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Relocation does not have a significant effect on the growth rate of *Bos indicus* cross steers

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Abstract. This experiment tested the hypothesis that relocating cattle is detrimental to their growth. The study examined the effect of having relocated cattle mixed with, or segregated from, the local acclimatised cattle at the destination property. *Bos indicus* cross steers (120) were allocated to three groups and were relocated, in two separate cohorts, 980 km from northern Queensland to improved pastures in central Queensland. At the start of Phase 1, the control group (C) was moved 3 months before the other two groups. The remaining two groups grazed native pastures; one group was supplemented (SR) to increase growth rate similar to that expected from improved pasture in central Queensland and the other was not supplemented (R). At the end of Phase 1, C was significantly ($P < 0.05$) heavier than SR, which was significantly ($P < 0.05$) heavier than R. At the start of Phase 2, the SR and R groups were relocated and after transportation the R and SR groups lost 12 kg or 4.4% of liveweight and 18 kg or 5.7% of liveweight, respectively; this weight loss was recovered after 5 days. All steers were reallocated to segregated (SEG) or mixed (MIX) treatment groups forming six treatments (SEG.C, SEG.R and SEG.SR and MIX.C, MIX.R and MIX.SR). There were no significant differences in liveweights within the SEG treatments by 57 days or within the MIX treatments by 106 days after relocation. There were few if any significant differences in the plasma constituents and differential leucocyte counts of the steers and most results were within physiologically normal ranges. We conclude on the basis of these results and of other experiments that the anecdotal poor performance of cattle after relocation appears to be unfounded.

Additional keywords: black spear grass, brigalow, cattle, liveweight gain.

Introduction

Relocation of cattle, particularly male cattle, for finishing on better-quality pastures is becoming increasingly important in the northern Australian cattle industry as producers and pastoral companies aim to reduce age at turnoff and capitalise on the various premium markets (Bortolussi *et al*. 2005*b*). Cattle may be moved short distances within regions or long distances between regions. There has been a perception by industry that relocation may be followed by a set back reflected in poor growth, which may persist for some months. However, there is little experimental work to substantiate this perception.

Some investigations of research station records and field trial data by Hasker *et al*. (1996*a*, 1996*b*) do not support this contention that relocation is detrimental to cattle growth rate. Hasker *et al*. (1996*a*) examined research station and field trial data where growth comparisons could be made between local cattle and cattle relocated to that environment. Relocated cattle grew as fast as, or faster than, local cattle in most cases, possibly because of compensatory gain. These results should be viewed with caution because it was not possible to have comparable control groups and standardised post-transport weighing intervals and procedures. In their study, Hasker *et al*. (1996*b*)

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examined the records of cattle relocated from different properties of origin to a common research station in the wet tropics where cattle grazed fertilised improved pastures. Again these results should be treated with caution because of the confounding effects of different sources of the cattle and of the small number of animals with large between-animal variation.

There is also anecdotal evidence that relocated cattle mixed with local cattle adapt more quickly to their new environment. The reasons for this are not clear, but relocation exposes cattle to new pasture, which may influence rumen microbial populations; thus, resulting in altered efficiency of fermentation. Mixing relocated cattle with local cattle may accelerate changes in rumen microbial populations and adaptation to local conditions. Similar principles are used for cattle introduced to leucaena (*Leucaena leucocephala*) pastures in northern Australia by either drenching a small proportion of the introduced cattle with rumen bacteria capable of breaking down the toxic degradation products of mimosine in leucaena (Quirk *et al*. 1988) or by retaining some cattle already adapted to leucaena.

In the absence of high-quality and conclusive experimental data, an experiment was conducted to test the hypothesis that relocating cattle is detrimental to their performance.

Materials and methods

Location and climate

The study was conducted at Swan's Lagoon Beef Cattle Research Station (20°S, 147°E) in the subcoastal region of north Queensland from May 1994 to August 1994 and at Brigalow Research Station (24°S, 149°E) in the brigalow region of central Queensland from May 1994 to April 1995.

The climate at Swan's Lagoon is dry tropical and has a distinct hot wet summer period (wet season) from December to April and a warm dry winter period followed by a hot dry period (dry season) from May to November. Mean maximum and minimum temperatures for January are 31°C and 23°C and for July are 26°C and 9°C, respectively. Average annual rainfall is 863 mm, and the distribution and amount of rainfall is highly variable. The study at Swan's Lagoon was conducted after an above average but late wet season, although little rain fell during the experimental period (Table 1). The dominant native grass species are black spear grass (*Heteropogon contortus*), golden beard grass (*Chrysopogon fallax*), Indian couch (*Bothriochloa petusa*) and wire grasses (*Aristida* spp.).

The climate at Brigalow is subtropical with a hot wet period from November to April followed by a drier cooler period from May to October. Mean maximum and minimum temperatures range from 32°C to 21°C in January and from 21°C to 6°C in July, respectively. Average annual rainfall is 745 mm, with a greater probability of winter rainfall than Swan's Lagoon. Rainfall during the study period was slightly below average with a seasonal break occurring in late October 1994 (Table 1). The cattle grazed improved pastures of green panic (*Panicum maximum* var. *trichoglume*), buffel (*Cenchrus ciliaris*) and Rhodes (*Chloris gayana*) grasses.

Experimental design

The design aimed to remove the confounding effects of age, liveweight and genotype when comparing relocated animals with animals adapted to the environment. There were two phases to the experiment.

Phase 1. 31 May–1 September 1994

One hundred and twenty yearling Brahman cross (5/8 *Bos indicus*, 3/8 *Bos taurus*) steers were allocated based on stratified fasted liveweight to three groups of 40 at Swan's Lagoon. The treatments were: (i) control (C) – these animals were relocated to Brigalow on 1 June 1994 and grazed improved pastures for 3 months, allowing them to adapt to the local environment; (ii) relocated (R) – this group remained at Swan's Lagoon grazing native grass pastures for 3 months and then relocated to Brigalow on 31 August 1994; and (iii) supplemented and then relocated (SR) – this was the same as R but the steers were supplemented in an attempt to produce growth rates similar to C steers at Brigalow.

Phase 2. 1 September 1994–20 April 1995

The three treatments were reallocated based on stratified full liveweights either at Swan's Lagoon before relocation (30 August 1994) for R and SR or at Brigalow (1 September 1994) for C into segregated (SEG) or mixed (MIX) herds. This strategy examined the effect on subsequent performance of having relocated cattle mixed with, or segregated from, local acclimatised cattle at the destination property. There were three treatments in the SEG herds, SEG.C, SEG.R and SEG.SR, with two replicates of 15 steers per paddock in a completely randomised design. The paddock was the experimental unit. In the MIX treatments there were two paddock replicates of three treatments, MIX.C, MIX.R and MIX.SR, and five animal blocks, resulting in 15 steers per paddock. The animal was the experimental unit.

Experimental procedures

The experiment was approved by the Tropical Beef Centre Animal Experimentation Ethics Committee and given an Ethical Clearance Certificate (TBC 34/94).

Phase 1

The steers had been grazing native pasture at Swan's Lagoon since weaning 12 months previously. On 31 May 1994 the steers were mustered and weighed in the morning and 30 steers at

Table 1. Monthly and annual rainfall at Swan's Lagoon and Brigalow Research Stations
Values measured in the experimental period are in italics

Location	Year	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Total
Swan's Lagoon	1993–1994	28	14	102	10	35	373	231	0	*17*	*0*	*0*	*0*	810
Brigalow	1993–1994	77	42	52	15	76	88	179	14	*25*	*30*	*0*	*0*	598
Brigalow	1994–1995	*22*	*77*	*53*	*125*	*157*	*11*	*33*	*79*	124	17	1	13	712

random were rumen sampled by stomach tube. Cattle were kept in the yards overnight with no water and the next day allocated to treatments based on fasted liveweight. Ten animals were randomly selected for bleeding based on initial liveweight in the same order within each weight block. Steers were bled by coccygeal venipuncture into evacuated tubes containing lithium–heparin. The R and SR groups were then returned to separate paddocks. The C group was given access to hay and water until 1700 hours and then given no access to feed and water overnight. At 0600 hours on 2 June 1994 these steers were transported 980 km to Brigalow, over a period of 14 h. On arrival, the steers were given hay and water in the yards overnight, weighed the next morning and four steers that had been at Brigalow for 1 year were added to this group. The group was then turned out as a common grazing group at a stocking rate of 1 steer/2.2 ha. Steers were weighed 3 and 7 days later and then weekly for the duration of the experiment.

At Swan's Lagoon, the SR group was supplemented with cottonseed meal in an attempt to mimic the growth rate of the C group steers at Brigalow. Initially, intakes averaged 0.3 kg/day, but within 5 weeks intakes were increased to 1.5 kg/day. Supplements were then switched to an *ad libitum* mixture of fortified molasses (100 g molasses, 3 g urea, 10 g cottonseed meal, 1.6 g dicalcium phosphate and 50 g monensin per tonne of supplement) for the rest of the period and intakes averaged 4.8 kg/day. Cattle were initially weighed after a fortnight in the paddock and then fortnightly (SR) or monthly (R) for the duration of the experiment.

Further blood and rumen samplings were carried out on the same animals at both sites 7 days after the allocation to treatments. The R and SR treatments were again bled and rumen sampled immediately before relocation on 30 August 1994 and the C treatment was bled and rumen sampled on 1 September 1994.

Phase 2

As much as possible, handling procedures and travel times of the R and SR groups followed those of the C group. On Day –1 (30 August 1994), both the R and SR groups were mustered at Swan's Lagoon, weighed and the 10 selected animals from each treatment were bled and rumen sampled. All steers were given access to water until 1700 hours then access to water was removed and the steers were kept as separate groups overnight. At 0600 hours the next day (Day 0), the groups were randomly loaded to top and bottom compartments of a 'B double' truck and trailer. The steers arrived at Brigalow at 1900 hours, were given hay and water overnight and then weighed next morning (Day 1). On this same day, the C steers were yarded, weighed and the 10 selected animals were bled and rumen sampled. The three groups (C, R and SR) were drafted into their new treatment groups and placed into their allocated paddocks at a stocking rate of 1 steer/2.5 ha.

Steers were weighed on Day 5 and Day 8 and then weekly until December 1994 when fortnightly weighings were introduced. Until Day 50, steers were mustered and weighed in their separate paddock groups with the segregated groups being weighed before the mixed grazing groups. After this date, cattle were mixed for mustering and weighing. Body condition scores were recorded on Days 8, 162 and 232. Body heights were recorded monthly at the top of the wither using a scale board mounted inside the crush.

The R and SR steers had regained their pretransportation liveweight by Day 5 and all liveweight change calculations start at this point. This 5-day period represented an appropriate settling down period for cattle transported long distances.

Steers were selected for blood and rumen sampling based on their reallocated liveweights in the same order within each weight block. In SEG paddocks, four steers per paddock were selected. In each MIX paddock, two steers from the C, R and SR groups, that is, six steers per paddock were sampled. The same steers were sampled on Days 8, 36, 86 and 232.

At bleeding, blood smears for differential leucocyte counts were made immediately and then the bloods were chilled and the plasma removed after spinning at 1600*g* (20 min, 4°C) within 4 h of collection. The blood was then frozen. Residual red blood cells were frozen and sent to the Animal Research Institute (Yeerongpilly, Qld) for determination of glutathione peroxidase (GPx) concentrations. Plasma concentrations of Ca, Mg, P, total protein (Pr), albumin (Alb), globulin (Glob), total bilirubin (Bil), urea, creatine phosphokinase (CPK), aspartate aminotransferase (AST), β-hydroxybutyrate (β-OHB), cortisol (Cort) and fructosamine (Fru) were determined.

Samples of crude rumen fluid were collected by stomach tube from the same animals that were bled. The rumen fluid was prepared using the technique of Klieve *et al*. (1989) and changes in protozoal and bacterial populations were reported by Klieve *et al*. (1998).

Paddock behavioural observations of steers were made mid-morning Day 2 and then twice weekly until Day 37. Steers were observed for 5–10 min and grazing, resting, drinking and agonistic activities were observed.

Statistical analyses

In Phase 1, an analysis of variance (ANOVA) was used to compare treatments using the animal as the experimental unit. In Phase 2, data for SEG and MIX treatments were analysed separately; thus direct statistical comparisons between the SEG and MIX treatments could not be made. The effect of SEG treatments was assessed by one-way ANOVA with paddock as the experimental unit. An ANOVA was also used to assess the effect of the MIX treatments after adjusting for paddock and block (based on weights at allocation) effects. The animal was the experimental unit. A log-transformation was applied to the CPK data before analysis to stabilise the variance. Treatment means were compared using the protected least significant difference (l.s.d.) procedure with a significance level of $P = 0.05$.

Results

Liveweights and gains in Phase 1

The mean ± s.d. liveweight at the commencement of the experiment was 296 ± 35 kg. The C group lost 25 kg or 8.5% of liveweight after transportation on 1 June 1994 but recovered this weight loss by the time of weighing at Brigalow 21 days later. During Phase 1 (31 May–1 September 1994), the overall growth rates were highest in the C group moved to Brigalow followed by the SR and R groups at Swan's Lagoon (Table 2).

Table 2. Phase 1. Liveweights and average daily gains (ADG) of control (C) steers transferred to Brigalow Research Station and relocated (R) or supplemented and relocated (SR) steers retained at Swan's Lagoon Research Station

Means in columns followed by a different letter were significantly different at $P = 0.05$

Treatment	Liveweight (kg)					ADG (kg)
	31 May	6–7 June	4 July	1 Aug.	30 Aug./ 1 Sept.[A]	31 May–30 Aug./ 1 Sept.[A]
C	296a	278a	308a	320a	333a	0.41a
R	295a	286a	289b	284b	279c	–0.18c
SR	295a	288a	303ab	310a	313b	0.21b
s.e.	5.5	5.4	5.6	5.4	5.5	0.017

[A]The final liveweight measurement was made on 30 August for R and SR steers and 1 September for C steers.

[B]ADG was measured from 31 May–1 September for C steers and 31 May–30 August for R and SR steers.

Liveweights and gains in Phase 2

Mean liveweight loss after transportation on 31 August 1994 was 12 kg or 4.4% of liveweight for the R group and 18 kg or 5.7% for the SR group. Recovery of this weight loss in both groups occurred by Day 5.

Segregated groups

At the start of Phase 2, SEG.C steers were significantly ($P < 0.05$) heavier than SEG.SR steers, which, in turn, were significantly heavier than SEG.R steers (Table 3). Liveweight differences still existed between the treatments at Day 50 and the SEG.R group was significantly ($P < 0.05$) lighter than the other two treatment groups (339, 333 and 312 kg (s.e. = 2.7) for SEG.C, SEG.SR and SEG.R, respectively). However, there were no liveweight differences between SEG treatments by Day 57, a situation that remained for the rest of Phase 2. Overall average daily gains were significantly ($P < 0.05$) greater in SEG.R than the other two treatments.

Mixed groups

MIX.C steers were significantly ($P < 0.05$) heavier than MIX.SR steers, which were, in turn, heavier than MIX.R steers at the start of Phase 2 (Table 3). Liveweight differences existed between treatments until Day 106 when MIX.C and MIX.SR were both significantly ($P < 0.05$) heavier than the MIX.R group. Thereafter, there were no significant liveweight differences between MIX treatments. Significant ($P < 0.05$) differences between treatments for average daily gains existed throughout Phase 2. Overall, average daily gains were significantly ($P < 0.05$) greater in MIX.R than MIX.SR, which were significantly greater than MIX.C.

Body condition scores

In the segregated groups there was no significant difference between treatments until the final observation when SEG.R cattle were in significantly ($P < 0.05$) better condition than the other two treatments (6.6 *v.* 6.4 and 6.4). In contrast, with the mixed groups, MIX.C and MIX.SR were significantly ($P < 0.05$) better than MIX.R on Day 8 (5.0 and 5.0 *v.* 4.4), but by the final observation there was no significant difference in body condition between the treatments in the mixed groups.

Body heights

There were no significant differences in body height detected between treatments in either Phase 1 or Phase 2. Mean ± s.e

Table 3. Phase 2. Liveweights and average daily gains (ADG) of control (C), relocated (R) or supplemented and relocated (SR) steers that were grazed as either segregated (Seg) or mixed (Mix) groups at Brigalow Research Station

Means in columns followed by a different letter were significantly different at $P = 0.05$

Treatment	Liveweight (kg)									ADG (kg/day)	
	30 Aug./1 Sept.[A] Day –1/Day1	5 Sept.[B] Day 5	29 Sept. Day 29	27 Oct. Day 57	25 Nov. Day 86	25 Jan. Day 147	23 Feb. Day 176	23 Mar. Day 204	20 Apr. Day 232	5 Sept. – 6 Oct. 31 days	5 Sept. – 20 Apr. 227 days
Seg.C	334a	327a	338a	339a	360a	418a	446a	463a	463a	0.74a	0.60b
Seg.R	278c	280c	301b	311a	337a	407a	443a	463a	460a	0.77a	0.79a
Seg.SR	312b	313b	323ab	326a	345a	404a	436a	457a	449a	0.48a	0.60b
s.e.	2.9	2.5	5.9	5.3	7.9	8.0	6.5	4.6	7.9	0.206	0.031
Mix.C	330a	331a	343a	328a	349a	414a	435a	457a	466a	0.31b	0.60c
Mix.R	280c	283c	307b	300b	332b	403a	436a	457a	471a	0.65a	0.83a
Mix.SR	318b	318b	338a	333a	353a	416a	446a	466a	478a	0.65a	0.71b
s.e.	2.8	3.0	3.7	4.0	4.1	6.5	8.4	9.1	8.9	0.061	0.033

[A]This liveweight measurement was made on 30 August (Day –1) for R and SR steers at Swan's Lagoon and 1 September (Day 1) for C steers at Brigalow.

[B]Date for the start of the comparison of liveweights and ADG.

Table 4. Values for total bilirubin, urea and glutathione peroxidase (GPx) of control (C) steers transferred to Brigalow Research Station and relocated (R) or supplemented and relocated (SR) steers retained at Swan's Lagoon Research Station

Means in columns followed by a different letter were significantly different at $P = 0.05$

Treatment	Total bilirubin (μmol/L)		Urea (mmol/L)		GPx (IU/g Hb)	
	1 June	6–7 June	1 June	6–7 June	1 June	6–7 June
C	2.8a	2.0a	4.7a	2.2a	223a	246a
R	3.5a	4.4b	5.2a	1.7b	187a	187b
SR	3.0a	2.6a	5.0a	1.6b	208a	207ab
s.e.	0.41	0.32	0.21	0.17	16.4	13.9

body heights across all treatments were 1252 ± 4.4, 1303 ± 4.5 and 1378 ± 4.0 mm for 1 June 1994, Days 52 and 227, respectively.

Behavioural observations

At most observations the cattle grazed and/or rested as one herd. The only variation to this was in the MIX groups. At the first observation date, in each of the two paddocks, four of the five C steers kept together, whilst the relocated steers grazed as another group. By the third day, however, they acted as one group. There was very little observed agonistic activity.

Haematology

Overall, there was very little effect of treatment on the differential leucocyte counts. In Phase 1, all the white cell differential count values were within normal ranges. The only treatment differences occurred with monocytes being significantly ($P < 0.05$) higher in SR than C or R on 1 June 1994 (3 *v.* 1 and 1%, respectively; s.e. = 0.5). Prior to relocation of R and SR steers to Brigalow Research Station (30 August 1994) there were no differences between the C, R and SR treatment groups for haematological values.

In Phase 2, all the differential leucocyte counts were within normal ranges in both SEG and MIX. During this phase the only treatment differences for haematological values occurred on Day 86. Neutrophils for MIX.SR were significantly ($P < 0.05$) lower than both MIX.C and MIX.R (16 *v.* 21 and 21%, respectively; s.e = 1.1). Monocytes were significantly ($P < 0.05$) lower in MIX.R than in the other treatments (4, 4 and 1%; s.e. = 0.6, respectively, for MIX.C, MIX.SR and MIX.R).

Biochemical data

In general, there were few differences between treatments across the trial.

Phase 1

Values of biochemical attributes were within the considered normal range with the exception of urea on 7 June 1994, where values of R (1.7 mmol/L) and SR (1.6 mmol/L) were lower than the normal range of 2.0–8.5 mmol/L (Table 4). Significant ($P < 0.05$) differences between treatments occurred only with total bilirubin, urea and GPx on 7 June 1994 (Table 4). Cortisol values for all treatments averaged 129 nmol/L on 1 June 1994 and 99 nmol/L on 7 June 1994.

At Day –1 immediately before transportation to Brigalow Research Station for the R and SR steers and at Day 1 for the C steers at Brigalow Research Station, there were differences between treatments for Pr, Alb, Bil, urea, β-OHB, AST, GPx and P (Table 5). Both urea and P were significantly ($P < 0.05$) higher in SR than the other treatments, reflecting the nutrient input from the supplement. Pr, Alb and AST were significantly ($P < 0.05$) higher in C and SR than in R. Bil was significantly ($P < 0.05$) higher in R than in the other two treatments, whilst the converse applied with β-OHB. GPx values were significantly ($P < 0.05$) higher in C than R and SR (Table 5).

Phase 2 – Segregated groups

After Day –1 there were no significant treatment differences on any date with the exception of GPx, which was significantly ($P < 0.05$) higher in SEG.C than SEG.R and SEG.SR on Days 8, 36 and 86; the overall treatment means for these 3 days were 353, 257 and 275 IU/gHb, respectively. Cortisol levels fluctuated with time, with mean treatment values (140 nmol/L) highest on Day 0, then falling and followed by a gradual increase. Values of all other biochemical attributes were in the normal range except urea on Days 8 and 36, where treatment means averaged 1.2 and 1.4 mmol/L, respectively.

Phase 2 – Mixed group

All biochemical values were in the normal range except urea on Days 8 and 36, where treatment means were lower than normal and averaged 1.0 and 1.3 mmol/L, respectively. On Day 36 a treatment difference occurred with log CPK, where MIX.C was significantly ($P < 0.05$) greater than MIX.R and MIX.SR (5.0, 4.9 and 4.5 IU/L, respectively); back-transformed means were 151, 133 and 92, respectively). A treatment difference for AST was also evident on this date and MIX.R was

Table 5. Values of some biochemical parameters of control (C) steers (Day 1) at Brigalow Research Station and relocated (R) and supplemented and relocated (SR) steers (Day –1) at Swan's Lagoon Research Station

Means in columns followed by a different letter were significantly different at $P = 0.05$. AST, aspartate aminotransferase; β-OHB, β-hydroxybutyrate; GPx, glutathione peroxidase

Treatment	Total protein (g/L)	Albumin (g/L)	Total bilirubin (μmol/L)	Urea (mmol/L)	β-OHB (mmol/L)	AST (IU/L)	GPx (IU/gHb)	P (mmol/L)
C	71.6b	34.2b	1.08a	1.17a	0.37b	62.3a	332.8b	2.24a
R	66.3a	32.1a	2.92b	1.23a	0.35b	59.7a	232.3a	2.04a
SR	70.8b	34.3b	1.25a	4.25b	0.23a	72.3b	238.6a	2.63b
s.e.	1.43	0.56	0.189	0.096	0.025	2.42	14.00	0.085

significantly ($P < 0.05$) less than MIX.SR, but MIX.C was not significantly different from either (56, 72 and 64 IU/L, respectively).

Discussion

This paper provides information on the effect of relocation of cattle under controlled conditions to provide objective data to evaluate anecdotal evidence. The data presented in this paper indicate that liveweight recovered relatively quickly after long-distance transport and growth continued relatively unhindered. It could be argued that the C treatment was not a true control, but just another relocation treatment that had been relocated to the grow-out property 3 months earlier. However, the C treatment represents animals from the same cohort, thus, eliminating effects such as genotype and cattle source effects on animal performance. Attempts to produce parallel liveweight performance at Swan's Lagoon and Brigalow Research Stations by supplementing were unsuccessful and highlight one of the difficulties of doing these types of studies.

In this case, cattle were relocated from lower nutritional conditions to higher nutritional conditions; the average annual liveweight change at Swan's Lagoon is ~100 kg (McLennan *et al*. 1988) compared with ~150–220 kg at Brigalow Research Station (Walker *et al*. 1987). The null hypothesis was that the relocated groups would grow as fast as the acclimatised control group. However, the relocated groups grew faster than the control groups, indicating that there was no relocation effect (i.e. diminished liveweight performance). The results of this experiment suggest that adjustment to relocation occurred relatively quickly.

Irrespective of relocation issues, steers with some growth restriction (at Swan's Lagoon) compensated for this growth restriction by growing faster when nutrition was apparently improved after relocation to Brigalow Research Station. This compensation tended to be directly related to the degree of growth restriction, such that compensation was complete. The liveweight response of the unsupplemented animals relative to the supplemented animals is typical of many reports from northern Australia (Winks *et al*. 1982; Winks 1984), where large liveweight losses are often followed by large positive liveweight responses when nutrient supply improves (Kidd and McLennan 1998). The changes in plasma urea concentrations indicate potential issues of animals adjusting to transportation and changes in diet composition. The haematological and biochemical measurements of blood reported in this paper indicate that, apart from brief periods following long-distance transport, the treatment groups did not experience prolonged physiological stress and, thus, growth rates were not affected. In addition, the bacterial and protozoal populations of the rumen were remarkably stable and little affected by relocation (Klieve *et al*. 1998).

There were some differences in average daily gain between the SEG and MIX treatments and the performance of relocated cattle was influenced by supplement treatments. Average daily gains for the 227-day post-relocation period were highest in MIX.R, intermediate in MIX SR and lowest in MIX.C, and in the SEG treatments the average daily gains in the corresponding period were higher in SEG.R than in SEG SR and SEG.C. However, there were no significant differences in final liveweights between any of the SEG or MIX treatments. Thus, it would appear that either mixing or segregating relocated cattle with local cattle did not adversely affect their liveweight performance, although direct statistical comparisons could not be made because of the experimental design.

In a survey of the northern Australian beef industry (Accessory Publication to Bortolussi *et al*. 2005*a*, available from the journal website), some northern Queensland beef producers perceived that cattle from various districts, source properties or soil types performed differently or poorly when brought to grow and finish on wet tropics improved pastures. This perception further underlines the complex nature of poor performance in relocated cattle. Whether this poor performance is a result of different genotypes, a reaction to increased parasite loads, changed temperature or humidity regimes or other environmental or management factors is not clear. We speculate that it may be because of a complex interaction between factors as, under relatively controlled conditions, we have failed to observe poor performance following relocation. We conclude, on the basis of the results of several trials conducted over time, including this study, that poor performance after relocation appears not to exist. In this trial, no indication of poor performance following relocation was observed after a lengthy truck journey to a pasture system that would be expected to provide a higher-quality diet. Neither plasma analyses nor changes in the microbial populations of the rumen (Klieve *et al*. 1998) gave indications of chronic stress or adverse health conditions.

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References

Bortolussi G, McIvor JG, Hodgkinson JJ, Coffey SG, Holmes CR (2005*a*) The northern Australian beef industry, a snapshot. 4. Condition and management of natural resources. *Australian Journal of Experimental Agriculture* **45**, 1109–1120. doi:10.1071/EA03262

Bortolussi G, McIvor JG, Hodgkinson JJ, Coffey SG, Holmes CR (2005*b*) The northern Australian beef industry, a snapshot: 1. Regional enterprise activity and structure. *Australian Journal of Experimental Agriculture* **45**, 1057–1073. doi:10.1071/EA03096

Hasker PJS, Holroyd RG, Doogan VJ (1996*a*) Comparison of growth rates of relocated and local steers. *Proceedings of the Australian Society of Animal Production* **21**, 397.

Hasker PJS, Sibson G, Doogan VJ (1996*b*) The effect of origin on liveweight gain of Brahman cross steers after relocation to fatten on high rainfall tropical pastures. *Proceedings of the Australian Society of Animal Production* **21**, 399.

Kidd JF, McLennan SR (1998) Relationship between liveweight change of cattle in the dry season in northern Australia and growth rate in the following wet season. *Animal Production in Australia. Proceedings of the Australian Society of Animal Production* **22**, 363.

Klieve AV, Hudman JF, Bauchop T (1989) Inducible bacteriophages from ruminal bacteria. *Applied and Environmental Microbiology* **44**, 402–412.

Klieve AV, Holroyd RG, Turner AF, Lindsay JA (1998) Rumen bacterial and protozoal populations in cattle being relocated in Tropical Queensland. *Australian Journal of Agricultural Research* **49**, 1153–1159. doi:10.1071/A97164

McLennan SR, Hendricksen RE, Beale IF, Winks L, Miller CP, Quirk MF (1988) Nutritive value of native pastures in Queensland. In 'Native pastures in Queensland: the resource and their management'. (Eds WH Burrows, JC Scanlan, MT Rutherford) pp. 112–124. (Queensland Department of Primary Industries: Brisbane)

Quirk MF, Bushell JJ, Jones RJ, Megarrity RG, Butler KL (1988) Live-weight gains on leucaena and native grass pastures after dosing with rumen bacteria capable of degrading DHP, a ruminal metabolite from leucaena. *Journal of Agricultural Science (Cambridge)* **111**, 165–170.

Walker B, Hodge PB, O'Rourke PK (1987) Effects of stocking rate and grass species on pasture and cattle productivity of sown pastures on fertile brigalow soil in central Queensland. *Tropical Grasslands* **21**, 14–23.

Winks L (1984) Cattle growth in the dry tropics of Australia. *Australian Meat Research Committee Reviews* **45**, 1–43.

Winks L, O'Rourke PK, McLennan SR (1982) Liveweight of grazing steers supplemented with molasses, urea and sulfur in northern Queensland. *Australian Journal of Experimental Agriculture and Animal Husbandry* **22**, 252–257. doi:10.1071/EA9820252

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