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SOME COMPONENTS OF IMPROVED BEEF COW PRODUCTIVITY ON HILL COUNTRY

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SUMMARY

Productivity was defined as measured output per cow exposed to the bull and retained through winter, for reproduction, weaning, lean meat production of steer progeny at approximately 20 months of age, and the generation of pregnant heifer replacements mated at 14 months of age. Similarly, cow efficiency in these traits was defined as productivity per 100 units of cow metabolic body weight at joining.

From the data recorded at the Whatawhata Hill Country Research Station, the performance levels of Friesian, Angus, Friesian \times Jersey, Friesian \times Angus and subsequent Friesian-sired backcrossed cows were compared for pregnancy rates, cow joining weights, calf weaning weights, carcass lean meat weights of steer progeny, and pregnancy rates of heifer progeny. These data were used to illustrate the relative contributions of components of performance to improved beef cow productivity and efficiency on hill country.

First-cross Friesian \times Jersey and Friesian \times Angus cows exhibited distinct advantages in productivity and efficiency for most aspects of performance, and were considered to offer a large potential in the improvement of beef cattle production on hill country.

INTRODUCTION

On hill country farms, beef cattle comprise approximately 30% of the total stock units carried (NZMWBES, 1977a), and on a per-farm basis, females of at least 18 months of age comprise about 61% of the beef herd (NZMWBES, 1977b). The relative importance of both the number of females in the beef herd and their feed requirements (70% of total feed consumption by the cow and her calf to weaning is required for cow maintenance; Baker and Carter, 1976) emphasizes that improvement in beef cattle production should concentrate on the breeding female. Dickerson (1970) considered that one of the main objectives in improving animal production efficiency was a higher rate of female production.

This report discusses some of the factors considered to be of importance in four areas of beef cow production on hill country (Table 1).

TABLE 1: DEFINITIONS OF BEEF COW PRODUCTIVITY AND EFFICIENCY RATIOS

	Productivity	Efficiency
Reproduction (R)	R_p = cows pregnant/cow exposed	$R_e = R_p/100$ kg (Mating weight ^{0.75})
Weaning (W)	W_p = kg calf weaned/cow wintered	$W_e = W_p/100$ kg (Mating weight ^{0.75})
Slaughter (S)	S_p = kg carcass lean meat/cow wintered	$S_e = S_p/100$ kg (Mating weight ^{0.75})
Replacement (H)	H_p = heifers pregnant/cow wintered	$H_e = H_p/100$ kg (Mating weight ^{0.75})

TABLE 2: PERFORMANCE DATA OF BEEF COWS OF DIFFERENT GENOTYPE

	Symbol	A_a	A_l	FA	FJ	$\frac{3}{4}$ FJ	F
Mean cow mating weight (kg) ¹	B	359a		393b	371c	399bd	408d
No. cows exposed to bull	C	678	266	217	299	244	672
No. cows pregnant	C'	557	223	193	261	211	543
No. cows wintered	C_w	553	221	191	260	218	564
Proportion culled ($C-C_w$)/C'		0.19a	0.17ab	0.12b	0.13b	0.11b	0.16ab
No. calves weaned	O	447	183	160	229	175	446
Mean calf weaning weight (kg) ¹	L	152a	164b	180c	185d	188d	186d
No. steers killed ²	M	166	57	35	78	45	141
Mean steer lean meat/carcass (kg) ^{1,2}	K	127a	154b	157b	152b	155b	157b
No. heifers pregnant	F	51	68	53	76	39	113

¹ Within each row, values with different letters differ significantly ($P < 0.05$).

² Applicable to 1970-73 matings only, in which cows wintered were 397 (A_a), 181 (A_l), 109 (FA), 191 (FJ), 124 ($\frac{3}{4}$ FJ) and 396 (F).

The weaning productivity measure defined in this paper is similar to that of Baker and Carter (1976), who used weight of calf weaned per cow exposed to the bull. In the absence of feed intakes, they defined the denominator of the efficiency ratio as cow weight when exposed to the bull. Metabolic body weight (mating weight^{0.75}) is used as the denominator in the present definition of relative efficiency. This assumes that genotypic differences exist in annual cow maintenance requirements.

MATERIALS AND METHODS

Examples of cow productivity and efficiency are calculated from the data of the beef cow herd at the Whatawhata Hill Country Research Station. Over the 1970 to 1977 matings, three sub-herds of Friesian (F), Friesian \times Jersey (FJ) and Angus (A_f) cows have been mated to F bulls to generate F, $\frac{3}{4}$ FJ and FA cows, respectively, which in turn have been backcrossed to F bulls. A further sub-herd of straightbred Angus (A_a) cows has also been maintained.

All cows were grazed together except during mating when cows were randomly assigned to single-sire groups according to genotype and age. The A_a cows were mated separately from the cows of other genotypes. All heifer replacements were reared together after weaning and exposed to the bull at 14 to 15 months of age, two weeks ahead of the older cows. The steer progeny were grazed at the Horotiu farm of the Auckland Farmers' Freezing Co. Ltd from weaning until slaughter at approximately 20 months of age when carcass assessments were conducted. Data from F, FJ, $\frac{3}{4}$ FJ, A_a, A_f and FA cattle for the 1970 to 1975 matings were used.

RESULTS

At the start of mating, A (A_a and A_f) cows had the lightest weights of all genotypes, followed by FJ cows (Table 2). After pregnancy diagnosis, the proportion of A_a cows culled relative to those exposed to the bull was greater than the proportion of FA, FJ and $\frac{3}{4}$ FJ cows, with the proportion of A_f and F cows being intermediate between these two groups. Calves out of FJ, $\frac{3}{4}$ FJ and F cows were weaned at heavier weights than those out of the other genotypes. Calves out of A_a cows had the lightest weights at weaning. Steers out of A_a cows had lighter meat weights than steers out of cows of all other genotypes.

A_a cows were not significantly different from other cow genotypes apart from the FA cows (Table 3). The FA and FJ cows

TABLE 3: PRODUCTIVITY AND EFFICIENCY VALUES OF BEEF COWS OF DIFFERENT GENOTYPE

		A_s	A_l	FA	FJ	$\frac{3}{4} FJ$	F
Productivity:							
Reproduction	$R_p = C'/C$	0.82ac	0.84bc	0.89b	0.87ab	0.86abc	0.81c
Weaning	$W_p = O L/C_w$	123a	136b	151cd	163d	151cd	147c
Slaughter	$S_p = M K/C_w$	53a	48a	50a	62a	56a	56a
Replacement	$H_p = F/C_w$	0.09a	0.31b	0.28b	0.29b	0.18c	0.20c
Efficiency:							
Reproduction	$R_e = R_p/B^{0.75} (\times 100)$	1.00a	1.02a	1.01a	1.03a	0.97a	0.89b
Weaning	$W_e = W_p/B^{0.75} (\times 100)$	149a	164b	171b	192c	169b	162b
Slaughter	$S_e = S_p/B^{0.75} (\times 100)$	64a	59a	57a	74a	63a	62a
Replacement	$H_e = H_p/B^{0.75} (\times 100)$	0.11a	0.37b	0.31b	0.35b	0.20c	0.22c

Within each row, values with different letters differ significantly ($P < 0.05$).

had greater reproductive productivity than F cows. The weaning productivity of A_a cows was distinctly lower than that of all other cow genotypes, followed by that of the A_f cows, with F cows being approximately intermediate between these genotypes and the crossbreds. No evidence of cow genotype effects was apparent in slaughter productivity, although FJ cows tended to be more productive than A_f cows ($P < 0.10$). Replacement productivity was poorest in the case of A_a cows, followed by $\frac{3}{4}$ FJ and F cows. First-cross FA and FJ cows or those rearing first-cross calves (A_f) exhibited advantages in replacement productivity.

When considering efficiency, differences due to cow genotype in reproductive productivity tended to be nullified by cow metabolic body size except in the case of F cows. At weaning, A_a cows were the least efficient group and FJ cows the most efficient; all other cow genotypes were intermediate between these two. Cow genotype had no effect on slaughter efficiency, although differences were apparent in replacement efficiency in favour of A_f , FJ and FA cows.

DISCUSSION

REPRODUCTION

Wilton and Morris (1976) found that increasing reproductive rates from 0.68 to 0.87 calves weaned per cow exposed produced higher gross margins for various mating systems. Increases in cow size also generally increased gross margins with increasing reproductive rate. From Table 3, R_e values tend to favour medium- to small-sized cows of higher reproductive ability, such as the FJ or A_f cow.

In practice, improvement in cow reproductive productivity and efficiency relies on increasing the number of cows pregnant after a concentrated mating period rather than on genetic improvement in such traits as twinning rate (e.g., Gordon, 1976). Among British beef breeds, Cundiff *et al.* (1974) reported advantages of crossbred cows over straightbreds in such traits as first service conception rate (6.6%) and pregnancy rate (5.6%) when these traits were expressed per cow exposed to the bull. Improvement in reproduction could therefore be achieved more readily by crossbreeding than by within-breed selection. This is apparent in Table 3 where the R_p and R_e values of A_f , F and FA cows (mated to the same bulls) are compared. The FA cows exhibited advantages over the mean parental breed values of approximately 8% in productivity and 6% in efficiency. How-

ever heterosis would be expected to be commercially less important at higher reproductive levels.

Cow age, lactation status and level of nutrition can also influence the proportions of cows exhibiting oestrus early in the breeding season and conceiving to first service (Wiltbank, 1970; Laster *et al.*, 1973; Scales *et al.*, 1977). There is a need to define further the feeding and management levels necessary to maintain a high reproductive performance in beef cows under New Zealand conditions and to determine the influence of genotype, age and time of calving on the responses obtained, if these aspects are to be manipulated to the best productive advantage.

Evaluations of beef cow productivity and efficiency for the weaning, slaughter and replacement classifications have relied on a denominator of cows exposed to the bull and retained to winter. Table 2 illustrates that the number of cows culled before winter varied with genotype. For experimental design purposes, A_a cows were culled more heavily than FA, FJ and $\frac{3}{4}$ FJ cows. The effect on productivity and efficiency ratios using a denominator of cows exposed to the bull (C) compared with cows exposed to the bull and wintered (C_w) was tested for the weaning, slaughter and replacement classifications. The W_p and W_e values calculated using the C and C_w denominators differed ($P < 0.05$) for each genotype, but the S_p , S_e , H_p and H_e values did not. However, differences between, and the rankings of genotypes on the basis of productivity and efficiency ratio values, were not materially altered.

WEANING

In beef breeding herds, the weight of calf weaned is frequently the first positive indication of the productive ability of both the cow herd and the surviving calf crop. Although weight of calf weaned, as a cow trait, is confounded by the calf's own genetic ability for growth, this confounding is not a serious handicap. When efficiency is defined as cow and calf total digestible nutrients (TDN) intake per kilogram calf weaning weight, then larger cows may produce enough additional calf weight to compensate for any greater nutrient requirements. Thus, cow weight may not affect efficiency at weaning (Klosterman and Parker, 1976). Marshall *et al.* (1976) considered that milk production and reproductive performance were major factors affecting cow efficiency. In Table 3 where the components of the W_e ratios for A_a and A_f cows are constant, except for weight of calf weaned, both weaning productivity and efficiency favour heavy weaning

weights. This presumably reflects both cow milk production and calf growth potential. The W_p ratios for FJ, $\frac{3}{4}$ FJ and F cows favour the higher reproductive rate of the FJ cow to the extent of approximately 2 kg extra of calf weaned per 1% increase in reproductive rate (calves weaned/cow wintered). Differences in cow size between these genotypes, however, preclude any evaluation of the importance of reproductive performance on cow weaning efficiency.

The economic importance of higher calf weaning weights will depend on the time interval between weaning and first mating or slaughter, as well as on the costs, seasonal distribution and quality of the feed provided. High weaning weights appear essential to improved post-weaning performance where heifers are mated at 14 months and steers slaughtered from 18 months of age, particularly if severe winter feed deficits are experienced (Everitt *et al.*, 1975).

Calf weaning weight has medium levels of heritability (0.25, Nicoll, 1975) and repeatability (0.34 for Angus; Nicoll and Rae, 1977), and is positively genetically correlated with post-weaning weights (Preston and Willis, 1970). Hence it frequently receives considerable emphasis in selection. Large between-breed variations in maternal ability and carry-over effects post-weaning have also been reported (Hight *et al.*, 1973). Comparing cow genotypes mated to F bulls in Table 2 (F, A₁ and FA cows), the FA cows weaned 4% more calves per cow wintered that were 3% heavier than the means of the parental breeds. Similarly, FA cows exhibited an advantage of 7% and 5% in the W_p and W_e ratios, respectively (Table 3). The high performance to weaning of the FJ and FA cows, particularly in relation to A_a, suggests that these first-cross cows offer considerable potential for increasing weaning productivity and efficiency on hill country.

SLAUGHTER

The biological components of beef breeding objectives should include efficiency of lean growth and meat quality (Dickerson *et al.*, 1974). The first component is incorporated in the present definitions of S_p and S_e , assuming that rapid growth is related to efficient lean growth. Meat quality factors are indirectly included, as tenderness and degree of fat cover are influenced by age and weight at slaughter. In this context, cow S_p and S_e ratios favour rapid growth to reach heavier slaughter weights at younger ages. These ratios assume, however, that all steers surviving to 20

months of age are slaughtered at this time. Commercial producers may delay killing lighter-conditioned animals. Klosterman and Parker (1976) observed that larger cows reared calves with greater edible meat weights than smaller cows, but that differences between cow sizes in the amount of TDN required to produce a kilogram of lean meat were not significant. Despite the absence of feed intake data in the present study, there were also no differences in the slaughter efficiency of cows of different sizes in Table 3.

The genetic parameters of post-weaning growth traits (Petty and Cartwright, 1966; Preston and Willis, 1970) favour selection for higher post-weaning weights within breeds. Genes for rapid growth are commonly considered to complement those for carcasses of high meat yield, especially when selection is for weight for age (Cunningham and Broderick, 1969; Cundiff *et al.*, 1971). However, selection for post-weaning weights may be associated with increases in cow size. This could improve cow slaughter productivity without changing cow slaughter efficiency.

Improvement through crossbreeding is likely, as post-weaning growth and consequently desirable carcass traits are responsive to heterosis (Long and Gregory, 1975). The use of first-cross, small-sized dams mated to large sire breeds could increase cow slaughter productivity and efficiency, through heterosis for dam reproductive and maternal abilities, and for calf survival and growth.

In a pastoral system of beef production, the nutritional objective is to equate the seasonal pattern of pasture production with the increasing feed requirements of growing animals. One of the economic objectives is to minimize the post-weaning growing period so that slaughter from about 18 months of age occurs before the second winter. A conflict may exist between achieving a high per-animal growth performance and an effective utilization of the herbage available for grazing. Through a knowledge of the relationships between herbage availability, intake, and animal performance, such a conflict may be minimized. This knowledge is necessary not only for the effective application of feed budgeting principles, but also for such management decisions as choosing the genotype of cattle reared post-weaning and the optimum slaughter policies to apply.

REPLACEMENTS (HEIFERS)

The H_p and H_e ratios in Table 5 may be biased by any selection for genotype (in order to maintain sub-herd numbers) and for size

at weaning. Selection for genotype would bias downwards the apparent survival rate to yearling mating of heifers of established genotypes (*e.g.*, A_a and F). Effective selection for size may bias upwards the mean joining weight, and thus the pregnancy rate, in view of the positive relationship between heifer joining weight and subsequent 2-year-old calving performance (Carter and Cox, 1973; Hanly and Mossman, 1977).

Among British beef breeds, crossbred heifers have exhibited advantages over their straightbred contemporaries in yearling weight (Warwick, 1968), age at first oestrus (Cundiff, 1970), and first service conception rate (Cundiff *et al.*, 1974). The H_p and H_e ratios of the A_e , FA and FJ cows genotypes, compared with A_a , $\frac{3}{4}$ FJ and F genotypes in Table 3, illustrate the benefits of adopting systematic crossbreeding programmes to exploit the first-cross female.

Improvement in beef cow replacement productivity and efficiency can also result from improved nutrition of heifers post-weaning, earlier onset of puberty and improved subsequent mating performance (Joubert, 1963; Axelsen and Morley, 1976). There is a need to define further the influence of herbage allowance and intake on post-weaning growth, onset of puberty, and reproductive performance at first mating of yearling heifers grazed under hill country conditions. In these traits, the relative responses of heifers of different genotypes also require investigation.

CONCLUSIONS

It is apparent from the results of the present study that a marked contribution to increased beef cow productivity and efficiency could arise from the use of first-cross beef cows, notably the Friesian \times Jersey and the Friesian \times Angus. Relative to Angus cows, for example, these genotypes have exhibited advantages in weaning productivity and in weaning efficiency of 22 and 32% and 14 and 29%, respectively. Baker and Carter (1976) have reported similar relative advantages for Friesian \times Hereford cows. Economic analyses of these and other highly productive genotypes under a range of management and breeding systems are required. It appears that beef producers should again review the advantages of beef-dairy crossbred cows generated by the dairy industry, which can offer a means for improving the total production and efficiency of beef cattle on hill country.

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