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PERFORMANCE OF CROSSBRED COWS IN THE RUAKURA BEEF BREED EVALUATION TRIAL

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SUMMARY

Progeny by 11 sire breeds out of Angus or Hereford cows were born 1973-7. Semen from the same bulls was used at each of three diverse research locations. This paper relates to 6187 matings (mainly by AI) and 4537 calvings of the 2163 female progeny, all being first mated as yearlings.

Location differences were greater for reproduction than for growth traits and indicated important genotype x environment interactions for the main components of cow performance, namely calving rate, calf survival and calf growth to weaning. All the European exotic crosses performed relatively much better at Tokanui (the most favourable environment) than Goudies (relatively harsh environment). In terms of weight of calf weaned per female joined, the Simmental cross ranked second at Tokanui but only seventh at Goudies; conversely the Hereford-Angus cross ranked fourth at Goudies but eighth at Tokanui.

At all locations, Friesian cross females weaned the greatest weight of calf per head but are likely to be matched in feed efficiency of calf production by the lighter Jersey cross.

The findings are compared with some overseas results, and implications are discussed in terms of breed utilisation strategies.

INTRODUCTION

Recent evidence from comparisons of genetically diverse breeds performing under widely differing environments is challenging traditional beliefs based largely on less extreme comparisons, that genotype-environment (GxE) interactions are of minor economic consequence in beef production. For example, British and European research results (Allen and Kilkenny, 1980; Andersen, 1978, 1979; Geay and Robelin, 1979) suggest that early maturing breeds (e.g. Hereford and Angus) are better suited to grass finishing systems with slaughter at relatively young ages and low carcass weights, whereas late maturing breeds or crosses (e.g. Charolais, Blond d'Aquitaine) are especially suited to intensive concentrate-based systems producing heavy, lean, carcasses at older slaughter ages. Australian studies (Frisch and Vercoe, 1978) indicate superior performance of *Bos indicus* over *Bos taurus* under tropical stresses but inferior performance in more favourable temperate conditions, as a consequence of the greater heat tolerance and resistance to parasites but lower voluntary feed intakes of the *Bos indicus* strains.

Apart from some comparisons of lines of Hereford cattle developed and tested in the differing environments of Montana and Florida in the U.S.A. (Butts *et al.*, 1971; Koger *et al.*, 1979; Burns *et al.*, 1979), little has been published on genotype environment interactions for reproductive and maternal traits in beef cattle.

The Ruakura Beef Breed Evaluation (BBE) Trial (Carter *et al.*, 1975; Baker and Carter, 1979, 1980) compares different breeds and crosses at three experimental locations which vary in climate, topography and feed production patterns. This paper presents evidence on GxE interactions for cow performance.

MATERIALS AND METHODS

Initial objectives in the BBE trial were to compare the performance of four "local" (Angus, Hereford, Friesian, Jersey) and seven "exotic" (South Devon, Charolais, Limousin, Blond d'Aquitaine, Simmental, Maine Anjou, Chianina) breeds of cattle in crosses with Angus and Hereford cows. This paper is concerned with reproductive and maternal performance of the female progeny.

Semen from the same bulls was used at each location which represent a wide range of environments as reflected in animal performance levels. Tokanui (Waikato — 500 Angus cows) has the most favourable conditions, Goudies (Lands and Survey block near Rotorua — 850 Angus and 500 Hereford cows) the hardest, with Templeton (near Christchurch — 300 Angus cows) being intermediate. From 1971-7, 191 different sires averaging 20 (range 12 to 32) of each breed, were used to generate test progeny by AI.

Mating, calving and weaning performance of all females were recorded for at least four seasons. Heifers were run with vasectomised bulls and age at first oestrus, designated age at puberty, recorded. They were mated as yearlings to Angus or Shorthorn bulls, with subsequent matings (mainly by AI) to Blond d'Aquitaine, Limousin, Simmental, Maine Anjou, Charolais and Murray Grey as terminal sires. Females twice non-pregnant were culled.

Provisional results covering survival, growth and carcass production of progeny as well as performance of the derived females have been reported by Carter *et al.* (1975), Baker and Carter (1979, 1980) and Carter *et al.* (1980).

This paper summarises information on 2163 heifers born 1973-7 (69% being at Goudies, 20% at Tokanui and 11% at Templeton), 6187 joinings (35% as yearlings, 30% as 2-year-olds, 21% as

3-year-olds and 14% as 4-year-olds), 4537 calvings (1975-8) and 4042 weaning records. Hereford dams are represented only at Goudies, and the first Chianina crosses were not born until 1975. Results, necessarily provisional at this stage, are presented as simple means pooled over calving years.

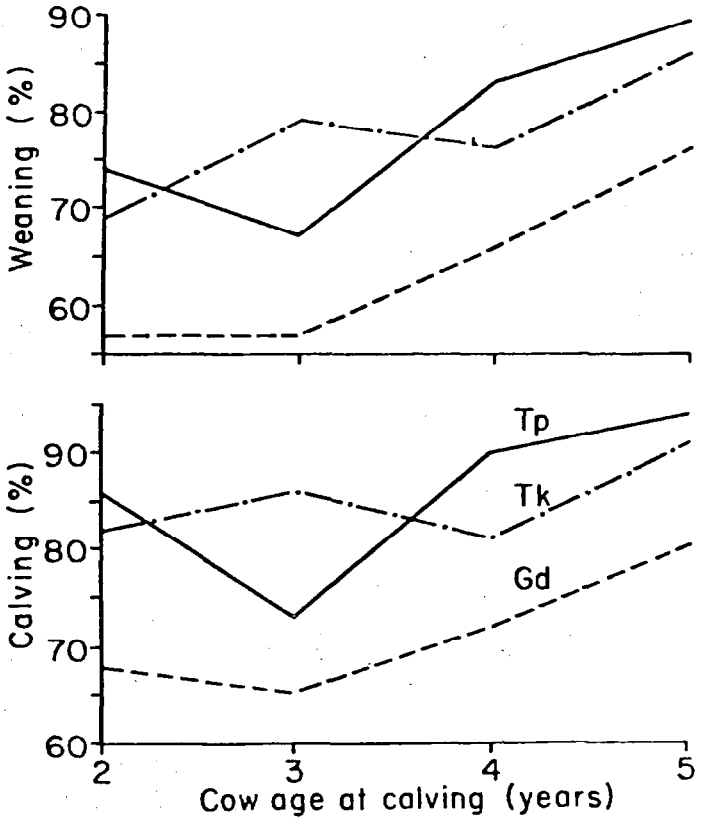

FIG. 1: *Cow age trends for calving (lower) and weaning (upper) percentage at Goudies (Gd), Tokanui (Tk) and Templeton (Tp).*

RESULTS AND DISCUSSION

Overall location means for the main reproductive and maternal traits are summarised in Table 1. Age trends at each location for calving and weaning percentage are illustrated in Fig. 1, corres-

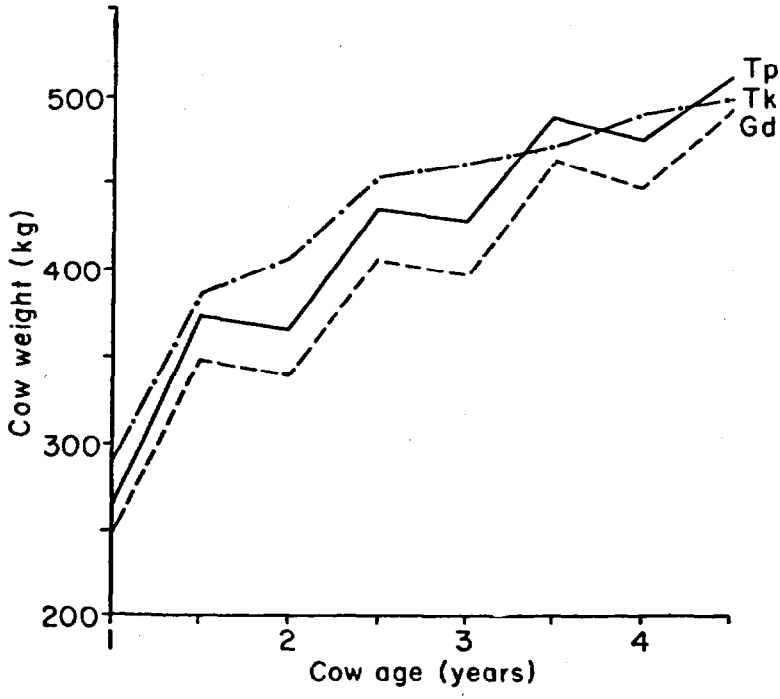

FIG. 2: *Age trends in cow liveweights at Goudies (Gd), Tokanui (Tk) and Templeton (Tp).*

ponding cow liveweight data being presented in Fig. 2. The less favourable Goudies environment resulted in a depression of cow liveweights by about 10% on average compared to those at Tokanui. This is reflected in lower reproductive performance at Goudies than at Tokanui and Templeton both of which are similar. Greater problems of heat detection and AI under the more extensive conditions at Goudies than at the other locations also influenced differences in pregnancy rates.

The late sexual maturity (age at puberty) of the Blond d'Aquitaine, Limousin and Charolais and the precocity of the Jersey and Friesian crosses relative to the Hereford-Angus, are sharply reflected in pregnancy rates to mating as yearlings, with less extreme breed differences at later matings (Table 2).

TABLE 1: COMPARISON OF OVERALL FEMALE PERFORMANCE AT THE THREE EXPERIMENTAL LOCATIONS

Location	*Age at Puberty (d)*	*In calf 1yr (%)*	*In calf 2yr+ (%)*	*Difficult births 2yr (%)*	*Difficult births 3yr+ (%)*	*Calf losses to weaning 2yr (%)*	*Calf losses to weaning 3yr+ (%)*	*Weaning % 2yr+*	*Weaning wt[1] 2yr+ (kg)*	*Productivity[2] 2yr+ (kg)*	*Cow weight[3] 1yr (kg)*	*Cow weight[3] 2yr+ (kg)*
Templeton	381	86	85	14	7	14	5	76	174	132	266	449
Tokanui	371	85	87	23	8	13	6	76	171	130	289	463
Goudies	415	71	73	16	8	15	7	61	165	101	248	422

[1] At approximately 5 months of age

[2] Weight of calf weaned per cow joined

[3] Yearling weight (1-yr) is the first joining weight; the 2-yr+ weight is the pre-mating and pregnancy diagnosis (autumn) liveweights averaged over cow age 2- through 4-years.

The freqency of difficult births and calf losses among 2-year-olds was, on average, more than twice that for 3-year-old and older calvings (Table 1). This was particularly evident for straightbred Angus cows and Charolais and Simmental crosses, as seen in calf losses to weaning (Table 2).

Combining results for all ages, Friesian, Jersey and Hereford-Angus crosses weaned the greatest number of calves. Calf weaning weights, influenced by both milk production and growth potential, were highest for Friesian, Simmental and South Devon cross dams, lowest for Angus, Hereford, Chianina and Limousin sired cows.

Productivity of cows for weaner calf production is conveniently measured by weight of calf weaned per cow mated, combining the effects of calf survival and pre-weaning growth. This assumes cows are mated to the same bulls and ignores sire x dam interactions for progeny performance to weaning. Breed rankings relative to the straightbred Angus (= 100) are presented in Table 3. Since all other breeds are represented by first-cross females they benefit from heterosis, estimated to be of the order of 20% for productivity in the Angus-Hereford cross (Carter *et al.*, 1980; Baker and Carter, 1980). Less reliability attaches to results for the Chianina, represented at this stage by fewer calvings, than the other breeds.

Table 3 indicates much wider variation among breeds in productivity as 2-year-olds (range 73%) than at older ages (range 34%). Breed rankings are however closely similar for both first and later calvings. The Friesian, Jersey, South Devon and Maine Anjou crosses have the highest productivity, straightbred Angus and Limousin and Chianina crosses the lowest.

Of particular significance in Table 3 is the much wider range among breeds for productivity in the hardest environment, Goudies (68%) than for the most favourable location, Tokanui, (34%) and the intermediate conditions of Templeton (39%). Important interactions are manifest when comparing relative breed rankings in the three herds. The Friesian and Jersey crosses excel at all locations. But whereas all the "exotic" crosses except Chianina and Limousin out-perform the Hereford-Angus at Tokanui and Templeton, all except the South Devon and Maine Anjou are clearly inferior to the Hereford-Angus at Goudies. Likewise the marked superiority of the Hereford-Angus over straightbred Angus at Goudies, and to a lesser extent at Templeton, is not evident at Tokanui, supporting other evidence (Barlow, 1981) that heterosis, at least for reproductive traits, may be expressed more strongly in less favourable environments.

TABLE 2: PERFORMANCE OF CROSSBRED FEMALES FROM THREE LOCATIONS

Breed[1]	*Age of Puberty (d)*	*No. cows joined as yearlings*				*In calf*		*Calf losses to weaning*		*Weaning%*	*Weaning Wt*
		Gd[2]	*Tk*	*Tp*	*Total*	*1yr (%)*	*2yr+ (%)*	*2yr (%)*	*3yr+ (%)*	*2yr+*	*2yr+ (kg)*
Angus	413	136	66	33	235	72	78	22	8	62	159
Hereford-Angus	392	162	46	19	227	85	82	15	8	71	164
Friesian	353	118	26	19	163	91	93	14	5	77	185
Jersey	340	121	23	20	164	89	78	11	4	74	172
South Devon	402	96	40	18	154	79	76	9	5	69	176
Charolais	430	87	29	16	132	67	74	17	7	62	173
Limousin	436	119	31	22	172	61	73	11	6	62	165
Blond-d'Aquitaine	443	113	26	19	158	68	75	14	6	62	169
Simmental	414	284	70	38	392	74	73	16	9	62	179
Maine Anjou	404	116	38	17	171	80	79	14	7	69	171
Chianina	—	90	34	15	139	58	74	12	9	55	163
Total or Average		1442	429	236	2107	75	77	15	7	66	170

[1] Angus are straightbred, all the remainder are crosses with Angus and Hereford cows
[2] Excludes 56 straightbred Herefords at this location

TABLE 3: PRODUCTIVITY RANKING OF CROSSBRED FEMALES BY CALVING AGE AND LOCATION

Breed[1]	*Calving age*		*Location (2yr+)*		
	2yr	*3yr+*	*Goudies*	*Tokanui*	*Templeton*
Angus	100	100	100	100	100
Hereford-Angus	127	113	125	104	120
Friesian	168	134	156	134	140
Jersey	158	122	138	117	139
South Devon	142	119	126	112	136
Charolais	107	114	110	102	119
Limousin	100	112	98	109	121
Blond d'Aquitaine	110	115	101	112	129
Simmental	129	117	109	126	130
Maine Anjou	130	120	124	113	129
Chianina	95	110	88	97	105

[1] Angus are straightbred, all others are crosses with Angus or Hereford cows.

Interaction between breeds and the two extreme environments is illustrated by plotting breed rankings for Goudies against those for Tokanui. Fig. 3 depicts results for pregnancy rate, weaning rate, weaning weight, and productivity. The simple (unweighted) regression line of Goudies performance on Tokanui performance is shown. Points above (below) the line indicate better (poorer) relative performance at Goudies than at Tokanui. Marked interactions, represented by deviations from the average relationship, are particularly evident for the Simmental and Hereford crosses. At Tokanui the Simmental crosses ranked second behind the Friesian crosses for productivity while under the less favourable conditions at Goudies they ranked only seventh; in contrast the Hereford-Angus cross ranked fourth at Goudies but dropped to eighth at Tokanui. Clearly all exotic crosses tested in this trial need high levels of feeding to express their reproductive potential.

In comparing the relative productive efficiency or profitability of different breeds or crosses, allowance should be made for the higher weight-related maintenance feed costs of larger animals. Under grazing conditions, annual cow requirements comprise about 70% of feed used when progeny are slaughtered off pasture at about 20 months of age (Carter, 1980). Since maintenance costs are known to be related to animal liveweight, a rough but useful measure of efficiency is productivity per 100 kg of cow liveweight. Both cow liveweight and efficiency rankings are presented by locations in Table 4. Differences in breed rankings at the three locations are comparatively minor for cow liveweight in agreement with the

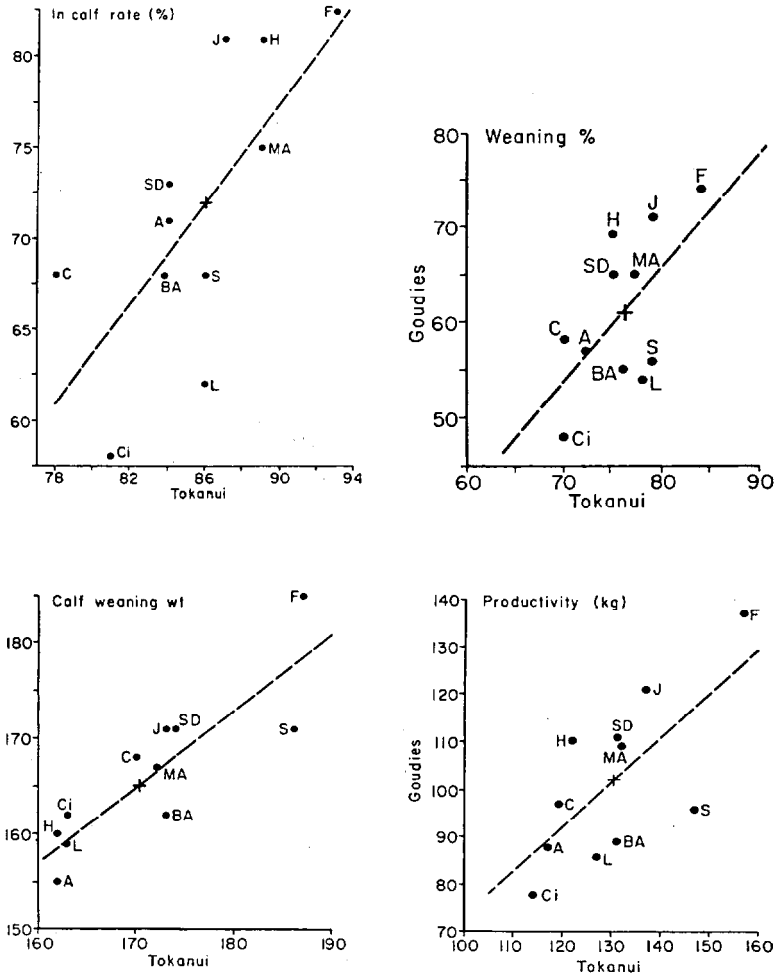

FIG. 3: *Sire breed means for daughter performance at Tokanui (Angus dams) versus Goudies (Angus and Hereford dams).*
Top left, in-calf rate; top right, weaning %; lower left, calf weaning weight; lower right, productivity (weight of calf weaned per female mated).
Note: In this and subsequent figures, + denotes overall mean, A = Angus (straightbred), H = Hereford-Angus cross, F = Friesian, J = Jersey, C = Charolais, S = Simmental, MA = Maine Anjou, SD = South Devon, BA = Blond d'Aquitaine, L = Limousin, Ci = Chianina.

TABLE 4: COW LIVEWEIGHT AND EFFICIENCY RANKINGS OF CROSSBRED FEMALES BY LOCATIONS

Breed[1]	*Cow liveweights (1yr+)*[2]			*Efficiency (2yr+)*		
	Goudies	*Tokanui*	*Templeton*	*Goudies*	*Tokanui*	*Templeton*
Angus	100	100	100	100	100	100
Hereford-Angus	107	106	112	117	100	107
Friesian	112	108	113	142	124	125
Jersey	100	100	102	138	117	139
South Devon	114	112	114	113	100	121
Charolais	114	110	113	96	93	107
Limousin	105	102	113	96	107	111
Blond d'Aquitaine	109	112	114	92	100	114
Simmental	110	109	113	100	117	118
Maine Anjou	113	115	118	113	100	111
Chianina	110	113	110	83	87	96
Average-actual units (kg)	394	432	417	26	30	32

[1] As in Table 3

[2] Pre-mating and pregnancy diagnosis (autumn) liveweights averaged over cow ages of 1 through 4 years.

400-day weight rankings of steers and heifers presented by Carter *et al.* (1980). However there is evidence, when comparing the Goudies and Tokanui environments (see Fig. 4), that the Maine Anjou, Chianina and Blond d'Aquitaine cross cows express their full growth superiority only under favourable conditions.

Efficiency rankings also show interactions of breed groups with locations as is evident in Table 4 and also Fig. 5. Both the Simmental and Limousin crosses rank much higher at Tokanui than Goudies. The small but quite productive Jersey crosses match the larger Friesian crosses in this measure of efficiency.

Results from the present study are in broad agreement with a similar large scale beef breed evaluation programme in the U.S.A. (Cundiff, 1980 and pers. comm.). It is instructive to compare breed rankings at Tokanui, the best environment in the present study with an average weaning rate of 75%, and at Clay Center (Nebraska) where the average weaning rate of 85% testifies to a higher (or more uniform) nutritional level than can be achieved on pasture alone.

Productivity rankings from Tokanui and Clay Center for those breeds in common in the two studies are broadly similar (the Clay Center trial did not include either the Friesian or Blond d'Aquitaine breeds). However the Chianina crosses ranked second at Clay Center just behind the Maine Anjou crosses but have performed

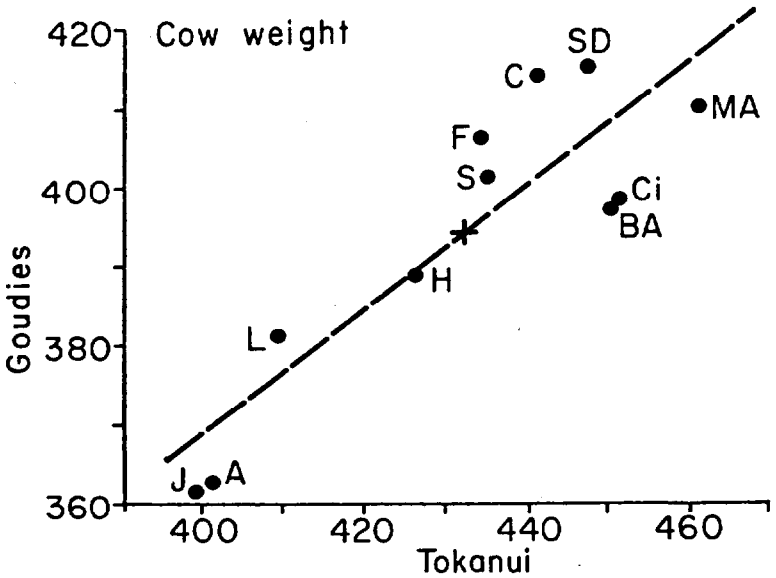

FIG. 4: *Sire breed means for daughter liveweights at Tokanui (Angus dams) Goudies (Angus and Hereford dams).*

very poorly (relative to the Hereford-Angus crosses) at all BBE locations. Conversely Jersey crosses have performed relatively better at Tokanui than at Clay Center. The latter results however, which include more calvings (2- through 8-year-old), suggest possible breed x calving age interaction in that the Jersey crosses ranked higher on initial assessment (after only three calvings) than in the subsequent more complete data.

Although the results for reproductive and maternal performance of crossbred females in the present study are not complete, the following conclusions can be drawn:

1. Exotic crosses, which tend to show later sexual maturity than local breeds as dams under a yearling mating regime, can be recommended only when conditions are favourable. Evidence from New Zealand studies clearly demonstrates however that yearling mating in the local Angus and Hereford breeds and their crosses can usefully increase lifetime calf production performance under commercial farming conditions (Carter and Cox, 1973; Carter *et al.*, 1980).

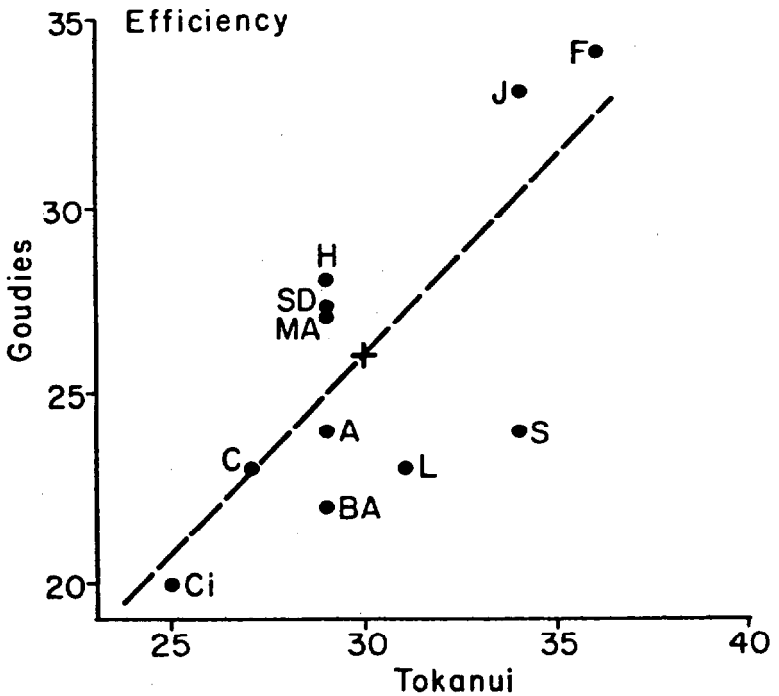

FIG. 5: *Sire breed means for daughter "efficiency" (productivity per 100 kg cow liveweight) at Tokanui v Goudies.*

2. In all environments, greatest calf productivity will be achieved by Friesian and Jersey crosses.
3. The Hereford x Angus female is substantially superior in calf production to the straight Angus or Hereford, especially at young ages and under hard conditions.
4. Under favourable conditions the Simmental, South Devon and Maine Anjou crosses perform at calf productivity levels well above the Hereford-Angus and approaching in some cases the Jersey-cross performance.

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