FIRE IN THE MANAGEMENT OF GRAZING LANDS IN QUEENSLAND

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ABSTRACT

The use of fire in the management of the grazing lands of Queensland is reviewed. Each pasture community is treated separately and the advantages and disadvantages of fire in its management are outlined.

The contribution that burning makes towards pasture degradation or regeneration, the effect of pasture burning on animal production, and the susceptibility of unwanted species to fire are factors which require further research. It is concluded that grazing management remains a major factor influencing the success or otherwise of pasture burning.

INTRODUCTION

Interest in the use of fire in the management of the grazing lands of Queensland has increased in recent years. This review is directed towards the reasons for burning and the way in which fire is presently used in the major grazing lands of Queensland. This is complementary to previous reviews which have been addressed more generally to the reasons for burning (Tothill 1971a) and the effect of fire on such factors as the microclimate (Savage 1980), soils and vegetation (*e.g.* West 1965). The map of Weston and Harbison (1980) has been used as the basis to define the pasture communities. The following communities are emphasized because of either their productivity or extent, even though at present fire is not necessarily used as a management tool: black speargrass (*Heteropogon contortus*)—kangaroo grass (*Themeda australia*); Queensland bluegrass (*Dichanthium sericium*); brigalow (*Acacia harpophylla*); *Aristida-Bothriochloa*; gidgee (*Acacia cambagei*); spinifex (*Triodia* spp.); Mitchell grass (*Astrebla* spp.); and mulga (*Acacia aneura*).

There have been few published studies of fire in rangelands of Queensland, so relevant data from work in the Northern Territory and New South Wales have been incorporated where possible. The paucity of factual data has also led me to include opinions of agrostology staff of the Queensland Department of Primary Industries. The latter have been used only when the opinions expressed cannot be factually refuted.

The gaps in knowledge highlighted in this review are later assessed and an attempt is made to indicate geographical areas in which fire research may be given a high priority in future studies into the pastoral areas of Queensland. Towards this end it is first necessary to review briefly the reasons for using fire in grazing lands and the possible effects of fire on each of the grazing communities in Queensland.

REASONS FOR BURNING

There are many reasons for the use of fire in the management of grazing lands, and West (1965) cites 10 previously detailed by Scott (1947) and Campbell (1960):

1. Remove unpalatable growth from the previous season; 2. Stimulate growth which would otherwise not occur (though it has also been suggested that fire simply makes green material more accessible); 3. Destroy parasites of animals; 4. Control encroachment of undesirable plants; 5. Aid in better distribution of animals; 6. Remove accumulated dry matter, including felled timber, which is otherwise a fire hazard; 7. Establish fire breaks against wild fire; 8. Prepare seedbeds for natural or artificial seeding; 9. Stimulate plants to seed; and 10. Encourage native legumes for forage and soil improvement.

Of these, numbers 1, 2 and 6 are the main reasons for the controlled use of fire in

Queensland, though in some areas, 4, 7 and 8 are also important. In grasslands having a minimal problem with woody weed invasion (e.g. Mitchell grass and bluegrass (*Dichanthium* spp.) the main use of fire lies in the rapid removal of accumulated dry matter. On the other hand, where woody weeds are considered to be a problem, such as in the brigalow and gidgee areas, fire is used in an attempt to suppress the regrowth.

FIRE AND ITS PRESENT USE IN QUEENSLAND PASTURES

Black speargrass-Kangaroo grass communities

These communities are the most widespread in the state (Figure 1) and occupy about 27 million hectares of land receiving 500 to 1500 mm of rain annually (Shaw and Bisset 1955, Isbell 1969, Weston and Harbison 1980).

Black speargrass now dominates these pastures probably due to an increase in grazing pressure and the prevalence of fire (Shaw 1957, Tothill 1969), but possibly also to a combination of these two factors followed by one or more growing seasons of above normal rainfall. Bisset (1962) for example found that black speargrass increased in central-western Queensland following good seasons but decreased in below average rainfall years. Shaw (1957) and Tothill (1969) cite a number of factors favouring the dominance of black speargrass: the sharply pointed seeds become buried in the soil and are protected from fire; burning itself stimulates germination; temperature of soils left bare immediately following a fire subsequently increases and may be more favourable for germination, particularly in southern Queensland; and fire reduces the basal cover of competing species, whereas established black speargrass plants are resistant to fire. Kangaroo grass is advantaged in a similar way (Groves 1974), but it is far more susceptible to damage by grazing (Moore and Biddescombe 1964). For instance, kangaroo grass is still common in areas exclosed from stock (cemeteries, railway reserves), yet is, or is almost, absent immediately outside these exclosures (Shaw 1957, Roberts 1972).

Annual burning of part of a property is now a common practice in most of the black speargrass areas, but burns are often patchy and rarely is the same area burnt each year. Burning is usually carried out in spring after the risk of late frosts has passed, but in the tropical areas autumn burning, when soil moisture is still available, is commonly used to promote green regrowth. This consequently assists cattle mustering.

Fire may be used in these pastures prior to sowing with exotic legume species. Burning reduces the foliage which would otherwise shade the seedling as well as providing a satisfactory seed bed (Norman 1965, Lowe 1972, Anon. 1974), though Cook and Lowe (1977) claim that initial establishment of Siratro (*Macroptilium atropurpureum*) may be reduced because of the reduced grass cover. Where Townsville stylo (*Stylosanthes humilis*) or other legumes have been sown into speargrass pastures, fires are not deliberately started as it is thought that they can seriously affect the legume stand and destroy valuable high protein fodder (Bishop 1973b). Shaw (1978) however, claims that burning of such pastures can aid the re-establishment of Townsville stylo in undergrazed pastures. A more detailed account of the fire-legume interaction may be found in Mott (1982).

There have been conflicting reports on forage production from black speargrass communities following spring burns, but Tothill (1966, 1969) suggests that these are probably due to differing soil moisture and soil temperature combinations. Soil temperatures rather than soil moisture are likely to determine the start of the growing season in southern Queensland, whereas in the north, soil moisture is the determinant. A sixfold increase in the density of speargrass and a tenfold increase in native legume have been recorded in the southern speargrass areas in response to firing. However, the density of the latter did not persist (K. B. Addison, personal communication).

Whilst burning is prevalent in speargrass pastures, the use of urea-molasses licks during periods of low feed quality can ensure a greater use of the standing dry feed (Alexander *et al.* 1970). In areas in which eucalypt regrowth is a problem, fire does have

a place in controlling the regrowth, though its role is secondary to that of grazing management (Tothill 1971b). Nevertheless, Tothill was of the opinion that provided sufficient fuel was available, fire was a useful method to contain regrowth. He concluded that in higher rainfall areas regrowth of woody species is checked by the grazing pressure, whereas in drier areas regrowth is more of a problem. Even if woody regrowth increased in the former area because of one or two very high rainfall years and the decreased grazing pressure, the subsequent increase in fuel would result in a more intense burn the following spring and would be severely detrimental to any woody regrowth.

Queensland bluegrass

The main areas of Queensland bluegrass pastures are in the Central Highlands and on the Darling Downs (Figure 1), though, because of the chemical and physical properties of the soil upon which they grow, a large proportion of these pastures has been replaced by grain crops. Where bluegrass pastures persist, fire has been, and still is, an important aspect of property management. Soon after sheep were introduced to these areas in the mid 1800s, pastoralists burnt strips of grass after the end of the summer rains to promote the growth of accessible green shoots (Bisset 1960). However, stock concentrated on these burnt areas and the preferred pasture species were partly replaced by less desirable ones including white speargrass (*Aristida leptopoda*) and yabila (*Panicum queenslandicum*). Ploughing is necessary to remove the white speargrass, but fire, followed by very light stocking or spelling for 3 to 6 months has proved effective in reducing the population of yabila in bluegrass pastures (Bisset 1960). Yabila tussocks are reduced in size by fire, leaving some space for regenerating bluegrass plants. The best time for burning is after the first good rainfall in summer, but before the commencement of the wet season. This will allow the bluegrass to grow, and seed on later rain.

In addition to its usefulness in containing yabila grass, fire is still used to remove the rank material produced following favourable early rain (C. N. Jacobson, personal communication) or following a series of above average rainfall years. This, and the confounding influence of grazing, have resulted in large variations in botanical composition of bluegrass pastures on both the Central Highlands and the Darling Downs (W. J. Scattini, personal communication).

Brigalow pastures

Fire is used in the development phase of brigalow pastures (Johnson 1976, Cameron and Wildin 1976), and later in an attempt to contain brigalow regrowth and the regeneration of problem shrubs such as sandalwood (*Eremophila mitchellii*). Brigalow scrub, either monospecific or mixed, is removed by pulling and subsequently is burnt within 15 months. An intense fire is preferable so that most timber is consumed and an ashy seed bed — into which both grasses and legumes may be sown (Coaldrake and Russell 1969) — results. Further, woody weeds including currant bush (*Carissa ovata*), sandalwood, yellow wood (*Terminalia oblongata*), and Ellangowan poison bush (*Myoporum deserti*), which are susceptible to very hot fires, are discouraged. Cameron and Wildin (1976) provide details of the planning, preparation and lighting techniques required to achieve these aims, but in essence they require a fire before the wet season commences so that seed sown into the ash will be planted by the impact of the subsequent rains.

Regrowth from brigalow and other woody species occurs in almost all brigalow development and as the regrowth ages, the effectiveness of chemical treatment decreases (Cameron and Wildin 1976). However a grass fire can produce a top-kill of all woody species provided there is sufficient fuel. This can be enhanced by sowing pasture species after the initial clearing burn, and encouraging pasture establishment by judicious stock management. A program of grazing for 3-4 years followed by spelling and burning will contain all brigalow regrowth but will have very little effect on the density of other woody weeds. If the cycle is broken by the use of pasture during a

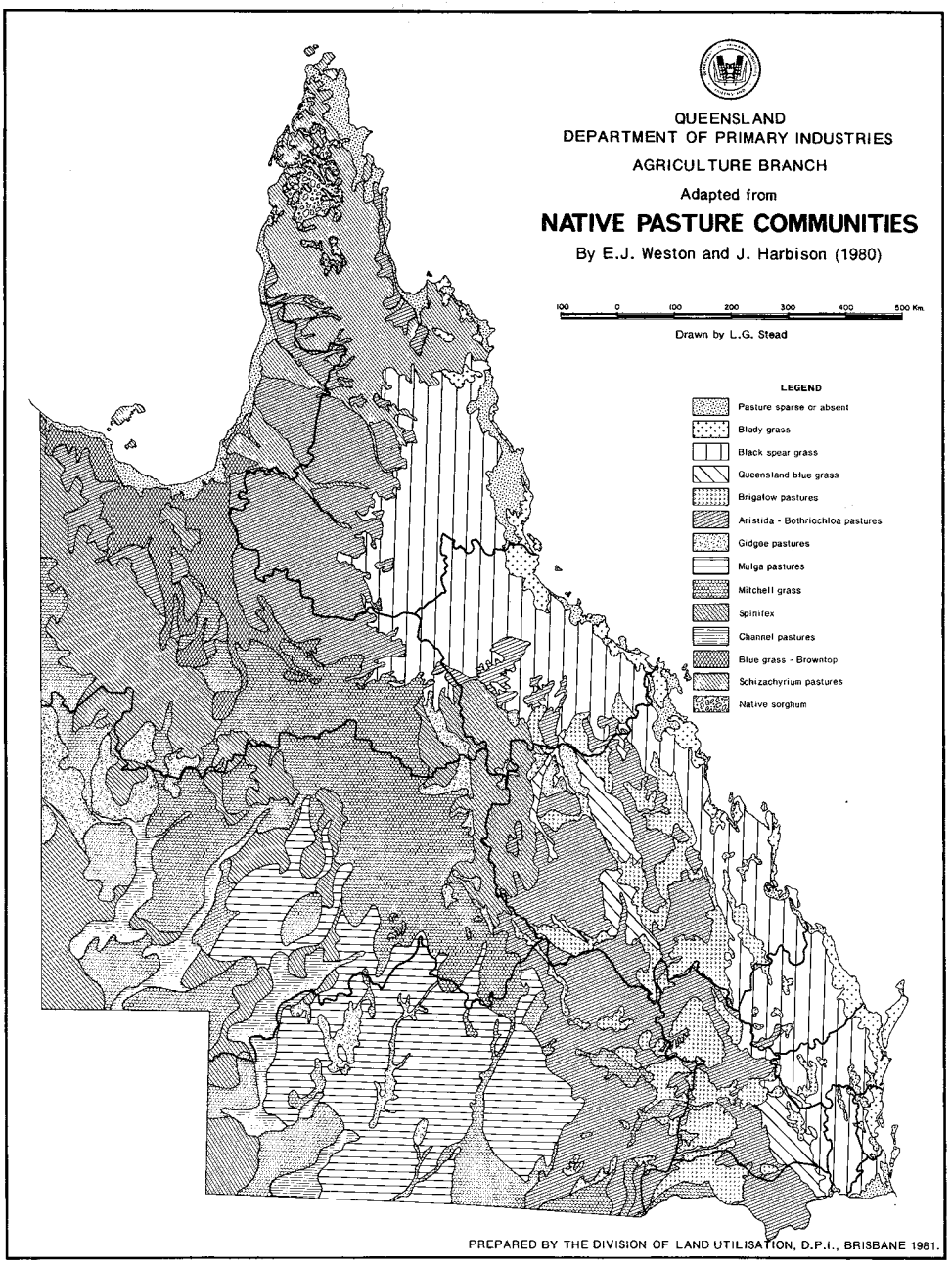

FIGURE 1
The native pasture communities of Queensland

scheduled spelling phase, the regrowth can increase to such an extent that there is insufficient fuel to carry a hot fire. This is particularly the case in the more arid western areas where the potential for grass production is lower than in the more eastern areas. The end result may be the need for an expensive program of mechanical reclamation to keep the area productive.

Fire is an inexpensive management aid, and in times of tight finances it may be preferable to burn than to allow brigalow to grow unchecked and thereby decrease pasture production. However, repeated fires can accelerate pasture degradation, so its use in conjunction with chemicals is preferable (Cameron and Wildin 1976).

Aristida-Bothriochloa complexes

Weston and Harbison (1980) recognize seven distinct groupings of the *Aristida-Bothriochloa* pastures in the State (Figure 1). However, in almost all of these pastures, fire is used often to remove rank growth, increase the accessibility of the green growth, and disadvantage eucalypt regrowth (C. P. Miller, T. W. G. Graham, C. N. Jacobson, K. B. Addison, and W. J. Scattini, personal communication, Hall 1979). The necessity to burn in much of the northern parts of these communities may be reduced if the results of recent research into the introduction of improved pasture species (*e.g.* Bishop 1974a,b) is implemented on a large scale. Even so, fire can be useful at the end of the dry season as it leaves the soil surface in a suitable state for ground machinery or aerial seeding (Bishop 1973b). Fires are however, detrimental to established stands of Townsville stylo (Bishop 1973b).

The poplar box (*Eucalyptus populnea*) associations of the Darling Downs and Near South West also support a sparse understorey of *Aristida* spp., *Chloris* spp., *Eragrotis* spp., and *Thyridolepis* spp. The potential is here to increase productivity by replacing the natural community with buffel grass (*Cenchrus ciliaris*). The tree stratum is either killed or felled (Robertson and Beeston 1981) and the area sown to buffel grass. It is important to encourage the growth of buffel grass in the twelve months following clearing, and this is most readily accomplished by destocking the area. Regeneration of poplar box, sandalwood, *Acacia* spp. and *Cassia* spp. is a problem following this disturbance, but follow-up fires can be effective in containing this regrowth (Harrington *et al.* 1979, Walker *et al.* 1981). Best results have been recorded when the shrubs are <60 cm in height (Moore and Walker 1972, K. C. Hodgkinson, personal communication) though burning alone is not always sufficient to kill *Eucalyptus* spp. because of their ability to regenerate from epicormic buds and lignotubers (Tothill 1971b).

Gidgee pastures

The largest expanse of gidgee (*Acacia cambagei*) pasture in Queensland occurs to the north and west of Boulia with smaller areas in the central-west around Tambo, Blackall and Barcaldine, and in the south-west along the Bulloo River and around Eromanga (Figure 1). Only in the central-west does fire have a significant place in property management. Here, the gidgee overstorey is felled, the trash is burnt as soon as possible, and buffel grass is sown into the resulting ash. Provided the burn is moderate to intense — and this is often the case in gidgee fires when the bark and leaves are still on the stems — little woody weed problem will ensue (Purcell 1964, 1965). A clean initial burn is essential to provide a good seed-bed for the buffel grass, to combat woody weeds, and to facilitate mustering. Providing this is accomplished, these areas can be highly productive (Ebersohn 1970). However, when the buffel grass is satisfactorily established and fuel conditions are adequate, one or more follow-up burns will effectively combat remaining woody weeds such as sandalwood and *Cassia* spp.

Spinifex communities

There are three extensive areas of spinifex (*Triodia* spp.) communities in the state (Figure 1): the central-west (Desert), the south-west, and the north-west or Isa

Highlands spinifex. In all areas, annual fires are detrimental to the pastures, and may lead to erosion, particularly if burning, which leaves the soil surface bare, is followed by high intensity rains. Too frequent burning also results in an increase in the proportion of spinifex and *Aristida* spp. at the expense of the more palatable annual and perennial grasses (Bishop 1973c, Turner 1979). Further, repeated fires can lead to an increase in undesirable woody species such as *Acacia* spp. and *Gastrolobium grandiflorum* (heartleaf poison bush).

The pastures are usually burnt after the first storm rains in spring, and spelled to encourage the growth of annual and perennial grasses between the spinifex tussocks (Suijdendorp 1981). Turner (1979) points out that if these pastures are burnt before the early storm rain, or they are stocked too early after burning, undesirable species, for example *Aristida* spp., become dominant and the spinifex may die out. Bishop (1973c) also indicated that fires after the wet season are detrimental because they destroy the inter-tussock plants so important to the diet of grazing animals. In the central west, selected paddocks are burnt every two or three years (Turner 1979) but the frequency is less in the north-west where a fire every three to four years is preferable (Bishop 1973c).

Only rarely is the spinifex in the south-west of the State burnt, and then mainly by wildfires. Here the low (<200 mm) and variable rainfall makes any major disturbance such as fire all the more significant: fire, followed by an extended drought period, can result in severe degradation of these lands, and increase their susceptibility to erosion.

Mitchell grass rangelands

The Mitchell grass communities of western Queensland are highly productive sheep lands and traverse the State from north to south (Figure 1). Wildfires are reasonably common, particularly in the north-west following above-average summer rainfalls. Until recently burning had not been considered by landholders as a management tool in these grasslands and limited research supported this policy (e.g. Purcell and Lee 1970). The grazier who burns surplus growth is considered to be "short sighted" as fuel for fire in good years may be fodder for stock in the next drought. Nevertheless, some graziers burn in the early spring, often after the first storms, to encourage green pick and to make the fresh growth more accessible to stock.

Recent studies (Scanlan 1980) have shown that there are advantages associated with burning a portion of a property: seeding of Mitchell grass is promoted and higher quality forage is produced. Hall and Lee (1980) suggest that excess dry feed should be removed either by heavy grazing or burning on portion of a property so stock have easy access to the current season's growth. Both of these studies led D. M. Orr (personal communication) to test the hypothesis that animal production is higher on areas supporting a sparse canopy of Mitchell grass than on ones with dense cover because of the greater quantity of high quality forbs which then grow in the inter-tussock areas. This work is continuing, though present indications are that the hypothesis may be in error.

Mulga rangelands

Mulga is the most important fodder tree in Queensland not solely for its nutritional qualities but also because of its extent (Figure 1). Its maintenance is therefore very important. Mulga is very susceptible to fire but its germination is enhanced by fire (Everist 1949, Wilson and Mulham 1979). However, there are many areas in the mulga lands east of the Warrego River where excessive mulga regeneration occurs following pushing for drought feeding or clearing to promote pasture growth (Burrows 1973). If left unchecked, such areas rapidly revert to thick mulga scrub which makes mustering of stock very difficult. Fire has been used by some graziers to contain this growth, but whereas fire has been reasonably successful in the control of mulga, its effect on other woody species can be variable (Wilson and Mulham 1979, Hodgkinson 1979). Further, the response of the ground flora to isolated or regular fires has not been documented, though data are being collected in similar country in north-western New South Wales (K. C. Hodgkinson, personal communication).

In those areas where mulga is scarce, fire is not used and can be detrimental to those fragile arid ecosystems. Wildfires following a series of above average rainfall years only occur once every ten to thirty years. Even so, one wildfire can be sufficient to kill a complete generation of mulga trees, but at the same time it stimulates seedling regeneration.

Other grazing lands

The only areas not so far discussed are the coastal areas dominated by blady grass (*Imperata cyclindrica*); and around the Gulf of Carpentaria dominated by either bluegrass (*Dichanthium* spp.)-browntop (*Eulalia fulva*), native sorghum (*Sorghum plumosum* and *S. australiense*) or firegrass (*Schizachyrium* spp.); and the Channel Country pastures of the far south-west of Queensland. As the latter are not intentionally burnt and wildfires pass through this area only infrequently, they are not discussed further.

The coastal blady grass lands are burnt haphazardly, but usually some areas of blady grass will be burnt each year. Repeated burning leads to progressive dominance of that species and is a key factor in its spread (J. C. Tothill, personal communication). The areas are not important in terms of grazing lands, so they too will not be mentioned further.

The bluegrass-browntop pastures are more extensive than the blady grass areas, and are more important as they, like the Mitchell grass pastures to the south, are productive in terms of animals. Fire is mainly wildfire orientated, though Bishop (1973a) suggests that controlled burns may be a useful adjunct to animal management when followed by spelling. Little is really known of the long term effects of burning on these pastures. J. C. Scanlan (personal communication) suggests that, as the rainfall which these areas receive is greater than that received by the Mitchell grass plains, and as only cattle graze them, bluegrass-browntop pastures should recover in one summer period from the effects of a burn. The effects of repeated burning are not known.

The native sorghum areas of the Gulf and Cape York Peninsula are not of great importance from a grazing viewpoint because they occupy only a small area and support few stock (J. C. Scanlan, personal communication). Studies in the Northern Territory on similar country supporting plume sorghum, (*S. plumosum*), kangaroo grass and golden beard grass (*Chrysopogon fallax*) have shown that regular burning every five years is more favourable in terms of plant production than annual or biennial burning, or no burning at all (Norman 1969).

BURNING IN THE FUTURE

Two main factors will affect the future use of fire in Queensland's grazing areas (Tothill 1971a): the extended feeding of urea-molasses which will allow the utilization of rank grass material; and the continued improvement of native pastures with legumes. However, in those areas where the latter is not likely (most of western Queensland), and where the former does not effectively remove a large proportion of standing dry matter due to exceedingly low stocking rates (e.g. spinifex pastures, bluegrass-browntop pastures) fire will continue to be used to remove excess dry matter, increase the accessibility to stock of green growth, and in the prevention of catastrophic wildfire. In some grazing lands, fire also will continue to play a role to contain woody regrowth.

Regardless of the use to which fire is, and may be put, it is difficult to separate the effects of fire and grazing. When fire is used its impact must be assessed in combination with both the number and type (sheep, cattle, goats) of stock grazing the area following the fire. Similarly, the necessity of assessing the impact of fire on woody weeds in relation to both the fuel available and the phenology of the woody species should not be underestimated.

The pasture communities where we require further knowledge of the effects of fire include those dominated by Queensland bluegrass, *Aristida* spp. and *Bothriochloa* spp.,

mulga, and bluegrass-browntop. Nevertheless for each of the grazing areas in Queensland we need to be able to answer the following questions with adequate confidence:

- Is regular burning going to contribute to pasture degradation or stability?
- How is animal production affected by pasture burning?
- How are woody weeds affected by fire, and at what stage of growth are they susceptible?

The last two questions need only be answered when the answer to the first question confirms that the regular use of fire is not detrimental to pasture and soil stability. The literature (West 1965) and common sense dictate that in areas of low soil fertility and low, variable rainfall, fire be used only rarely, and then only for a very particular purpose (*e.g.* to contain woody weeds or modify pasture composition such as in the spinifex areas). In such areas fire will only be possible following a series of above average rainfall years, so its use will of necessity be opportunistic, and mainly to remove accumulated dry matter. On the other hand, in humid areas fires may be used routinely in a planned management program.

Despite the upsurge in interest in assessing the usefulness of fire in Australian rangelands (e.g. Ralph 1980, Scanlan 1980) and the contribution to the subject made by many groups and organisations (see Conference papers edited by Gill *et al.* 1981, Queensland Fire Research Workshop 1981, personal communication) there remains a dearth of factual data on this topic. Nevertheless, an understanding of the population dynamics and environment of each plant community, together with factors such as fire dynamics, defoliation responses and relative phenology (see for example Walker and Tothill 1981) should allow some intuitive deductions to be made on the likely effects of fire in each pasture type. J. P. Ebersohn (personal communication) claims that only in those situations in which sufficient confidence cannot be placed on these deductions may it be necessary to undertake detailed studies. Finally, while either reasoning or research may lead to the conclusion that fire does have a place in a particular ecosystem, it is probable that grazing management both before and after the burn will be the major factor influencing the success of the operation.

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DRY MATTER AND NITROGEN CHANGES IN FIVE TROPICAL GRASSES AS INFLUENCED BY CUTTING HEIGHT AND FREQUENCY

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ABSTRACT

*A clipping experiment to examine the effect of cutting height and frequency on dry matter yield and nitrogen concentration of five tropical grasses was carried out (1973–75) in a high rainfall, humid environment at South Johnstone in north-eastern Queensland. The grasses examined were common and Makueni guinea (*Panicum maximum*), setaria (*Setaria sphacelata *var.* splendida*), Basilisk signal grass (*Brachiaria decumbens*) and*