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Growth and carcass characteristics of three-way Africander x Simmental x Hereford crossbreds in south-western Queensland

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Summary. Liveweight and carcass traits of 3-way Africander (A) x Simmental (S) x Hereford (H) crossbreds and purebred Herefords were monitored predominately on native pastures at Dirranbandi, Queensland, for 2 calf crops over 6 years. The relative breed compositions of the crossbreds were A4S2H2, A4S1H3 and A4H4.

The mean liveweight of the A4S2H2 cattle ranked highest from about 250 days post-weaning to slaughter (520 days post-weaning) for steers, and at first joining for heifers (560 days post-weaning). Differences in liveweight were not significant at all times. The A4S2H2 and A4S1H3 steers had the highest (P<0.05) post-weaning average daily gains. Differences in weaning weight between crossbreds were carried through to slaughter for steers and to joining for heifers.

The A4S2H2 steers had the highest (P<0.05) mean final liveweight (433 kg) and mean carcass weight (232 kg). There was no difference in carcass weight between the other crossbreds and Herefords. Fat depth at the P8 rump site of A4H4 crossbreds (8.5 mm) was higher (P<0.05) than that of Herefords (5.5 mm) and other crossbreds. Dressing percentages were similar for all breed types.

The A4S2H2 maiden heifers had higher (P<0.05) liveweights at first joining (369 kg) than the A4S1H3 (353 kg) and A4H4 (337 kg) heifers.

These data show that beef producers in south-western Queensland can increase carcass weights with A4S2H2 crossbreds and produce carcasses that primarily meet the Korean–EC market and the requirements of domestic supermarket outlets.

Introduction

Beef production in south-west Queensland is based on early-maturing British breeds such as Hereford, Angus and Shorthorn. In the absence of heat stress, and with adequate nutrition, these breeds have higher growth rates than *Bos indicus* x *Bos taurus* crossbreds (Moran 1970; Morgan *et al.* 1978). However, the environment in south-western Queensland is variable and could, at times, depress growth rate and reproductive performance. High ambient temperatures in summer result in heat stress, whilst the variable and relatively low rainfall (mean annual rainfall at Dirranbandi is 473 mm; Anon. 1973) can cause feed shortages and poor nutrition. Sometimes the environment is conducive to high growth rates. Winter rain allows native broadleaf plant growth which provides high quality feed, and forage crops and crop stubbles are commonly used to finish cattle.

Zebu crossbred cattle have higher growth rates under conditions of high temperature and fluctuating nutrition than early-maturing British breeds (Turner 1975; Darnell *et al.* 1987). Other studies show that late-maturing European breeds (e.g. Simmental) have weaning weights and post-weaning liveweight gains that are 10–20% greater than those of early-maturing British breeds under subtropical conditions (Pahnish 1969; Smith *et al.* 1976; Barlow and O'Neill 1978; Strachan *et al.* 1980). This suggests there is potential to increase growth rates of cattle reared in south-western Queensland by crossbreeding for the growth characteristics of European breeds and the adaptation of *B. indicus* breeds. Problems such as dystocia (Wythes *et al.* 1976) and eye cancer (Nishimura and Frisch 1977) may also be reduced.

This study compared the liveweights and carcass traits of 3-way crosses between zebu and early- and late-maturing *B. taurus* breeds, and pure Herefords, in south-western Queensland from 1983 to 1988.

Materials and methods

Environment

The experiment was conducted in 1983–88 at 'Nulky' (28°48'S., 148°12'E.), about 20 km south of Dirranbandi in south-western Queensland. Rainfall is summer-dominant (65% in October–March), with an annual average over 110 years of 473 mm. Distribution is highly variable, and a major or seasonal drought has occurred in at least 1 year in 3 over the last 80 years (Anon. 1973).

Table 1. Rainfall at Dirranbandi for the period of the experiment

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1983	79	22	85	118	253	98	16	31	42	42	132	52	969
1984	200	64	7	42	5	35	134	17	38	37	24	7	609
1985	50	36	5	8	9	5	68	91	14	39	138	54	517
1986	34	2	0	58	29	0	46	34	29	17	54	37	341
1987	30	45	28	0	52	30	9	49	1	60	43	66	412
Mean	63	54	50	33	36	33	30	22	26	33	42	51	474

Rainfall was generally below average for most of the experiment, and often little pasture feed was available (Table 1). The annual rainfall at Dirranbandi varied from 341 mm (1986) to 969 mm (1983). Frosts occur regularly from late April to early August. Mean maximum temperature in summer at Dirranbandi is 33°C (Anon. 1973).

Cattle

The experimental animals were all progeny born in 1983–84 of 2 matings of Africander bulls to Simmental–Hereford females, and 2 matings of purebred Herefords (Table 2). The breeding program and corresponding feed regime are outlined in Fig. 1.

In April 1983, 119 pregnant 30-month-old S4H4, S2H6, and H8 heifers were transferred to Nulky from Brigalow Research Station, Theodore, in central Queensland. They were in calf to 4 Africander bulls. The S4H4 heifers were F_1 progeny of a breeding program involving 80 Simmental bulls. The S2H6 heifers were some of the progeny of 8 Simmental–Hereford bulls.

Thirty-seven Hereford breeders (2–7 years of age) from the Nulky herd in calf to 2 Hereford bulls were also included. These breeders were typical of the Herefords in the area and were the progeny of at least 4 commercial sires. All heifers and cows calved during September–December 1983.

From November 1983 to March 1984, the heifers originally from Brigalow Research Station were remated to a sire group of 4 Africander bulls. The Hereford cows were remated to 2 Hereford bulls. All calves were born during September–December 1984.

Table 2. Nominal breed composition of the experimental animals and their parental breeding

A, Africander; S, Simmental; H, Hereford

Progeny	Sire	Dam
H8	H8	H8
A4H4	A8	H8
A4S1H3	A8	S2H6[A]
A4S2H2	A8	S4H4[B]

[A] Bred by reciprocal joinings of H8 x S4H4.
[B] Bred by joining S8 bulls with H8 cows.

Grazing

The cattle grazed native pastures that were predominantly Mitchell grass (*Astrebla* sp.), saltbush (*Atriplex* sp.), and neverfail (*Eragrostis setifolia*), on poplar box (*Eucalyptus populnea*) country and some heavier, flooded country. Pastures were grazed continuously at about 1 adult equivalent to 6 ha.

Steers born in 1983 were fattened on a relatively poor crop of forage oats (*Avena sativa*) from June to August 1985. Cows and calves grazed forage sorghum (*Sorghum* sp.) from October 1984 to March 1985. Steers born in 1984 grazed standover silk sorghum (*Sorghum* sp. cv. Silk) from February to May 1987, at which time they were slaughtered. Breeding cattle were supplemented with about 2.5 kg/cow.day of whole cottonseed on native pastures during drought conditions (Fig. 1).

From the start of joining until weaning, the Herefords grazed separately from the crossbred cows and calves, but grazing pressure, type of country, and available pasture were similar. From weaning onwards, the Herefords and crossbreds grazed together. For normal ease of management, heifers and steers grazed as separate groups. The paddocks had similar grazing histories, land types, and pasture yield, composition and quality.

All heifers were randomly joined at 24–28 months of age, weighing >275 kg, to either a Hereford bull or a Poll Hereford bull.

Husbandry

In December each year all calves were branded and dehorned and all male calves were surgically castrated. Calves were weaned at about 6 months of age in May each year and fed hay in the yards for the next 10–14 days. At this time, they were treated once for lice with either Ridlice or Tiguvon spot-on insecticide and for intestinal worms with Nilverm injectable anthelmintic.

Steers were sold using a CALM 'C' sale (cents/kg carcass weight). Steers born in 1983 and 1984 were sold at $A1.83 and $1.74/kg carcass weight, respectively. Gross income per steer was calculated from the mean carcass weight of treatment groups.

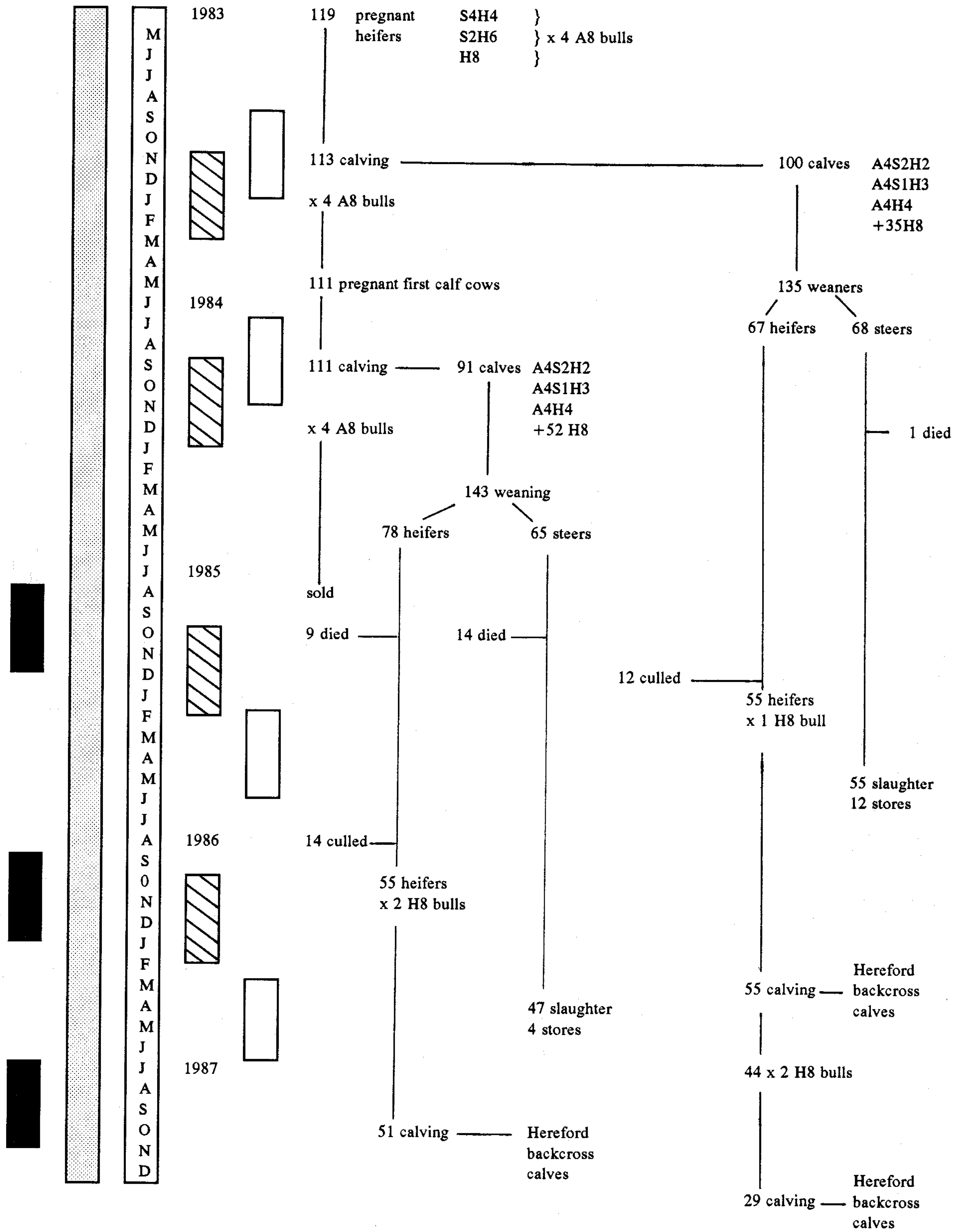

Fig. 1. The breeding program of the study: ▧ mating period; ☐ calving period; ▩ native pasture; ■ drought feed (whole cotton seed).

Steers were slaughtered at the same time at about 2 years of age. They were transported by road directly to an abattoir (about 400 km in 1985 and 850 km in 1986) and were rested for 2 or 3 days, with hay and water available, prior to slaughter. The period between mustering and slaughter was about 1 week.

Experimental measurements

All animals were weighed at about 3-month intervals after overnight fasting. They were immediately returned to pasture after weighing. Heifer liveweights were recorded until joining at 560 days post-weaning. Liveweight at second joining (920 days post-weaning) was also recorded. Steer liveweights were recorded until slaughter.

For slaughtered steers, trimmed hot carcass weight and P8 rump fat depth were recorded. Dressing percentage was calculated as the ratio of hot carcass weight to final fasted liveweight.

Statistical analysis

For all measurements (average daily gain, liveweight, and carcass data) analysis of variance for unequal replication was used, with factors of breed and year, and the interaction. A protected least significant difference (l.s.d.) test was then used to indicate differences between main effects and interaction means. Information was bulked across years when the breed x year interaction was not significant. Heifer and steer data were analysed separately.

To allow liveweight data to be analysed across years, measurements for cattle born in 1984 were interpolated using average daily gain for that weighing interval to correspond with weighing dates of the 1983 cattle. This gave a common series of weights in the post-weaning period at intervals of about 100 days. Separate analyses for breed differences were undertaken on the liveweight data at each weighing time.

Results

Liveweight

Steers. The Hereford steers had higher ($P<0.05$) mean weaning weights than the A4H4 steers in both groups of calves (Table 3). Differences in weaning weight between crossbreds generally persisted to final liveweight.

The A4S2H2 steers had higher ($P<0.05$) mean liveweights than the other crossbreds at weaning and at 217 days post-weaning (Table 3). They ranked highest in mean liveweight from 300 days post-weaning to final weight, although differences between treatments were not significant ($P<0.05$).

Hereford steers had similar liveweights to A4S2H2 steers up to 217 days post-weaning. From 300 days post-weaning they gradually lost their liveweight advantage over all the crossbreds (Table 4).

The A4S2H2 and A4S1H3 steers consistently had the highest ($P<0.05$) mean daily gains (Table 4), except during a period of liveweight loss 306–408 days post-weaning when the A4H4 steers lost the least ($P<0.05$) weight.

Table 3. Weaning and post-weaning liveweight (kg) of steers

Breed x year interaction was not significant
A, Africander; S, Simmental; H, Hereford
Within columns, values followed by the same letter are not significantly different at $P = 0.05$

	n	Weaning	Days post-weaning: 102	217	306	408	524
			Breed				
A4S1H3	26	156.2b	193.9c	266.6b	297.9	263.1	363.5
A4S2H2	34	173.1a	210.1ab	284.1a	307.7	281.3	377.5
A4H4	25	157.5b	197.8bc	266.4b	290.5	271.5	359.7
H8	46	184.5a	216.3a	283.6a	303.5	270.7	359.6
			Year				
1983	68	210.5	272.7	821.6	334.8	305.5	428.2
1984	63	125.1	136.3	228.8	265.0	237.7	301.9
s.d.		25.79	22.16	24.83	26.28	25.60	29.81

The Hereford steers ranked lowest or second-lowest in average daily gain from weaning to final weight. Their average daily gains were significantly ($P<0.05$) lower than at least one of the crossbreds from weaning to final weight.

Females. The liveweights of females from weaning to first joining at 560 days post-weaning are presented in Table 5. The trends between crossbreds were the same as for the steers and were more pronounced. Weaning weight differences were carried through to joining. The A4S2H2 and Hereford females consistently had the highest ($P<0.05$) liveweights from weaning onwards.

The A4S2H2, A4S1H3 and Hereford heifers had higher ($P<0.05$) liveweights at first joining (560 days post-weaning) and at second joining (920 days post-weaning) than the A4H4 heifers (Table 6). At first joining the A4S2H2 heifers had the highest ($P<0.05$) liveweights of all the crossbreds.

Table 4. Post-weaning average daily gain of steers (kg/steer.day)

Breed x year interaction was not significant
A, Africander; S, Simmental; H, Hereford
Within columns, values followed by the same letter are not significantly different at $P = 0.05$

	n	Days post-weaning: 0–102	102–217	217–306	306–408	408–524
		Breed				
A4S1H3	24	0.36a	0.63a	0.35a	–0.34b	0.86a
A4S2H2	32	0.34a	0.64a	0.28ab	–0.26ab	0.83a
A4H4	21	0.33a	0.60ab	0.25b	–0.19a	0.74b
H8	41	0.26b	0.58b	0.23b	–0.32b	0.76b
		Year				
1983	68	0.61	0.43	0.15	–0.29	1.06
1984	50	0.038	0.80	0.40	–0.26	0.54
s.d.		0.010	0.091	0.161	0.146	0.143

Table 5. Weaning and post-weaning liveweight (kg) of heifers
Breed x year interaction was not significant
A, Africander; S, Simmental; H, Hereford
Within columns, values followed by the same letter are not significantly different at $P = 0.05$

	Weaning	Days post-weaning: 102	217	306	408
		Breed			
A4S1H3	158.1b	212.4b	350.7b	370.9b	434.5b
A4S2H2	164.1b	224.1b	370.5a	391.2a	462.5a
A4H4	144.9c	198.5c	332.5b	348.9c	410.1c
H8	175.9a	238.6a	379.8a	385.1ab	432.4bc
		Year			
1983	199.4	258.0	314.6	308.9	283.8
1984	122.2	178.8	402.2	439.1	585.9
s.d.	23.29	26.78	38.99	37.12	46.66

Carcass characteristics

The A4S2H2 steers had the highest (P<0.05) mean final liveweight and mean carcass weight, and generated the highest gross income per steer (Table 7). The A4H4 steers had the greatest (P<0.05) mean fat depth, while dressing percentages were similar (P<0.05). The carcass weights of the Herefords were similar to those of the A4S1H3 and A4H4 crossbreds and were lower (P<0.05) than those of the A4S2H2 steers. The fat depth of the Herefords ranked lowest but was similar (P>0.05) to those of A4S1H3 and A4S2H2.

Discussion

Our study shows that beef producers in south-western Queensland can increase carcass weights with A4S2H2 crossbreds and produce carcasses that meet the requirements of premium sectors of the export and domestic markets. Steers of all treatments were suitable for the Korean–EC market (180–280 kg carcass weight, 4–12 mm P8 rump fat) and domestic supermarket outlets (up to 220 kg carcass weight, 4–9 mm fat; Anon. 1991).

Table 6. Effect of breed type on liveweight (kg) of females at joining
A, Africander; S, Simmental; H, Hereford
Within columns, values followed by the same letter are not significantly different at $P = 0.05$

	First joining		Second joining[A]			
			Born 1983		Born 1984	
	n	Liveweight	n	Liveweight	n	Liveweight
A4S2H2	30	369a	11	383a	10	389a
A4S1H3	27	353b	15	386a	15	369ab
A4H4	24	337c	11	344b	9	369ab
H8	27	360ab	11	386a	12	355b
s.d.		24.6		32.2		32.2

[A] A significant breed x year interaction meant that data could not be combined across years.

Table 7. Effect of breed type on final liveweight (LW) on farm, trimmed hot carcass weight, and carcass characteristics of steers
Breed x year interaction was not significant
A, Africander; S, Simmental; H, Hereford
Within columns, values followed by the same letter are not significantly different at $P = 0.05$

	n	LW (kg)	Carcass weight (kg)	Dressing percentage	Mean P8 rump fat depth (mm)	Mean gross income ($A/steer)[A]
A4S1H3	20	417ab	218b	52.4	6.8b	392
A4S2H2	31	433a	232a	52.9	6.5b	411
A4H4	20	412b	216b	52.5	8.5a	386
H8	31	413b	220b	52.6	5.5b	387
s.d.		30.9	17.2	1.74	2.49	

[A] Steers were sold on a CALM 'C' sale (i.e. cents per kg carcass weight); steers born in 1983 and 1984 were sold at $1.83 and $1.74/kg carcass weight, respectively.

Because of the European breed content of the A4S2H2 and A4S1H3 crossbreds, a growth rate and carcass weight advantage can be expected (Mason 1971; Kellaway 1972). The half Africander content of the crossbreds could also contribute to higher growth rates and carcass weights (from hybrid vigour and environmental adaptation) (Wood *et al.* 1985; Tierney *et al.* 1992). The findings that steer liveweights were not significantly different after 300 days post-weaning and that only the A4S2H2 steers had significantly higher carcass weights go against these expectations. However, the A4S2H2 and A4S1H3 steers consistently had higher average daily gains. This was a more reliable indicator of relative performance, since it is not influenced by differences in weaning weight.

The Simmental content appeared to contribute to growth rates, with the A4S2H2 and A4S1H3 crossbreds having higher average daily gains and ranking higher than the A4H4 steers for liveweight on most occasions, and for carcass weight. At least one-quarter Simmental content is needed to make any commercially significant difference. The slightly lower Simmental content and slightly higher Hereford content of the A4S1H3 steers compared with A4S2H2 made their liveweights and carcass weights similar to those of the A4H4 steers. In contrast, the A4S2H2 steers had significantly higher liveweights until 200 days post-weaning and ranked highest from then on, and had the highest carcass weights.

It appears that the growth advantage of the Simmental content must be linked with zebu content. Adaptation to poor feed quality and quantity would have been derived from the zebu content of the crossbreds (Frisch 1972, 1973; Barlow 1974). This combination inconsistently led to a growth rate advantage compared with the A4H4 steers; however, it is reasonable to assume that during a period of liveweight loss (306–408 days post-weaning) the crossbreds with Simmental content would have lost considerably more weight without zebu content. Adaptation to other stressors such as heat and pink eye may have had a minor role. Vercoe *et al.* (1972) found that Africander multiple crosses had greater liveweights than Herefords and Shorthorns in central Queensland as a direct result of heat tolerance.

The higher ($P<0.05$) P8 rump fat depth in the A4H4 steers is consistent with the findings of Wood *et al.* (1981) with Africander x Hereford crossbreds and Winks *et al.* (1979) with Brahman x British breed crossbreds. However, the carcass weight of Herefords in Wood *et al.* (1981) was 53 kg less than the Africander x Hereford cross, thus biasing the fat depth information. At similar carcass weights, Brahman x Hereford steers (Hearnshaw 1987) and Africander x Hereford steers (Johnson and Ball 1987) have had similar fat depths to Herefords.

In stressful environments there is a tendency for Africander x British or Brahman x British breed crossbreds to have greater fat depths than Herefords and European crossbreds (Hearnshaw and Doyle 1981; Hearnshaw 1987; S. J. Wood unpublished data). However, differences are relatively minor.

This previous research is consistent with the relatively low fat depth of the Herefords. Herefords at similar carcass weights to those in this study have had 10–18 mm rump fat depth (Cole *et al.* 1963, 1964; Johnson and Ball 1987). Under environmental stress, however, rump fat depths have been 2–6 mm for Herefords and up to 8 mm for zebu x Hereford crossbreds at carcass weights of 225–250 kg (Hearnshaw 1987; S. J. Wood unpublished data).

Crosses involving late-maturing European breeds have consistently had lower fat depths than British breeds at the same carcass weight (Gartner and O'Rourke 1976; Strachan 1980; Hearnshaw and Doyle 1981; Hodge 1987). The lower fat depths in the A4S1H3 and A4S2H2 steers than in A4H4 steers would therefore be due to the Simmental content, but the influence of the European breed was not great enough to lead to fat depths that were commercially too low at carcass weights of about 220 kg.

The weaning weights of the experimental animals were affected by age of dam. Weaning weight largely reflects the milk production of the dam, and heifers yield less milk than cows. Therefore, the Hereford dams (2–8 years of age) probably produced more milk than the dams of the crossbreds, and this would have contributed to the higher weaning weight of the Hereford calves. The importance of an age of dam effect, rather than a breed effect, is supported by the consistently low weaning weights of the A4H4 animals. These animals were the progeny of Hereford dams in their first (1983) and second (1984) lactation.

With dams of the same age, the Herefords would have been expected to have a weaning weight similar to, if not lower than, the crossbreds (Thompson *et al.* 1981; Hodge 1987). The age of dam effect is likely to have led to the high relative liveweights of the Herefords up to 300 days post-weaning. Seifert *et al.* (1980) and Wood *et al.* (1985) showed that dam age affected liveweights after weaning until 379 days of age. Over the 700-day post-weaning period, the Herefords gradually lost their weaning weight advantage.

Commercial implications

On a CALM 'C' sale, buyers bid on a carcass weight basis with a full assessment of the animals' characteristics including fat depth. Commercial abattoirs purchased the steers for the same price per kg carcass weight in each group. Therefore, the heavier carcass weights of A4S2H2 steers meant a higher gross income per steer.

Although the cattle were stocked at the same rate, until 250 days post-weaning the heavier A4S2H2 and A4S1H3 animals are likely to have consumed more feed than the other crossbreds. Therefore, if some multiple crosses must be stocked at a lighter rate, net income per ha would be less than indicated by the relative net income per head. This would be particularly important if European breed content delays maturity, and age of turnoff is increased to allow animals to reach market fatness.

Buyers at saleyards in southern Queensland often pay a premium for British breeds (Hall 1981). In our experiment there was no difference in price per kg between the breed types, due to sale by computer auction on a carcass weight basis. This emphasises the need for beef producers to investigate alternative marketing methods to get an adequate return for the heavier carcass weights of European, British and Africander multiple crossbreds.

Sale on a weight and grade basis (e.g. CALM 'grid') would lead to price premiums for heavier carcass weights, and to fatness that meets market requirements.

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