LIVEWEIGHT AT JOINING AND FERTILITY IN BEEF CATTLE

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Summary

The fertility of groups of lactating Angus cows of similar age, grazing the same pastures and joined at the same times, was highly correlated with average liveweight and change in liveweight at joining. Within groups of lactating cows, and between and within groups of non-lactating cows, there was little relationship with these variables. The significance of these results to management of nutrition for high fertility is discussed.

I. INTRODUCTION

Relationships between liveweight during joining and fertility, although mostly studied in heifers, have been reported in older cows by several authors (e.g. Wiltbank et al. 1962; Lamond 1969; Hight 1968; Carter and Cox 1973). These reports all indicate the importance of nutritional status to reproductive efficiency-. Prediction equations are required for models of beef production systems to evaluate variables such as stocking rates, time of calving, pasture management or supplementation. This paper presents estimates, from data of Axelsen et al. (1972), of the response of calving percentage to liveweight variables at the second and subsequent joinings of a herd of Angus cows.

II. MATERIALS AND METHODS

The pastures, livestock, and the design of the experiment are described by Axelsen et al. (1972). In each of six years the herd of approximately 75 cows consisted of two groups at a "low" stocking rate and four groups at a "high" stocking rate. In these stocking rate treatments, the cows on half the plots were joined for six weeks for an "early" calving (autumn-early winter) or a "late" calving (late winter-spring). Low stocking rate treatments were not replicated; high stocking rates were replicated twice. Thus there were 36 groups of animals, which consisted largely, but not wholly, of 'the same animals from year to year. Cows were classed as "lactating" or "dry" depending whether they were nursing a calf at joining time. The "characteristic weight" (W) of a cow was her weight on Jul. 6, 1965, prior to her first calving when she would have been approximately 24 months old'and in good condition following favourable spring growth. All liveweights (LW) were measured without prior fasting.

III. INFERENCES FROM STATISTICAL ANALYSES

The relationships between fertility and LW is obviously one of correlation, not of causation, the correlations being generated because both' fertility and LW are functions of nutritional status. The model might therefore reasonably be based on LW, reflecting the nutritional reserves in the body of the cow, and on the change in LW during joining, reflecting the nutritional reserves being stored by the cow after meeting the needs of maintenance and lactation.

In the experiment analysed, the effects of managerial controls on fertility, as indicated by LW, could be estimated from the "between group"

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relationships, after removing the effect of age of cow by a "within year" analysis. The effects of genotype and other uncontrolled variables could be estimated by "within group within year" analysis, since the cows within groups were random samples from a herd of weaners, and had been exposed to similar environments in the same paddocks during the period of joining. It is important that bulls were rotated around paddocks during the joining period. .

The data were analysed by an iterative weighted regression procedure which yields maximum likelihood estimates of logit $(p) = \ln(p/(1-p))$, where p is the expected proportion of cows calving. The fitting was facilitated by the computer program GLIM developed by a working party of the Royal Statistical Society for statistical computing. The order in which terms are fitted can be arbitrary and, in the absence of a clear understanding of cause and effect, this can give rise to problems of inference.

The contribution of each term in the model is measured by the <u>deviance</u>, which is analagous to the sum of squares in the classical regression model. The deviance has an approximate χ^2 distribution which is asymptotic, i.e. large n, in binomial data. A summary of the fitting is given as a generalization of the analysis of variance of Nelder and Wedderburn (1972).

The models for both the individual animals and the groups assume that observations be independent, although the same animals were used from year to year. The serial independence of cow responses was tested by fitting models on 50 cows (all those with complete records for six years, except four which were excluded as being statistical outliers) for each year. The deviations from prediction were calculated and included as an independent variable for the following year's model. Since the reduction in deviance from fitting this variable was non-significant ($\chi^2_1 < 1.0$) for all years the assumption of independence was accepted. This is not stating that genotype and other variables do not affect fertility, but only that such effects were of negligible importance in the data analysed.

IV. RESULTS

(a) Effect of lactation

The fertility of non-lactating cows was not related to LW variables, in contrast with that of lactating cows ($P \simeq 0.02$). This is consistent with results of Lamond (1969) for fertility and condition score. Since the 61 joinings with dry cows is inadequate for detailed study the remainder of this report is concentrated on the 263 joinings with lactating cows.

(b) Between and within groups of lactating cows

The 36 groups were divided by years into two sets of 18 since the GLIM program could not accommodate 36 groups. Each of these was analysed in two ways, fitting groups then LW variables, or LW variables then groups. The results, presented in table 1, demonstrate no significant relationship <u>within groups</u> between LW and fertility since the χ^2 variables <u>after fitting groups and years</u> in no case approach statistical significance. . Further since the χ^2 values for groups <u>after fitting LW variables and years</u> approximately equal the degrees of freedom ($P \simeq 0.5$), virtually all fertility differences <u>between groups</u> are related to the effects of appropriate treatments on LW and fertility.

Since the effects of some variables over the six years might be obscured in the partial analysis, the 263 joinings over six years were analysed as far as was feasible with the GLIM program. Results are presented in table 2.

TABLE 1
Deviances from fitting model to sets of data
(approximate χ^2 distribution)

Source of deviance	Degrees of freedom	Order of fitting	1966-1968	1969-1971	Order of fitting	1966-1968	1969-1971
Years	2	1	4.8*	2.8	1	4.8*	2.8
Groups	15	2	33.4***	25.7**	6	14.5	14.3
LW	1	3	0.1	0.3	2	11.5***	3.4*
LW^2	1	4	2.5	2.6	3	1.4	10.5***
LW gain	1	5	0.9	1.0	4	8.1***	0.0
W	1	6	0.1	1.2	5	1.5	2.0
Residue	1966-68=118 1969-71=103		145.6	76.0		145.6	76.0

* P<0.10; ** P<0.05; *** P<0.01

TABLE 2
Deviances from fitting model to total data
(A indicates LW=LW; B indicates LW=LW/W)

Source of deviance	Degrees of freedom	A	B
Years	5	26.8***	26.8***
LW	1	13.6***	18.2***
LW gain	1	6.0*	8.0**
W	1	4.9*	
LW^2	1	11.9***	3.3
Year x LW	5	2.5	2.6
Stocking rate	1	0.1	2.0
Calving time	1	0.0	0.4
Replicate	1	3.0	3.0
Residue	245	247.0	251.9 (246 d.f.)

* P<0.05; ** P<0.01; *** P<0.001

The probability of a cow becoming pregnant was estimated from a multiple regression equation calculated from weighted group means. The predicted probabilities for different LW/W and LW gains are presented in table 3 for cows 4½ years old or older.

TABLE 3
Probability of pregnancy for mature Angus cows

Relative weight	Actual weight*	LW gains during 6-week joining (kg)			
X = LW/W	LW (kg)	-40	-20	0	20
0.7	290	.07	.09	.12	.15
0.9	370	.44	.50	.57	.63
1.0	410	.64	.70	.75	.79
1.1	450	.77	.81	.85	.88
1.3	530	.86	.88	.91	.93

Equation: $\ln(p/(1-p)) = -16.69 + 28.4X - 10.62X^2 + .0126$ LW gain.
* For 2nd and 3rd joinings subtract 30 and 15 percent from this column.

The effects of all LW variables in table 2 are significant, and the effects of all treatments are not significant after fitting LW variables. The residue approximately equals its d.f., indicating that nearly all the non-random binomial variance is accounted for by the model fitted. The effect of fitting W, by letting LW=LW/W, is to decrease markedly the quadratic term in the response of LW without, however, changing the fit appreciably. The more linear model seems likely to be preferable when extrapolating to other genotypes or herds, and is used in table 3.

V. DISCUSSION

The analyses showed that the relationship between fertility, LW and LW gain are of negligible significance within groups of animals of similar age and history. The group average LW in relation to age, and current nutritional status, are however, strongly related to reproductive performance, These relationships are correlative, not causitive, and some factor could distort the relationships if it were to stimulate reproductive activity without necessarily affecting LW. For example, protein content of diets may be critical (Knight, Oldham and Lindsay 1975).

From the viewpoint of management, the economics of. improved nutrition depends on the cost of raising the mean liveweight of all the lactating cows in the herd in relation to the response expected. Lamond's (1969) results, and ours, suggest that non-lactating cows in moderate condition are likely to be more fertile than indicated by the LW-fertility relationships of table 3. It is important to emphasize that responses are likely to be disappointing if only the lighter 50% of cows in a herd are supplemented. The response expected would be the same if only the heavier 50% were supplemented. This contrasts somewhat with expectations in heifers in which LW is strongly correlated with age and age and LW tend to act additively (Axelsen and Morley 1976).

Whilst fertility would be improved by improving the nutrition of lactating cows, this might be difficult to achieve by supplementation. Apart from the effect on grazing intake by supplementation, much of the increase in intake might be channelled into the calf, especially in breeds with high milk production potential, with only a minor improvement in the nutritional status of the cows. The effect of variations in pre- and post-calving management in relation to reproductive efficiency requires further investigation over a range of production systems.

VI. REFERENCES

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