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The effect of stocking rate on pasture & animal production from native pasture & native pasture oversown with Indian couch *(Bothriochloa pertusa)*

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ABSTRACT

CS.PO20

The effect of stocking rate on pasture and animal production from native pasture and native pasture oversown with Indian couch (*Bothriochloa pertusa*).

ABSTRACT

Indian couch grass *(Bothriochloa pertusa)*, has spread naturally in central and northern Queensland, and is particularly dominant in the Bowen/Charters Towers region. Its value as a pasture in comparison with native pasture has not been assessed in terms of animal production.

The work reported here sought to assess its value as a pasture grass in comparison with a species-rich native pasture dominated by the tufted perennial species *Bothriochloa decipiens*, *Heteropogon contortus*, *Themeda triandra*, *Chrysopogon fallax* and *Eulalia fulva*.

The native pasture formed an understory to a Eucalyptus woodland growing on a solodic-solodised-solonetz soil with an available phosphorus level of 7.5ppm.

Twelve paddocks were created. These varied in size to accommodate three stocking rate (SR) treatments of 0.3, 0.6 and 0.9 steers/ha for each pasture. There were two pasture treatment blocks, each containing three stocking rate treatments in a split plot design. Blocks were replicated giving a 2x2x3 layout = 12 paddocks.

The areas destined to become Indian couch pastures were heavily grazed prior to, and after, sowing 7kg seed/ha without any cultivation. The Indian couch established well and paddocks were stocked with the experimental SRs 13 months after sowing in March 1988. The experiment terminated in June 1993.

Despite some atypical seasons and the need to destock for various periods, the objectives of the work were largely achieved.

Stocking rate increases reduced both pasture yield (by 3-5t/unit increase in SR) and steer gains (by more than 100kg unit increase in SR).

Differences between pastures were only apparent at the medium and high SR where, over time, Indian couch tended to give higher pasture yields and steer gains. The better gains with Indian couch at these SRs was more of academic interest than of practical significance, since at these rates gain/ha was similar to or lower than the gains/ha at low SR.

Native pasture remained fairly stable botanically at the low SR, but the tufted perennial species declined at both the medium and high SR. Sowing Indian couch hastened the botanical changes due to stocking rate, and it became the dominant species at these higher SRs. At the low SR, the contribution of Indian couch declined from initial values indicating that this is not an invasive species in the area at low SR. Contribution of Indian couch to pasture yield was linearly related to SR. Quality of the Indian couch was similar to the other native perennial grasses. Increased steer gains were related to higher yield on Indian couch pastures at the higher SRs.

Maximum liveweight gain/ha was achieved between 0.3 and 0.6 steers/ha. Stocking at 0.9 steers/ha was not sustainable and scalds appeared in the pastures.

Even at low SR, steers would need to spend 2.8 years on the pastures after weaning to reach 500kg liveweight.

An unexpected outcome from the experiment was the effect of age of steers grazing together on annual liveweight gains. Weaners gained more than yearlings, and yearlings more than 2yr olds, at all stocking rates. In some years these differences were greater than the main treatments imposed.

PART 2

EXECUTIVE SUMMARY

CS.PO20

The effect of stocking rate on pasture and animal production from native pasture and native pasture oversown with Indian couch (*Bothriochloa pertusa*).

EXECUTIVE SUMMARY

Background:

Pressure on the perennial native grasses - the major understory component of the grazed open woodlands of northern Australia - is causing a decrease in vegetative cover and an associated increase in soil erosion and land degradation through weed invasion over large areas. This increase in grazing pressure is due to a combination of factors that have led to increasing stocking rates on most properties and full utilisation of the pastures. The change to *Bos indicus*-based herds, the use of urea and other supplements, and the economic pressures on graziers in recent times, have contributed to this increase in stocking pressure.

The trends in pasture degradation observable in recent years are likely to continue unless grasses better able to withstand grazing or better able to re-colonise bare areas from seedlings or stolons are introduced.

Indian blue grass (*B. pertusa*) is a low growing, stoloniferous grass which was originally introduced into Australia from India. It is now naturalized in north Queensland and dominates large areas in the Bowen - Collinsville - Charters Towers - Townsville region. Although all the reasons for the spread and dominance of *B. pertusa* have not been determined, its presence is associated with heavy defoliation by grazing or mowing. The area colonized by *B. pertusa* is continuing to increase.

The replacement of spear grass by *B. pertusa* at high stocking pressures raises the question - *"What is the effect of this replacement on animal production?"*. This needs to be answered in terms of both carrying capacity and production per head. If production per head is similar for the two grasses and more cattle can be carried on *B. pertusa* pastures, then by encouraging the spread of *B. pertusa*, animal production could be increased. However, if total production (i.e. per hectare) is similar or lower from *B. pertusa* , then the spread should be discouraged since the heavy grazing may lead to soil erosion and hence a lower long term production potential. There have been no comparisons of animal production from the two grasses prior to this experiment and it is not known if the spread of *B. pertusa* should be encouraged or arrested.

Graziers are divided in their attitude to *B. pertusa.* Some claim it is superior to the pastures it replaced, others see it as undesirable and an indicator of overgrazing.

Objectives:

There were three major objectives: a) to measure liveweight gains of steers grazing native pastures and native pastures oversown with Indian couch *(Bothriochloa pertusa)* at three stocking rates (SRs); b) to measure the effect of both SR and pasture type on yield and botanical composition of the pastures over time and c) to relate steer gains to pasture characteristics.

Methodology:

An area of mixed Eucalypt woodland growing on a solodic-solodised-solonetz soil of pH 5.4 and available P level of 7.5ppm P (bicarbonate extraction) on the CSIRO Division of Tropical Crops and Pastures Research Station at Lansdown, 50km south of Townsville, was used. It had carried an understory of native pasture dominated for many years by black spear grass *(Heteropogon contortus)* but which had declined in recent years. Dominant species at the commencement of the experiment in 1988 were: *Bothriochloa decipiens*, *Heteropogon contortus*, *Themeda triandra* and *Chrysopogon fallax.*

The area of 73.3ha was divided into four blocks. Two of the blocks to be sown with Indian couch were heavily grazed by cattle in the period prior to oversowing at 7kg/ha in March 1988, to encourage its establishment and spread. Each block was fenced into three paddocks of different sizes to accommodate stocking rate treatments of 0.3, 0.6 and 0.9 steer/ha. Subsequent to establishment, 'Graslan' was flown on to the area to kill trees on two occasions - at 7.5kg/ha in February 1989 and at 10kg/ha in April 1991.

Paddocks were stocked with three Droughtmaster steers of different ages - 1 weaner and 2 yearlings in 1989-90, and 1 weaner, 1 yearling and one 2 year old subsequently. Steers were weighed every 4 weeks.

Botanical composition and yield were measured using the BOTANAL technique.

Ground cover estimates were made in February 1993 to assess effects of treatment.

Herbage quality was measured on plucked leaf samples for comparison of Indian couch with native grass species. Herbage yield and liveweight gain were related to SR using regression analyses. Stocking rate for maximum gain/ha was calculated from the regression of steer liveweight gain (LWG) on SR, as was the gain/steer at this rate (Jones and Sandland 1974, Jones 1981). Steers were provided with salt licks in the paddocks year-long. From May to break of the season in November/December, urea/molasses blocks were provided in each paddock.

Results and Conclusions:

The seasonal conditions encountered were highly variable - from 1988 - 1990-91 above average annual rainfall was received, whereas in 1991-92 and 1992-93 drought conditions prevailed with only 51% and 34% respectively of the long-term mean rainfall of 861mm. Stocking rate had the major effect on both pasture yield and botanical composition and on steer gains. Sowing Indian couch hastened the botanical changes caused by increasing the stocking rate. Whereas the tufted native perennial grasses declined with increasing SR, Indian couch increased to become the dominant grass. At low SR, Indian couch declined from an initial level of ≈30% to about 20% of the pasture.

At low SR, the native pasture remained fairly stable botanically, except in the 1992-93 season when stocking pressure was very high. Ground cover was higher for Indian couch pastures than for native pastures - 25.2% versus 16.9%, but there was no SR effect.

Steer gains declined linearly with increasing SR. This decline was most marked after the first year of grazing amounting to >100kg/unit of SR, and was most pronounced with the native pasture. Gains/steer were similar for the grass treatments at low SR, but at high SR steer gains were higher for the Indian couch pasture. However, stocking at 0.9 steers/ha was not sustainable.

The higher steer gains on Indian couch pastures at higher SR were associated with higher pasture yield rather than higher quality. Chemical composition and digestibility of Indian couch was similar to that of the native perennial grasses.

It was calculated that at the SR for maximum gain/ha, steers would gain only about 77kg/yr, and would need to spend 4 years on the pastures after weaning to reach 500kg LW. Stocking at the lower rate of 0.3 steers/ha would enable gains of 110-120 kg/yr and steers could reach the 500kg in about 2.8 years. At these lower rates the pasture would be sustainable and the fluctuations in gain from year to year would be reduced.

In the severe drought of 1992-93 when only 34% of the average rainfall of 861mm fell, only the low stocked treatments could support the steers, and then only at two thirds of the pre-determined SR, i.e., at 0.2 steers/ha.

The effect of age of steer on LWG was significant ($P<0.01$) in every year - weaner>yearling>2yr old. In some years the differences were greater than the effects of stocking rate. Overall weight gain/yr declined with age of steer in the ratio 100:74:24.

Finally, the fear that Indian couch would invade well managed native pastures is not supported by the results of this experiment. Invasion of native pasture following heavy grazing will not lead to a reduction in steer gains and it could give the pasture greater flexibility to withstand variations in SR.

Since it was not possible to have Indian couch-dominant pastures at low SR in this experiment, the performance of steers at low SR needs to be measured on pastures converted to Indian couch by high stocking.

PART 3

FINAL REPORT

CS.PO20

The effect of stocking rate on pasture and animal production from native pasture and native pasture oversown with Indian couch (*Bothriochloa pertusa*).

Background:

The introduced stoloniferous grass *Bothriochloa pertusa* (Indian bluegrass or, as it is known locally, Indian couch) has spread naturally at a surprising pace over the last 10-20 years in central/northern Queensland. In the north, the early flowering, grazing-tolerant strain "Bowen" has been the most successful ecotype (Bisset 1980). At the CSIRO Lansdown Research Station, 50km south of Townsville, the plant was unknown in 1976. During the 1980's, it spread dramatically, to be the dominant grass in native pastures oversown with Verano stylo (*S. hamata* cv Verano) and stocked at 0.95 and 1.25 steers/ha. These were formerly dominated by *Themeda triandra*, *Heteropogon contortus* and *Bothriochloa decipiens* which have since completely died out (Jones and Kerr 1993).

It has been estimated (Walker and Weston 1990) that *B. petusa* now covers about 1 million ha in Queensland. This is probably an underestimate for 1993, since its rate of spread showed no signs of declining when the estimate was made in 1990.

The cattle industry is divided in its assessment of its worth as a pasture grass. Many graziers are pleased with its potential for beef production, others see it as an indicator of overgrazing and do not want to see it spread on their properties. In general, graziers nearer the coast are favourably disposed toward the grass, whereas those in drier areas are concerned about its productive potential and, in particular, its ability to maintain bulk during droughts.

Part of the division among graziers in their assessment of the grass is the lack of comparative information on its value for feeding cattle. There is general agreement that the grass can tolerate - even likes - heavy grazing. However, there was no information on its ability to grow and fatten cattle.

This study was designed to provide information to answer this question.

Objectives:

The primary objective was to measure and compare the liveweight gains of steers grazing native pastures or pastures dominated by Indian couch at a range of stocking rates. A secondary objective was to relate the performance of the steers to pasture characteristics in an attempt to explain any differences that might arise between the pasture treatments.

Initially, the study was linked under CS/DAQ.NAP P20 **"Effects of stocking rate, legume augmentation, grass replacement and supplements on animal production and stability of native pastures"**, with the QDPI study at Galloway Plains, Calliope, Queensland, 4068. The objective of the Lansdown study was to supply information on the performance of steers at the higher end of the stocking rate range compared with those in the Calliope trial and so to provide a more complete picture of the relationship between steer gain and stocking rate (SR) on native pastures.

However, from 1991, the two experiments reported results separately to MRC, since the trial at Calliope was extended beyond the planned termination date for the Lansdown study.

When both studies are completed, the results should enable a fuller understanding of the response of native pastures to stocking rate than any previous study in Queensland.

Methodology

A few options presented themselves as approaches to address the issue of comparing steer gains on native pasture and Indian couch pastures. One approach was to set up grazing paddocks on areas already dominated by Indian couch and on other areas (adjacent where possible) in native pasture. This technique, however, would have assumed that the two areas chosen were identical, and that they had similar grazing histories which would not have influenced the results. Such assumptions could not be justified and the results would have been suspect.

The method chosen was to start with a uniform woodland area with an understory of native pasture, to divide it up into paddocks and to convert half of the area to an Indian couch pasture before imposing the stocking rate variables. This conversion to Indian couch pasture was to be made by oversowing the selected areas with seed of Indian couch. The site was reasonably free of Indian couch at the start (<0.5% of the total yield).

The experiment therefore had two phases - the establishment phase when the sections allocated for Indian couch were sown and established, and the experimental phase when the two pasture treatments were grazed at the same rates and when animal and pasture measurements were made.

The site

A level 73.3ha site adjacent to Double Barrell Creek on the CSIRO Pasture Research Station, Lansdown, near Woodstock, was chosen for the experiment. The major tree species on the eucalypt woodland site were:

Eucalyptus alba	Poplar gum
Eucalyptus brownii	Reid River box
Eucalyptus crebra	Narrowleaf ironbark
Eucalyptus polycarpa	Longfruit (Grey) bloodwood
Eucalyptus tessellaris	Moreton Bay ash
Grevillea striata	Beefwood
Melaleuca viridiflora	Tea tree
Acacia spp	

Planchonia careya	Cocky apple
Eremophila mitchelli	Sandalwood
Ziziphus mauritiana	Chinee apple
Cryptostegia grandiflora	Rubber vine

There were, on average, 149 ± 7 trees/ha with a diameter greater than 7.5cm at breast height. The weed shrubs chinee apple and rubber vine were controlled with GARLON herbicide sprays at various times over the experimental period. In addition, the site, except for a 50m strip along the southern boundary retained for shade, was aerially sprayed with "Graslan" to kill trees and shrubs. This was to make the site more comparable with the site at Calliope which had trees killed well before the experiment commenced. However, the first application of "Graslan" on February 2, 1989 at 7.5kg/ha was not very successful in killing trees. A subsequent application on April 4, 1991 at 10kg/ha was more effective with trees continuing to die up to the termination of the experiment in June, 1993.

The grass understory of this woodland had been black spear grass - dominant for many years prior to the 1980's. However, like many other areas in N. Queensland the contribution of black spear grass had declined. This was certainly not due to overgrazing, but could have been associated with a lower incidence of burning.

The botanical composition of the native pasture in May 1988 before oversowing with Indian couch was:

Species	%
Bothriochloa decipiens	25
Heteropogon contortus	15
Themeda triandra	13
Chrysopogon fallax	12

Eulalia fulva	9
Sorghum nitidum	9
Bothriochloa pertusa	0.4
Other	16.6

The mean dry matter yield at this time was 1080 ± 137 kg/ha.

The soil at the site is described as a solodic-solodised-solonetz (Typic Natrustalf) (Murtha and Crack 1966). The soils have a pH range of 5.4 to about 9, with the pH increasing with depth below about 20cm. This increase in pH is associated with an increase in total soluble salts from 0.22% to 0.45% - mainly due to increases in Na and Mg. The marked texture contrast from the sandy A2 to the heavy clay B horizon is very sharp at about 20-25cm depth.

The surface soils have organic carbon values of about 1.6% and N% of 0.126. These values drop sharply to 0.3 and 0.028% respectively below 3.5cm depth.

Water-holding capacity of the soil is low, with only 85-100mm water available in the profile (McCown 1971).

The available P level in the top 10cm of soil of the experimental site was 7.5ppm (bicarbonate extraction) on samples taken on July 20, 1988. No fertilisers had been, or were, applied to the site.

Experimental layout

The site was fenced into twelve paddocks. All paddocks were 600m long. There were three widths of paddocks to create three paddock sizes for the stocking rate treatments. The widths were 166.7, 83.3 and 55.5m. Water was piped to each paddock in concrete troughs.

The 12 paddocks were allocated in two replicates with two blocks in each replicate. These blocks were allocated at random, and each block contained three paddocks of different sizes, also allocated at random.

The experimental treatments compared were:

Grass treatments: Native pasture
Native pasture oversown with Indian couch (*B. pertusa* cv. Bowen)

Stocking rate treatments:
0.3 steers/ha
0.6 steers/ha
0.9 steers/ha

Replicates: I
II

Three steers were allocated to each paddock to create the stocking rate treatments. Paddocks were continuously stocked at the pre-determined fixed stocking rates unless drought necessitated destocking or a reduction in SR.

Establishment of the Indian couch paddocks:

All paddocks were heavily grazed by cattle from January 18th, 1988 before sowing 7kg seed/ha by a spinner spreader. The seed was mixed with sawdust (1:2 vol:vol) as a carrier. The machine was driven between the trees to get as full a cover of seed as possible.

Seed was oversown on March 4th and 5th 1988 and then bare areas were oversown again at 7kg/ha on February 2nd 1989 in an attempt to produce a uniform cover of Indian couch.

During the establishment phase of the Indian couch, the native pasture blocks were stocked continuously at a SR of about 0.3 steer/ha. The Indian couch blocks were intermittently grazed at high stocking rate to reduce competition from the native species. Overall, the number of grazing days for the two native pasture blocks was approximately equal. The number of grazing days for the two Indian couch blocks was also similar, but higher than the grazing days for the native pasture blocks as shown below:

Grazing days on the four blocks from 15.12.88 to 20.4.89:

Native paddocks 1-3	582 days	(32/ha)
Native paddocks 10-12	540 days	(29/ha)
Indian couch 4-6	1503 days	(82/ha)
Indian couch 7-9	1375 days	(75/ha)

Experimental stocking:

All paddocks were stocked with two steers on April 28th, 1989 and with the full complement of 3 steers from June 26th, 1989. In 1989-90, each paddock was stocked with 1 weaner steer about 8 months old and 2 yearling steers aged about 20 months. In subsequent years, paddocks were stocked with 1 weaner, 1 yearling and one 2 year old steer. Each year in June the oldest steer was removed and replaced by a weaner steer. This full SR could not be maintained when drought conditions prevailed. Figure 1 shows the stocking history of the experiment from 1989 to 1993.

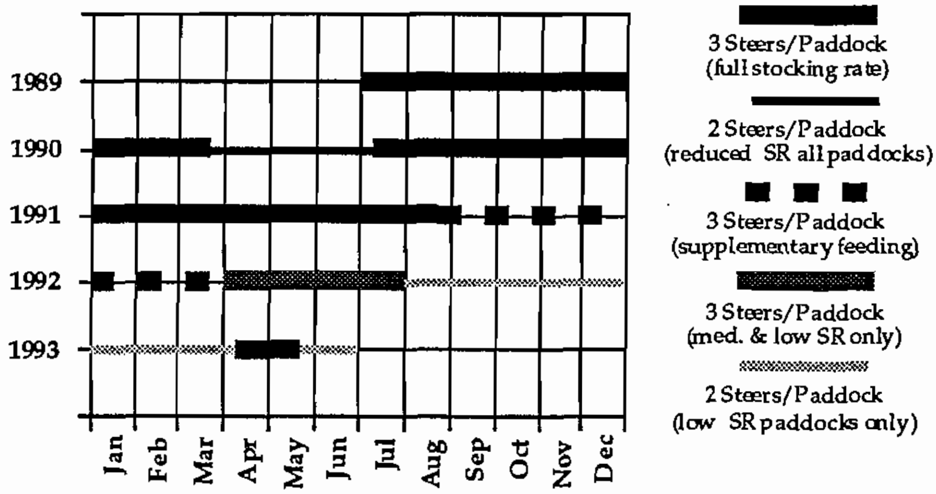


Figure 1. Stocking history of the grazing trial.

Parasite control:

All steers were dipped for tick control before entering the experiment and at intervals during the year if ticks became a problem. Worms were controlled using NILVERM at entry and subsequently if animal condition and faecal egg counts suggested a worm problem. Steers were also sprayed in the yards to control buffalo fly during the summer months.

Supplementation:

Salt blocks were available in each paddock throughout the year. From May to break of the season, urea-molasses blocks (U-30) were also provided. During the drought of 1991-92, steers on the high stocking rate paddocks (paddocks 1, 5, 9, 10) were fed sorghum hay from 20th August 1991 to 2nd December 1991. Feeding increased from 2 bales/paddock/week from 20.8.91 to 12.9.91, to 4 bales/week to 10.10.91 and then to 8 bales/week up to 2.12.91. This provided approximately 1.25, 2.5 and 5kg of sorghum hay/steer/day for the three periods. For the month of November 1991, three of the four medium stocked paddocks (2, 6, 12) were fed four bales of hay per week (2.5kg hay/steer/day) and the medium stocked Indian couch pasture in Replicate II (paddock 7) one bale of hay/week (0.7kg hay/steer/day).

In February 1992, 2 bales of hay/week were fed to the steers on the native and Indian couch paddocks at high SR in Replicate II (paddocks 9 and 10) - i.e., 1.25kg sorghum hay/steer/day.

Measurements:

Pasture yield and botanical composition

These measurements were made using the BOTANAL procedure (Tothill *et al* 1978). This was conducted using three trained operators to rank the species in each (0.5m x 0.5m) quadrat and to make yield estimates (1-10) on the same quadrats. The number of quadrats measured varied with paddock size - 144, 72 and 45 for the low, medium and high-stocked paddocks respectively.

BOTANAL assessments were made on the following 9 dates:
31.05.88; 19.04.89; 12.12.89; 15.06.90; 28.11.90; 29.04.91; 18.12.91; 14.05.92; and 02.03.93

Species and groups recorded were those listed in Appendix I.

Chemical composition and in-vitro digestibility:

Chemical analysis (for N, P, K, Na, Ca, Mg, Cl, S, Cu, Zn, Mn, Al and B) of the main pasture species in the experiment were performed on plucked samples from the grazed paddocks in January 1990. Samples of the components of *H. contortus* and *B. pertusa* were also taken at other times (August 1989 and August 1990) to assess the relative nutritive value of leaves, stems and seed heads.

Selected samples, taken in December, 1989, were analysed for *in-vitro* digestibility using the pepsin/cellulase technique (McLeod and Minson 1978). These analyses were performed to see if any differences in animal production could be related to either chemical composition or digestibility of Indian couch grass compared with the native perennial grasses.

Ground cover assessment:

On February 11th, 1993, ground cover estimates were made on all paddocks using three operators, each assessing grass ground cover on twenty 50cm x 50cm quadrats/paddock. Ground cover was visually assessed on a percentage basis for each quadrat. Paddock means were then compared to assess differences due to grass treatment and stocking rate.

Steer weights:

Steers were weighed off pasture every four weeks - they were not fasted.

Data analysis:

Pasture yield estimates for both total and component yields, as well as the percentage contribution of each species to total yield, were computed by the BOTANAL package (Tothill *et al* 1978). The data were then subjected to AOV using the GENSTAT 5 package. Where necessary, the data were transformed to normalise the variances. For yield data the $\text{Log}(y+1)$ transformation was often appropriate, and for the percentage contribution to yield, the data were given an $\text{Arcsine}(\sqrt{y})$ transformation.

Steer gains were combined on a paddock basis for AOV each month. When different-aged steers were used, the age groups were also treated separately as if they constituted a split-plot layout. Transformation of LWG data was not required.

Regression analysis was used to relate steer gain data to stocking rate, and pasture presentation yield to stocking rate. Calculations of maximum liveweight gain/ha and of the SR for maximum gain/ha were as described by Jones and Sandland (1974) and Jones (1981).

RESULTS

Seasonal conditions

The experiment experienced extremes of weather conditions from cyclone Aivu in April 1989, which caused considerable damage to fences and a newly erected sign describing the experiment, to excessive flood rains in March and April 1990 following unseasonal drought in the preceding January and February 1990; an excessively wet, but short, rainy season in 1990-1991, when 93% of the total rainfall fell over 9 weeks, to severe drought from February 1991 to the end of the experiment in June 1993. Despite above-average total annual rainfall in 1988-89, 1989-90 and 1990-91, distribution was poor and cattle numbers had to be reduced at times due to lack of feed. The periods 1991-92 and 1992-93 were extremely dry when only 51% and 34% respectively of the mean annual rainfall of 861mm fell. During these years, steers had to be removed from some treatments for prolonged periods. The rainfall data and the soil water balance are presented in graphical form in Figures 2 and 3.

Effect of treatments on pasture yield and botanical composition

Prior to the imposition of the stocking rate treatments, yields of pasture on the native pasture treatment in April 1989 were higher than for the Indian couch pastures 2210 -v- 1780 kg/ha ($P<0.05$). This was undoubtedly due to the earlier intensive grazing applied to the Indian couch pastures to control competition from other grasses and promote establishment. Subsequently, the

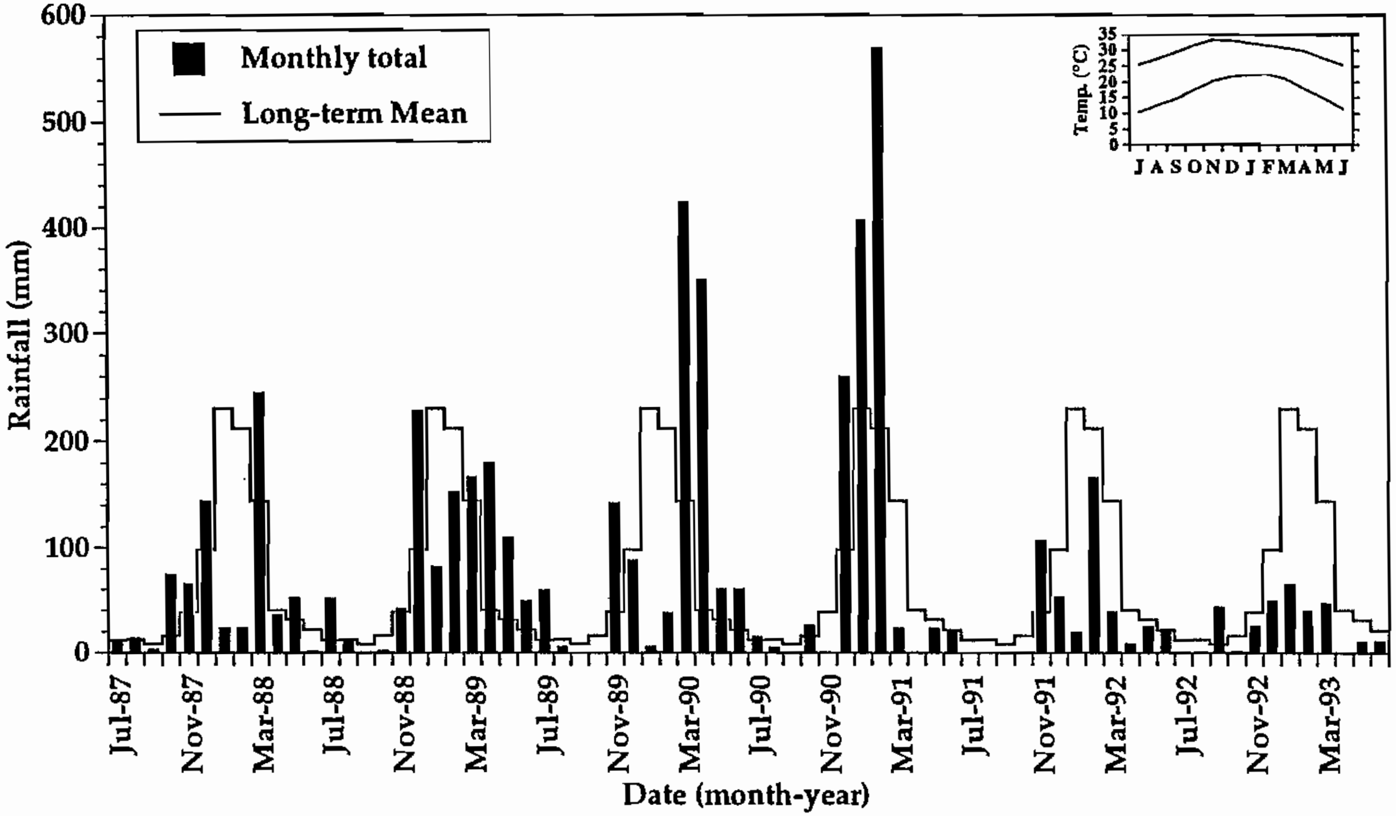


Figure 2. Monthly rainfall (bars) over the experimental period with mean monthly rainfall for Lansdown superimposed. Insert is the maximum and minimum temperatures for Lansdown.

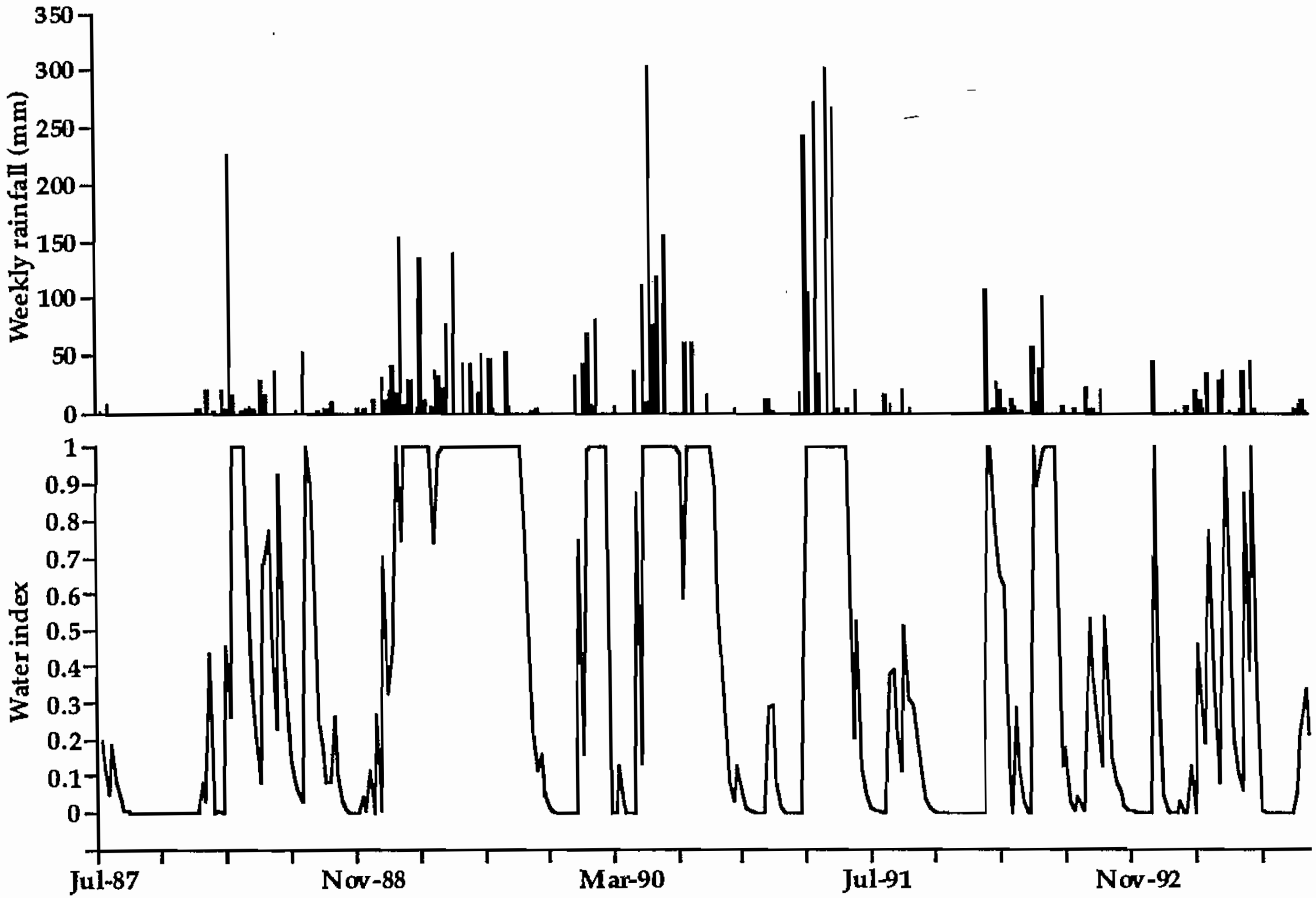


Figure 3. Weekly rainfall and weekly soil water index for the period of the experiment (soil water store estimated at 85 mm).

effect of grass treatment was generally small and not significant (P>0.05) except for two occasions (November 1990 and March 1993) when Indian couch significantly (P<0.05) outyielded the native pasture by 21% and 29% respectively (Table 1).

Table 1. The linear relations between stocking rate (SR) and presentation pasture dry matter yield for the native and Indian couch pastures at the various sampling times. The effect of the grass component is also shown

Sampling Time	Native Pasture 'a'	'b'	'r'	Indian Couch 'a'	'b'	'r'	Grass Effect
12/12/89	3737	-3287	-0.941	2958	-1952	-0.991	NS
15/6/90	9221	-6938	-0.970	8928	-5370	-0.985	NS
28/11/90	5549	-5328	-0.970	5300	-4273	-0.999	P<0.05
29/4/91	5467	-5370	-0.944	5588	-5092	0.993	NS
18/12/91	2158	-2268	-0.913	2487	-2545	-0.946	NS
14/5/92	2880	-2940	-0.903	3312	-3048	-0.932	NS
2/3/93	1203	-33.3	-0.130	1761	-31.2	-0.529	P<0.05

No significant difference due to SR as animals were off the medium and high stocking rate treatments. However mean yield for Native 1220 kg/ha and for Indian couch 1570 kg/ha (P<0.05)

Note: There was never any significant (P<0.05) Grass x SR effect

The dominant effect of SR on pasture yield was seen at every sampling until March 1993 (Table 1, Figure 4). These effects are also portrayed in Plates 5-26 in Appendix IV.

On no occasion was there a significant interaction of grass x SR although at high SR there was a consistently higher yield of pasture with Indian couch

(Figure 4). Compared to the effects of grass treatment, the effect of stocking rate was dramatic.

Yields of pasture declined linearly ($P<0.01$) with increasing stocking rate (Table 1). The lack of a SR effect for March 1993 was clearly due to the fact that steers had been removed firstly from the high SR, then the medium SR, whilst two steers were retained on the low SR treatment throughout.

In general, the slopes (b values) of the regression of yield on SR were lower for the Indian couch pastures. Overall, the mean b values for the two pastures were: -4355 -v- -3713 kg/unit increase in SR which suggests that Indian couch forms a more grazing tolerant pasture, although the decline in yield for both pastures per unit increase of stocking rate was very large.

The effects of SR on the yields of the various pasture components are presented in Figures 5a-d. The trends are discussed in the following section on botanical composition.

Botanical changes:

Both treatments (grass and SR) resulted in marked changes in botanical composition of the pastures over time. In general, the sowing of Indian couch tended to hasten the changes associated with increased SR imposed on the native pastures. The combination of sowing Indian couch and increasing the SR was to rapidly move the pasture to dominance by this species. The species to decline as Indian couch increased with higher SR were:

Heteropogon triticeus, Themeda triandra, Bothriochloa decipiens, Sorghum nitidum, Heteropogon contortus, Chrysopogon fallax - all perennial tufted species. The effect of grass treatment and stocking rate over time is illustrated graphically for the dominant grass species in the native pasture - *Bothriochloa decipiens* (Fig.6).

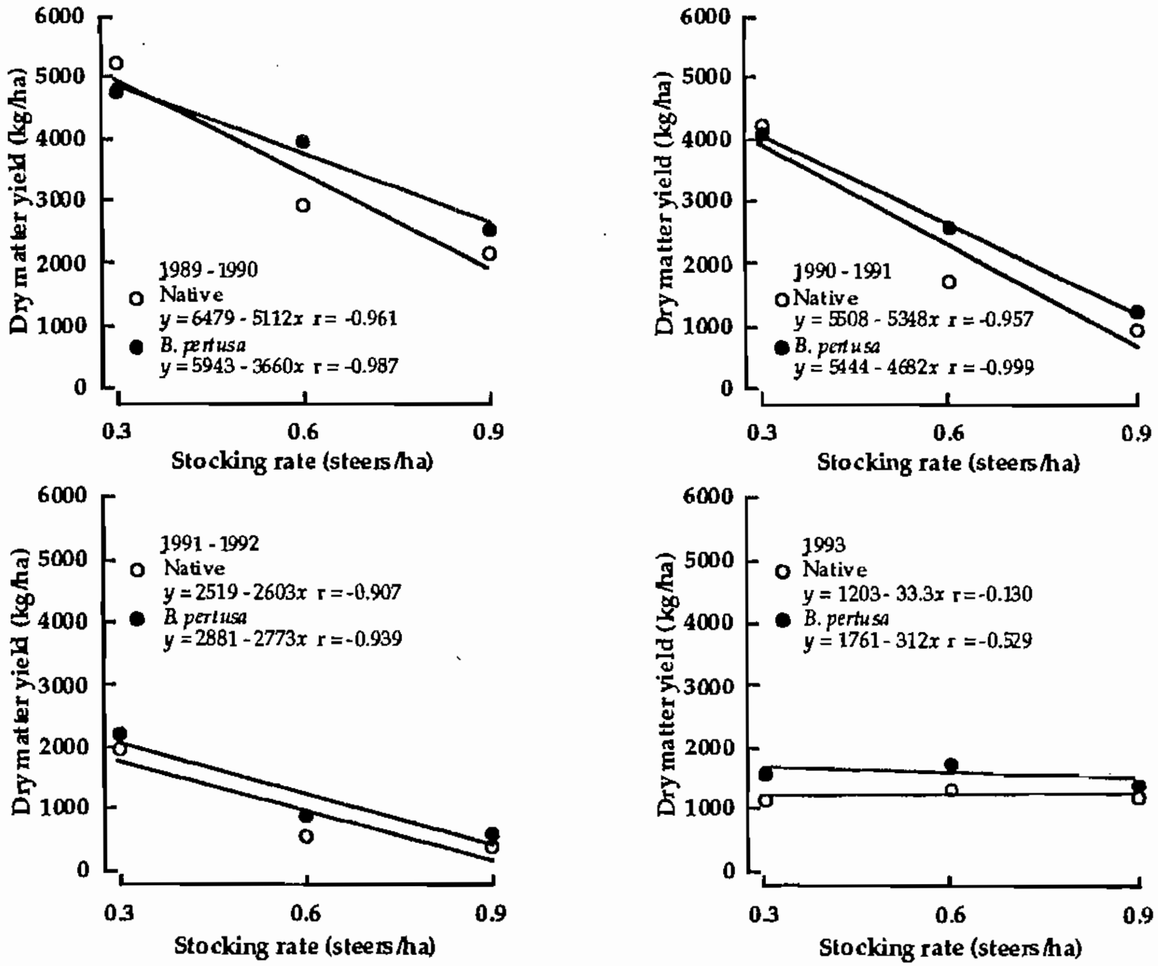


Figure 4. Effect of stocking rate on pasture yields of dry matter over four years.
Note: In 1992 - 1993 only the low stocked paddocks were grazed for the full year.

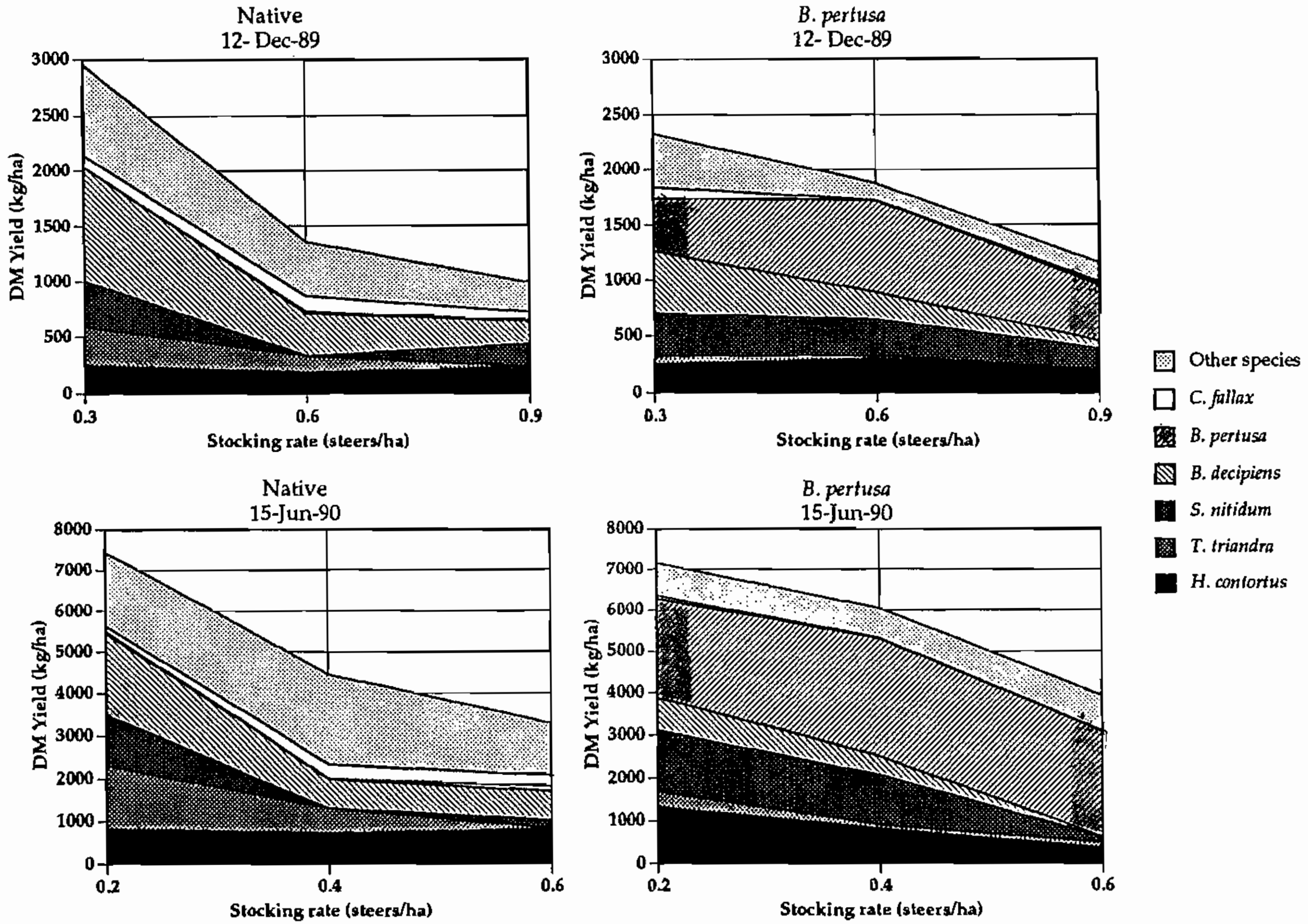


Figure 5(a). Yields of dry matter for the various pasture components as influenced by stocking rate, and by oversowing with Indian couch for the various sampling times (values are the means of two replicates).

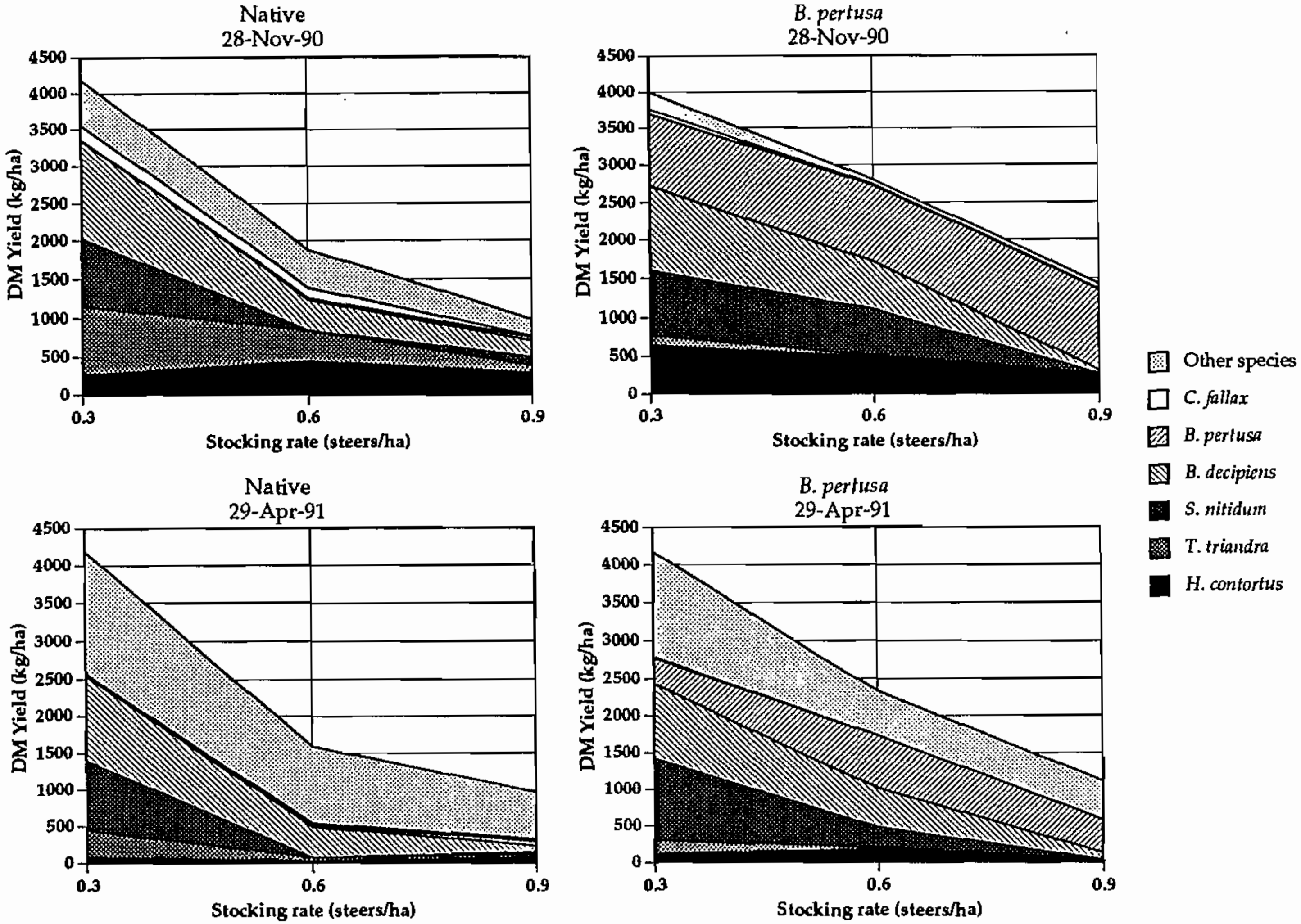


Figure 5(b). Yields of dry matter for the various pasture components as influenced by stocking rate, and by oversowing with Indian couch for the various sampling times (values are the means of two replicates).

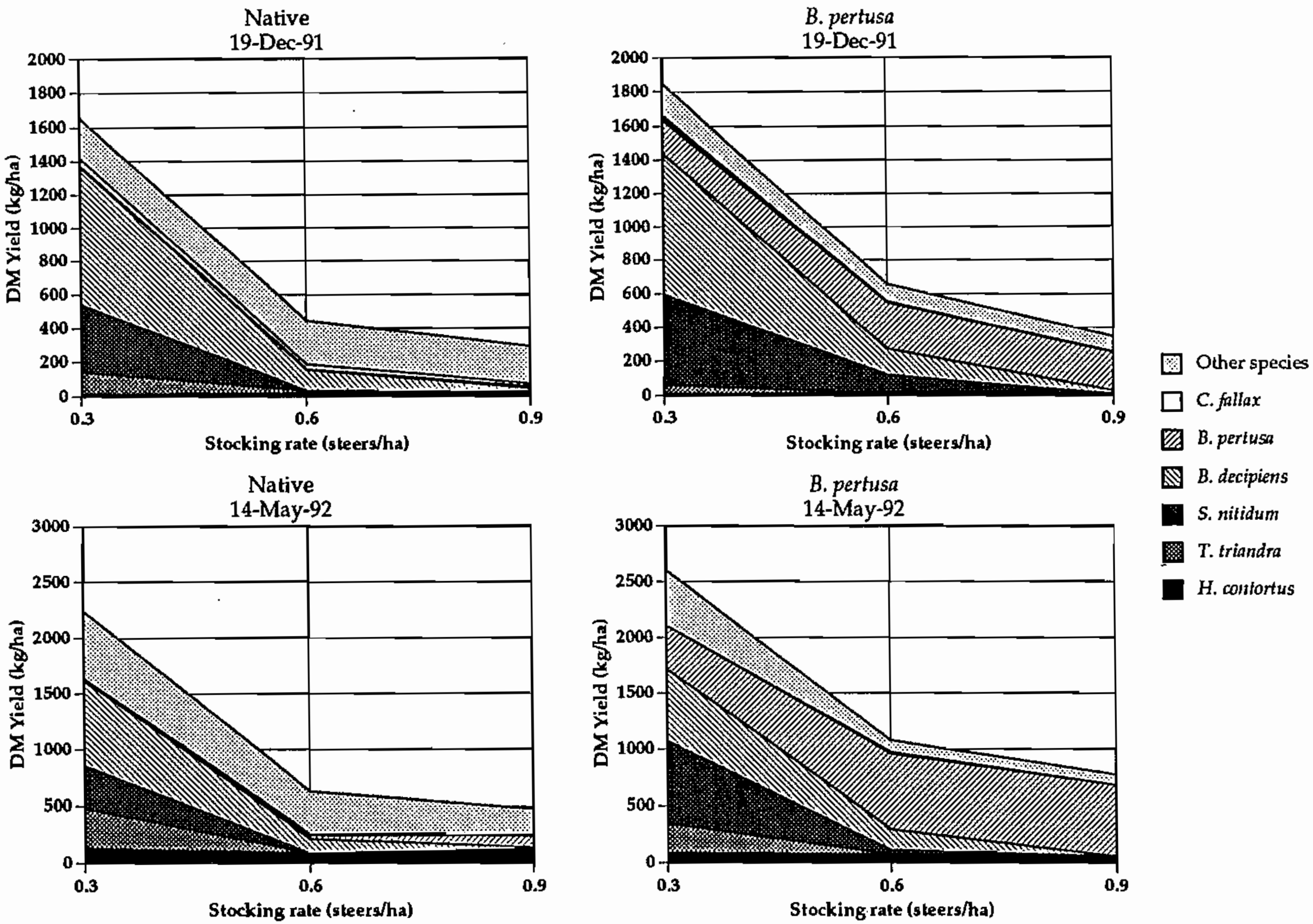


Figure 5(c). Yields of dry matter for the various pasture components as influenced by stocking rate, and by oversowing with Indian couch for the various sampling times (values are the means of two replicates).

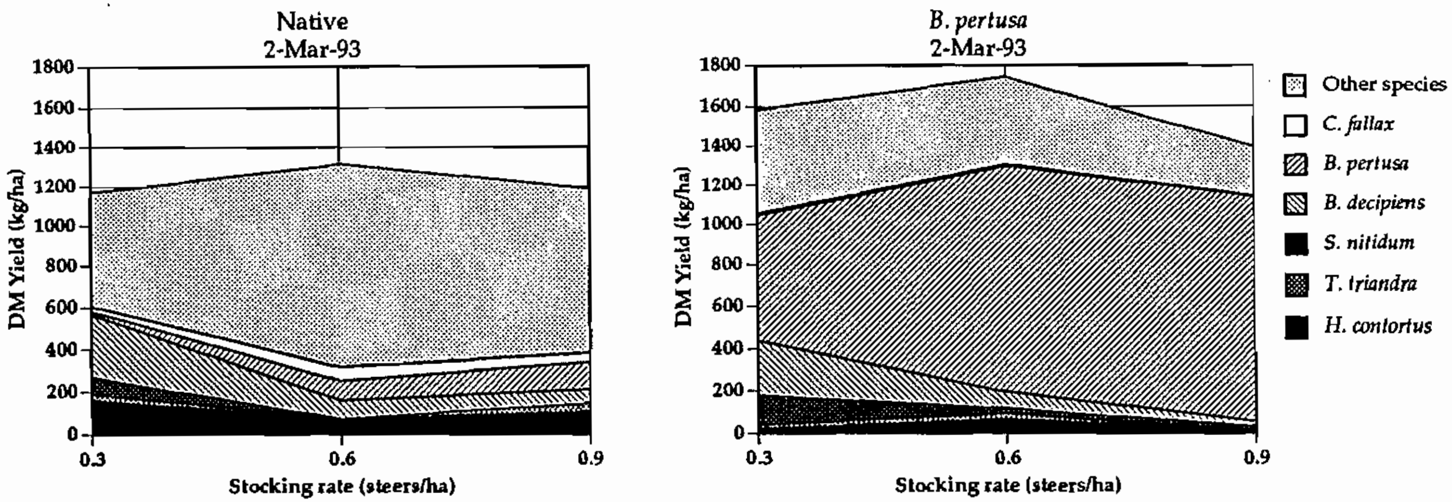


Figure 5(d). Yields of dry matter for the various pasture components as influenced by stocking rate, and by oversowing with Indian couch for the various sampling times (values are the means of two replicates).

It is interesting that Indian couch declined in the low stocking rate treatment from its initial contribution of about 33% before SR treatments commenced in April 1989, to about 13% in December 1991. Conversely, the percentage contribution of Indian couch increased from the initial value of about 30% to 63% in December 1991 at the high SR (Fig.7).

Although Indian couch was only present in small amounts in the native pasture, there was a clear trend for its contribution to total yield to increase with SR and with time (Fig. 5). By the end of the experiment, the percentage contribution in the native pasture treatment was 1.4%, 6.9% and 10.9% for the three SR's.

At low stocking rate, stability was maintained over time for most of the species initially present in the native pasture. The exception to this was giant spear grass, *Heteropogon triticeus,* which disappeared very rapidly at all stocking rates imposed.

Sorghum nitidum proved to be a good indicator of stocking rate (or stocking pressure). With no feed shortage at low SR it was rarely eaten. At medium SR plants were eaten to about half their height and at high SR the plants were grazed low and most eventually died out. The SR treatment could readily be determined by visually assessing the utilisation of any *S. nitidum* in the respective paddocks.

Species to increase with SR in addition to Indian couch were: Native *Chloris spp., Sporobolus spp.*, other perennial grasses, annual grasses, dicot weeds and sedges.

At low SR in native pasture, *Sorghum nitidum* increased. *Heteropogon contortus* and *Themeda triandra* and *Bothriochloa decipiens* remained fairly constant, whereas *Heteropogon triticeus*, and *Chrysopogon fallax* decreased. *B. petusa,* other 'grasses', annual grasses and dicots increased slightly. At low

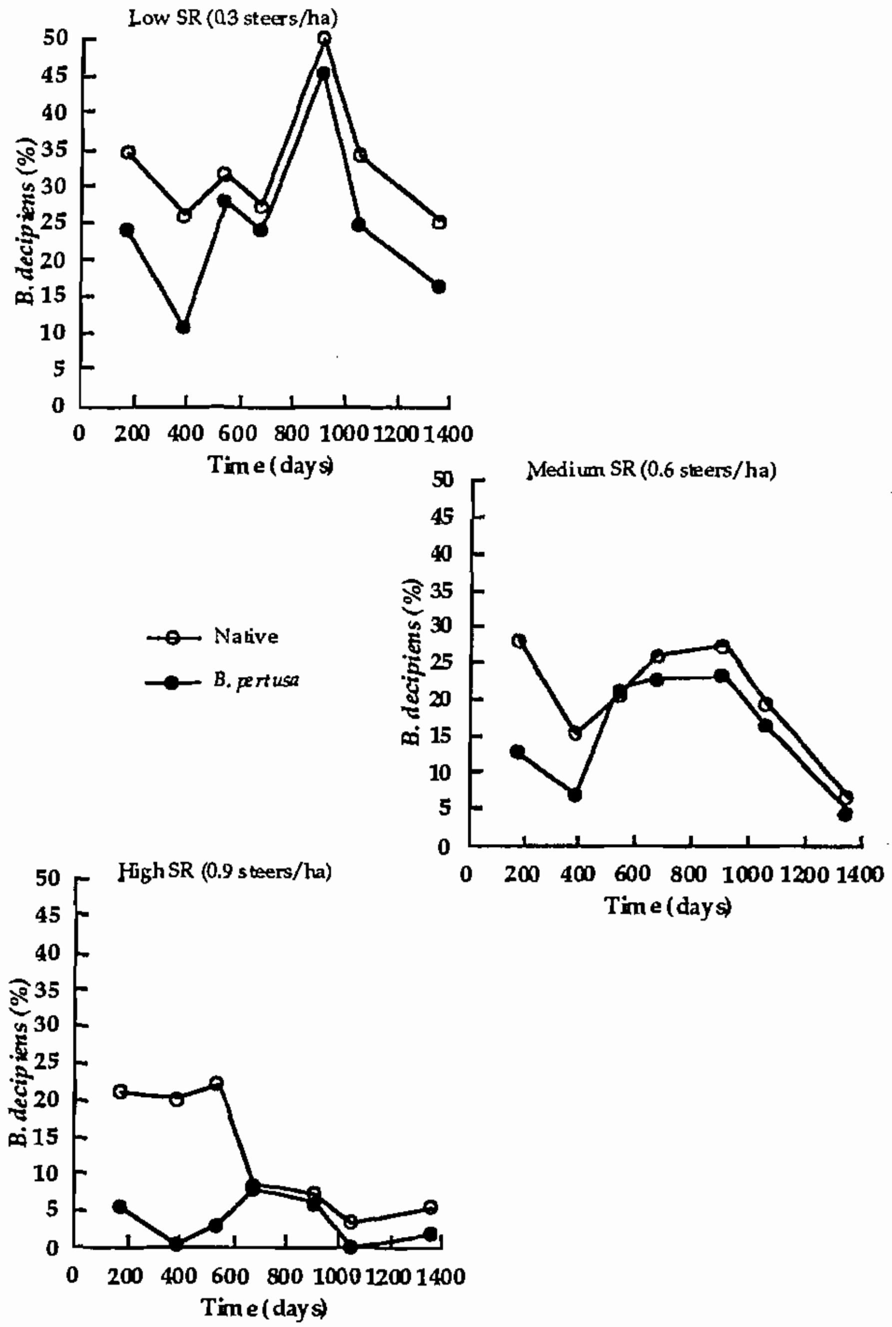


Figure 6. Effect of stocking rate and oversowing with Indian couch (*B. pertusa*) on the percentage component of *Bothrochloa decipiens* with time (days from 22nd June 1989) and experimental stocking.

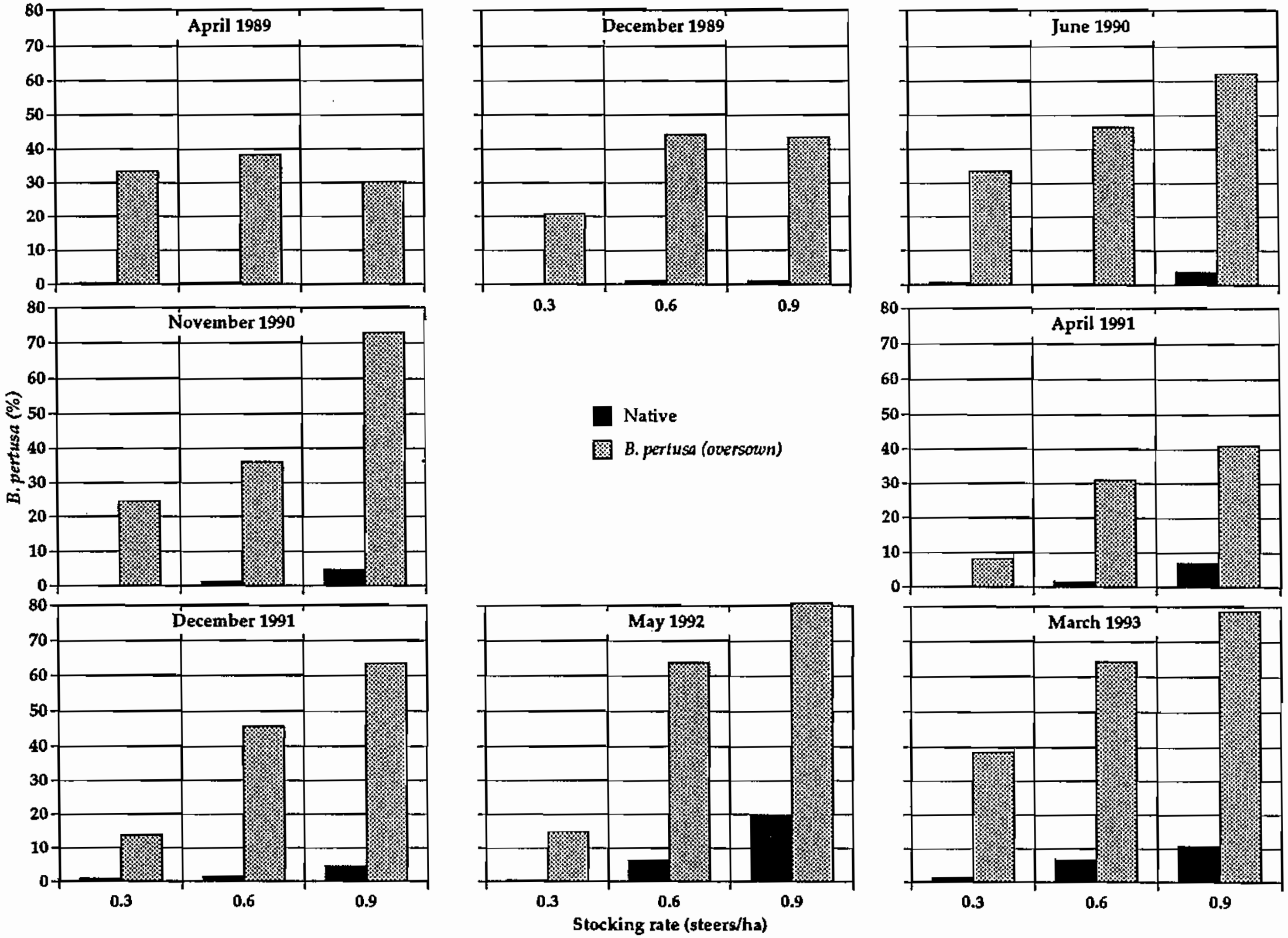


Figure 7. Effect of stocking rate on the percentage Indian couch (*B.pertusa*) in native pasture and native pasture oversown with *B. pertusa* from 1989 to 1993.

SR with Indian couch, there was a decrease in Indian couch with time, except for the final sampling in March 1993 when there was a sharp rise. Both *Heteropogon spp* and *Chrysopogon fallax* declined virtually to zero, *Themeda triandra* remained fairly constant, or increased, and *Sorghum nitidum* increased, except for the last sampling in March 1993. *Eragrostis* species declined overall, whereas *Chloris* spp increased. Annual grasses and dicots showed small increases, but their contribution to total yield was below 5%.

At medium SR, *H. triticeus*, *T. triandra*, *S. nitidum*, *B. decipiens*, *C. fallax*, *Aristida* spp all declined. The decline of these species was hastened on the pastures oversown with Indian couch and on these, *H. contortus* was greatly reduced. In addition *Melenis repens*, was eliminated. The decline of these species was matched by an increase in the sown Indian couch over time. *Chloris* spp. and annual grasses increased at this SR on both pastures.

At high SR, the trends described for the medium SR were hastened. Surprisingly, the *H. contortus* remained fairly stable in the absence of sown Indian couch, but decreased markedly in the presence of Indian couch. On both the native and oversown pasture, Indian couch increased with time, as did *Chloris* spp., annual grasses, other perennial grasses and dicots.

On all pastures, native legumes never contributed more than 4% to total yield, usually less than 2%. The contribution of sedges was also small except after the excessive but short wet season in 1991. In that year, the high SR native pastures contained 25% of sedges, and the medium SR 15% sedges. The presence of Indian couch reduced the contribution of sedges to pasture yield at high and medium SR to 15% and 2% respectively. The species composition at each sampling is given in Appendix I.

Ground cover estimates:

Pastures oversown with Indian couch had a higher vegetative cover in February 1993 than the native pastures - 25.2% -v- 16.9% ($P<0.01$). Somewhat surprisingly, there was no significant ($P>0.05$) effect of SR and differences between treatments were small : 21.0, 20.2 and 21.7% for the low, medium and high SR respectively.

Chemical composition:

All species had low sodium levels, despite growing on a solodised solonetz soil with high sodium and magnesium in the sub-soil.

Table 2. Chemical composition of leaves of Indian couch *(B. pertusa)* and the main native pasture species.

Species	N	P	K	S	Na	Ca	Mg
B. pertusa	1.94	0.22	2.1	0.12	0.015	0.46	0.25
H. contortus	1.63	0.21	1.69	0.11	0.012	0.35	0.18
B. decipiens	1.72	0.24	1.63	0.01	0.01	0.34	0.145
C. fallax	2.03	0.18	2.05	0.15	0.03	0.23	0.21
T. triandra	1.4	0.18	1.27	0.07	0.01	0.28	0.125

The chemical composition of the leaves of Indian couch was similar to that of the native species (Table 2). As anticipated, there were marked differences in composition between the leaf and stem components where these were measured, with stems having very low N and minerals, though the Mg content of stems of *H. contortus* was higher than that for leaves (Appendix II).

A notable feature of the native species was the low Ca content of the leaves, particularly *C. fallax*, compared with Indian couch (0.23% -v- 0.46%). Unlike the seed heads of *H. contortus* which had low N and P levels, the N and P content of seed heads of Indian couch were much higher and approached the levels found in leaves.

Table 3. Percentage dry matter digestibility (*in-vitro* converted to *in-vivo* values) of five perennial grasses. Plucked samples taken in December 1989.

Grass	Mean digestibility (%)	Standard deviation (%)
Chrysopogon fallax	55.3	2.80
Bothriochloa decipiens	49.3	1.48
Heteropogon contortus	49.2	1.26
Themeda triandra	48.6	1.06
Bothriochloa pertusa	50.3	0.94

The trace elements appeared adequate in the leaves of all species with the exception of *T. triandra* which had low Cu levels. However, stems of *H. contortus* and Indian couch were low in Cu, and the seed head of *H. contortus* also low in Zn (Appendix II). In general, leaves of Indian couch had marginally higher levels of N and most minerals than the other grasses measured.

Digestibility:

Apart from *C. fallax,* which had the highest digestibility, the remaining native grasses had values similar to that of Indian couch in December 1989 (Table 3).

All values were lower than may have been expected from plucked samples in early summer.

Steer gains:

The dominant effect of SR in reducing steer gains was evident throughout the experiment (Fig.8) except for the period March 1990 to July 1990. Over this period when SR was reduced to 2 steers/paddock (0.2, 0.4, 0.6 steers/ha), steer gains increased with SR (Fig.9).

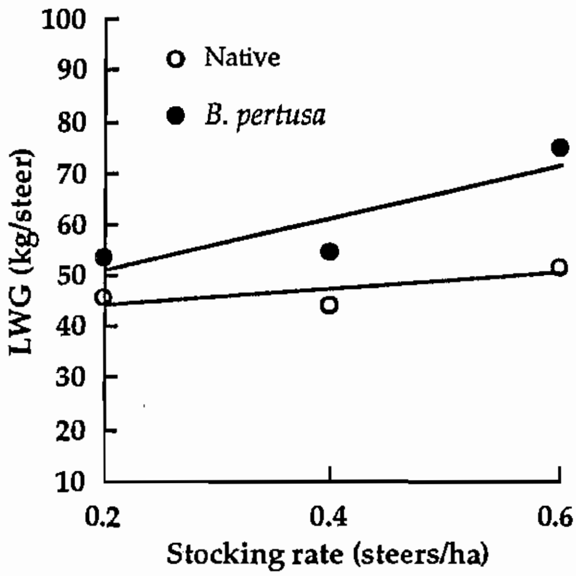
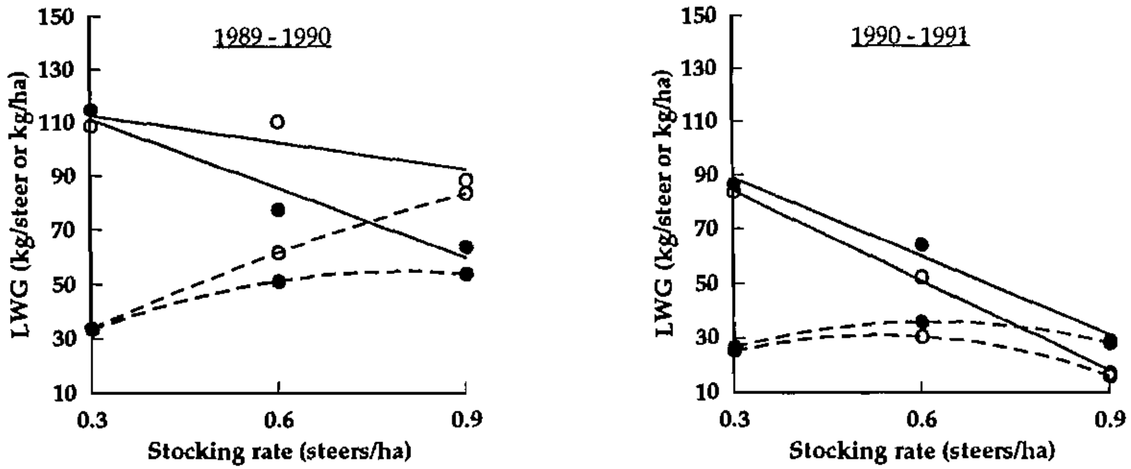
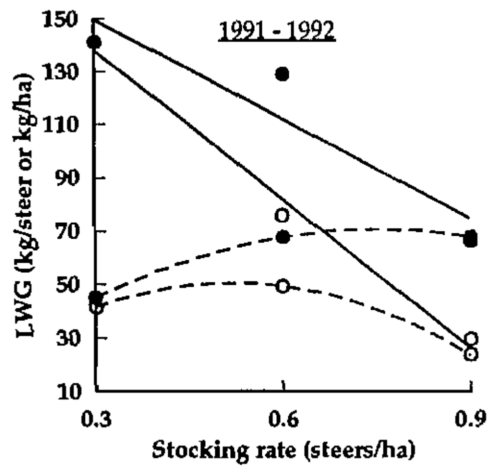


Figure 9. Steer liveweight gain (LWG) for the two pasture treatments at each stocking rate for the period 1/3/90 to 19/7/90 (140 days).





Period	Pasture	Intercept	Slope	r
1989-1990	Native	122.6	-33.7	-0.827
	B. Pertusa	136.6	-85.5	-0.968
1990-1991	Native	116.8	-109.7	-0.999
	B. Pertusa	117.2	-95.3	-0.992
1991-1992	Native	193.5	-185.6	-0.995
	B. Pertusa	187.6	-124.4	-0.931

Figure 8. Effect of stocking rate on steer gain and steer gain per ha for the native and oversown *B. pertusa* pastures in each of three years.

This effect is explicable by invoking compensatory gain as the mechanism for the atypical result. Steers which had gained the most weight from June 1989 to March 1990 gained the least weight after late rains in March 1990. This resulted in steers on the Indian couch pastures gaining more weight than those on the native pastures - the opposite of what occurred from June 1989 to March 1990.
Compared with the large effect of SR on steer gains, the effect of the grass treatment was smaller (Fig.10). In general, there was little difference at any time between steers grazing at the low SR of 0.3 steers/ha. At the medium and high SR there was a surprising difference in favour of the steers grazing native pasture for the first grazing period from June 1989 to March 1990 (Fig.8). This unexpected result may have been partly due to the lower yields on the Indian couch pastures following the heavy grazing designed to speed up establishment of the oversown Indian couch. However, this cannot be the full story since steers at high SR on native pasture gained more weight than steers at medium SR on Indian couch, despite the fact that pasture yields were lower. Observations of grazing steers suggested that part of the reason for their lower LWG performance was their selection of species other than Indian couch. The time taken to select these could have reduced their total intake, which in turn resulted in lower LWG.

Apart from this unexpected result in the first year, there was little difference between the grasses in response to increasing SR though there was a trend for gains to be higher at the medium and high SR on the Indian couch pastures and this difference increased with time (Fig.8). These higher steer gains were also associated with higher pasture yields on the Indian couch pastures. This strongly suggests that yield rather than pasture quality was the main difference associated with the higher gains on Indian couch pastures. The results from the chemical analysis and *in vitro* digestibility measurements also support this conclusion.

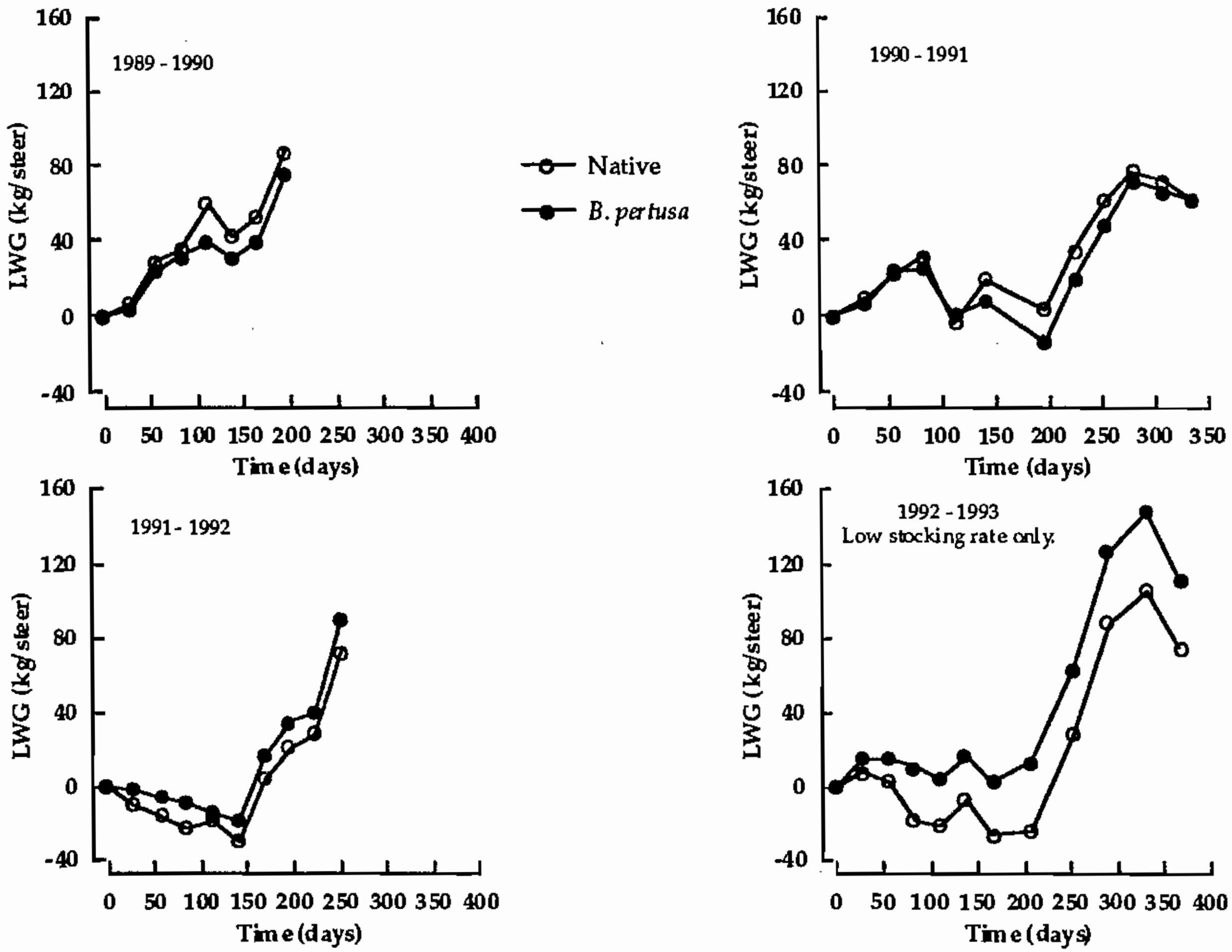


Figure 10. The effect of pasture type on seasonal steer liveweight change (mean of three stocking rates, except for 1992-1993 when only the low stocked treatment was grazed).

In the final year, when stocking over a long period was only possible on the low SR treatment, gains/steer were higher on the Indian couch pasture (by 35 kg). Most of this higher gain was established by September 1992, thereafter, the gains/steer for both treatments were remarkably similar (Figure 10). For this year the pressure on the pasture was similar to the pressure on the high SR treatment in previous years, so the result is not at all unexpected since pasture yields were also higher ($P<0.05$) in 1993 on the Indian couch pastures.

Effect of steer age:

The differences in gains per steer between age groups in 1989-90 and 1990-91 was greater than the differences due to grass species or to the effect of SR. This was a surprising result. The differences between ages (weaner>yearling>2year old) was consistent across SR's in both years, indicating that feed availability was not involved in the differences measured. The results were presented at the ASAP meeting in Melbourne in July 1992 and a reprint is attached in Appendix III. Summarising the results for this and other experiments at Lansdown, the relative effect of age on gains/steer/annum were 100:66:25 for a weaner, yearling and 2year old steer grazing the same pasture. In 1991-92 the effect of steer age was again highly significant ($P=0.004$), though the magnitude of the differences was much smaller than in previous years. The respective mean gains for weaner, yearling and 2 year olds were 109, 102 and 81kg. There was no interaction with grass or SR; a result which confirmed those from the two previous years. The results for the three years are summarised in Table 4.

Table 4. Effect of steer age on mean liveweight gain (kg) when grazing together on native pastures and pastures oversown with Indian couch *(Bothriochloa pertusa).*

	YEAR		
	1989-90	1990-91	1991-92
Steer age			
Weaner	170	96	109
Yearling	115	61	102
2 yr old	†	10	81

Values are means across the two grass species and the three stocking rates

† 2yr old steers not used in 1989-90.

Achievement of objectives:

Despite the extremely variable seasons experienced for the duration of the experiment, the major objectives were achieved. Some reservations need to be attached to the conclusions drawn, but the data do provide us with evidence that was lacking previously to assess the value of Indian couch on the nutrition of growing beef cattle, and to measure its response to grazing pressure. We can also be fairly confident, over the SR ranges used, in relating steer gain to pasture yield rather than to any specific quality difference between the two pasture types.

Implications of the results:

1. It is quite clear that the dominance of Indian couch is related to two factors. Firstly, the presence of seed of Indian couch and secondly the grazing pressure imposed on the pasture. In this experiment the availability of seed (by sowing it) was the main factor, since paddocks grazed at low SR but with seed sown, had a far higher percentage of Indian couch than did paddocks grazed at the high SR where seed was not sown. However, with time, it is clear that even the paddocks not sown with Indian couch would become dominated by this species with continued heavy grazing pressure.

2. The fear that Indian couch would take over pastures in general, is not supported by the results. At low SR the Indian couch declined from approximately 30% to 20% of pasture yield, and with more favourable seasons may have declined further. Where seed was not sown, and where paddocks were grazed at the low SR, the contribution of Indian couch did not exceed 2.5% of the pasture. The species may well be regarded as an indicator of previous stocking intensity. This has been also shown for improved stylo-based pastures at Lansdown where Indian couch totally replaced native species, similar to those in the present trial, at SRs of 0.95 and 1.25 steers/ha (Jones and Kerr 1993).

It is likely that there will be a continuing trend for Indian couch to spread to new areas, particularly those areas adjacent to existing Indian couch-dominated paddocks where seed spread is possible by wind and water movement and which are heavily grazed. The severe droughts in the 90's in northern Australia will have resulted in high stocking pressures conducive to such rapid spread as shown from the results at another long-term grazing experiment at Lansdown (Jones and Kerr 1993).

3. The marked decline in pasture presentation yield as stocking rate increased was a major feature of the results. Although the rate of yield decline with Indian couch was slower than for the native pastures, it was still fairly dramatic. Yield depressions of 3-5 t DM per unit increase of stocking rate is higher than the rates of decline recorded for improved legume-based pastures at Lansdown which are usually less than 3 t/unit increase in SR (R.J. Jones - unpublished data).

This emphasises the susceptibility of native pastures to heavy stocking or high utilisation rates. The penalty for heavy stocking is reduced pasture yield and further stocking pressure on the remaining pasture. In the first year of grazing, steers at all stocking rates in this experiment were presented with approximately the same amount of feed. This situation never occurred again. Hence the first year may be regarded as atypical, with low 'b' values for the relation between pasture yield and stocking rate (Table 1).

4. A result of the depression in yield of pasture with increasing stocking rate was the vastly depressed yield presented per steer. For example, in April 1991, steers at low SR would have been able to select from 13.3t (4/0.3) feed available per head, whereas those at high stocking rate would have had access to only 1.1t (1/0.9) feed. As a result, steers gained much faster at the lower SR and the decline in gain/steer with increasing SR was very marked at 100 to 150 kg/steer/unit of SR.

This high 'b' value for these native pastures contrasts with the much lower values for improved stylo-based pastures, where the values are less than half (37-44kg) of those measured in this experiment (R.J. Jones unpublished data).

Thus, the sensitivity of the native pasture to increased SR is expressed in both low pasture yields and resultant low gains/steer. In this sense they are less robust to SR changes than are improved stylo-based pastures.

5. The general similarity of steer LWG on both pastures at low SR and the similarity of the decline in LWG with increasing SR suggests that invasion of native pasture by Indian couch will not have any adverse effect on steer gains. The trends which developed over the four years suggest that with time steer production was higher at the medium and high SR on Indian couch pastures, though this may well have been due more to a decline in steer production at the higher SR's on the native pastures. Certainly the steer gains would not be sustainable at the highest SR of 0.9 steers/ha and so any difference in steer gains in favour of the Indian couch pastures at this SR is of academic interest rather than having any practical implications. At the highest SR, steer gains/ha were also lower than at medium SR and so on sustainability and economic grounds, grazing these pastures at such a SR is not a viable option.

Using the mean of the regressions for LWG on stocking in 1990-91 and 1991-92 (1989-90 was atypical for several reasons), some interesting predictions can be obtained. These predictions are calculated from the linear regressions as set out in Jones (1981). The regressions for the two pastures are:

Native: $y = 155.1 - 147.6x$

Oversown with *B. pertusa* : $y = 152.4 - 109.8x$

where y = annual steer gain (kg)

x = the SR in steers/ha

From these regressions of the form $y = a - b\,x$, the following calculations were made:

Stocking rate for maximum gain/ha (a/2b)

Native: 0.52 steers/ha — Indian couch 0.69 steers/ha

Gain/ha at SR for maximum gain/ha ($a^2/4b$):

Native: 41kg — Indian couch 53kg

Gain/steer at SR for maximum gain/ha (a/2):

Native 77.5kg Indian couch 76.2kg

The predicted gains/steer at the three stocking rates used are then:

SR	Native	Indian couch
0.3	110.8	119
0.6	66.5	87
0.9	22.3	54

If the weight of weaners put on to the pastures is 180kg and steers are turned off at 500kg liveweight, they will need to gain 320kg/head. At the stocking rates used, and from the gains predicted, the time to turn-off from the low, medium and high SRs would be:

Native: 2.8yr, 4.8yr and 14.3yr

Indian couch: 2.7yr, 3.7yr and 5.9yr respectively.

At the SR for maximum gain/ha the time taken to reach 500kg would be 4.13yr and 4.21yr for the native and Indian couch pastures respectively. Clearly, the pastures need to be stocked at rates lower than these rates for the class of animal increasingly demanded these days. From the results only the steers stocked at the lowest rate of 0.3 steers/ha would gain sufficient weight/steer to fatten in three and a half years from birth,. There is a penalty in gain/ha to stock at this conservative rate, but the penalty is small - 4kg for the native pasture and 13kg for the Indian couch pastures - but the advantages of improved pasture sustainability, lower year to year variation in LWG production and lower costs involved with lower numbers of steers per unit area would be very real.

The results provide a strong basis for conservative stocking to improve sustainability of the resource without sacrificing financial return.

6. It should be noted that it was not possible in this experiment to have pastures dominated by Indian couch at low SR. We could not therefore assess the steer gains on Indian couch-dominated pasture. Such data should be obtained to give the whole picture. Areas would first need to be heavily grazed to induce dominance by Indian couch, and then stocked at the lower rates. It is also not known if a pasture converted to full dominance by Indian couch and then stocked lightly would revert to a pasture where native perennials would re-invade.

Doubtless, the availability of seed in the seed bank, or the likelihood of wind-borne or water-borne seed would be critical to re-establishment.

7. The effect of steer age on LWG could have important implications for the industry in the north. The results differ from those obtained at the CSIRO Narayen Research Station at Mundubbera in S.E. Queensland (C. K. McDonald, personal communication). At that site, there were no differences between weaner and yearling cattle in annual growth rates on either native or improved pastures. There is an urgent need to assess how widespread this finding is, and to seek some understanding of its basis in animal nutrition terms. Questions to be answered include - how frequently are such differences between age groups observed? Are the differences correlated with seasonal patterns of rainfall, soil fertility, breed of cattle or combinations of these? Is there any nutrient deficiency or nutrient excess involved? The implication of a nutrient deficiency seems unlikely since the class of animal requiring the highest quality feed would be the weaner, yet weaners overall performed better than the other age groups.

8. This research has dealt specifically with grass pastures. An additional consideration is the effect of Indian couch on oversown legumes. Evidence from another experiment at Lansdown has shown that steer gains on pastures of Indian couch/Verano have been far lower than those on *Urochloa mosambicensis*/Verano pastures when stocked at 1.25 steers/ha. The differences of 80-100kg/steer are such as to influence the economics greatly. The main reason for the poor steer gains on the Indian couch/Verano pastures is the decline in the legume component following invasion of the formerly native pastures by Indian couch.

The need to find legumes compatible with Indian couch or to use cultivars of Indian couch which do not display this poor compatibility with Verano is obvious.

In work supported by MRC, the poor compatibility of Indian couch and *Stylosanthes* (Verano and Seca) is being studied by a PhD student at the CSIRO Davies Laboratory.

Technology Transfer:

The results of the experiment have been discussed with members of the Northern Region Advisory Committee of the CSIRO Division of Tropical Crops and Pastures on two occasions - in May 1989 and in April 1993. Early in the experiment, the producer members (and the scientists) were surprised by the better performance of steers on the native pastures at the medium and high stocking rates. On the second visit, the Committee was surprised and puzzled by the large differences in liveweight gain between the cattle of different ages. All agreed that the results could have important ramifications for the industry if these had applicability to areas other than Lansdown. Comparisons with industry results were not possible as most graziers fattened bullocks in a separate paddock to younger stock. Such paddocks are usually more productive than others; hence, the performance of these older stock would not be comparable with that of younger animals.

Three Field Days gave the opportunity to present results to graziers, extension staff and other scientists. These were held on 27th July, 1989, 15th May 1990 and on 14th May 1991. The May 1990 Open Day was held in conjunction with the North Queensland Field Days and was poorly attended. Only 6 people turned up, but they received a very personalised treatment which resulted in good interaction. The other two Field Days were attended by about 90 people on each occasion.

A fourth Field Day, planned for May/June 1993, was not held due to the severe drought which necessitated destocking of all but the low-stocked treatments.

On 22nd July 1991 the results of the experiment were presented to the Division of Tropical Crops and Pastures AM Program staff.

In addition to the specific days described above, the experiment was visited by many Australian and overseas scientists who visited the CSIRO Davies Laboratory over the four years of the experiment. Among these was Dr. W. Burrows, QDPI, Rockhampton, who was able to compare results with those in the stocking rate experiment at Galloway Plains, Calliope.

The effect of steer age on liveweight gain in this and two other experiments at Lansdown, was presented in a four-page research paper at the Australian Society of Animal Production meeting in July 1992 in Melbourne (Jones and Coates, 1992).

The presentation resulted in active discussion, but none of the animal production experts came up with any satisfactory explanation for the large liveweight gain differences that were reported.

The results of steer gains at the different stocking rates were combined with results from other work conducted from the Davies Laboratory in a poster presentation "*Bothriochloa pertusa* - a useful tropical grass?" at the 17th International Grassland Congress at Rockhampton. This attracted the interest of both scientists and graziers. The paper (Jones and Kerr 1993) will appear in the Proceedings of the Congress which will be available in late December 1993.

Radio interviews, both locally and interstate, on the value of *Bothriochloa pertusa* (Indian couch) which included results from the experiment, were given on 4 occasions in 1992/3.

The ongoing work will contribute to a wider assessment of Indian couch in northern Australia conducted from the CSIRO Davies Laboratory with Commonwealth funding through the Land and Water Care Program (project terminates in December 1993) and with MRC funding in project CS152 - Grasses for heavy grazing and land restoration.

An information leaflet describing the results of the experiment to 1991 was produced and circulated to scientists, the QDPI at Charters Towers and the graziers who visited the Laboratory or attended the Field Days.

A further leaflet, summarising the final experimental results, will replace the 1991 leaflet in early 1994.

A scientific paper, to be published in the Tropical Grasslands Journal, will be written in 1994.

ACKNOWLEDGEMENTS

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Mr. Ron Dixon, Manager of the Lansdown Research Station, made available equipment and farm help in the choosing of cattle, their mustering and weighing.

Mr. R.P. LeFeuvre was responsible for statistical analysis, for processing much of the data and in producing the graphics to illustrate the results. I am grateful for such professional support.

Finally, I thank my secretary, Mrs Nola Stokes for the production of the report.

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PART 4

APPENDICES

CS.PO20

The effect of stocking rate on pasture and animal production from native pasture and native pasture oversown with Indian couch (*Bothriochloa pertusa*).

Appendix I

Appendix I

Botanical composition (%) of the various treatments over time. Values are the means of two paddocks per treatment.

Pdk. 3 & 11 Native - LOW SR	19-04-89	12-12-89	15-06-90	28-11-90	29-04-91	18-12-91	14-05-92	02-03-93
Heteropogon contortus	10	7	11	6	2	1	6	14
Heteropogon triticeus	5	3	3	3	0	1	1	0
Themeda triandra	14	9	19	22	9	7	14	2
Eulalia fulva	1	0	0	0	0	0	0	2
Panicum spp.	1	1	3	0	0	0	0	3
Sorghum nitidum	7	12	13	20	22	24	17	6
Eragrostis spp.	1	4	3	1	7	2	5	1
Aristida spp.	0	1	1	0	0	0	0	1
Bothriochloa decipiens	40	38	26	32	28	50	34	22
Bothriochloa pertusa	0	0	1	0	0	0	0	1
Cynodon spp.	0	0	0	0	0	0	0	0
Chloris spp.	1	1	6	1	6	2	11	17
Sporobolus spp.	0	0	0	0	0	0	0	0
Chrysopogon fallax	8	3	2	5	0	3	0	2
Melinis repens	0	1	1	0	5	2	0	0
Other perennial grasses	1	5	3	2	5	3	2	9
Annual grasses	0	1	0	1	4	1	1	6
Native legumes	1	0	0	0	0	1	1	2
Dicots	1	1	1	0	1	0	0	2
Cyperus spp.	0	0	0	0	6	2	1	1

Pdk. 4 & 8 *B. pertusa* - LOW SR	19-04-89	12-12-89	15-06-90	28-11-90	29-04-91	18-12-91	14-05-92	02-03-93
Heteropogon contortus	17	11	19	16	3	0	3	1
Heteropogon triticeus	1	0	0	0	0	0	0	0
Themeda triandra	1	3	5	3	4	3	10	1
Eulalia fulva	0	0	0	0	0	0	0	1
Panicum spp.	2	1	1	0	0	0	0	1
Sorghum nitidum	5	15	18	20	26	29	28	9
Eragrostis spp.	5	6	2	0	8	0	4	1
Aristida spp.	1	1	0	0	0	0	0	0
Bothriochloa decipiens	14	24	12	28	25	45	25	16
Bothriochloa pertusa	31	22	33	25	9	11	15	39
Cynodon spp.	0	1	0	0	0	0	0	0
Chloris spp.	4	5	3	2	7	0	10	21
Sporobolus spp.	2	2	1	0	5	1	1	1
Chrysopogon fallax	10	4	1	2	0	2	0	1
Melinis repens	2	1	2	2	1	0	0	0
Other perennial grasses	1	2	2	0	1	3	2	1
Annual grasses	1	0	0	0	4	1	1	2
Native legumes	1	0	0	0	0	0	0	0
Dicots	2	0	0	0	1	1	0	3
Cyperus spp.	0	0	0	0	5	4	1	1

Pdk 2 & 12 Native - MED. SR	19-04-89	12-12-89	15-06-90	28-11-90	29-04-91	18-12-91	14-05-92	02-03-93
Heteropogon contortus	14	13	16	23	1	3	14	5
Heteropogon triticeus	1	1	0	0	0	0	0	0
Themeda triandra	12	8	11	17	2	3	0	0
Eulalia fulva	0	0	0	0	0	0	0	2
Panicum spp.	2	2	4	0	0	0	0	14
Sorghum nitidum	0	0	0	0	0	0	0	0
Eragrostis spp.	5	7	8	1	10	3	5	1
Aristida spp.	3	0	2	2	0	0	0	1
Bothriochloa decipiens	29	8	13	19	22	23	18	7
Bothriochloa pertusa	0	1	0	2	1	1	6	7
Cynodon spp.	0	0	0	0	0	0	0	0
Chloris spp.	0	8	0	0	0	0	0	21
Sporobolus spp.	7	11	8	11	2	11	11	8
Chrysopogon fallax	18	10	6	5	2	6	1	5
Melinis repens	1	1	3	0	0	0	0	0
Other perennial grasses	1	10	7	5	2	18	4	13
Annual grasses	0	0	1	4	17	11	1	4
Native legumes	1	0	0	0	0	0	0	1
Dicots	1	1	1	0	1	2	1	3
Cyperus spp.	0	0	1	0	16	4	2	0

Pdk 6 & 7 *B. pertusa* - MED. SR	19-04-89	12-12-89	15-06-90	28-11-90	29-04-91	18-12-91	14-05-92	02-03-93
Heteropogon contortus	24	16	14	17	8	2	7	4
Heteropogon triticeus	0	0	0	0	0	0	0	0
Themeda triandra	1	2	2	0	1	0	0	1
Eulalia fulva	0	0	0	0	0	0	0	1
Panicum spp.	0	0	0	0	0	0	0	3
Sorghum nitidum	8	13	18	22	12	16	3	1
Eragrostis spp.	2	1	1	0	6	0	2	0
Aristida spp.	0	0	0	0	0	0	0	0
Bothriochloa decipiens	9	14	6	21	23	21	15	4
Bothriochloa pertusa	37	45	46	36	31	43	64	64
Cynodon spp.	0	0	0	0	0	1	0	0
Chloris spp.	6	2	6	0	5	4	2	8
Sporobolus spp.	1	1	0	0	5	0	2	2
Chrysopogon fallax	3	1	0	0	0	1	1	0
Melinis repens	2	0	3	0	1	0	0	0
Other perennial grasses	1	3	2	0	0	3	1	3
Annual grasses	0	0	0	0	4	3	0	3
Native legumes	2	1	0	0	0	1	0	0
Dicots	3	1	1	0	3	1	0	4
Cyperus spp.	0	0	0	0	2	1	1	1

Pdk 1 & 10 **Native HIGH SR**	19-04-89	12-12-89	15-06-90	28-11-90	29-04-91	18-12-91	14-05-92	02-03-93
Heteropogon contortus	11	25	25	29	7	7	27	9
Heteropogon triticeus	3	1	1	0	0	0	0	0
Themeda triandra	8	0	1	10	3	0	0	3
Eulalia fulva	0	1	0	1	0	0	0	1
Panicum spp.	2	2	5	0	0	0	1	5
Sorghum nitidum	11	14	8	11	5	1	0	0
Eragrostis spp.	4	5	4	0	3	6	4	2
Aristida spp.	0	0	0	0	0	0	0	2
Bothriochloa decipiens	39	23	17	22	9	7	4	6
Bothriochloa pertusa	0	1	4	5	6	3	19	11
Cynodon spp.	0	2	0	0	0	0	2	0
Chloris spp.	2	4	15	8	6	20	17	18
Sporobolus spp.	0	2	0	1	6	2	5	10
Chrysopogon fallax	15	8	0	2	3	6	0	4
Melinis repens	1	0	4	3	1	0	0	0
Other perennial grasses	1	10	3	4	2	18	4	8
Annual grasses	0	0	1	3	23	23	5	4
Native legumes	1	1	1	0	0	0	0	3
Dicots	1	1	2	1	1	1	8	6
Cyperus spp.	0	0	1	0	24	6	4	0

Pdk 5 & 9 ***B. pertusa*** **- HIGH SR**	19-04-89	12-12-89	15-06-90	28-11-90	29-04-91	18-12-91	14-05-92	02-03-93
Heteropogon contortus	19	18	9	18	2	2	7	1
Heteropogon triticeus	2	0	0	0	0	0	0	0
Themeda triandra	5	0	3	0	0	0	0	0
Eulalia fulva	0	0	0	0	0	0	0	0
Panicum spp.	2	0	0	0	0	0	0	0
Sorghum nitidum	4	9	2	0	1	0	0	2
Eragrostis spp.	4	3	4	0	3	1	2	0
Aristida spp.	0	0	0	0	0	0	0	0
Bothriochloa decipiens	16	6	0	3	8	5	0	2
Bothriochloa pertusa	31	45	62	74	42	66	81	79
Cynodon spp.	0	0	0	0	0	1	0	0
Chloris spp.	3	7	10	2	6	9	6	7
Sporobolus spp.	0	3	1	0	10	0	0	1
Chrysopogon fallax	9	4	0	0	0	1	0	0
Melinis repens	1	0	2	0	0	1	0	0
Other perennial grasses	1	2	2	1	2	5	0	3
Annual grasses	0	0	1	1	9	5	2	1
Native legumes	1	1	1	0	0	0	0	1
Dicots	2	1	2	0	2	1	2	3
Cyperus spp.	0	0	0	0	16	3	0	0

Appendix II

Appendix II

Chemical composition of plucked components of selected grasses

Species	Part	Date		N (%)	P (%)	K (%)	S (%)	Na (%)	Ca (%)	Mg (%)	Cl (%)	Cu (ppm)	Zn (ppm)	Mn (ppm)	Al (ppm)	B (ppm)
B.pertusa	LEAVES	1-Feb-90		2.44	0.22	2.46	0.11	0.03	0.42	0.32	1.14	14	55	60	65	8
				1.61	0.18	2.10	0.12	0.02	0.36	0.18	0.92	7	29	111	25	7
				2.03	0.33	2.23	0.13	0.01	0.51	0.22	0.84	8	27	76	61	7
				1.84	0.26	1.98	0.10	0.01	0.51	0.21	0.78	7	28	91	154	6
				1.89	0.17	2.00	0.12	0.01	0.45	0.28	1.03	8	25	121	55	10
				1.83	0.17	2.10	0.12	0.01	0.50	0.28	1.06	7	21	113	93	6
			Mean	**1.94**	**0.22**	**2.10**	**0.12**	**0.02**	**0.46**	**0.25**	**0.96**	**9**	**31**	**95**	**76**	**7**
H.contortus	LEAVES	1-Feb-90		1.51	0.17	1.66	0.10	0.01	0.32	0.23	0.67	6	21	79	5	6
				1.55	0.26	1.75	0.10	0.02	0.32	0.14	0.64	6	22	73	64	8
				1.74	0.26	1.70	0.12	0.01	0.48	0.14	0.50	7	19	50	13	6
				1.69	0.27	1.68	0.10	0.01	0.44	0.17	0.64	6	25	86	17	5
				1.52	0.15	1.55	0.10	0.01	0.30	0.21	0.88	9	25	130	35	7
				1.74	0.17	1.78	0.16	0.01	0.26	0.20	0.88	5	19	78	31	5
			Mean	**1.63**	**0.21**	**1.69**	**0.11**	**0.01**	**0.35**	**0.18**	**0.70**	**7**	**22**	**83**	**27**	**6**
B.decipiens	LEAVES	1-Feb-90		2.18	0.27	2.61	0.16	0.01	0.43	0.17	1.20	7	26	43	16	6
				1.75	0.33	1.41	0.08	0.01	0.31	0.12	0.67	7	21	63	24	8
				1.67	0.29	1.56	0.08	0.01	0.35	0.14	0.72	6	22	75	16	7
				1.37	0.21	1.53	0.09	0.01	0.33	0.16	0.77	5	21	79	25	5
				1.57	0.14	1.18	0.08	0.01	0.33	0.10	0.71	7	16	33	37	11
				1.79	0.22	1.49	0.09	0.01	0.27	0.18	0.96	6	51	77	24	10
			Mean	**1.72**	**0.24**	**1.63**	**0.10**	**0.01**	**0.34**	**0.15**	**0.84**	**6**	**26**	**62**	**24**	**8**

Species	Part	Date		N (%)	P (%)	K (%)	S (%)	Na (%)	Ca (%)	Mg (%)	Cl (%)	Cu (ppm)	Zn (ppm)	Mn (ppm)	Al (ppm)	B (ppm)
C.fallax	LEAVES	1-Feb-90		1.32	0.13	1.80	0.11	0.04	0.23	0.17	1.05	7	45	72	45	7
				2.07	0.16	2.21	0.14	0.01	0.20	0.24	1.10	11	41	111	152	7
				1.58	0.20	1.94	0.12	0.01	0.30	0.19	0.99	6	28	47	56	4
				2.30	0.19	2.11	0.15	0.02	0.20	0.18	0.94	8	36	61	172	5
				2.21	0.24	2.28	0.18	0.07	0.18	0.24	1.33	7	37	93	81	5
				2.80	0.18	1.98	0.18	0.04	0.26	0.26	0.99	9	35	81	115	6
				1.92	0.18	2.68	*	0.01	0.26	0.17	1.56	5	20	36	26	7
			Mean	**2.03**	**0.18**	**2.05**	**0.15**	**0.03**	**0.23**	**0.21**	**1.14**	**8**	**35**	**72**	**92**	**6**
T.triandra	LEAVES	1-Feb-90		1.30	0.14	1.46	0.03	0.01	0.25	0.14	0.67	5	22	74	31	5
				1.36	0.21	1.37	0.07	0.01	0.29	0.11	0.67	4	29	68	18	5
				1.23	0.22	1.30	0.07	0.01	0.25	0.11	0.65	4	132	104	20	5
				1.39	0.17	1.15	0.09	0.01	0.29	0.11	1.00	4	39	81	36	5
				1.49	0.14	1.11	0.07	0.01	0.21	0.14	0.78	5	24	147	17	6
				1.65	0.20	1.25	0.08	0.01	0.38	0.14	0.63	5	19	139	22	8
			Mean	**1.40**	**0.18**	**1.27**	**0.07**	**0.01**	**0.28**	**0.13**	**0.73**	**5**	**44**	**102**	**24**	**6**
B.pertusa	STEMS	11-Aug-89		0.34	0.06	0.40	0.05	0.01	0.43	0.14	0.09	2	37	133	*	4
		29-Jun-90		0.27	0.07	0.90	0.07	0.01	0.22	0.12	0.10	5	44	156	34	*
				0.32	0.10	1.05	0.08	0.02	0.26	0.10	0.16	8	37	101	49	*
		10-Aug-90		0.21	0.13	0.73	0.07	0.02	0.15	0.12	0.33	1	32	141	25	*
				0.34	0.07	1.07	0.08	0.01	0.24	0.13	0.48	2	54	149	23	*
			Mean	**0.30**	**0.09**	**0.83**	**0.07**	**0.01**	**0.26**	**0.12**	**0.23**	**4**	**41**	**136**	**33**	**4**

Species	Part	Date		N (%)	P (%)	K (%)	S (%)	Na (%)	Ca (%)	Mg (%)	Cl (%)	Cu (ppm)	Zn (ppm)	Mn (ppm)	Al (ppm)	B (ppm)
H.contortus	STEM	8-Oct-90		0.26	0.07	0.68	0.04	0.02	0.15	0.17	0.56	2	52	159	25	*
				0.43	0.05	0.89	0.20	0.01	0.17	0.30	0.49	3	50	148	30	*
			Mean	**0.35**	**0.06**	**0.79**	**0.12**	**0.02**	**0.16**	**0.23**	**0.53**	**3**	**51**	**154**	**28**	*
B.pertusa	HEADS	14-Aug-89		1.15	0.25	1.29	0.09	0.01	0.24	0.16	0.35	7	28	30	*	5
		29-Jun-90		1.22	0.18	0.71	*	0.03	0.13	0.13	*	8	29	75	80	*
				1.47	0.24	0.75	0.03	0.03	0.15	0.14	*	7	28	58	49	*
			Mean	**1.28**	**0.22**	**0.92**	**0.06**	**0.02**	**0.17**	**0.14**	**0.35**	**7**	**28**	**54**	**65**	**5**
H.contortus	HEADS	8-Oct-90		0.64	0.04	0.22	0.02	0.01	0.15	0.13	0.12	3	12	110	23	*
				0.31	0.03	0.16	0.02	0.02	0.14	0.13	0.11	3	15	139	22	*
			Mean	**0.48**	**0.04**	**0.19**	**0.02**	**0.02**	**0.15**	**0.13**	**0.12**	**3**	**14**	**125**	**23**	*

Appendix III

Reprint of ASAP (1992) paper, 'The effect of age on steer liveweight gain in continuously stocked tropical pastures.' by R. J. Jones and D. B. Coates.

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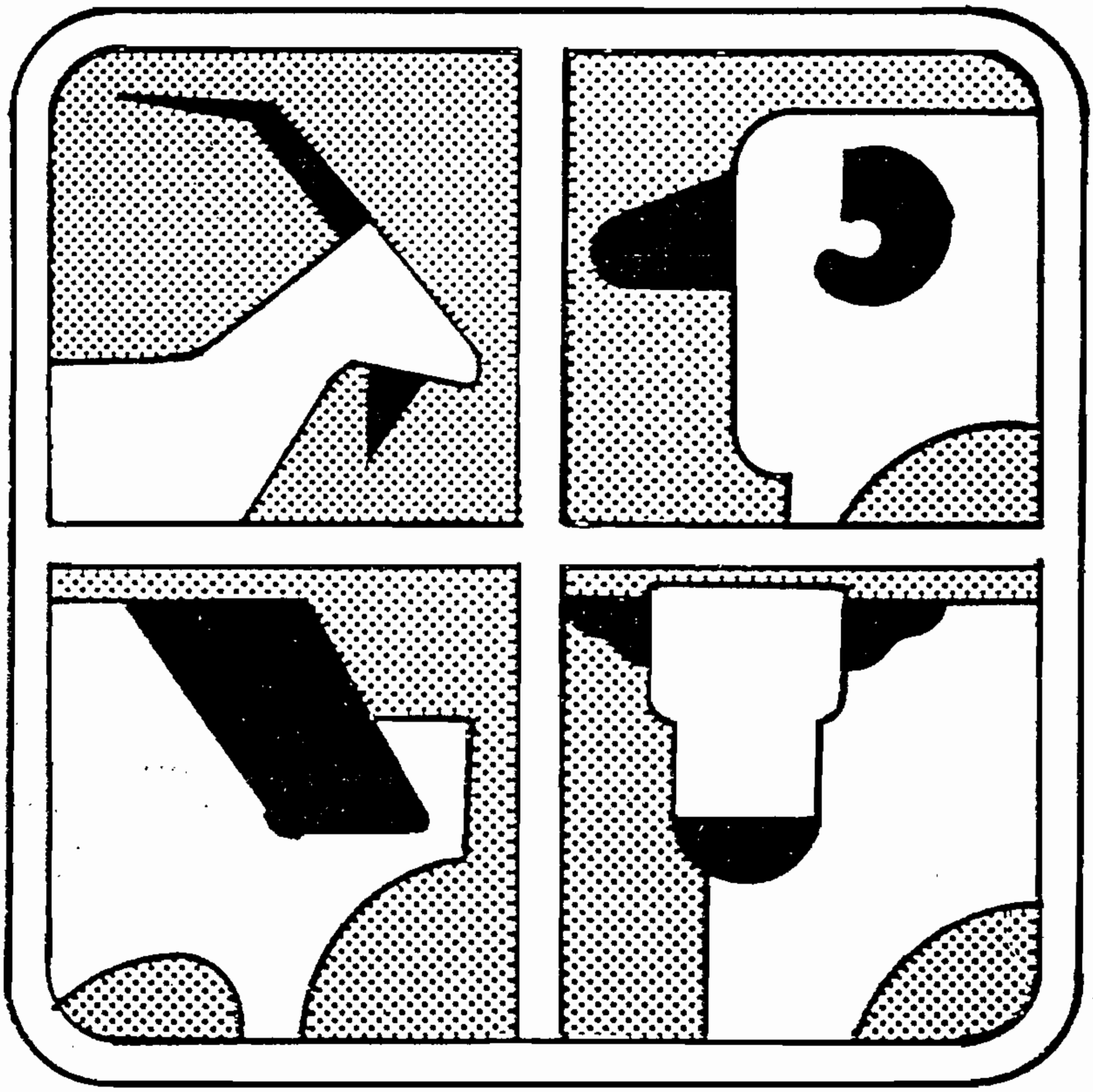

5–9 July 1992
La Trobe University
Melbourne

THE EFFECT OF AGE ON STEER LIVEWEIGHT GAIN ON CONTINUOUSLY STOCKED TROPICAL PASTURES

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SUMMARY

The annual liveweight gain of steers of different ages (grazing together the same paddocks), was compared in 3 grazing experiments at the CSIRO Lansdown Research Station, near Townsville. With both native pasture and legume-based sown pastures, the consistent ranking in liveweight gain was: weaners > yearlings > 2-year-old steers ($P < 0.001$). In 2 stocking rate experiments, the difference in liveweight gain of steers of different ages was maintained at all stocking rates with no significant age x stocking rate interaction. The magnitude of the effect of age was generally large, with differences between weaners and 2-year-olds up to 86 kg/year and between weaners and yearlings of up to 55 kg/year. Possible reasons for these large differences are considered, but no fully adequate explanation can be given.

Keywords: steers, liveweight gain, age, tropical pasture.

INTRODUCTION

The implications of any marked differences in the liveweight gain (LWG) of grazing steers due to their initial weight or age are of obvious importance in relation to the assessment of pastures for beef production in grazing experiments, to modelling annual production from grazed pastures, and to commercial decisions regarding the optimum age or weight of turnoff. Most published reports indicate that even large variations in the initial weight or age of growing cattle have little effect on the annual LWG made on experimental pastures (Matches 1970; 't Mannetje *et al.* 1976; Winter 1988), but this view is not universally accepted (Rickert *et al.* 1988). On tropical pastures in the high rainfall zone of North Queensland, Wilson and O'Rourke (1990) showed that average daily liveweight gains of steers between introduction and turn-off increased with initial liveweight. However, the same authors reported a decrease in LWG/day as steers fattened. These apparently conflicting results may well be associated with seasonal factors prior to date of entry of steers to the fattening pastures and during the variable fattening period.

In a grazing experiment where paddocks were stocked with steers of different ages, it was observed that the weight gain of weaner steers was much higher than that of older steers. The opportunity was therefore taken to examine more closely the effect of steer age on seasonal and annual LWG on this experiment as well as 2 other grazing trials stocked with steers of different ages.

MATERIALS AND METHODS

This paper examines data from 3 grazing experiments that were established for other purposes. All were located at the CSIRO Pasture Research Station at Lansdown, 50 km south of Townsville, Queensland, and all were continuously stocked with Droughtmaster steers bred on the research station. Steers were weighed every 4 weeks.

Experiment 1

The area was a woodland with a mixed native grass understory consisting of *Bothriochloa decipiens, Heteropogon contortus, Themeda triandra, Chrysopogon fallax, Sorghum nitidum* and *Eulalia fulva* as the main species. The soil type was a solodic–solodized–solonetz (Typic Natrustalf) with an available soil P concentration of 7.5 mg/L. In 1988, half of the area was oversown with *Bothriochloa pertusa* (Indian couch). The aim of the experiment was to compare animal production on native grasses with that on Indian couch at 3 stocking rates (SR) of 0.3, 0.6 and 0.9 steers/ha with 2 replicates. From July 1989 to June 1990, each paddock was stocked with steers of 2 ages, 1 weaner (starting age about 8 months) and 2 yearlings (starting age about 20 months). In July 1990, an older steer was replaced with a new weaner so that steers of 3 ages (weaner, yearling and 2-year-old) were present throughout 1990–91. In March 1990, 1 yearling was temporarily removed from each paddock due to drought. Therefore, in 1989–90 the effect of age x SR was studied for the period July–March. In 1990–91 the age x SR effect was studied for the whole year.

Experiment 2

This was established in 1977 on a yellow earth–yellow podsolic intergrade soil (Haplustalf) with an initial available soil P concentration of about 4 mg/L. Treatments were: 3 grasses x 3 SR (0.65, 0.95 and 1.25 steer/ha) factorially combined in a fully randomised design with 2 replicates. A common legume mixture of *Macroptilium atropurpureum* cv. Siratro, *Stylosanthes hamata* cv. Verano (Verano) and *S. viscosa* CPI 34904 was sown, but most of the legume present in the period 1990–91 was Verano. Originally the grasses compared were *Urochloa mosambicensis* cv. Nixon, *Chloris gayana* cv. Callide and native pasture (*Heteropogon contortus* dominant). By 1989, most paddocks, except for those sown to *Urochloa*, were dominated by the invading Bowen strain of Indian couch. Single superphosphate at 100 kg/ha was applied every second year from 1977. By 1989 the soil had an available soil P concentration of 7 mg/L. Before July 1990, paddocks were stocked with steers of the same age. Data for the July 1990–June 1991 period were analysed when paddocks were stocked with 2 yearlings and 1 weaner.

Experiment 3

This experiment was immediately adjacent to experiment 2. It was sown to stylo based pasture in December 1986 and comprised twenty 4 ha paddocks which were stocked with 3 steers per paddock from August 1989. Phosphorus supplement was fed to steers in half the paddocks at 5–7 g P/head.day. A comparison of age of steer was made in the period 1 August 1990 to 31 July 1991 when there was 1 weaner, 1 yearling and one 2-year-old steer in each paddock.

In all experiments the different age groups were analysed as a subplot treatment of a split-plot factorial design to assess statistical effects of age on the measured LWG.

RESULTS

Experiment 1

Significant differences in LWG occurred between steers of different ages ($P < 0.001$) for both years. In year 1, weaners gained a mean of 170 kg v. 115 kg for yearlings. In year 2, there was a very short growing season and annual LWG's were lower overall, but age differences were large. Most of the difference occurred during the period of main weight loss at the end of the long dry season and the break of the wet season (Table 1). The older, heavier steers did not compensate during the short growing season when gains were similar for all age groups. Age x SR (Fig. 1) or age x grass species interactions were not significant in either year ($P > 0.05$).

Table 1. Experiment 1. Liveweight changes (kg/steer) of weaner, yearling and 2-year-old steers of during 1990–91

Periods were determined according to points of inflection along the cumulative liveweight gain curve

	Weaner	Yearling	2-year-old
Initial liveweight (kg)	239	354	489
Liveweight gain			
Annual (19. 7.90–18. 7.91)	96	61	10
Period 1 (19. 7.90–11.10.90)	37	34	14
Period 2 (11.10.90–31. 1.91)	–8	–31	–60
Period 3 (31. 1.91–24. 4.91)	77	79	80
Period 4 (24. 4.91–18. 7.91)	–10	–21	–23

Experiment 2

Weaners gained 140 kg compared with 106 kg for the yearlings ($P < 0.001$). There was no significant interaction between age x SR or age x grass species ($P > 0.005$). Most of the difference (70%) associated with age occurred at the end of the 1990 dry season when yearlings lost weight while, in contrast, small gains were made by weaners.

Experiment 3

The pattern of weight change noted in experiments 1 and 2 was repeated in experiment 3. Overall, the mean LWGs for the 3 age groups were: 120, 65 and 45 kg respectively for supplemented steers and 52, 36 and 32 kg for unsupplemented steers.

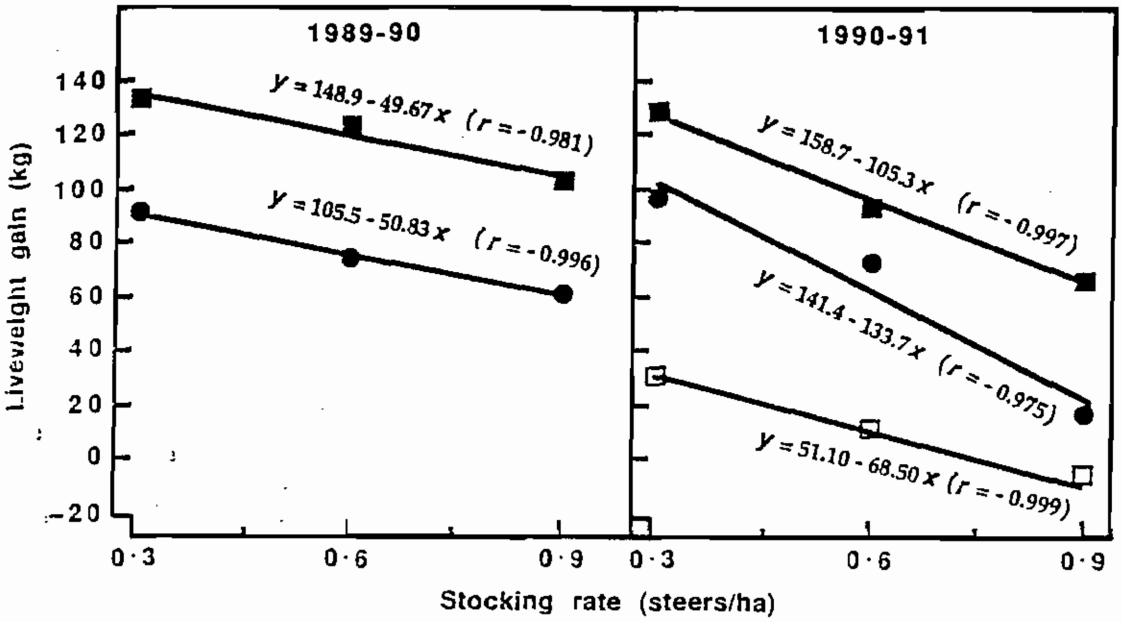

Fig. 1. The effect of stocking rate and steer age (■ weaner, ● yearling, □ 2-year-old steer) on LWG for experiment 1 for 1989–90 (July–March) and 1990–91 (July–June). Values are means for the 2 pasture treatments.

DISCUSSION

The results clearly show an effect of age (or weight) of steers on their LWG when grazing tropical pastures in northern Australia. This is in contrast to the reports of Matches (1970) and 't Mannetje *et al.* (1976). It also contrasts with the observation by T. R. Evans (pers. comm.) that there was no effect of age (or initial weight) on the annual LWG of native cattle grazing improved pasture in the wet tropics of Malaysia.

Most of the LWG difference associated with steer age occurred during stress periods when weight losses were recorded (Table 1). This was consistent across the 3 experiments examined. Winter (1988) also observed that older, heavier steers grazing Verano based pastures near Katherine in northern Australia, lost more weight in the dry season than younger, lighter steers. However, he observed that the older steers gained more in the wet season so that there was usually no overall age effect on annual LWG. In our experiments, gains during the wet season were similar across age groups (Table 1, period 3) so that a substantial LWG advantage was maintained by the younger steers. Higher weight losses during times of inadequate nutrition are to be expected in older, heavier steers with higher maintenance requirement (Robinson 1967). However, with the improvement of pasture quality in the wet season, compensatory gains could also be expected in these older animals. Thus, the unexpected observation in our experiments was the lack of any difference in wet season gains between age groups.

The differences in LWG in our experiments were probably due to low forage intake by the older steers. Low intakes can be associated with mineral deficiencies or toxicities in the herbage and low pasture availability. However, it seems unlikely that weaners would be less affected than older steers except where a gradual deficiency may develop over time. The classic example is where sodium replete animals gradually become deficient on low sodium pastures (Winter and McLean 1988). Although all grasses in experiment 1 were sodium deficient, salt blocks were provided in all paddocks. Apart from the unsupplemented steers in experiment 3 which were P deficient, the steers in our experiments appeared to be healthy. In experiment 3, the effects of age on LWG were noted in both supplemented and unsupplemented steers.

The lack of an age x SR interaction (Fig. 1) shows that steers of all ages responded to SR in a similar way. Had there been some deficiency or toxicity limiting production of the older steers a positive response in growth to the lower SR would not have been anticipated. In addition it is difficult to believe that low feed availability could have occurred at low SR since there was 4 t/ha DM yield or more than 12 t/forage.steer. Yet the age effect was just as pronounced.

While we propose that the observed differences in LWG due to age or initial weight were probably the result of a lower than expected forage intake by the older steers, the reasons are not readily apparent.

Further work to assess intakes of the different groups is necessary. The effect may have been associated with particular seasonal influences on pasture growth and quality. Certainly, the 1990-91 season was atypical, with a very short but intense wet season in which twice the average annual rainfall fell in a 2-month period from late December to late February with very little rain outside that period. The results from this year, the only 1 in which 3 age groups were studied, therefore need to be viewed with caution. If such seasonal conditions contributed to the effect, the mechanisms involved are not readily identified. Also it does not explain the occurrence of the effect in experiment 1 in the previous year when very good gains were recorded.

Provided all paddocks in an experiment are balanced as far as steer age is concerned, comparisons of imposed treatments would be valid. However, comparisons of gains from such experiments with others where only single aged steers were used would need to be made with caution. The use of mean data (which are normally published) for modelling animal production could also give biased results if applied to cattle of different ages.

If the age effect demonstrated in our experiments is a common occurrence in the semi-arid tropics of northern Australia, the economic and management implications would be of great importance, especially with differences of the magnitude seen in experiment 1.

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Appendix IV

Colour plates 1 - 32, illustrating the experiment, the effects of treatment and Field Day activities.

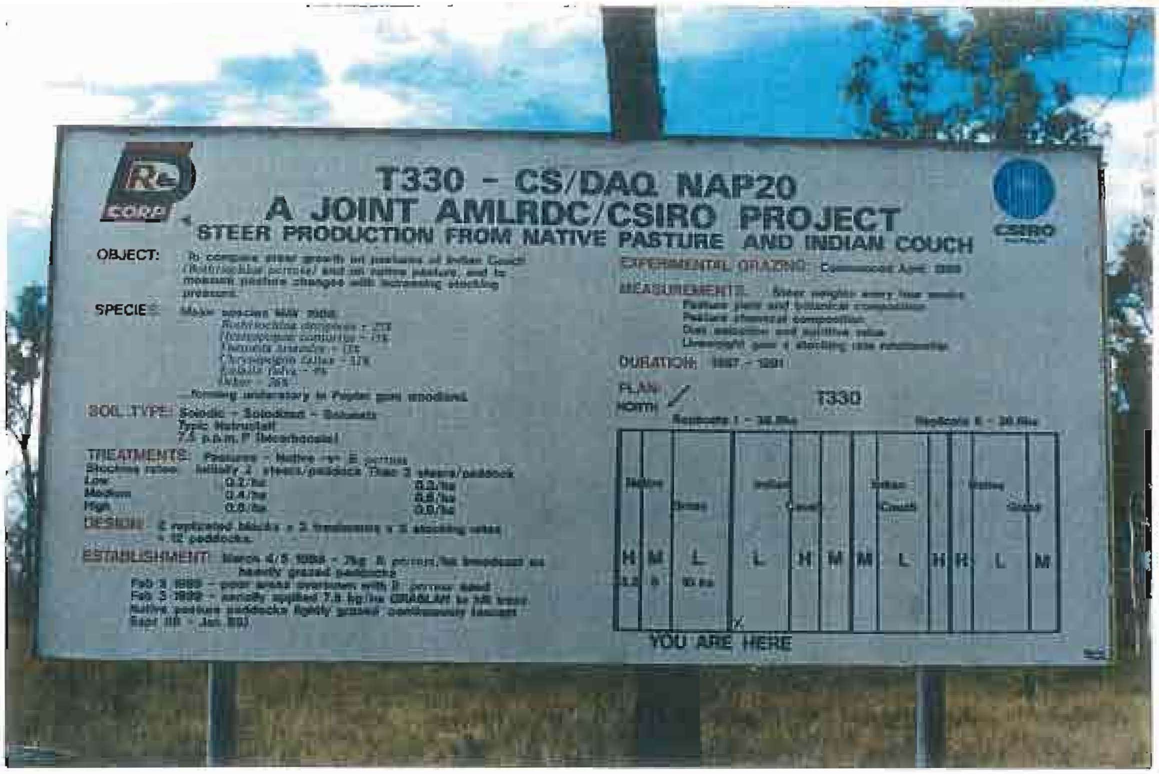

Plate 1. **Project sign at trial site - Lansdown Research Station**

Plate 2. **Portable yards purchased with MRC funds.**
Weighing steers and introducing new weaners 18/7/91

Plate 3. **Broadcasting B.pertusa and sawdust to establish trial following cyclone "Charlie" 5/3/88**

Plate 4. **B.pertusa paddocks Medium(Paddock 7 on left) and Low stocked(Paddock 8 on right) before subdivision fencing completed**

Plate 5. ***Native grasses*** LOW STOCKED ***B.pertusa***
Paddock 3 Paddock 4

16/8/89

Plate 6. **B.pertusa** HIGH STOCKED ***Native grasses***
Paddock 9 Paddock 10

Plate 7. ***Native grasses*** LOW STOCKED ***B.pertusa***
Paddock 3 Paddock 4

22/2/90

Plate 8. ***B.pertusa*** HIGH STOCKED ***Native grasses***
Paddock 9 Paddock 10

Plate 9. ***Native grasses*** LOW STOCKED ***B.pertusa***
Paddock 3 Paddock 4

22/11/90

Plate 10. **B.pertusa** HIGH STOCKED ***Native grasses***
Paddock 9 Paddock 10

Plate 11. ***Native grasses*** Paddock 3 LOW STOCKED ***B.pertusa*** Paddock 4

19/3/91

Plate 12. **B.pertusa** Paddock 9 HIGH STOCKED ***Native grasses*** Paddock 10

Plate 13. ***Native grasses*** Paddock 3 LOW STOCKED ***B.pertusa*** Paddock 4

27/8/91

Plate 14. **B.pertusa** Paddock 9 HIGH STOCKED ***Native grasses*** Paddock 10

Plate 15. ***Native grasses*** Paddock 3 LOW STOCKED ***B.pertusa*** Paddock 4

10/2/92

Plate 16. **B.pertusa** Paddock 9 HIGH STOCKED ***Native grasses*** Paddock 10

Plate 17. ***Native grasses*** LOW STOCKED ***B.pertusa***
Paddock 3 Paddock 4

29/1/93

Plate 18. **B.pertusa** HIGH STOCKED ***Native grasses***
Paddock 9 Paddock 10

Plate 19. **LOW** Paddock 8 **29/12/89** **HIGH** Paddock 9

B.pertusa **Stocking rate effect**

Plate 20. **LOW** Paddock 8 **18/7/91** **HIGH** Paddock 9

Plate 21. **HIGH** Paddock 10 **22/11/90** **LOW** Paddock 11

Native grasses Stocking rate effect

Plate 22. **HIGH** Paddock 10 **19/3/91** **LOW** Paddock 11

LOW
Paddock 11

MEDIUM
Paddock 12

HIGH
Paddock 10

Plate 23. NATIVE PASTURES Stocking rate effect 25/7/91

LOW
Paddock 11

MEDIUM
Paddock 12

HIGH
Paddock 10

Plate 24. NATIVE PASTURES Stocking rate effect 19/3/92

HIGH
Paddock 5

MEDIUM
Paddock 6

LOW
Paddock 8

Plate 25. B.pertusa Stocking rate effect 25/7/91

HIGH
Paddock 5

MEDIUM
Paddock 6

LOW
Paddock 8

Plate 26. B.pertusa Stocking rate effect 19/3/92

Plate 27. **15/5/90 Dr.R.J.Jones assessing pasture quality with steers on low stocked B.pertusa paddock 4**

Plate 28. **16/6/93 Steers on high stocked B.pertusa paddock 9**

Plate 29. **FIELD DAY on site 14/5/91**

Plate 30. **Interacting with producers**

Plate 31. **Another Field Day**

Plate 32. **Interacting with researchers**