SELECTION FOR IMPROVEMENT OF ECONOMIC RETURNS FROM WEANER CATTLE

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Summary

The heritabilities and genetic and phenotypic correlations of birth weight, suckling weight gain, weaning weight and conformation score have been estimated from half-sid correlation analyses of data from 1,970 Hereford calves. These calves were the progeny of 63 sires and were born between 1955 and 1964. The data were corrected for year, age, sex and age of dam. Additional estimates of each parameter were obtained from birth weight corrected for weight of dam, weaning weight corrected from birth weight and conformation score corrected for weaning weight.

Heritabilities were low to moderate (0.17 to 0.37). The only large genetic and phenotypic correlations were between weaning weight and suckling weight gain (0.97 and 0.87 respectively). There were positive genetic correlations between conformation score and weaning weight or weight gain (0.29 to 0.32), which became negative (-0.24 to -0.26) when the weight-corrected conformation score was used.

The greatest genetic improvement in value of weaner stock would result from selection based on the following index when the average conformation score of the herd is low:

I = Weaning weight + (9.61 x conformation score) When the conformation standard of the herd is satisfactory, the index becomes:

I = Weaning weight — (2.41 x conformation score).

I. INTRODUCTION

Cattle selection within pure-bred herds in Australia is traditionally based on visual appraisal. However, there is a growing interest in the use of measured performance as a selection criterion in breeding plans. A number of producers have selected breeding stock on a combination of visual appraisal and weight gains, and a performance recording scheme is now available to assist with data processmg. Unfortunately, there have been no Australian estimates of the parameters needed for the construction of efficient breeding plans to fully utilize the performance records. Thus, it has been necessary to rely on parameters estimated in other countries. These may differ from parameters applicable for Australian conditions and the value of breeding plans based on such estimates may be limited even when locally applicable economic weightings are used.

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A series of analyses is now being carried out with data obtained from a large Hereford herd in New South Wales in order to estimate genetic and phenotypic parameters of measured and visually assessed characters. Selection indices for various enterprises are to be constructed by combining these parameters with appropriate economic weightings derived from the analyses presented by Williams et *al.* (1970). This paper presents the first results in the series and deals with performance to weaning age with selection indices appropriate for the production of weaner cattle for sale.

II. MATERIAL AND METHODS

(a) Animals

Data for this study were obtained from cattle born between 1955 and 1964 in a Hereford herd on the southern tablelands of New South Wales. From a total of 3,046 animals recorded, 1,970 bulls, steers and heifers, the progeny of 63 sires, had complete records from birth to weaning which could be included in the analysis. Before the start of performance recording on this property in 1956, selection was based largely on visual appraisal but, in recent years, measured growth rates have been included as a selection criterion.

Calving commenced in July each year and extended for three months. At marking (3 to 4 months), selected males were left entire and retained until 14 months of age for use or sale. All steers were sold after weaning (6 months). Heifers were kept for herd replacement or were sold at 18 months of age.

Cattle were grazed on improved pastures, with supplements in periods of feed shortage. All animals were treated alike within *sexes.*

(b) Records

Bodyweights at birth and weaning and conformation scores at weaning were recorded. Suckling weight gains were calculated from the birth and weaning weights. Conformation scores were based on the visual estimates described by Williams and Murphy (1958), each grade (A, B, C) being divided into three subgrades. These were allotted scores from 0 (poor) to 9 ideal) for this analysis. Dams were weighed when their calves were weaned.

(c) Statistical analysis

The influence of various factors known to affect each character was estimated by regression analyses which involved fitting constants for sex, age of dam, herd (homed or polled) and year of birth. Age of calf at weaning and birth weight were included as co-variates in the analyses of weaning weight, conformation score and suckling weight gain. The analyses were carried out with the data available from all 3,046 animals and individual records were adjusted to a "standard animal" — bull calves born to mature dams (five years and older) in the homed herd in 1959. In addition to these adjustments a number of models were used which either omitted or included co-variates as follows:

Birth weight (a) — no co-variates
Birth weight (b) — additional adjustment for weight of dam
Weaning weight (a) — adjusted to 180 days of age
Weaning weight (b) — adjusted to 180 days of age and a standard birth weight (33.6 kg)

Suckling weight gain — adjusted to 180 days of age and 33.6 kg birth weight
Conformation score (a) — adjusted to 180 days of age
Conformation score (b) — adjusted to 180 days of age and a standard weaning weight of 181.6 kg

Paternal half-sib correlation analyses on the adjusted data were used to estimate heritabilities and genetic and phenotypic correlations for each character, together with their standard errors.

To estimate the most profitable combinations of weaning weight and conformation score, selection indices were calculated from genetic and phenotypic variances and co-variances from this analysis, and economic weightings derived from the data of Williams et *al.* (1970). For conformation score, which showed a curvilinear relationship with price, two linear regressions were fitted to the ranges 1 to 3 and 3 to 7, and separate indices were calculated. These gave economic weightings of $2.22 per grade and $0.29 per grade respectively. The economic weighting for weaning weight was $0.112 per kg (Williams et ***al.*** 1970).

To compare the efficiency of various selection plans, expected genetic changes in weaning weight, conformation score and total value were estimated for selection based on: (a) the appropriate index, (b) weaning weight alone and (c) conformation alone. These estimates were made for an assumed selection intensity of 40 per cent female, and 3 per cent male progeny retained for breeding each generation (selection differential $= 1.618\sigma$).

III. RESULTS AND DISCUSSION

Heritabilities and genetic correlations, with their standard errors, and phenotypic correlations are given in Table 1. In general, the heritabilities are low to moderate and agree well with similar estimates reported in other countries (Pahnish et ***al.*** 1964).

The inclusion of weight of dam as a co-variate significantly increased the heritability of birth weight, indicating that any plans which aimed at changing birth weights by selection should take into account bodyweight of the dam. However, the small genetic and phenotypic correlations between birth weight and the characters measured at weaning indicate that there would be no direct advantage in changing birth weight unless it were found to be associated with other economically important factors such as dystokia or calf survival.

Weaning weight had a moderate heritability that was not affected by the inclusion of birth weight as a co-variate. Thus, a record of birth weight would not be necessary in a breeding plan aimed at increasing weaning weights, where age corrections are made using regression analysis. The very high genetic and phenotypic correlations between weaning weight and suckling weight gain indicate that they may be interchanged in a breeding plan according to particular circumstances in individual herds.

The heritability of conformation score was low and was slightly, though not significantly, increased when weaning weight was included as a co-variate. There were moderate genetic and phenotypic correlations between conformation score, weaning weight and suckling weight gain. However, when the weight-corrected conformation score was used, the genetic correlations were negative. This indicates that the positive correlations between score and weight are a result of bias in

TABLE 1

Heritabilities and genetic correlations with standard errors (in brackets), together with phenotypic correlations (lower half of matrix), of various characters of Hereford calves

	Herit-ability	Birth Weight (a)*	Birth Weight (b)*	Weaning Weight (a)	Weaning Weight (b)	Suckling Weight Gain	Conformation (a)	score (b)
Birth weight (a)	0.17 (0.05)		0.52 (0.13)	0.16 (0.19)	—0.07 (0.19)	0 (0.20)	—0.18 (0.20)	—0.27 (0.19)
Birth weight (b)	0.37 (0.08)	0.70		0.12 (0.16)	—0.05 (0.17)	0.06 (0.17)	—0.15 (0.18)	—0.22 (0.16)
Weaning weight (a)	0.26 (0.07)	0.23	0.16		0.97 (0.01)	0.97 (0.01)	0.31 (0.17)	—0.26 (0.17)
Weaning weight (b)	0.26 (0.07)	0.15	0.11	0.87		0.99 (0)	0.32 (0.17)	—0.24 (0.17)
Suckling weight gain	0.24 (0.06)	0.18	0.13	0.83	0.98		0.29 (0.18)	—0.26 (0.17)
Conformation score (a)	0.18 (0.05)	0	0.03	0.48	0.47	0.44		0.84 (0.06)
Conformation score (b)	0.22 (0.06)	—0.12	—0.06	0.12	0.13	0.14	0.91	

* The designations (a) and (b) indicate that the measurement has been adjusted for different covariates — see Methods.

favour of the heavier animals, even though. the scoring system attempts to disregard weight. The remaining components of conformation score (shape or desirable visual features) have a negative genetic association with weaning weight.

Selection for conformation and, more recently, for growth rate may have biased the half-sib correlations resulting in underestimates of the various parameters. However, they are of the same order, within the range of the standard errors, as overseas estimates (Clark et ***al.*** 1963).

The selection index giving the most efficient combination of weaning weight and conformation score when there was a high proportion of animals of poor type (between scores 1 and 3) in the herd was:

$$I = WW + 9.61\ CS$$

where WW = weaning weight (kg)
and CS = conformation score.

When the average conformation score of the herd was intermediate to good (between scores 3 and 7), the index became:

$$I = WW - 2.41\ CS.$$

The expected genetic changes in weaning weight, conformation score and total value under different selection plans, and for the two different economic weightings for conformation score, are given in Table 2. Within the index, weaning weight was the more important character and selection based on the index would be only slightly more efficient in improving total value than selection for weaning weight alone. In contrast, selection for conformation score alone would be relatively inefficient.

Where the conformation standard of the herd is low, its inclusion in a selection program is warranted. However, where conformation is satisfactory, there is little to be gained by seeking its improvement. In fact, the index gives this character a small negative co-efficient so that relatively more selection pressure is applied to weaning weight. Despite this negative co-efficient, conformation would still improve slightly under selection for the index. From a practical point of view, it

TABLE 2

Expected genetic changes in weaning weight, conformation score and value per head under various selection plans

Selection plan	Genetic changes per generation		
	Weaning Weight (kg)	Conformation Score	Value ($)
(a) Conformation standard low			
Index (I=WW+9.61CS)	8.74	0.27	1.59
Weaning weight alone	10.29	0.15	1.48
Conformation alone	2.65	0.40	1.18
(b) Conformation standard satisfactory			
Index (I=WW−2.41CS)	10.57	0.11	1.21
Weaning weight alone	10.29	0.15	1.19
Conformation alone	2.65	0.40	0.42

would be unrealistic to suggest that producers should select against conformation as indicated in the second index. The appropriate recommendation would be that selection should be based on weaning weight with a light culling of animals showing skeletal deformities or very poor conformation scores.

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V. REFERENCES

CLARK, R. T., BRINK, J. S. BOGART, R., HOLLAND, L. A., ROUBICEK, C. B., PAHNISH, 0. F., BENNETT, J. A., and CHRISTIAN, R. E. (1963). Oreg. Agric. Exp. Sta. Tech. Bull. No. 73.

PAHNISH, 0. F., ROBERTSON, R. L., TAYLOR, R. L., BRINKS, J. S., CLARK, R. T., and ROUBICEK, C. B. (1964). *J. anim.* Sci. 23: 562.

WILLIAMS, L. G., and MURPHY, W. J. B. (1958). *Proc. Aust. Soc. Anim. Prod. 2:* 81.

WILLIAMS, L. G., KIRTON, H. C., PATTIE, W. A., and GARNOCK, J. C. (1970). *Proc. Aust. Soc. Anim. Prod.* (in press).