.7	6.4	10.5	7.3	8.1	4.7	7.7	4.0
	M-4	442	1.2	4.4	4.7	3.1	3.8	2.1	4.4	2.3
	M	979	28.6	—	154.4	—	183.1	—	196.9	—

[1] 2-, 3-, 4-year-old and mature (five years and older) aged cows.
[2] Number of 2-, 3-, 4-year-old and mature aged cows.
[3] Multiplicative correction factors, *i.e.*, M/2, M/3 and M/4. Percentage above 100%.

TABLE 5: AGE-OF-DAM EFFECTS OVER YEARS FOR WEANING AND YEARLING WEIGHTS AT WAIKITE

	March Weight				*Oct. Weight*			
Effect[1]	*69*	*70*	*71*	*72*	*69*	*70*	*71*	*72*
M-2 (kg)	25.0	28.6	—	17.5	10.6	28.3	—	7.7
M-3 (kg)	13.1	18.7	8.4	1.7	9.1	14.3	7.7	0.0
M-4 (kg)	1.8	6.0	8.9	1.9	5.5	4.9	8.3	0.0
M (kg)	154.1	160.5	157.1	145.9	161.1	208.8	208.2	209.6
M/2 (%)[2]	19.4	21.7	—	13.6	7.0	15.7	—	3.8
M/3 (%)	9.3	13.2	5.7	1.2	6.0	7.4	3.8	0.0
M/4 (%)	1.2	3.9	6.0	1.3	3.5	2.4	4.2	0.0

[1] 2-, 3-, 4-year-old and mature (five years and older) aged cows.
[2] Multiplicative correction factors.

Although the significant year by age of dam interaction limits generalization of the results, average age-of-dam effects are summarized in Table 4 for the different herds and locations. Despite the heavier mean weights at Waikeria than at Waikite, the average age-of-dam effects (additive correction factors) are of similar magnitude. Expressed as percentages (multiplicative correction factors), however, the values are higher at Waikite than Waikeria. Seasonal variation in age-of-dam differences in March weights at Waikeria is illustrated in Fig. 1. The additive correction factors show little association with corresponding mean weights of calves from mature dams and hence do not support multiplicative in preference to additive adjustments. Corresponding results for Waikite, summarized in Table 5, lead to similar conclusions.

The only groups of animals retained unculled beyond 15 months of age were the steers in Herd 2 at Waikeria. Analysis of 533 animals over an 8-year period, including the age of dam by year interaction in the model, yielded estimates of average age of dam effects some of which are shown in Table 6. In absolute terms, the average handicaps incurred by calves

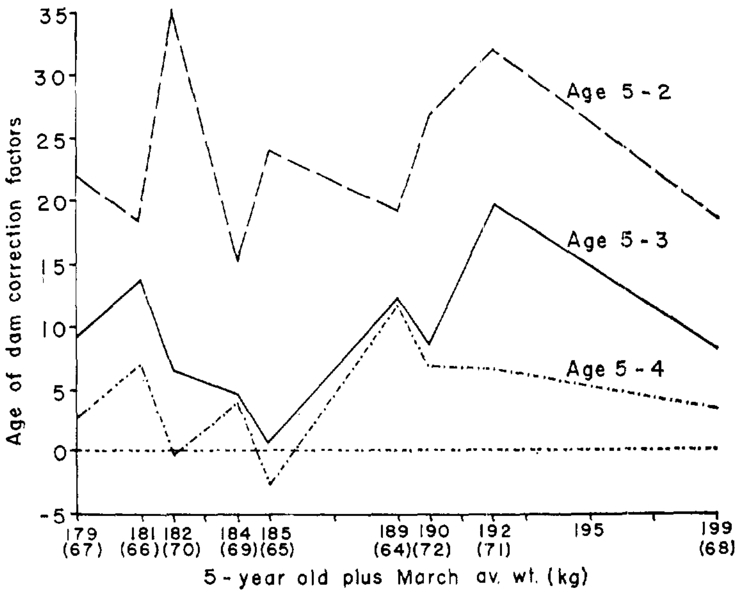

FIG. 1: *Age-of-dam correction factors for March weight (kg) plotted against mature (5-year-old and older) performance for each year (years shown in parentheses).*

TABLE 6: AGE OF DAM AND REGRESSION-ON-AGE EFFECTS FOR WAIKERIA STEERS

		Weight				
Effect[1]	*n*[2]	*Birth*	*March (6 months)*	*Sept. (12 months)*	*Dec. (15 months)*	*March (18 months)*
M-2 (kg)	104	4.8	24.0	14.9	15.1	13.8
M-3 (kg)	86	2.2	7.6	3.4	5.0	3.0
M-4 (kg)	79	0.9	3.2	0.0	0.8	— 0.4
M (kg)	264	33.1	195.1	252.2	338.1	379.0
M/2[3] (%)		16.6	14.0	9.3	4.7	3.7
M/3 (%)		7.0	4.1	2.1	1.5	0.8
M/4 (%)		2.7	1.6	0.0	0.2	0.1
Regression on age		— 0.06 ± 0.01	1.01 ± 0.06	0.94 ± 0.07	0.84 ± 0.08	0.73 ± 0.09

[1] 2-, 3-, 4-year-old and mature (five years and older) aged cows.
[2] Number of 2-, 3-, 4-year-old and mature aged cows.
[3] Multiplicative correction factors.

TABLE 7: AVERAGE AGE OF DAM EFFECTS FOR ADJUSTED WEIGHTS AND GAINS

Location	*Effect*[1]	*n*[2]	*200-day Adjusted Weight*	*Sept./Oct. Adjusted Weight*	*Birth-March Gain*	*March-Sept./Oct. Gain*
Waikeria	M-2	639	— 1.3	— 9.6	19.0	— 8.3
	M-3	607	— 8.9	— 14.2	7.2	— 5.4
	M-4	535	—4.6	— 7.6	3.7	— 3.0
	M	1 084	175.4	233.4	154.4	58.1
Waikite	M-2	138	8.8	— 0.1	20.5	— 8.9
	M-3	469	— 1.9	— 5.9	9.9	— 4.0
	M-4	442	— 2.5	— 3.4	4.2	— 1.0
	M	979	165.6	210.7	123.2	45.1

[1] 2-, 3-, 4-year-old and mature (five years and older) aged cows.
[2] Number of 2-, 3-, 4-year-old and mature aged cows.

from younger dams declined from weaning to 12 months but thereafter showed little change through to 18 months. They were significant at all ages for 2-year dams, only at 6 months for 3-year-olds and not significant for 4-year-olds. Similarly the regression coefficient on age declined slowly up to 18 months of age but its effect remained significant and important to that stage.

One of the objectives of this paper is to evaluate the method of correction for age of dam and birth date presently used by the N.Z. National Beef Recording Scheme (BeefPlan). The gain per day of each animal from birth to weaning is calculated, then multiplied by 200 and added to birth weight. To this figure is added 15%, 10% or 5% if the animal is out of a 2-, 3- or 4-year-old cow, respectively. The result is a corrected 200-day (weaning) weight adjusted for age of dam and birth date. When birth weight is not recorded, an assumed average weight is used. To derive a corrected 400- to 550-day weight the actual gain per day from the weaning weight to the appropriate subsequent weight is calculated, multiplied by 200 or 350 and this figure added to the 200-day corrected weight. These procedures were followed to calculate the 200-day corrected weight and a September/October (about 400-day weight) corrected weight in the present data. These corrected weights, plus the birth to March gain and March to September/October gain were analysed jointly with actual liveweights using the models shown in Tables 2 and 3. The importance of the age of dam and the regression-on-age effects were reduced but by no means totally removed. This is illustrated for age-of-dam effects in Table 7. Again the average values should be interpreted in the light of the significant year-by-age-of-dam interaction. The other point of interest in Table 7 is the age-of-dam correction factors for the March to September gain which show that calves out of cows younger than 5 years grew faster than calves out of 5-year-old and older cows over this period, providing evidence for compensatory growth. For this gain the year-by-age-of-dam interaction was not significant for the Waikeria data but was for the Waikite data.

The interaction of regression on age with years and sex was investigated. Although the regression coefficients varied considerably from year to year, the differences were not significant. Regressions pooled over years and age-of-dam classifications were higher in males than females as illustrated in Table 8. The sex differences were significant for Waikeria but not for the Waikite data. The results indicate higher regression coefficients at Waikeria than at Waikite for both sexes, in line with higher growth rates at the former location.

TABLE 8: REGRESSION COEFFICIENTS OF WEIGHTS ON AGE (kg)[1]

Location	*Sex*	*Weight*		
		Birth	*March*	*Sept./Oct.*
Waikeria	Male	— 0.05 ± 0.01	0.97 ± 0.04	1.01 ± 0.05
	Female	— 0.04 ± 0.01	0.82 ± 0.03	0.84 ± 0.04
Waikite	Male	— 0.03 ± 0.01	0.83 ± 0.04	0.84 ± 0.04
	Female	— 0.05 ± 0.01	0.72 ± 0.03	0.76 ± 0.04

[1] Regression coefficients ± standard error.

TABLE 9: ESTIMATES OF SEX EFFECTS FOR WEANING WEIGHT

Location	*Effect*	*Additive*	*(male/female)*	*Multiplicative*	*(male/female)*
Waikera	Bull-heifer	16.4	(11.5-26.4)	1.097	(1.066-1.124)
	Steer-heifer	14.2	(8.1-20.9)	1.086	(1.046-1.156)
Waikite	Bull-heifer	14.0	(9.1-20.0)	1.102	(1.065-1.153)
	Steer-heifer	10.4	(3.7-19.4)	1.076	(1.026-1.154)

Figures in parentheses are the range of values over the years analysed.

Estimates of sex effects for March weight are shown in Table 9 for the two locations. At both Waikite and Waikeria the sex-by-year interaction was significant and the range of the sex differences over years is shown. Additive sex effects were higher at Waikeria than Waikite and at both locations bulls were heavier than steers. Additive sex effects for each year were plotted against the mean March weight for each year and it was found that the regression-of-sex difference on year means was not significant for either location. On this criterion multiplicative sex corrections would not appear to fit these data any better than additive sex effects.

DISCUSSION

The main emphasis in these analyses has been to estimate age-of-dam effects on calf growth. An important finding has been the significant interaction between year and age-of-dam effects. This suggests that correction factors for age-of-dam effects should be calculated for each herd and each year separately. Clearly, however, adequate numbers of calves within each herd-year would be needed to provide reliable estimates. On the basis of the standard deviations presented in Table 1 and a normal herd-age distribution, it can be deduced that approximately 25 animals per immature age group would be needed to reduce the estimated standard error of the age-of-dam estimates in any year to 5 kg. This would imply a herd size of about 125 cows.

As pointed out by Lush and Shrode (1950) and Koch and Clark (1955) observed differences among contemporary progeny of different-aged dams are subject to two types of bias as measures of strictly environmental differences: first, an upward bias reflecting genetic superiority of older dams following sequential culling on previous performance; secondly, a downward bias resulting from steady genetic improvement whereby younger animals are genetically superior to unselected older herdmates. In the present study, the close similarity at Waikeria of age-of-dam effects in Herd 1 where cows were culled solely on age (or failure to calve) and in Herd 2 where older cows were culled on previous calf-weaning records, suggests that the former bias is unimportant. On the other hand, the intense long-term selection of sires for growth rate in both Waikeria herds could result in appreciable under-estimation of environmental age-of-dam effects. The same factor could explain the lower age-of-dam effects at Waikite (see Table 5) in 1972 relative to earlier years; intense sire selection for growth rate was initiated in 1968 (calves born 1969) so that the 2- and 3-year-olds in 1972 should be genetically superior for growth.

Apart from systematic genetic effects of the above kind and real interaction between seasonal conditions and dam maturity effects, variation between years in observed age of dam differences could reflect differential management of dam age groups prior to weaning. In the present experiments, although an endeavour is made to preferentially graze the in-calf yearling heifers through to subsequent calf weaning, their actual feed superiority relative to older cows varies markedly from season to season. A further sources of annual fluctuation is the genetic effect of sire sampling, aggravated in the present herds by the fact that sires are in general used for one year only.

Estimates of correction factors for environmental effects for beef cattle were summarized by Petty and Cartwright (1966). Weight differences in progeny of 2-, 3- and 4-year-old cows, respectively, relative to 5-year-old dams averaged 4.4, 2.2 and 0.5 kg at birth and 25.8, 15.4 and 6.8 kg at weaning. These values are in excellent agreement with those shown in Table 4. Mason *et al.* (1970) and Barlow *et al.* (1974) found significantly higher multiplicative correction factors in males than females. However, several other studies (Swiger, 1961; Cunningham and Henderson, 1965; and Cundiff *et al.*, 1966a) have failed to detect significant interactions between age of dam and sex for either weaning weight or pre-weaning average daily gain. In the present study the age of dam by sex interaction was significant at Waikite but not significant at Waikeria.

As discussed by Searle and Henderson (1960) in relation to dairy cattle records there are a number of different methods of comparing the effectiveness of alternative correction factors. Few studies with beef cattle have attempted to determine the relative appropriateness of multiplicative or additive factors for correction for age of dam. Cundiff *et al.* (1966b) found that additive adjustments were more appropriate than multiplicative for the effects of age of dam, season of birth and type of management. Multiplicative corrections were found to be more appropriate in adjusting for the effect of sex. The present data do not indicate any advantage of multiplicative over additive correction factors for age of dam. Table 4 shows that there are in fact marked differences between the two locations in the average multiplicative factors whereas the additive adjustments are substantially similar.

The multiplicative adjustments for age of dam effects on weaning (200-day) weights at present used in New Zealand under BeefPlan are markedly different from the corresponding percentage adjustments derived from the present study (see Table 4). In particular the BeefPlan factors greatly over-estimate the handicaps incurred by progeny of 3- and 4-year-old dams.

Cardellino and Frahm (1971), comparing standardized and internally estimated multiplicative age of dam correction factors in Oklahoma Angus and Hereford herds, concluded that since essentially the same individuals would be selected for breeding using either method, the currently-used industry factors were adequate for these herds. From the present Waikeria data, rank correlations, calculated within each year, herd and sex between weights corrected for age of dam and calf's age based on BeefPlan factors and based on internal estimates, ranged from 0.85 to 0.95 for both weaning and yearling weights. We conclude that use of present BeefPlan correction factors may be adequate for selecting heifers but that more accurate adjustment is desirable in selecting the much smaller proportion of bulls required for breeding.

On statistical grounds, adjustment for age by means of regression methods is considered more accurate than adjustment according to individual daily gains. The latter not only assumes continuing linear growth but also aggravates the effects of short-term environmental fluctuations and of errors in predicting true body mass from a single weight. Frequent assumption of an arbitrary birth weight provides a further source of error and possibly of bias. In the present data, analyses for a number of separate years have failed to establish any significant departure from linearity in the regressions of liveweights on age. On the other hand, the linear regression coefficients vary considerably from year to year, and are consistently higher for male than for female calves. On the present evidence we would recommend estimation of the appropriate regression coefficient within each herd-sex-year as a basis for adjustment for age effects. Study of the data suggests, however, that the herd-sex-year average daily gain from birth to weaning, *after* applying additive age-of-dam correction factors, would provide a very satisfactory approximation in most cases.

In conclusion it should be emphasized that this is not a final definitive study of correction factors for beef cattle in New Zealand. Further study, desirably covering a range of herds, breeds and environments, is needed to establish the relative merits of additive versus multiplicative adjustments, to check further the validity of present standardized correction factors, and to examine regional, breed or production level influences on the magnitude of age of dam effects. This study does however provide the first comprehensive estimates of correction factors for beef cattle in New Zealand. The results also seem to cast enough doubt on the accuracy and validity of the present methods of correcting for age and age of dam used by BeefPlan to warrant further study and perhaps some reappraisal.

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