PRODUCTIVITY OF *MACROPTILIUM ATROPURPUREUM* CV. SIRATRO PASTURES

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ABSTRACT

Trials in Queensland, Uganda and Fiji have shown that the inclusion of Siratro into native or improved pastures greatly increases liveweight gain, improves breeder performance and increases weaning weight. With dairy cattle milk production and quality from Siratro pastures is superior to that from unimproved pastures, but can be lower than from other tropical pastures due to lower intake. Siratro has no deleterious effects on cattle.

Stocking rate is the main management factor affecting liveweight gain on fertilized Siratro pastures, due largely to its effect on Siratro yields. There is generally a highly significant negative correlation between stocking rate (beasts ha^{-1}) and liveweight gain (kg steer^{-1}). In two of the experiments reviewed, the slope of the regression line increased over time, reflecting a decline in production at the highest stocking rates due to heavy grazing pressures.

The highest weight gains recorded (163 to 202 kg beast^{-1} year^{-1}) occurred over a range of sites where rainfall, soil, associated grasses, breed and sex of cattle varied. These levels of weight gain compare favourably with the liveweight gains recorded from other improved tropical pastures.

INTRODUCTION

"The triple combination of improved legume-based pastures, superphosphate and selected tropical cattle has resulted in spectacular and profitable increases in beef production in the Australian tropics" (Hutton 1974). One of the most successful of the improved tropical legume is Siratro (*Macroptilium atropurpureum*). It has proved to be adaptable to a range of soils and climatic conditions (Jones and Jones 1977), and can be used in a wide range of developmental situations (Tothill 1975). Sufficient data are now available on the productivity of Siratro pastures to review this information and examine the practical contribution of Siratro to animal production.

SIRATRO PASTURE PRODUCTION

Yield

Siratro influences animal productivity by contributing nitrogen to associated grasses (Vallis 1972) and by increasing the quality of the diet. The nitrogen input into tropical legume/grass pastures is correlated to the yield of legume (Jones 1971). Management therefore should aim at increasing or maintaining the legume yield at an adequate level. If the content is too high there is a risk of weed infestation and erosion early in the growing season. If the Siratro yield is too low the total dry matter yields are also low (Anon. 1975). Total yield and percentage of Siratro are mainly determined by stocking rate and to a lesser extent by grazing method (Tothill and Jones 1977).

Quality and diet selection

The voluntary intake of mature Siratro by sheep in indoor feeding trials is much higher than the intake of mature grasses (Milford and Minson 1966). This effect is probably due to a shorter retention time in the rumen coupled with a greater packing density (Thornton and Minson 1973). This higher intake of legumes, together with

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their higher digestibility and nutrient content, results in greater intakes of digestible energy and digestible protein (Milford 1967).

In lightly grazed Siratro-grass swards, cattle select grass in preference to Siratro in the spring and summer, whereas in late summer and autumn cattle prefer Siratro (Stobbs 1977, R. J. Jones, B. Walker, unpublished data). Stobbs and Frazer (1971) have reported diets of over 90% Siratro in autumn in mixed Siratro/Kazungula setaria pastures. Stobbs (1977) has shown that this reversing of preference could be due to changes in the legume in the autumn months, rather than a lowering of the palatability of the associated grass. Selection is of most importance at lenient stocking rates because under heavier grazing pressures cattle eat Siratro throughout the year. This eventually results in lower Siratro yields.

Sward structure is important to the grazing animal. In pure stands trailing legumes like Siratro offer a smaller bite size (Stobbs and Cowper 1972) than do grasses such as *Digitaria decumbens* and *Setaria anceps* which have better availability and a greater bulk density (Stobbs and Hutton 1974). This can make it difficult for cattle to prehend sufficient legume, although they can compensate for this by grazing for longer periods (Stobbs 1970b). Further breeding work with *M. atropurpureum* has resulted in a number of inbred lines which have a greater yielding ability and leaf density than the cultivar Siratro (Stobbs and Hutton 1974) and these should have an improved effect on animal productivity.

With Siratro there are no deleterious effects from oestrogens or toxins (Bindon and Lamond 1966) or from bloat producing compounds (Jones and Lyttleton 1971). Siratro does not adversely affect the flavour of meat (Park and Minson 1974) or milk (Stobbs and Frazer 1971).

ANIMAL PRODUCTION

Comparison of Siratro with Native Pastures

Liveweight gain from Siratro based pastures is much superior to that from native pastures. This can be seen from three experiments at the Narayen Research Station, near Mundubbera in Queensland where production from Siratro pastures was compared with that from unimproved (unfertilized but cleared) native pastures.

't Mannetje and Nicholls (1974) have shown that liveweight gain from Siratro/Biloela buffel grass pastures was five times that from native pastures. Also the introduction of Siratro with phosphatic fertilizers into native pastures, mainly spear grass (*Heteropogon contortus*), can result in a 4 to 10 fold increase in animal production on an area basis and a 1.4 to 2.4 fold advantage on a per animal basis depending on stocking rate (Tothill 1974).

The third experiment ('t Mannetje and Coates 1976) compared breeding performance of Hereford cattle from four pasture systems were:—

NP Native pasture, trees killed; stocking rate 0.17 cow ha^{-1}
SPL Green panic—Siratro, stocking rate 0.51 cow ha^{-1}
SPH Green panic—Siratro, stocking rate 0.68 cow ha^{-1}
NPSP Cows and calves on native pasture during summer (November to April) at 0.34 cow ha^{-1} with access to sown pasture for the rest of the year at 1.00 cow ha^{-1}.

Native pastures were not fertilized but improved pastures received 125 kg ha^{-1} Mo superphosphate per annum.

Over three years the reproductive index (kg of calf weaned cow^{-1} mated) averaged 166 (NP), 210 (SPL), 221 (SPH) and 193 (NPSP) kg. Conception, calf weight gain and weaning weights and calving rates were highest on the improved pasture, but the authors commented that there was not sufficient data to critically distinguish between treatment means. The disappointing performance of the NPSP treatment was attributed to the high stocking rate on the native pastures in the summer months not allowing sufficient dietary selection.

Liveweight gain

On Siratro based pastures in Queensland, cattle follow a cyclical pattern of weight change which can be illustrated by data from Koumala, 70 km south of Mackay (B. Walker, unpublished data). Under lenient grazing pressures cattle lose weight at the rate of 1.5 to 2 kg day^{-1} for a few weeks at the start of the wet season in October/November, followed by a period of 4 to 8 weeks of accelerated weight gain, which includes some contribution from compensatory growth. Then there is a period of steady weight gain at 0.4 to 0.7 kg day^{-1}, until June or July in most years. This is followed by a period ending at the start of the next wet season where weight change is small (-0.1 to $+0.3$ kg day^{-1}). In other areas of Queensland the length of growth periods and rate of weight gain or loss will vary, but generally the pattern remains the same.

The oldest Siratro pasture deserves special mention. It was sown in November 1961 at Rodds Bay in Central Queensland. The Siratro/Pioneer Rhodes pasture received an annual mixture of 126 kg ha^{-1} Mo superphosphate and 63 kg ha^{-1} of muriate of potash. Regular grazing started in May 1962 at 0.4 beast ha^{-1} and grazing was continuous until the cessation of observations in 1973, except for a 5 month rest given in 1967/68. Stocking rates were adjusted according to pasture availability and in fair to good years it carried 1.2 to 1.7 beasts ha^{-1}, giving an annual liveweight gain of 136 kg $head^{-1}$. In 1973 the Siratro was dominant despite having almost disappeared in the drier (heavily grazed) years (N. H. Shaw, personal communication).

In Table 1 details of a number of stocking rate experiments conducted in Queensland, Uganda and Fiji are summarised. The highest annual average daily liveweight gain for these experiments ranges from 0.40 kg at Serere to 0.58 kg at Lowmead. Stobbs (1974) reviewed animal performance from grazing experiments in the tropics. The mean annual liveweight gains were 0.35 kg day^{-1} and rarely exceeded 0.60 kg day^{-1}. The daily liveweight gains given in Table 1 compare favourably with these levels and indicate that liveweight gains from Siratro based pastures are similar to results from other tropical pasture species. However, the stocking rates at which these levels of weight gain are achieved varied greatly between sites (Table 1). This could mainly be attributed to annual rainfall.

Stocking rates

The liveweight gain of cattle on Siratro pastures is (negatively) linearly correlated to stocking rate. This is seen from Fig. 1, which summarises the results from seven trials, details of which are given in Table 1. All experiments received the recommended fertilizers and were continuously grazed, except for the experiment at Narayen which was rotationally grazed every four weeks.

Also in Table 1 are the optimum stocking rates for each site, calculated by the "half intercept method" of Jones and Sandland (1974), and the liveweight gains at these optimum stocking rates.

At Samford there was a decline in liveweight gain of 43.7 kg $beast^{-1}$ for each unit increase in stocking rate (Jones 1974). Over the three years the annual slopes of the regression line (that is the "b" values) increased each year, reflecting the decline in the Siratro and total pasture yields at the higher stocking rates (R. J. Jones, personal communication), while maintaining a similar level of production at the low stocking rates.

A similar decline in gain $animal^{-1}$ occurred on Siratro/Kazungula setaria pastures at Koumala (mean "b" value of -41.5 kg $steer^{-1}$), but over the three years "b" values increased due to depression of Siratro yield and total yield at the higher stocking rates (B. Walker, unpublished data). Only the steers on the lightest stocking rates (1.2 and 1.7 steers ha^{-1}) had a degree of condition and finish.

At two sites in south-east Queensland the planted grass *Paspalum commersonii* cv. Paltridge (Scrobic) failed and was replaced by weed grasses (Bisset and Marlowe

TABLE 1

Site and liveweight data for seven stocking rate experiments with Siratro based pastures.

Site	Samford (Qld)	Koumala (Qld)	Narayen (Qld)	Lowmead (Qld)	Broweena (Qld)	Serere (Uganda)	Sigatoka (Fiji)†
Reference	Jones (1974)	B. Walker (unpublished data)	't Mannetje and Nicholls (1974)	Bisset and Marlowe (1974)	Bisset and Marlowe (1974)	Stobbs (1970a)	I. Partridge (personal communication)
Location	27°22′S, 152°53′E	20°43′S, 149°15′E	20°41′S, 150°52′E	24°37′S, 151°37′E	24°43′S, 152°15′E	1°43′S, 33°27′E	17°55′S, 177°25′E
Soil	Red, yellow and gleyed podzolics plus some alluvial soil.	Dy 3·42*	Polzols (Dy)*	Dy 3 and Um*	Dy 3*	Shallow infertile	Rendzina
Mean Annual Rainfall (mm)	1 070	1 503	722	1 090	1 008	1 356	1 730
Period of trial	1969-72 (3 years) Whole year	1970-73 (3 years) Whole year	1968-73 (5 years) Whole year	1966-71 (5 years) Mean 314 days/year	1966-71 (5 years) Mean 329 days/year	1967-69 (2 years) Mean 336 days/year	1973-75 (2 years) Whole year
Associated grasses	*Setaria anceps* cv. Nandi	*Setaria anceps* cv. Kazungula	*Cenchrus ciliaris* cv. Biloela	*Paspalum commersonii* cv. Paltridge Mainly *Cynodon dactylon*	*Paspalum commersonii* cv. Paltridge Mainly *Heteropogon contortus*	*Panicum maximum* cv. Likoni	*Dichanthium caricosum*
Cattle	Hereford heifers	Brahman (⅜) × Shorthorn steers	Hereford steers	Hereford × Shorthorn × Brahman steers	Hereford steers for 4 years. Brahman (⅜) × Hereford steers for 1 year	Small East African Zebu steers	Hereford × Santa Gertrudis
Stocking rates (beasts ha^{-1})	3·0, 2·3, 1·7 and 1·1	5·0, 3·3, 2·5, 2·0, 1·7 and 1·2	1·1, 0·7 and 0·5	1·2, 0·8 and 0·6	1·2, 0·8 and 0·6	5·0, 3·0 and 2·0	5·0, 2·5 and 1·25
Highest annual treatment gain (kg beast^{-1} day^{-1})	0·44	0·47	0·47	0·58*a*	0·55*a*	0·40*a*	0·55
Highest recorded l.w.g. (kg^{-1} ha^{-1} year^{-1}) and stocking rate (beasts ha^{-1})	280 2·3	303 3·3	155 1·1	215*a* 1·2	115*a* 1·2	480*a* 5·0	500 5·0
"b" values (kg l.w.g. steer^{-1} unit of stocking rate^{-1})	—43·7	—41·5	—52·9	—17·3	—134·9	—13·0	—27·3
Optimum stocking rate (beasts ha^{-1}) determined by the "half intercept method" (Jones and Sandland 1974)	2·42	2·70	1·88	5·63	0·95	6·15	4·34
l.w.g. at optimum S.R. (kg ha^{-1} year^{-1})	256	303	186	550*a*	121*a*	492*a*	514

* Northcote (1971) soil classification. *a* Values given are weight gains recorded for the number of days grazed, not for a full year.

† Only data for 1974-75 presented in Fig. 1.

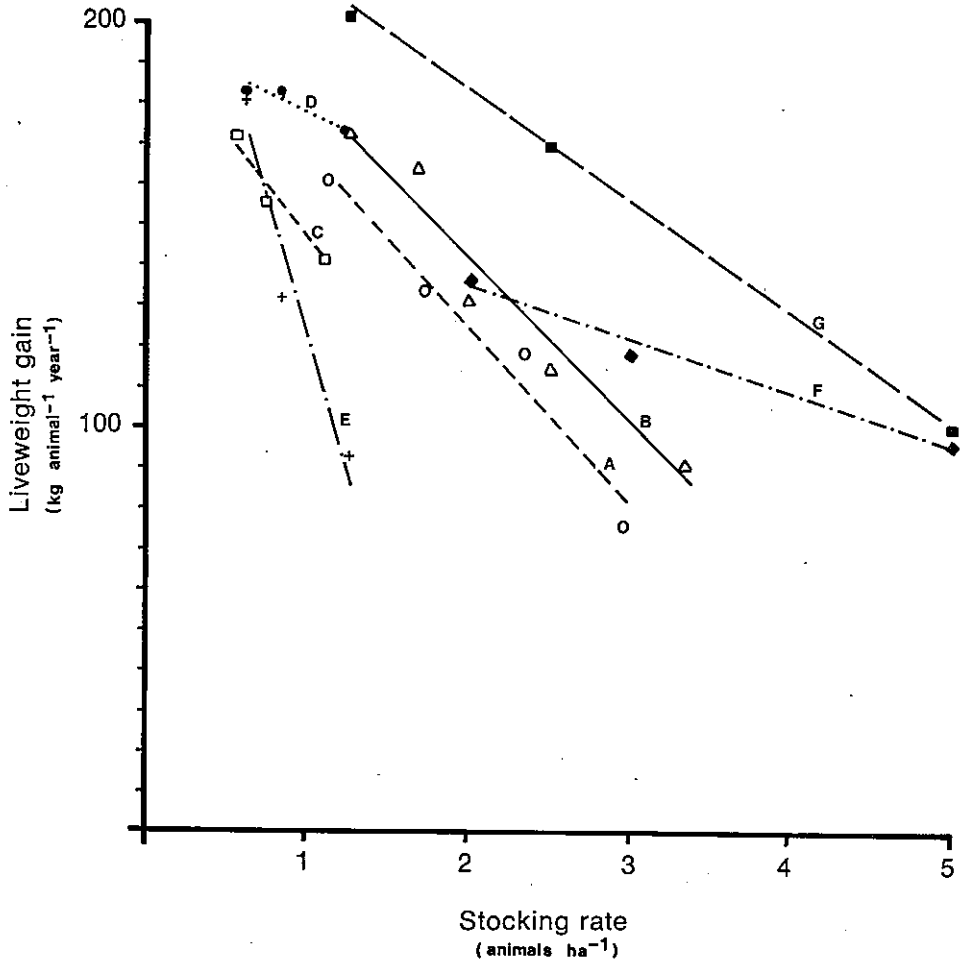

FIGURE 1

Liveweight gains and linear regressions plotted for seven stocking rate experiments with Siratro pastures. (A—Samford (Jones 1974), B—Koumala (B. Walker, unpublished data), C—Narayen ('t Mannetje and Nicholls 1974), D—Lowmead (Bisset and Marlowe 1974), E—Broweena (Bisset and Marlowe 1974), F—Serere (Stobbs 1970a) and G—Sigatoka (I. Partridge, personal communication).)

1974). At the Lowmead site, where Siratro became dominant and green couch (*Cynodon dactylon*) was the main grass, stocking rate had little effect on the five years mean weight gain. This is probably because the range of stocking rates was narrow and too low (see Fig. 1). When sold for slaughter there was only a slight margin in favour of the lighter stocking rate treatments.

At Broweena, the native spear grass was dominant on all treatments and stocking rate had a pronounced effect on Siratro yield and liveweight gain. In 1967 the cattle on the 0.62 steer ha^{-1} treatment had better finish and in the other four years only cattle from this treatment were fit for slaughter (Bisset and Marlowe 1974).

At Narayen the weight gains from stocking rates of 0.54, 0.74 and 1.09 steers ha^{-1} over five years from 1968-1973 were 172, 156, and 142 kg head^{-1} annum^{-1}. These results compared with 156 kg head^{-1} obtained from a buffel grass pasture at a stocking rate of 1.09 steers ha^{-1}, receiving 168 kg N ha^{-1} year^{-1}. Although there was little difference in annual liveweight gains, the steers from the buffel grass/Siratro

pastures had a better carcase finish than those from the buffel grass/nitrogen pastures ('t Mannetje and Nicholls 1974). A close relationship was also found between liveweight gain of steers and total green material, green grass or green legume ('t Mannetje 1974).

The stocking rate response at Serere (Stobbs 1970a) was not as pronounced as those recorded in Queensland (with the exception of the Lowmead site). However, the small East African Zebu cattle used in this experiment had a low potential liveweight gain of less than 0.5 kg day^{-1} (T. H. Stobbs, personal communication) and this probably accounts for the low "b" value.

At Sigatoka in Fiji, under annual rainfalls in 1973-74 and 1974-75 of 3150 and 2250 mm respectively, there was a strongly linear effect of stocking rate on liveweight gain. At the heaviest stocking rates *Desmodium heterophyllum* is replacing Siratro as the main legume. In the first year of another trial, where this change occurred very quickly, there was no depression in liveweight gain at the heaviest stocking rate (I. Partridge, personal communication).

Due to the narrow range and choice of stocking rates used in some of the trials, the recorded liveweight gains ha^{-1} do not always agree with those determined by the Jones and Sandland (1974) method. However, the desirable stocking rate is usually one which will produce an animal suitable for sale. In these trials this only occurred when the weight gains were in excess of 160 kg $beast^{-1}$. The stocking rates used to achieve this level of weight gain were much lighter than those which gave the greatest gain per hectare.

Grazing method

Grazing method has only a marginal effect on animal production from Siratro pastures. At Serere, Uganda, continuous grazing, rotational three paddock grazing moving cattle every two weeks, and rotational six paddock grazing, moving cattle weekly, were compared on a Siratro/*P. maximum* pasture using small East African Zebu steers (Stobbs 1969). A stocking rate of 5.0 steers ha^{-1} was used in order to maximise production per hectare. Mean liveweight gains for the three treatments over the 1218 days of the trial were 0.24, 0.26 and 0.22 kg $steer^{-1}$ day^{-1} respectively. Steers were observed to prefer the *P. maximum* to Siratro. It was only when herbage yields were low, due to the high stocking rates used, that rotational grazing proved to be better than continuous grazing.

Milk Production and Quality

Milk production from smaller breeds, such as Jersey, grazing solely on tropical pastures is low, particularly from unimproved pastures where milk yields rarely exceed 6 to 7 kg cow^{-1} day^{-1} (Stobbs 1976). Lactation yields are increased to 8 to 9 kg cow^{-1} day^{-1} when either a legume, such as Siratro, is included in a pasture or when fertilizer nitrogen is used. However in spring, when Siratro yields are low, milk production from Siratro pastures can be lower than from nitrogen fertilized pastures (Stobbs and Brett 1972). Later in the year, as Siratro yields improve, such differences would not be expected and the beneficial effects of the legume would extend into the dry season.

Milk yields from pure Siratro or Greenleaf desmodium (*Desmodium intortum*) pastures were lower than from nitrogen fertilized pangola grass (Stobbs 1971) because of the low intake of energy due to difficulty in harvesting the legume (Stobbs and Brett 1974) which resulted in low solids-not-fat content and protein, especially casein. Problems with making cheese were overcome by feeding a grain supplement (Stobbs and Frazer 1971).

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