# Technote

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# Mitchell Grass Pasture Dynamics on the Barkly Tableland, Northern Territory

## Comparison of a long-term study with research in Queensland

***(Astrebla spp)***

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## SUMMARY

Mitchell grass (*Astrebla* spp.) pastures are an important pastoral resource in the Northern Territory. Despite their value to N.T. cattlemen, relatively little research has been conducted into the dynamics of the grassland in relation to seasonal and management influences. This contrasts markedly with the abundance of research literature pertaining to the *Astrebla* grasslands of western Queensland.

This report describes the only long-term study of Mitchell grass pasture dynamics conducted in the Northern Territory, and presents comparisons with similar studies in western Queensland.

The study was conducted on the western Barkly Tableland over a period of some 18 years, initially from 1974 to 1979, and subsequently between 1989 and 1991. Data presented demonstrate the effects of rainfall and of grazing on total pasture biomass and botanical composition of the grassland.

The conclusions drawn from this work, as well as from similar studies in Queensland, suggest that the dynamics of *Astrebla* grassland are affected more by fluctuations in rainfall than by grazing. This does not preclude grazing as an influencing factor; rather it indicates that the impact of grazing on the pasture is closely related to recent rainfall history.

The relevance of the findings to the cattle industry on the Barkly Tableland is discussed, and suggestions made for potential future pasture research directions in the region.


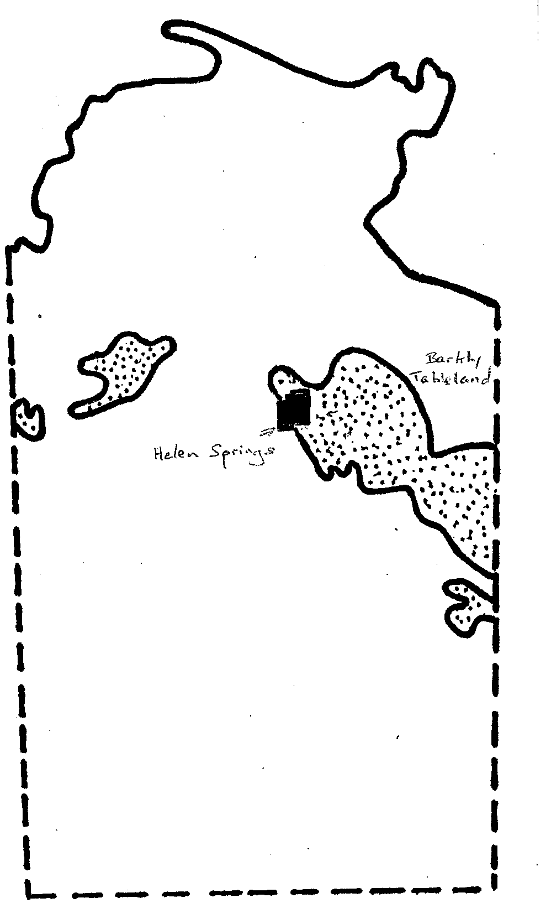


**Figure 1.** Distribution of large scale Astrebla grassland in the NT

## BACKGROUND

The Barkly Tableland is an extensive region of cracking clay soils supporting a perennial tussock grassland dominated by *Astrebla* species (Mitchell Grass). This highly valued and productive cattle country occupies 57 000 km$^2$ of the total 99 000 km$^2$ of Mitchell grass rangelands in the Northern Territory (Foran and Bastin 1984) (Figure 1).

The climate of the region is monsoonal with greater than 90% of the rainfall occurring between November and March. Average wet season rainfall varies from 625 mm in the north to 250 mm in the south-east corner and droughts may occur in 10% of years (Foran and Bastin 1984)

In a survey of the Barkly Tableland beef industry, Holt and Bertram (1981) estimated a total herd of some 439 230 head on 22 of the 25 stations in the region, 25% of the Northern Territory herd. Turn-off in that year was 119 306 head, 26% of the Territory total. Recently, turn-off has been lower, with 77 560 and 73 672 head in 1990 and 1991 respectively (J. Stefani, personal communication). This lower turn-off is probably due partly to the recent spell of drier than average years, and partly to the flow-on effects of the National disease eradication campaign (BTEC).

*Astrebla* grasslands, especially their soil component, are seen to be essentially stable with large changes in plant composition being related mainly to season (Foran and Bastin 1984). The pasture is generally regarded as resilient to grazing and drought (Williams and Roe 1975), although Orr (1981a) comments that it is susceptible to drought because of the paucity of edible trees and shrubs on the grassland.

The capacity of any vegetation to provide long term grazing for livestock depends on the dynamics of the major forage species, particularly their ability to regrow and reproduce following grazing (Hodgkinson and Williams 1983, cited by Orr and Evenson 1991a). The ability of range scientists and pastoral extension officers to make recommendations about appropriate management of rangelands depends on their understanding of pasture dynamics in relation to all influencing factors.

Despite the extent of the Mitchell grasslands, and their importance to the Northern Territory beef industry, relatively little research has been conducted to gain a better understanding of the ecology and management requirements of these pastures. Only one major study of *Astrebla* grassland dynamics, of which the present study is a follow-on, has been reported (Foran and Bastin 1984). This situation contrasts markedly with that in the Queensland Mitchell grass regions, where numerous short-term and on-going studies have been reported (for example, see Hall and Lee 1980; Orr 1975, 1980a, 1980b, 1981a, 1981b; Roe and Allen 1945; Roe and Davies 1985; Scanlan 1981).

The response of Mitchell grass rangelands to any one, or a number of environmental influences is not entirely predictable. An understanding of the reaction of *Astrebla* spp. grasslands to grazing is complicated by the difficulty in distinguishing between the effects of grazing *per se* and the effects of seasonal fluctuations in rainfall (Orr 1975).

Floristic change will be determined by prior rainfall history, grazing management and whether normal or extreme climatic fluctuations are needed to cause death or recruitment of particular species (Foran and Bastin 1984).

Rainfall is generally regarded as the major factor influencing floristics (Foran and Bastin 1984; Orr 1981b), and fluctuations in species composition can occur over a relatively short time, particularly when summer rainfall is above average (Orr 1981b). Such changes in plant composition affect the grazing value of the pasture (Foran and Bastin 1984). An increased annual component, and corresponding decrease in *Astrebla* spp reduces the ability of the pasture to provide adequate forage into the late dry season.

The yield of *Astrebla* spp at the end of the wet season is not merely a function of seasonal rainfall. Orr (1980b) found that forage use at the end of the dry season is significantly and negatively correlated with the yield of *Astrebla* at the end of the following wet season.

Grazing is regarded as beneficial to *Astrebla* pasture if it occurs in moderation. As grazing pressure increases, the yield of *Astrebla* decreases and yields of annual grasses and forbs increase (Orr 1980b). While heavy grazing may control undesirable species such as *Aristida latifolia* (Hall and Lee 1980), in the long term it will increase drought susceptibility (Orr 1980a).

Grazing is known to promote seed production in *Astrebla* (Orr 1981a; Orr and Evenson 1991b), although rainfall is probably the factor of most importance in subsequent recruitment (Roe and Davies 1985).

## INTRODUCTION

This study of Mitchell grass dynamics was commenced in 1973 at Helen Springs Station on the western Barkly Tableland, in order to define the responses of Mitchell grassland to season and grazing. The study initially ran for a period of six years, ceasing in 1979, and has been reported previously (Foran and Bastin 1984). Data collection then lapsed for ten years, before re-commencing in 1989. Although the procedures for assessment in this most recent phase of the study are different to those used initially, the aim of the project is essentially the same; that is, to continue recording the effects of season and grazing on *Astrebla* grassland over the long term, with a view to better understanding the dynamics of the grassland.

This report presents results for the last three years of study from 1989 to 1991. Comparisons are made with results from the initial phase of the study, and with experience in other *Astrebla* grasslands. The relevance of the study to the local pastoral industry, and implications for future research and management options are discussed.

## METHODS

On commencement of the study in 1973, a livestock exclosure, 3.2 km long by 0.8 km wide, was established adjacent to Jingerah Bore. Thirty six permanent transects were marked, 6 inside and 6 outside the exclosure at each of three distances from the bore: 0.8 km, 1.6 km and 3.2 km (Figure 2). A detailed description of the sites and methods used from 1974 to 1979 is provided by Foran and Bastin (1984).

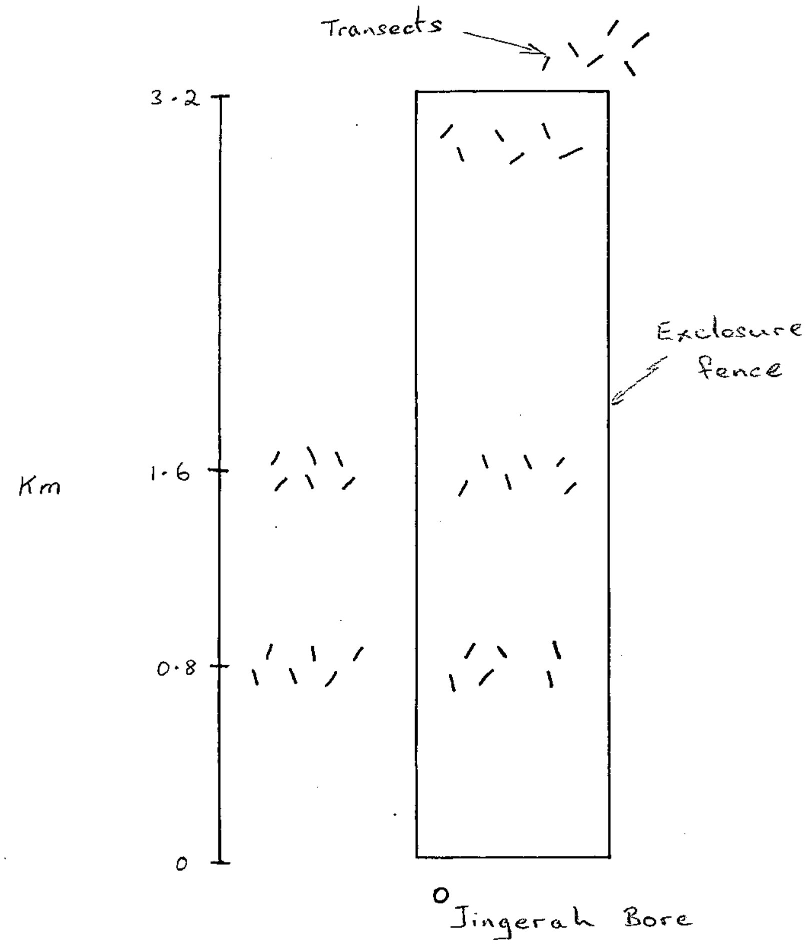


**Figure 2.** Design of exclosure at Jinerah Bore

Data collection lapsed between 1980 and 1989, when the original transects were relocated and assessments recommenced. In March 1989, prior to recommencement of data collection, part of the exclosure was mown for hay. This was beyond the control of the officers involved at the time, and effectively simulated a grazing utilisation level of about 80% of *Astrebla* on the mown areas. The mown area included parts of three transects at the 1.6 Km point, and accounted for about 40% of the `1.6 Km Ungrazed' assessment data.

Pasture assessments were carried out in June of 1989, 1990 and 1991 using the modified comparative yield and dry weight rank technique described by Friedel and Bastin (1988). Data were collected from the area immediately surrounding each of the original transects.

Rainfall records for the period were obtained from Helen Springs homestead, and compared with the long term average at the same location.

No attempt was made to measure grazing intensity outside the exclosure during the study. Foran and Bastin (1984) reported that the probable long term stocking rate had been about 20 beasts per $Km^2$ prior to commencement of this study in 1973. During the 1989-91 period, cattle numbers on Jingerah bore varied, but remained at about the district average of around 20-25 per $Km^2$. Where the terms `light' and `heavy' are used in the text, they refer only to relative grazing intensities, based on distance from water and relative number of stock using the transect areas in question (lighter at 3.2 Km; heavier at 0.8 Km).

No statistical analyses were conducted on the data, due to the smaller data set and different methods used. Major changes observed are readily apparent from the graphical representations of the data and are not substantially different from previously reported observations (Foran and Bastin 1984) to warrant the detailed analysis of variance procedures which would be required.

## RESULTS

The results for the initial phase of the study (1974 - 1979) have been reported previously (Foran and Bastin, 1984). Dry matter yield, pasture composition and rainfall data from that period are presented again here for comparison with recent pasture assessments.

<u>Rainfall</u>

Wet season (November - March) rainfall at Helen Springs Station for the period 1968-69 to 1990-91 are presented in Figure 3. The long-term wet season average (1945-1984) at the station (27 km south of Jingerah Bore) is 387 mm. This is similar to the 92 year wet season average for Powell Creek (28 km north-west of Jingerah Bore) of 407 mm (Foran and Bastin, 1984).

Prior to commencement of the study in 1973, rainfall had been well below average in the late 1960s (66mm in 1969-70), returning to above-average in the early 1970s (492mm in 1971-72). During the first phase of the study, rainfall was well above the long term average. Significant peaks occurred in 1973-74 (806mm), 1975-76 (685mm) and 1978-79 (680mm).

For the period during which pasture data collection lapsed, rainfall ranged from above-average (491mm in 1981-82), to average (389mm in 1983-84) in the early 1980s, followed by a period of below-average rainfall (159mm in 1985-86), except fo 1986-87 when 538mm was recorded for the wet season.

More recently, rainfall has been much lower, with reduced wet season totals recorded for 1988-89 and 1989-90. The 1990-91 wet season saw a return to above average rainfall, with a total of 593mm recorded.

## Pasture Yield

Total dry matter yield between 1989 and 1991 exhibited several fluctuations due to grazing and season, but little variation due to distance from water. These yield changes, plus those for the first phase of the study, are demonstrated in Figure 4.

With the exception of the exclosed sites at 0.8 km from water (Figure 4a), all sites were lower yielding in 1990, due to the poor wet season. The return of higher rainfall in 1990-91 (Figure 3), produced an increase in dry matter production on all sites.

Grazing appeared to reduce dry matter yield at 0.8 km and 1.6 km from water in 1990, and at 3.2 km in 1991. However, yield was greater under grazing than in the exclosure at 3.2 km in 1989 and at 1.6 km in 1991. Most other sites exhibited little difference between years and between grazing and exclosure.

The positive response of yield to grazing at 1.6 km in 1991 is similar to that observed in the comparably wet years of 1977 and 1979 (Figure 4b). A similar response was recorded at 3.2 km in 1989 and 1977 (Figure 4c). Conversely, a negative response to grazing was recorded at 3.2 km in 1991, and this is analogous with the 1979 observation at this distance (Figure 4c).

There was no consistent trend in pasture yield with distance from water. The combined effects of exclosure and low rainfall in 1989-90, produced a considerably higher yield at 0.8 km from water compared to more distant transects.

## Pasture Composition

Pasture composition was broken down into four main components: palatable perennial grasses (predominantly *Astrebla* spp.); *Aristida latifolia*; annual grasses (mainly *Iseilema* spp., *Brachyachne convergens* and *Panicum whitei*); and forbs (mostly summer-growing annual, but some perennials). A list of species included in each component is appendixed.

There has been a marked change in pasture composition at all sites since the project commenced in 1973. This change has been from a predominately annual grass and forb pasture in 1974 to one dominated by perennial grasses, mainly *Astrebla* spp. and *Aristida latifolia*, in 1991 (Figure 5).

During the 1989-91 period, several relatively minor changes in composition have occurred in response to rainfall and grazing. Observations also indicate an interactive effect between grazing and distance from water.

In response to the higher rainfall of 1990-91 (Figure 3), there was a slight increase in the proportion of annual grasses (mainly *Iseilema* spp. and *Panicum whitei*) at most sites. This increase was more pronounced within the exclosure at 1.6 km in 1991 (Figure 5b), where it was due to an abundance of *Sorghum australiense*.

The proportion of palatable perennial grasses decreased slightly in response to the higher rainfall in 1991. This is also somewhat exaggerated at the 1.6 km exclosed sites, and is proportional to the increase in abundance and yield of annual grasses.

No substantial difference in the proportion of palatable perennial grasses was observed due to the interaction between grazing and distance from water. If anything, a slight increase in this component occurred due to grazing at 0.8 km and 1.6 km in 1991 (Figure 5a and b).

The interaction of grazing and distance from water, resulted in a decrease in the proportion of *Aristida latifolia* at sites closer to the water point. Within the exclosure, the contribution of *Aristida* to total biomass remained relatively stable (28-34%) in all three years. However, in 1991, the proportion of *Aristida* in the grazed pasture was considerably lower at 0.8 km (20%) and 1.6 km (21%) than at 3.2 km (32%). The reverse situation occurred in the initial phase of the study, with *Aristida* contributing a much larger percentage of the grazed pasture biomass at 0.8 km (47%) than at 3.2 km (26%) (Foran and Bastin 1984).

## DISCUSSION

Recent studies on the *Astrebla* grasslands of south- and central-western Queensland have indicated that rainfall, rather than grazing, is the major factor influencing biomass and population dynamics of the grassland (Orr 1981b; Orr and Evenson 1991a). The present study, including the initial phase reported by Foran and Bastin (1984), supports these claims. That is not to say that grazing impact is of no consequence; rather that under normal management the fluctuation due to rainfall is greater than that due to grazing.

The pastoral value of Mitchell grasslands derives mainly from the strong perennial grass component, with the *Astrebla* species being renowned for their resilience to drought and grazing. It is the *Astrebla* component of these grasslands which provides an indication of the stability or condition of the pasture. Roe and Davies (1985) observed that where the density of *Astrebla* had declined, the capacity of the grassland to sustain stock through dry (or drought) seasons was reduced compared with similar grasslands with a high proportion of *Astrebla* in the pasture.

Everist (cited by Orr 1975) considered that fluctuation in *Astrebla* spp. composition in pastures that was attributable to season far outweighed the effects of normal grazing management. He also reported that while extremes in management may have an immediate impact on species composition, the long term effect is far less predictable.

Rainfall and Pasture Composition

In the present study, substantial yield and composition fluctuations occurred in response to seasonal rainfall, but only relatively minor fluctuations occurred due to grazing pressure. While the overall yield response of the grassland appeared to be linked positively to rainfall, the contribution of each component (palatable perennial grasses, *Aristida*, annual grasses, forbs) varied according to recent rainfall history.

Notably, a considerable decrease in the proportion of annual grasses and forbs occurred in conjunction with the increase in the perennial grass component during the wetter years of the mid-1970s, and subsequent drier years of the early 1980s. The annual grass and forb components again responded to the higher rainfall of 1991, although the biomass increase recorded was only marginal in relation to the changes recorded in the 1970s.

The effect of rainfall on botanical composition is related to the competitive ability of the perennial grasses, especially *Astrebla* spp. (Orr 1981b). Relative abundance and basal cover of perennial grasses is determined by recent rainfall history (1-3 years), while that of annual grasses and forbs is determined by immediate past rainfall. Drought periods reduce the survival of *Astrebla*, making soil moisture recharge from subsequent rainfall more available for the growth of annual grasses and forbs. Increased biomass of perennial grasses from favourable summer rainfall increases their competitive ability for moisture and light thus decreasing the presence of annual grasses and forbs.

Fluctuation in the proportion of the undesirable perennial grass *Aristida latifolia* in this study followed a similar pattern to that in comparable studies elsewhere. Its increase in the early part of this study (Foran and Bastin 1984) was similar to increases observed by Hall and Lee (1980) and Purcell and Lee (1970). A series of drier years, such as that prior to the recommencement of this study, has a negative influence on the biomass of *Aristida* and relative increase in the biomass of *Astrebla*. On observing similar trends in Queensland *Astrebla* grasslands, Purcell and Lee (1970) noted that *Astrebla* is more drought resistant than *Aristida*.

Grazing and Yield

Grazing has had only a minor impact on pasture biomass and composition at Jingerah bore. It appears to have maintained, or slightly improved, the grazing value of the grassland on the study area.

The reduced yield recorded at 0.8 Km and 1.6 Km in 1990 is as much due to low rainfall as to grazing. The impact of grazing at 0.8 and 1.6 Km in 1990 may be explained in terms of recent rainfall and management history. Given the slightly below-average season of 1988-89, the moderate grazing throughout 1989 would have depleted the *Astrebla* yield to a moderate level by the end of the dry season. With the failure of the 1989-90 wet season, and continuation of grazing, the pasture suffered considerable depletion by the time of survey in June 1990. Orr (1975) comments that normal stocking rates established at the start of a below average season constitutes overgrazing as the season progresses and pasture quantity and quality deteriorates. The resultant reduction in *Astrebla* in the pasture may be due to either grazing or the poor season but it is difficult to apportion the blame to one cause alone.

In later work, Orr (1986) found that forage utilisation of greater than 40% of peak standing biomass following summer drought may be deleterious to the basal area (hence biomass) of perennial grasses. No forage utilisation measurements were made during the present study, however a subjective estimate revealed that forage utilisation of *Astrebla* at 0.8 and 1.6 Km in June 1990 was in the order of 35-50 percent.

Grazing and Pasture Composition

The overall effect of grazing on pasture composition was minimal, and related to seasonal conditions. Trends in the contribution of palatable perennial grasses, mainly *Astrebla*, were slight but noticeable. The *Astrebla* component appeared to be slightly more prevalent at sites under heavier grazing (0.8 and 1.6 Km) than on exclosed sites or lightly grazed sites (3.2 Km). These trends in *Astrebla* appeared to be inversely related to the biomass of *Aristida latifolia* and, to a lesser extent, annual grasses and forbs. *Aristida* appeared to be favoured by nil or light grazing; higher proportions being observed at 3.2 Km grazed sites and all exclosed sites.

Reductions in the relative biomass of *Astrebla* under light grazing have been observed in similar studies on Queensland Mitchell grasslands. Winders (1936) considered that under-utilisation is deleterious to *Astrebla* while Orr (1980a;1980b) commented that light grazing accelerates senescence of *Astrebla lappacea* tussocks; and failure of lightly grazed (<10% forage utilisation) *Astrebla lappacea* to set appreciable seed suggests loss of vigour.

Orr and Evenson (1991a) suggested that in the longer term moderate grazing will be beneficial to *Astrebla* because of the effect of grazing on seed production and subsequent plant recruitment. Orr (1980b) regarded moderate defoliation (20-50% utilisation) as beneficial to *Astrebla lappacea* during wet years because it encourages better regrowth and seed production. The higher proportion of *Astrebla* at the 0.8 and 1.6 Km grazed sites during the latter part of this study would support these suggestions.

The apparent increase in *Aristida latifolia* under light and nil grazing, especially with higher rainfall, was described by Foran and Bastin (1984) and is similar to trends observed by Hall and Lee (1980). Under heavier grazing (at 0.8 and 1.6 Km) the proportion of *Aristida* in the pasture was observed to decline. Hall and Lee (1980) observed a similar response and suggest that heavy grazing could be a useful mechanism for the control of *Aristida* in pastures grazed by sheep, where seed from the grass can cause severe vegetable fault in wool.

The simulated heavy grazing utilisation due to mowing at the 1.6 Km exclosed sites caused an increase in the proportion of annual grasses in 1991. This annual grass response was substantially larger than on all other sites and was largely due to an abundance of Downs Sorghum (*Sorghum australiense*). With the dry conditions of 1989 and failure of the wet season in 1989-90, *Astrebla* biomass at these sites remained relatively lower than on other sites. With the return of high rainfall in 1990-91 and the low biomass of *Astrebla* and other perennials, the annual grasses had more suitable growing conditions than on other sites.

This result is comparable with observations by Orr (1980b), who suggested that an increase in grazing utilisation of *Astrebla* causes reduced projected foliage cover thus reducing shading and making more moisture available in the soil surface layers which promotes an increase in annual grasses and forbs. Light or nil grazing increases projected foliage cover and basal area of *Astrebla*, reducing moisture in the soil surface layers and increasing shade thus causing a reduction in yield of annual grasses and forbs (Orr 1980b). Such a response was observed on other exclosed sites and the lightly grazed sites (3.2 Km) at the study area. Other areas on Helen Springs which had been mown for hay in 1989 displayed a similar response to that observed at Jingerah bore.

<u>Stocking Rate</u>

Although stocking rates were not considered in this study, the following comments are pertinent to the discussion of pasture dynamics in relation to rainfall and grazing.

It is important to realise that stocking rates must be altered according to current pasture condition and recent rainfall history. Increasing utilisation of *Astrebla* during drought means a greater recovery time is required after drought (Orr 1981a).

Of considerable importance is Orr's (1975) suggestion that normal stocking rates established at the start of a below average season constitutes overgrazing as the season progresses and pasture quantity and quality deteriorates. If the seasonal rainfall is below average, then grazing pressure must be reduced to an appropriate level to decrease the possible risk of overgrazing an already depleted pasture.

Orr and Evenson (1991a) suggest that stocking rates which result in up to 30% utilisation of *Astrebla lappacea* are unlikely to be detrimental to the vegetation. They found that the decrease in basal area (and biomass) of perennial grasses during drought is more accentuated at 50-80% utilisation than at 10-30% utilisation. With return of favourable summer rainfall basal area of perennial grasses retured to a higher level at 10-30% utilisation than at 50-80% utilisation.

## CONCLUSION

The dynamics of the grassland at this site, and those reported elsewhere, indicate that rainfall is the most important factor determining biomass and composition in *Astrebla* pastures. Although not shown decisively in this study, available evidence suggests that the intensity of grazing and its timing relative to seasonal conditions will still have considerable influence on the grazing value of the pasture.

The findings of this study and the others described herein present sufficient information from which basic grazing and pasture management decisions can be derived. However, given the inherent geographic, climatic, botanical and pastoral enterprise differences between the Barkly *Astrebla* grasslands and those in western Queensland, significantly greater research effort is required to ensure sound future management of these grasslands.

Of particular note in this regard is that a large part of the research conducted in Queensland has been in *Astrebla* grasslands grazed by sheep. The inherent differences in dietary requirements and grazing behaviour between sheep and cattle is enough to warrant a more serious requirement for detailed studies in the Barkly Tableland Mitchell grass rangelands.

The utilisation studies conducted in Queensland (eg. Orr and Evenson 1991a and b) are providing valuable information which is directly related to grazing capacity of the grassland and management of grazing pressure. An investigation into grazing and pasture management based upon stocking rates and *Astrebla* utilisation would provide vital data to encourage more appropriate management techniques.

## ACKNOWLEDGMENT

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**Table 1.** List of species recorded at Jingerah Bore exclosure, 1989 to 1991

| BOTANICAL NAME | COMMON NAME |
|---|---|
| **Palatable Perennial Grasses** | |
| *Astrebla elymoides* | Weeping Mitchell grass |
| *Astrebla pectinata* | Barley Mitchell grass |
| *Astrebla squarrosa* | Bull Mitchell grass * |
| *Chrysopogon fallax* | Golden Beard grass * |
| *Eulalia fulva* | Silky Browntop grass * |
| **Unpalatable Perennial Grass** | |
| *Aristida latifolia* | Feathertop Wire grass |
| **Annual Grasses** | |
| *Brachyachne convergens* | Spider grass (Native Couch) |
| *Iseilema* species | Flinders grasses |
| *Panicum whitei* | Pepper grass |
| *Paspalidium retiglume* | + |
| *Sorghum australiense* | Downs sorghum |
| *Sporobolus australisicus* | Australian Dropseed grass + |
| **Other Species ++** | |
| *Cyperus bifax* | Downs Nut grass |
| *Cyperus species* | Nut grass |
| *Sesbania species* | Pea bush |

| BOTANICAL NAME | COMMON NAME |
|---|---|
| **Forbs** | |
| *Abutilon malvaefolium* | Bastard Marshmallow |
| *Corchorus olitorius* | Jute |
| *Corchorus tridens* | Jute |
| *Crotalaria dissitiflora* | Grey Rattlepod # |
| *Desmodium campylocaulon* | |
| *Glycine falcata* | |
| *Gomphrena conica* | |
| *Gomphrena* species | |
| *Goodenia lunata* | Hairy Goodenia |
| *Goodenia* species | |
| *Heliotropium tenuifolium* | *Heliotrope* |
| *Heliotropium* species | |
| *Hibiscus trionum* | Bladder Ketmia |
| *Indigofera trita* | # |
| *Ipomoea polymorpha* | Silky Cowvine |
| *Neptunia gracilis* | Native Sensitive Plant # |
| *Operculina aequisepala* | Potato (Onion) Vine |
| *Phyllanthus* species | |
| *Polymeria longifolia* | Erect Bindweed # |
| *Psoralea cinerea* | Annual Verbine |
| *Ptilotus conicus* | |
| *Rhynchosia minima* | Rhyncosia # |
| *Sauropus trachyspermus* | Slender Spurge |
| *Sida fibulifera* | Silver Sida # |
| *Sida spinosa* | Spiny Sida # |
| *Spermacoce auriculata* | |
| *Streptoglossa bubakii* | |
| *Teucrium* species | Germander |

* Minor contribution to palatable perennial grass component.
\+ Minor contribution to annual grass component.
++ Minor contribution to overall pasture biomass.
\# Major species contributing to forb component.

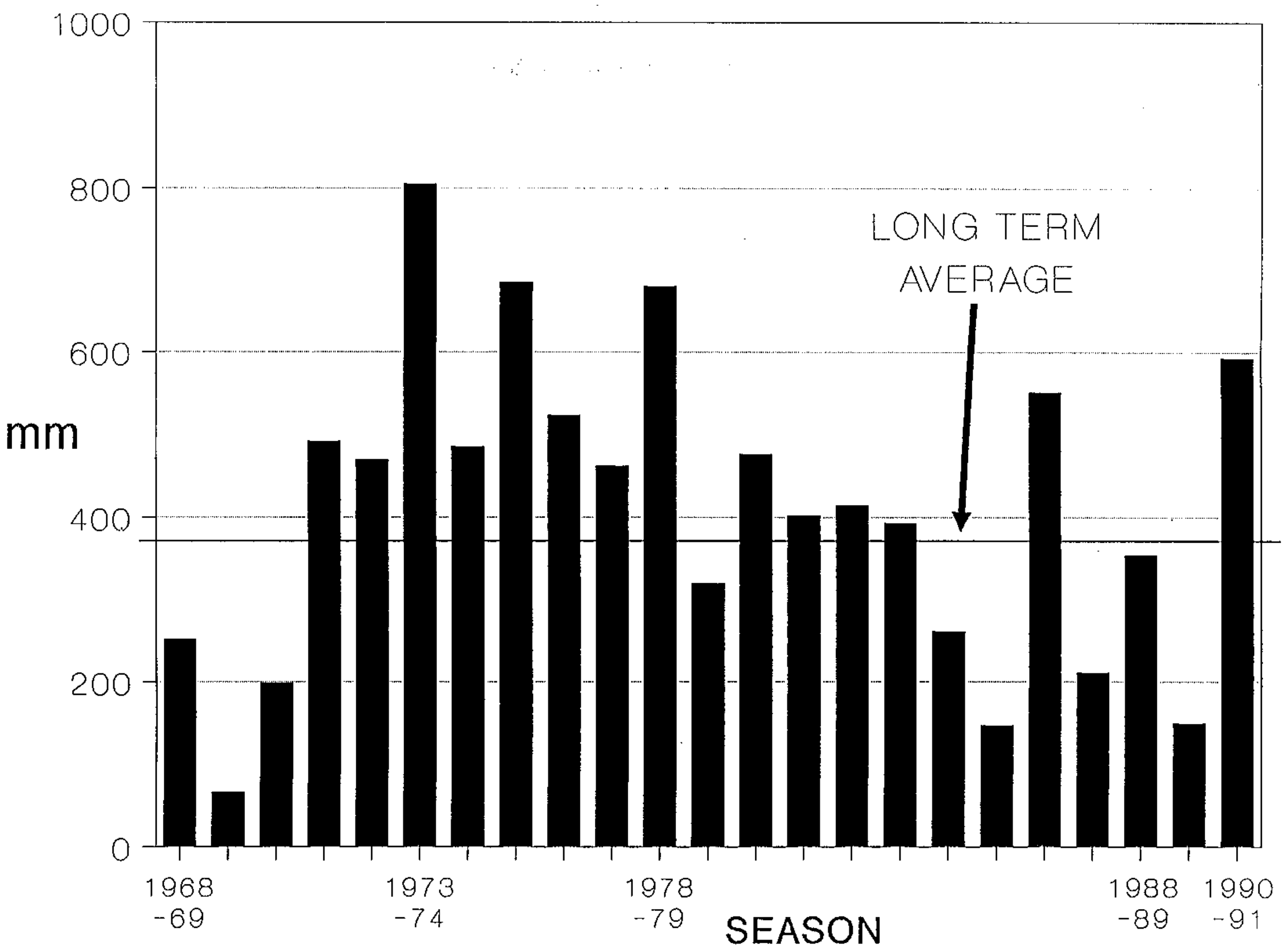


**Figure 3.** Wet season (Nov. to March) rainfall (mm) at Helen Springs homestead

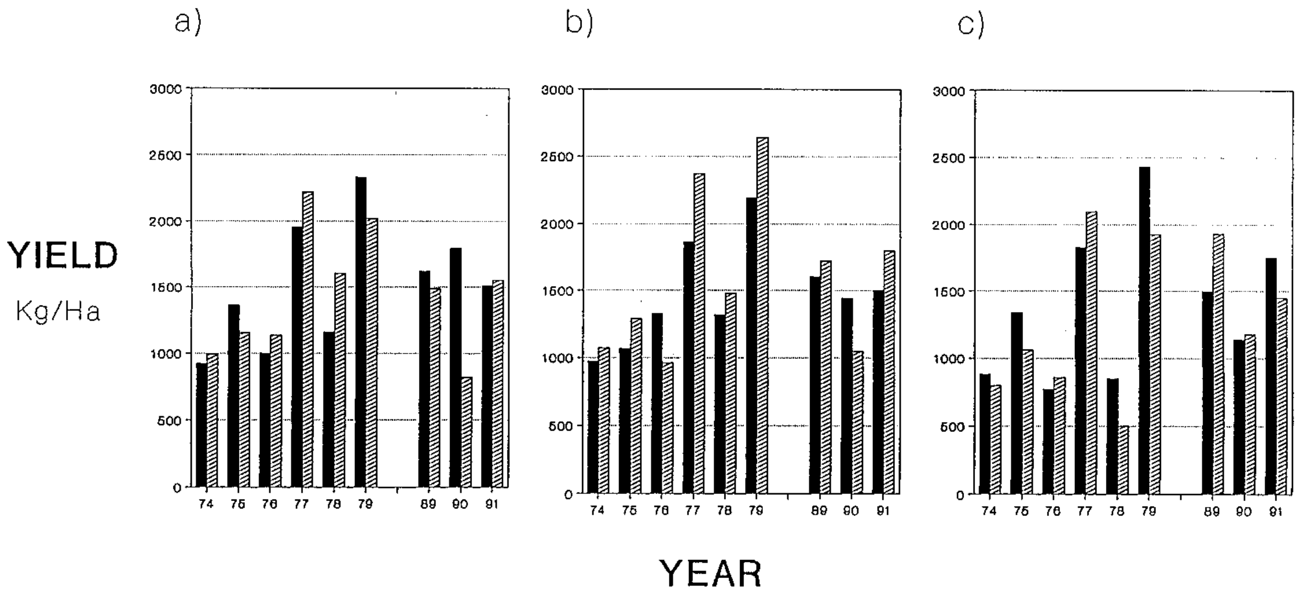


**Figure 4.** Yield on ungrazed (solid bar) and grazed (lined bar) sites at 0.8 km (a), 1.6 km (b) and 3.2 km (c) from Jingerah Bore

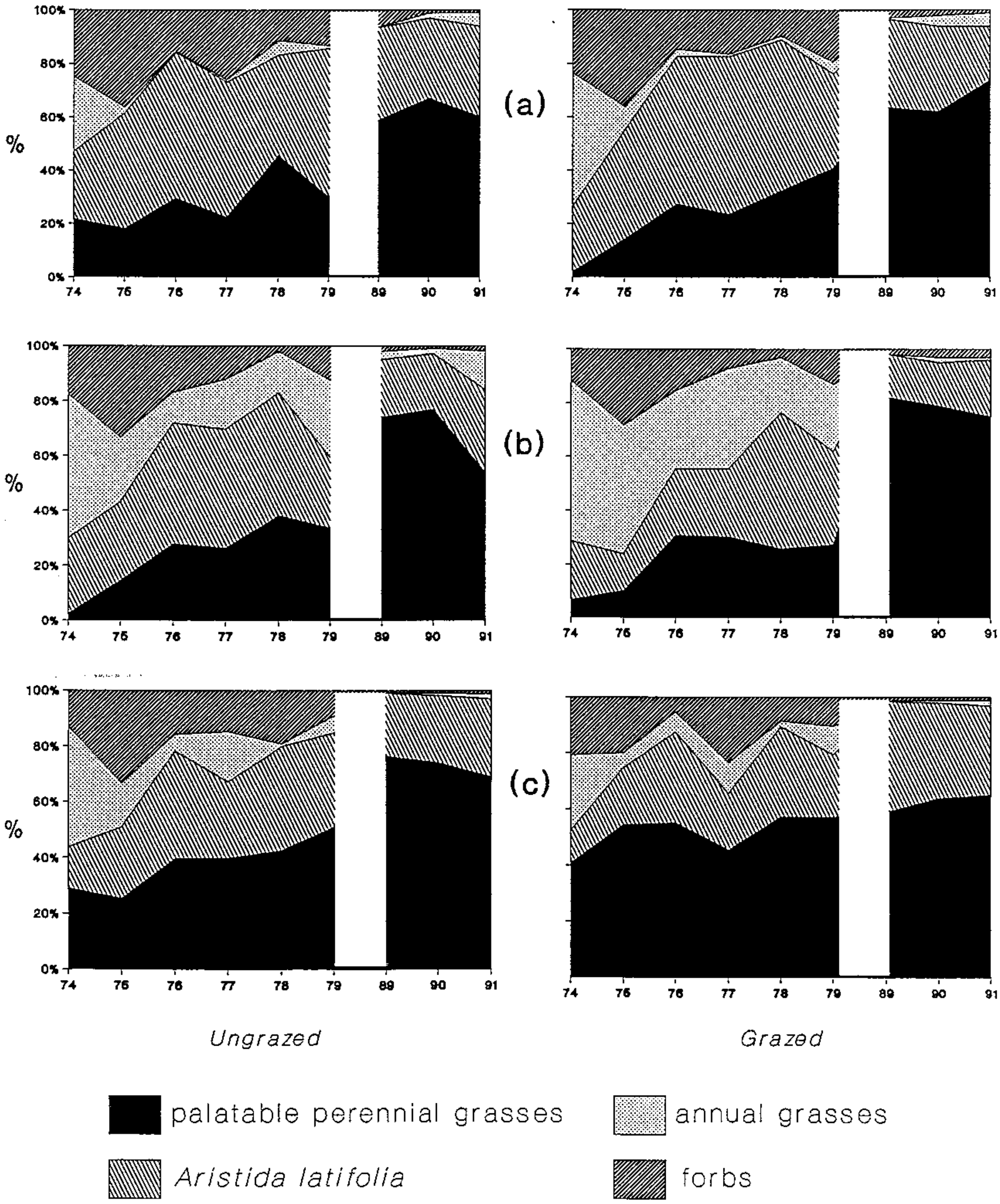


**Figure 5.** Composition (%) of ungrazed (left) and grazed (right) treatments at 0.8 km (a), 1.6 km (b) and 3.2 km (c) from Jingerah Bore

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