Stenotaphrum secundatum: a valuable forage species for shaded environments

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Abstract

The potential of *Stenotaphrum secundatum* (buffalo grass) as a forage species for ruminants is reviewed. Buffalo grass has been used as a pasture grass to a limited extent in Florida, the Caribbean, the Pacific Islands and Australia. From agronomic and animal production data, it is concluded that buffalo grass has value as a pasture grass for shaded, humid-tropical environments in developing countries, where smallholders require a robust, persistent grass. Considerable genetic variation exists within the species with the sterile triploid types showing greatest potential for grazing. Dry matter productivity is only moderate but buffalo grass is tolerant of a wide range of edapho-climatic conditions. Its moderate nutritive value can be improved by combination with legumes such as *Leucaena leucocephala, Arachis pintoi* cv. Amarillo, *Aeschynomene americana* cv. Glenn and *Desmodium* spp. Animal production from buffalo grass is highly sensitive to stocking rate. It has been well adopted by smallholders grazing cattle under coconuts in the Pacific Islands because of its ease of establishment and tolerance of long-term heavy grazing. The ability of buffalo grass to form a dense, stable and weed-free sward under heavily shaded and heavily grazed conditions makes it worthy of consideration for grazing under plantation crop systems.

Introduction

Stenotaphrum secundatum has a wide range of common names (Sauer 1972) e.g. “St Augustine grass” in the USA and “buffalo couch” or “buffalo grass” in Australasia and the Pacific Islands (Plucknett 1979), but buffalo grass is the preferred name for the purposes of this paper. Buffalo grass is an important turf grass in south-east USA (Busey and Augustin 1980) and much of the recent agronomic research is turf-related. It has been popular as a grazing resource in the Everglades region of south-east USA (35 000 ha) (Allen and Kidder 1970), and in the southern Pacific Islands, where it was introduced at the end of last century as a cover crop to control weeds in coconut plantations (Sauer 1972). Buffalo grass is an important native pasture in Puerto Rico and Jamaica (Anon. 1975), but is no longer recommended for improved pasture development in Australia (J. Murtagh, personal communication), and the species is no longer the subject of forage research in the USA (W. Hanna, personal communication).

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In recent work in Vanuatu, buffalo grass pastures have demonstrated excellent stability when heavily grazed under plantation crops, and this has led to renewed interest in the species for smallholder cattle enterprises throughout south-east Asia and the Pacific (Shelton 1991). However, there are conflicting reports regarding the levels of animal production achievable from both shaded and full-sun grown buffalo grass pastures. This report aims to assess the future potential of buffalo grass as a grazing resource, by reviewing the literature and examining some recent experiments and experience with the species.

Botanical history

The genus *Stenotaphrum* comprises 7 species originating in south-east Asia and evolving from the genus *Paspalidium* (Sauer 1972). *Stenotaphrum* spp. are mostly sea-shore colonisers and their inflorescences have adapted for short-range dispersal of seed by ocean currents (Sauer 1972). Genetically, the genus is diverse and *S. secundatum* includes fertile diploids and sterile polyploids (Long and Bashaw 1961). The original *S. secundatum* is a fertile diploid which evolved from the *S. dimidiatum* of the western Indian Ocean (Sauer 1972). It is believed to be native to Africa, the West Indies, southern Mexico and the United States (Busey and Augustin 1980). Two distinct variants are noted, of which the most agronomically important is a sterile triploid, native to the Cape of Good Hope. This Cape deme was spread by man throughout the tropics from the late nineteenth century and is now naturalised in Australia, the Pacific Islands and North America. It forms the basis of buffalo grass pasture and turf grass selections (Long and Bashaw 1961; Sauer 1972), including Roselawn and Floratam cultivars and the Vanuatu ecotype referred to earlier. The Natal-Plata deme is a fertile polyploid and has spread along the west coast of Africa into Spain, France and the Mediterranean (Sauer 1972).

A cytogenetic study of American buffalo grass (Long and Bashaw 1961) found that 70% of Texas types were fertile diploids, whereas Florida types included diploid, triploid and tetraploid types. The progeny of diploid seedlings displayed wide phenotypic variation, while tetraploids approached 100% sterility. Triploids were found to be highly sterile (Long and Bashaw 1961), and propagation is nearly always by vegetative means (Busey and Myers 1979). Morphological mutation in triploids is common (Powell and Toler 1980), which may account for the diversity within the Cape deme.

This complex genetic background explains the diversity within the species and underscores the need to specify the ecotype/selection used in research.

Agronomic characteristics

Environmental adaptations

Edapho-climatic. Plucknett (1979) suggested that buffalo grass is suited to dry, sandy sites in the humid tropics, but Williams (1974) and Shelton (1991) found it to be tolerant of a wide range of edapho-climatic conditions (Table 1) including a soil pH range from 5.0–8.0 (Hacker and Williams 1993). Although no published information on rainfall requirements was found, we have observed buffalo grass growing productively in annual rainfall regions varying from 1200–3500 mm. In Vanuatu, buffalo grass pastures were more drought tolerant than carpet grass (*Axonopus compressus*) pastures, but still hayed off rapidly during extended dry spells. Macfarlane and Shelton (1986) reported that growth of buffalo grass in the cooler months was generally poor and lower than that of carpet grass, an observation supported by Samarakoon *et al.* (1990b).

Flooding and salinity tolerance. Buffalo grass tolerates occasional flooding (Reynolds 1988; Fry 1991), high salinity (Meyer *et al.* 1989; Marcum and Murdoch 1990), and continuous salt spray on leaves (Joy 1985). It was shown to respond to high salinity by increasing shoot and root concentrations of sodium and chlorine and by maintaining osmotic potential through increased tissue water levels (Marcum and Murdoch 1990). Variation in tolerance of salinity occurs within the species with cv. Seville considered more tolerant than cv. Floratam (Meyer *et al.* 1989).

Shade tolerance. The shade tolerance of buffalo grass is widely reported (Smith and Whiteman 1983; Macfarlane and Shelton 1986; Evans *et al.* 1992). Morphological responses to

Table 1. Range of soil types and fertility conditions in which *Stenotaphrum secundatum* is productive.

Country	Soil pH	Soil type/description	Fertility	Ref[1]
Florida, USA	—	organic, peat-derived	high N; low P, K	1
Vanuatu (a)	5.5	ferallitic clay	high sulphate; low K, P, Zn, N	2
Vanuatu (b)	8.1	coralline rendzina	high Ca; low P, K, N, Mg	2
Indonesia	6.5	brown clay loam	fertile; low organic matter	3
Solomon Is.	4.2	red-brown clay	high N, OM; low P, K, Mg	4

[1] References 1. Pate *et al.* (1980).
2. Evans *et al.* (1992).
3. Mendra *et al.* (1995).
4. Shelton *et al.* (1987b).

shading are typical of pasture grasses with increases in chlorophyll content, leaf and internode length and specific leaf area, and a decrease in leaf width (Winstead and Ward 1974; Samarakoon *et al.* 1990b), but these increases are only a fraction of those recorded in the shade-intolerant species (Winstead and Ward 1974). Therefore, in contrast with shade-intolerant species which elongate and lose vigour under dense shade, buffalo grass remains prostrate and dense.

Yield and competitive advantage

The literature indicates large variation in dry matter (DM) production of buffalo grass. In Florida, unshaded Roselawn buffalo grass pastures grown on nitrogen-rich organic soil produced 15 t/ha/yr DM when fertilised with 220 kg/ha 0–10–20 NPK (Pate *et al.* 1980) and 19.2 t/ha/yr when fertilised with 220–660 kg/ha 0–10–20 NPK.

In species comparisons in Bali, Indonesia, on fertile alfisols under mature coconuts [60% light transmission (LT)], Floratam and Vanuatu buffalo grass produced 14.1 and 13.6 t/ha/yr DM, respectively, in combination with 3 *Arachis* spp., and 15.9 t/ha/yr DM in combination with the tree legume, *Calliandra calothyrsus* (Mendra *et al.* 1995). At the same site, buffalo grass fertilised with 200 kg/ha N produced 18.5 t/ha/yr DM. When compared with other shade-tolerant grasses, yields were similar to those of *Paspalum notatum* and *P. wettsteinii* and superior to those of carpet grass. However, *P. notatum* was very slow to establish, and in a related experiment (Wong and Stür 1993), *P. wettsteinii* persisted poorly under shade and carpet grass was prone to weed invasion. Other species, such as *Panicum maximum*, *Digitaria milanjiana* and *Digitaria smutsii*, had sharply declining DM yields and increasing weediness over the 2-year trial period. *Paspalum malacophyllum* was the highest yielding of the unfertilised species (18.6 t/ha/yr), but its erect habit limited its usefulness for the coconut understorey (Mendra *et al.* 1995). In 3 related experiments in North Sulawesi, Indonesia, under 55% LT, buffalo grass yields ranged from 7.7–11.5 t/ha/yr DM and were similar to yields of *P. notatum* (Kaligis *et al.* 1995a). Buffalo grass yields were exceeded by those of *Brachiaria humidicola*, but *B. humidicola* pastures were found to be far less robust under shade than buffalo grass pastures in Vanuatu (Macfarlane *et al.* 1993).

In other research in Vanuatu, Sabi grass (*Urochloa mosambicensis*) and Indian blue grass (*Bothriochloa pertusa*) competed strongly with weeds when grown in full sun, but neither species was competitive under shade (Macfarlane *et al.* 1993).

The competitive advantage and DM production of triploid buffalo grass types has been shown to increase under shade. Smith and Whiteman (1983) found buffalo grass to be the highest yielding of a range of tropical grasses grown under 20% LT, but DM production was relatively poorer when LT was >50%. In pot trials, Samarakoon *et al.* (1990b) found that DM production increased as LT was reduced, and at 32% LT, buffalo grass produced 59% more DM than in full sun. At the Rubber Research Institute of Malaysia, Sungei Buloh Research Station, the yields of 6 buffalo grass cultivars were compared (N.K. Foh, personal communication). At 50% photosynthetically active radiation (PAR), DM production of the diploid Seville and triploid Floratam cultivars decreased 7% and increased 39%, respectively, compared with growth in full sun. In contrast, many of the high yielding tropical pasture species are adversely affected by shade to such an extent that their persistence and ability to compete with weed species is compromised (Shelton *et al.* 1987a; Samarakoon *et al.* 1990b).

The special ability of buffalo grass to maintain yield and vigour at low LT gives it a huge competitive advantage in shaded environments and allows it to maintain a dense and weed-free sward. This advantage was noted in the coconut plantations of Vanuatu where weed growth (*Cassia tora*, *Psuedoelephantopis spicatus*, *Sida* spp. and *Urena lobata*) can be vigorous, but was well controlled by buffalo grass (Macfarlane and Shelton 1986).

In summary, the data indicate that buffalo grass has a competitive advantage in shaded environments of low-medium fertility.

Management

Establishment

Commercial plantings of buffalo grass nearly always involve the sterile Cape deme triploid types, which must be planted by vegetative methods (Powell and Toler 1980). In Vanuatu, smallholder farmers planted buffalo grass manually into newly partially cleared bush before pioneer grasses and weeds emerged. Being shade-tolerant, the buffalo grass established quickly and outcompeted naturalised grasses such as Tee grass (*Paspalum conjugatum*) and carpet grass (Macfarlane *et al.* 1993). In North Sulawesi, Vanuatu buffalo grass cuttings planted at 1 m × 1 m spacings fully covered a 1 ha paddock within 4 months (Kaligis *et al.* 1995b). In comparison, *Paspalum notatum* was quickly over-run by weeds and failed to cover a similar area during the 3-year experimental period. The slow rate of establishment of *P. notatum* has been reported elsewhere (Firth and Wilson 1995).

In summary, within its edapho-climatic range, buffalo grass establishes and spreads rapidly after planting from stem cuttings. However, we have observed that Floratam spreads more slowly than the Vanuatu ecotype.

Grazing management

As mentioned, buffalo grass is tolerant of heavy grazing and has the ability to resist weed invasion (Macfarlane and Shelton 1986). In North Sulawesi, a buffalo grass pasture under mature coconuts was continously grazed at 4.0 steers/ha over a 2-year period. The weed content of the pasture remained stable at approximately 5% (Kaligis *et al.* 1995b). Evans *et al.* (1992) suggested that the sustainable stocking rate was dependent on the degree of shading and increased linearly from 0.4 breeding cow units at 20% LT to 1.4 breeding units at 70% LT. Stolons of Vanuatu buffalo grass are prone to damage from heavy grazing during the dry season (D.C. Macfarlane, personal communication). Whilst not greatly affecting its persistence, this greatly increases the percentage of dead leaf in the pasture. The condition can be avoided by reducing dry season grazing pressure.

Invasion by weeds has been reported to occur from prolonged overgrazing but long-term spelling of the paddock allowed the buffalo grass to re-establish (Mullen and Banga 1993).

Companion legumes

The competitive nature of buffalo grass, although a great benefit in weed control, causes difficulties for persistence of pasture legumes. A wide range of legume species were tested for compatibility with buffalo grass grown under coconuts (70% LT) in Vanuatu (Macfarlane *et al.* 1993). Many herbaceous and shrub legumes failed to persist for more than 12 months. Persistent legumes were: *Leucaena leucocephala* cv. Cunningham, *Aeschynomene americana* cv. Glenn and *Stylosanthes scabra* cv. Seca. When rotationally grazed, the regrowth cycles of *L. leucocephala* and buffalo grass were found to be compatible. Other legumes of relatively low palatability (*Desmodium ovalifolium*, *D. incanum* and *Mimosa pudica*) also persisted, provided stocking rate was moderate. The latter 2 legumes were naturalised throughout Vanuatu, and increased in frequency as stocking rate was reduced to an estimated 1.5 head/ha.

Others reports have suggested that *Desmodium heterophyllum* (Macfarlane and Shelton 1986) and *Arachis spp.* will spread in buffalo grass under grazing (D.C. Macfarlane, personal communication). This was confirmed in North Sulawesi, where Kaligis *et al.* (1995a) found that *Arachis pintoi* cv. Amarillo and *A. glabrata* CPI 93483 combined well with buffalo grass in grazed small plots under coconuts (55% LT). Amarillo was persistent, but yielded poorly in larger paddocks under heavy grazing (Kaligis *et al.* 1995b; Rika *et al.* 1995). In Bali, the tree legume, *Calliandra calothyrsus*, was productive and persistent when grown in combination with Vanuatu buffalo grass under coconuts (60% LT) (Mendra *et al.* 1995).

Nutritive value

Although buffalo grass is very suitable and palatable as a grazed forage in a wide range of conditions, there are conflicting reports regarding its nutritive quality (Shelton 1991). Reports from Florida and Vanuatu indicate very satisfactory animal production levels (Haines *et al.* 1965; Weightman 1977; Pate *et al.* 1980) but these contrast with the NSW (Australia) and Solomon Island experience, where the species was considered an inferior forage of low palatability and digestibility (J. Murtagh, personal communication; Shelton *et al.* 1987b). These conflicting reports may indicate variation in nutritive value between cultivars/ecotypes.

Chemical composition of forage

Crude protein (CP) concentration of buffalo grass herbage is generally lower than the 15 percent required for lactation and growth (Table 2), although this is a common problem with tropical grasses (Norton 1982). Total non-structural carbohydrate (TNC) percentages reported by Samarakoon *et al.* (1990a; 1990b) were very low in comparison with other tropical grasses (Smith 1972). High TNC concentrations reported by Winstead and Ward (1974) may reflect non-limiting growth conditions provided in this experiment. Cell wall constituents, including lignin, cellulose and hemicellulose, were in the high range for tropical grasses (Ford *et al.* 1979; Minson 1990).

Analysis of essential nutrients from plucked leaf samples revealed no limiting factors for animal production (Samarakoon *et al.* 1990b) (Table 3), although Norton (1994) suggested that values above deficient levels may not always indicate sufficiency. Major interactions such as N:S and Ca:P ratios were within acceptable limits (ARC 1980). Sodium concentrations were very high so that the salt supplementation commonly recommended for cattle grazing tropical pastures (Gutteridge *et al.* 1983) would be unnecessary.

Table 2. Chemical composition (%) of herbage of buffalo grass in a range of studies.

Treatment	Plant part	Crude protein	TNC[1]	Cell wall content	Cellulose	Hemicellulose	Lignin	Ash	Ref[2]
50% LT[3]	tops[4]		0.5	70.8	31.5	33.8	4.7	1.1	1
full sun	tops		0.7	74.9	31.5	37.4	5.6	1.0	1
41% LT	tops	11.3	0.5	59			5.3		2
full sun	tops	10.6	1.3	67			4.6		2
41% LT	YEL[5]	15.0	4.1	53			3.6		
full sun	YEL	15.6	5.5	58			3.0		
25% LT	stolons		10.3						3
full sun	stolons		16.6						3
4-week cut	tops	12.9			30.5	35.2	7.0		4
8-week cut	tops	11.5			30.8	34.9	7.1		4
continuous grazing	tops	13.0						6.4	5
28-day rotational grazing	tops	14.4						7.3	5

[1] Total non-structural carbohydrate.
[2] References 1. Samarakoon *et al.* (1990a).
2. Samarakoon *et al.* (1990b).
3. Winstead and Ward (1974).
4. Coleman *et al.* (1978).
5. Pate *et al.* (1980).

[3] Light transmission.
[4] Herbage above 5 cm.
[5] Youngest expanded leaf.

Table 3. Nutrient concentrations from plucked leaf samples of *Stenotaphrum secundatum*.

	N	P	K	Ca	Mg	S	Cu	Zn	Na	Ref[1]
Vanuatu 80% LT[2]	1.6	0.28	1.78	0.5	0.35	0.25	5	71	1.55	1
Solomon Is. 34% LT	1.95	0.2	2.47	0.44	0.27	0.36	9	58	0.68	2
Vanuatu	2.11	0.29	1.95	0.6	0.35	0.41	—	—	0.65	3
Australia full sun	1.2	0.2	1.55	0.25	0.2	0.2	—	—	0.7	4
Australia 50% LT	1.15	0.25	1.75	0.3	0.25	0.25	—	—	0.55	4

[1] References 1. Evans *et al.* (1992).
2. Shelton *et al.* (1987b).
3. Macfarlane and Shelton (1986).
4. Samarakoon *et al.* (1990a).

[2] Light transmission.

Voluntary intake and digestibility

Coleman *et al.* (1978) found that voluntary intake (VI) and *in vivo* digestibility (cattle) of green-chopped buffalo grass cv. Roselawn were not significantly reduced by increasing forage maturity from 4 to 8 weeks (Table 4). Luxury N levels may have limited the decline in digestibility with increasing maturity. In contrast, Reynolds (1988) and Anon. (1975) reported that the generally high acceptability of buffalo grass to cattle declined rapidly with increasing maturity.

Pate *et al.* (1980) found that continuous grazing reduced both CP (Table 2) and *in vitro* DMD (Table 4) compared with 4-week rotationally grazed buffalo grass, and noted the high percentage of "dry grass residue" in continuously grazed swards as the possible cause. Anecdotal evidence from Vanuatu concurs with this observation. Heavily grazed buffalo grass (Vanuatu ecotype) pastures contained a higher percentage of stem and dead leaf (D.C. Macfarlane, personal communication), which may result in lower VI and DMD. However, Samarakoon *et al.* (1990b) found the DMD of stem was comparable with that of leaf. DMD data for buffalo grass (Table 4) were consistently comparable with the 55.4% average DMD for tropical grasses reported by Minson and Wilson (1980).

Intra-specific variation in nutritional quality and morphology may be of great importance for development of buffalo grass as a forage. "Floratam", a turfgrass cultivar selected from cv. Roselawn, is leafier, has shorter internodes and often contains less dead material than the Vanuatu ecotype (Shelton 1993).

Quality under shade

Buffalo grass has potential primarily as a shade-tolerant pasture (Shelton 1991) and it is therefore appropriate to review its nutritive quality under shade. Macfarlane and Shelton (1986) noted that cattle prefer to graze unshaded rather than shade-grown buffalo grass, but this reduced acceptability may not be related to nutritive quality. Samarakoon *et al.* (1990a; 1990b) found that shade marginally increased VI and DMD. They noted that increases in leaf nitrogen concentration and decreases in cell wall content (CWC) and insoluble ash concentrations were largely balanced by an increase in lignin content and a decrease in TNC (Table 2). They also found that the nutritive quality of buffalo grass, in terms of VI and *in vivo* DMD, compared favourably with kikuyu (*Pennisetum clandestinum*) under shade, but was inferior to carpet grass in both unshaded and shaded conditions, irrespective of nitrogen fertiliser application.

It is concluded that, although nutritive quality data are somewhat variable, they indicate that shade-grown buffalo grass is of moderate nutritive quality in terms of VI, DMD and CP content. Further, it has comparable nutritive quality to other commonly recommended tropical forage grasses (Minson and Wilson 1980). However, the acceptability of buffalo grass to grazing animals is reduced under shade, probably due to its low TNC content.

Table 4. Voluntary intake and digestibility of *Stenotaphrum secundatum* in a range of studies.

Cultivar/ ecotype	Treatment	Animal	*In vivo* DMD (%)	Voluntary intake of digestible DM (g/kg LW/d)	*In vitro* DMD (%)	Ref[1]
Roselawn	4-wk cut	cattle	61.3	48.0		1
	8-wk cut		59.4	43.4		
unknown	50% LT	sheep	52.7	53.7	51.5	2
	full sun		49.9	45.0	47.6	
Roselawn	continuous grazing				47.2	3
	28-day regrowth				53.6	
unknown	41% LT/low N				57.3	4
	full sun/low N				55.7	
	41% LT/high N				62.1	
	full sun/high N				59.0	

[1] References 1. Coleman *et al.* (1978).
2. Samarakoon *et al.* (1990a).
3. Pate *et al.* (1980).
4. Samarakoon *et al.* (1990b).

Animal production

Documented animal production data from buffalo grass reveal a wide range of results with direct comparisons confounded by variations in associated pasture species, shading levels and edapho-climatic conditions. However, as with other tropical grasses, stocking rate and liveweight gain per head are inversely related (Table 5). In Vanuatu, Weightman (1977) reported good liveweight gains from unfertilised buffalo grass-Siratro pastures. Weaner heifers gained 0.61 kg/hd/d at 1.25 hd/ha compared with 0.43 kg/hd/d at 2.5 hd/ha. Research in Vanuatu indicated the importance of combining high quality legumes with buffalo grass to achieve desired animal production levels (Evans *et al.* 1992). Without legumes, liveweight gains on buffalo grass rarely exceeded 0.32 kg/hd/d (Macfarlane and Shelton 1986). Under 40-year-old coconuts in Indonesia, cattle grazing buffalo grass (Vanuatu ecotype) with less than 5% legumes at 4 hd/ha averaged 0.25 kg/hd/d during the first year of a grazing trial (Kaligis *et al.* 1995b).

In the Solomon Islands, Shelton *et al.* (1987b) reported poor cattle liveweight gains (Table 5) from buffalo grass (Vanuatu ecotype) grazed at a high stocking rate under low LT (34%). Batiki blue grass (*Ischaemum aristatum*) gave better liveweight gains (0.32 kg/hd/d at a stocking rate of 3 hd/ha and 58% PAR) than buffalo grass, but was less shade-tolerant and persistent (Macfarlane and Whiteman 1983). Similar results were recorded on coral lime soils under 70% LT in Vanuatu during a drought year (Macfarlane *et al.* 1993). Increasing stocking rates greatly reduced individual liveweight gains, and a stocking rate of 2.5 hd/ha was unsustainable over a 6-month period in the prevailing dry conditions (Table 5). A high proportion of dead material, predominantly detached stolons, was evident in heavily grazed Vanuatu buffalo grass pastures.

In Florida, Haines *et al.* (1965) studied animal production over 10 years from unshaded buffalo grass on nitrogen-rich peat soils fertilised with potassium and phosphorus. Paddocks were stocked at an average 7.1 yearlings/ha, ranging from 5 hd/ha in winter to 10 hd/ha in the peak growing season. Liveweight gains averaged 1168 kg/ha with individual gains of 0.44 kg/hd/d. It is probable that, under such high fertility and unshaded conditions, other pasture grasses (e.g. *Pennisetum clandestinum*, *Setaria sphacelata*) would have surpassed this result. Such long-term

Table 5. Animal production from shaded and full-sun grown *Stenotaphrum secundatum*.

Associated treatment	Light transmission	Stock rate	Liveweight gain	Grazing period	Ref[1]
	(%)	(hd/ha)	(kg/hd/d)	(years)	
Mimosa pudica & *Desmodium incanum* (5–10% DM)	65	1.5	0.32	unknown	1
Native legume (<2%)	70	1.5	0.32	1	2
		2.0	0.14	1	
		2.5	0.14	0.5	
—	34	3.0	0.2	1	3
P & K fertiliser	100	7.1[2]	0.44	10	4
Siratro (low contribution)	high	2.5[2]	0.43	1	5
		1.25[2]	0.61	0.5	
Mimosa pudica & *D. heterocarpon* (<5% DM)	70	4.0[2]	0.25	1	6

[1] References
1. Macfarlane and Shelton (1986).
2. Macfarlane *et al.* (1993).
3. Shelton *et al.* (1987b).
4. Haines *et al.* (1965).
5. Weightman (1977).
6. Kaligis *et al.* (1995b).

[2] Weaners/yearlings.

data cannot be dismissed, but are of limited relevance to the performance of buffalo grass under plantation crops.

In summary, as with all tropical grasses, poor liveweight gains result from heavily shaded and/or heavily stocked buffalo grass pastures, with low legume content. As shading does not reduce the nutritive value of buffalo grass (Samarakoon *et al.* 1990a; 1990b), it is probable that poor animal growth rates occur from a reduction in intake due to the higher proportion of stem and dead material in heavily grazed pastures and perhaps to the low TNC concentrations of shaded pastures. At low–moderate stocking pressure, daily liveweight gains from shaded buffalo grass pastures were acceptable and would be improved with a stable, high quality legume component. Data support the suggestion by Macfarlane and Shelton (1986) that buffalo grass pastures are highly suited to breeding herds.

Conclusions

Buffalo grass is a tropical forage of moderate nutritive value and DM production. It establishes rapidly and reliably from stem cuttings and is tolerant of a wide range of edapho-climatic conditions. The ability of buffalo grass to form a stable, dense sward, highly resistant to weed invasion under heavily shaded conditions, is perhaps its most important attribute. Forages with these characteristics are in demand throughout south-east Asia and the Pacific, where interest in grazing under plantation crops is increasing. In this environment, native and improved pastures commonly succumb to weed invasion and cost savings in weed control of buffalo grass pastures may be significant.

Animal production from buffalo grass pastures is adversely affected by high stocking rates but acceptable animal production can be reliably achieved at low-moderate stocking rates. The great advantage of buffalo grass is that it forms a highly robust pasture, tolerant of poor grazing management, and there is great scope to improve animal production by the addition of high quality legumes such as *Leucaena leucocephala* and *Arachis* spp. The aggressive nature of buffalo grass limits the persistence of many herbaceous legumes. More research is required to identify suitable companion legumes. Variation within *Stenotaphrum secundatum* is great and there may be potential to identify selections of superior nutritive value or improved morphological characteristics. Certainly, buffalo grass has potential as a forage for breeding herds in tropical plantations, and with the addition of suitable legumes, it will also have potential as a fattening pasture.

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