CONSEQUENCES OF SELECTION IN TWO *BOS TAURUS* BREEDS IN THE TROPICS

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SUMMARY
Two *Bos taurus* breeds, the Belmont Red (AX) and the Belmont Adaptaur (HS), have been selected since 1983 for high EBV for 550-day liveweight, and for both high 550-day liveweight and high resistance to cattle ticks respectively. When selection began, the AX was moderately resistant to the stresses of the tropics while the HS was lowly resistant, particularly to cattle ticks. Changes in liveweights at different ages, tick resistance and calving rates for each breed were measured relative to the unselected populations. In the AX, liveweights at all ages increased markedly, but calving rate, relative growth rate and tick resistance did not change significantly. Selection for high EBV for 550-day liveweight had been selection primarily for the scale components of growth rather than for increased productivity. In the HS, liveweight at 18 months, relative growth rate, tick resistance and calving rates all increased significantly without corresponding increases in birthweight or mature cow weight. Selection for both increased growth rate and tick resistance had increased production efficiency without increasing the scale components of growth. The genetic trends corroborated the observed responses in growth in both breeds. Thus, if an increase in productivity rather than mature size is required, selection must target the components of productivity, not just high growth potential.
Keywords: selection, *Bos taurus*, growth, fertility, tick resistance.

INTRODUCTION
Selection is an effective method for changing characteristics of beef cattle and both direct and correlated responses have been well documented (Baker and Morris, 1984). In northern Australia, the greatest difficulties associated with successful implementation of selection lie in identifying the characteristics that should be selected and in developing programs that can be applied in extensive husbandry systems. Until 1996 the only Estimated Breeding Values (EBV) offered by BREEDPLAN for breeds in northern Australia were for growth-related traits (BREEDPLAN Report for AX, HS and Brahman, 1995). A study conducted at the National Cattle Breeding Station, 'Belmont', allowed retrospective examination of how successful selection for high EBV for growth is likely to be in changing not only growth, but also productivity, in the dry tropics of northern Australia.

MATERIALS AND METHODS
Breeds and Animals. The study was conducted at 'Belmont', near Rockhampton, using the Belmont Red and Belmont Adaptaur breeds. The Belmont Red (AX) was formed from reciprocal crosses between Africander (A) and Hereford (H) and A and Shorthorn (S)

(nominally 50% A and 50% HS). The Adaptaur (HS) was formed from reciprocal crosses between H and S (nominally 50% H 50% S). The same H and S females were used as the foundation females of both breeds, which have been closed since 1953 and mated *inter se*.

Selection procedures. Since 1983, the AX has been selected for high EBV for 550-day liveweight (Mackinnon *et al*, 1991). Selection within the HS has been principally for high resistance to cattle ticks (*Boophilus microplus*), with some bulls also selected for high age-adjusted liveweight at 550 days of age. All animals from both breeds were reared together and treated alike at all times. Females had a breeding period of about 10 weeks and joined the breeding herd at 2 years of age and remained in the herd until culled for age (at about 10 years of age), for two consecutive failures to calve or for physical defects such as bottle teats. In the HS, cows that were extremely susceptible to cattle ticks were also culled.

Measurements. See references below for a detailed description of the measurements of birthweight, 18 month liveweight, mature cow (5-10 years) liveweight, tick count (/animal/day) and calving rate (calves born/100 cows joined). Baseline data (1964-1972) were drawn from Kennedy and Chirchir, 1971 (liveweights at birth and 18 months), Turner and Short, 1972 (tick counts), Frisch, 1973 (mature cow liveweights) and Seebeck, 1973 (calving rates). Post-selection data (1992-1996) are from Frisch and O'Neill, 1997 (liveweights at birth and 18 months) and Frisch and O'Neill, unpublished data (mature cow liveweights and calving rates). The data for growth and calving rates were analysed using SAS, (1993) GLM and GENMOD procedures respectively. Relative growth rate was calculated as 18 months liveweight/mature cow liveweight. The difference between pre- and post-selection means were tested using 't' tests for liveweight, assuming that the standard error of the means (SE_m) were imilar for both populations and chi-square for calf crops (Snedecor and Cochran, 1980). The genetic trends (1980 to 1994) in growth were from BREEDPLAN reports for the AX and HS herds on 'Belmont'.

RESULTS AND DISCUSSION

The changes in each variable for each breed are shown in Tables 1 and 2. In the AX the changes in relative growth rate, tick resistance and calving rate were small and not significant (Table 2). However, liveweights at all ages, including mature cow liveweight, increased significantly (Table 1). That these changes were genetic were corroborated by the genetic trends of 0.24 ±0.03 kg/year for birthweight and 1.17±0.17 kg/year for 550-day liveweight. As found in previous selection studies (see Baker and Morris, 1984), selection for high liveweight at 18 months of age had increased the scale components of growth. The question is whether the increased liveweights resulted in increased production efficiency. Any such measure must account for the increase in feed requirements that accompanies increased mature cow liveweight. The measure used, called 'cow efficiency', is liveweight of progeny at 18 months/100 kg of cow joined (ie. relative growth rate x calving rate). Assuming mortality rates were the same after selection as before, values for 'cow efficiency' for the AX are:-

Before selection, cow efficiency = (283/478) x 77 = 45.6 kg/100 kg cow joined

After selection, cow efficiency = (321/532) x 82.1 = 49.5 kg/100 kg cow joined

Since the change in relative growth rate was small, the 8% increase in cow efficiency was associated almost entirely with the increase in calving rate, not with any direct increase in growth rate. There is no reason to believe that selection for high EBV for growth in other 'tropically adapted' breeds would not achieve similar results to those achieved in the AX.

Table 1. Changes in liveweights (±SE$_m$) after selection for different traits in different breeds

	Birthweight (kg)		18 mth liveweight (kg)		Mature cow Liveweight (kg)	
Before Selection (1964-72)	AX 29.6[a] (273)[+]	HS 30.8[a] (139)	AX 283[a] (222)	HS 244[a] (110)	AX 478[b] (65)	HS 485[b] (51)
After Selection (1992-96)	35.2±0.8[e] (31)	31.1±0.6[e] (52)	321±5[e] (30)	265±4[e] (44)	532±10[f] (34)	454±6[f] (72)
Absolute Change	5.6	0.3	38	21	54	-31
% Change	18.9	1.0	13.4	8.6	11.3	-6.4

+ number of animals
a, b, e, f see text for source of data

Table 2. Changes in relative growth rates*, tick counts (±SE$_m$) and calving rates after selection for different traits in different breeds

	Relative growth rate* (%)		Tick count (/animal/day)		Calving Rate (%)	
Before Selection (1964-72)	AX 59.2	HS 50.3	AX 53±12[c] (9)	HS 155±16[c] (13)	AX 77[d x] (868)	HS 67[d y] (515)
After Selection (1992-96)	60.3	58.4	54±4[f] (43)	32±3[f] (75)	82.1[f x] (84)	89.4[f z] (179)
Absolute Change	1.1	8.1	1.0	-123	5.1	22.4
% Change	1.9	16.1	1.9	-79.4	6.6	33.4

* see text for definition
c, d, f see text for source of data
z>x> y P<0.01

At the time selection began the HS were lowly resistant to cattle ticks (Table 2 and Frisch and O'Neill unpublished data) but after selection there was an outstanding increase in tick resistance, relative growth rate and calving rate (Table 2). However, birthweight remained unchanged while mature cow liveweight decreased (Table 1). The genetic trend in birthweight of the HS was 0.07±0.03 kg/year suggesting that there has been little genetic change in size of the HS. However, the genetic trend in 550-day liveweight was 1.34±0.21 kg/year a value not significantly different to that of the AX. Relative growth rate of the HS after selection also approached that of the AX. Moreover, HS 'cow efficiency' increased by 55% from 33.7 kg to 52.2 kg/100 kg cow joined. Thus, selection for high tick resistance and high growth to 550 days of age has markedly increased production efficiency without increasing the scale components of growth. This is not unexpected given that growth in a stressful environment is a reflection of resistance to the stresses of that environment (Frisch, 1981). The results strongly indicate that improvements in productivity can be best achieved by selecting for all of the characteristics that affect production efficiency, rather than selecting solely for the scale components of growth. Thus, the use of selection indices that incorporate multiple traits (Barwick *et al.*, 1994) is necessary for efficient genetic improvement.

Where objective selection has been used in northern Australia, the main focus has been on high EBV for 550-day (or similar) liveweight. While there is clear evidence that such selection will increase absolute growth rate (Table 1), that increase will be accompanied by a corresponding increase in liveweight at all other ages, including maturity, without necessarily increasing production efficiency. However, if the real purpose of selection is to increase productivity, selection must be directed towards improving the range of characteristics that affect production efficiency, which for the AX and HS includes resistance to environmental stresses. These results have implications for objective selection schemes in the tropics.

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