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Blade Ploughing or Chaining Unproductive Scrub Improves Pasture Production

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ABSTRACT

Increases in native tree and shrub density, may result in a reduction in pasture and the loss of sustainable economic and ecological production bases. The increasing woody weed problem in the northern Alice Springs district prompted a number of local producers to implement mechanical control methods. No local information previously existed on the effectiveness of the methods used.

*Both chaining and blade ploughing were effective in improving pasture growth and controlling some woody weeds. Pasture growth was enhanced by up to 300% after chaining mature stands of gidyea (*Acacia georginae*) and mulga (*Acacia aneura*), and by up to 225% after blade ploughing juvenile ironwood (*Acacia estrophiolata*), mature mulga and turkey bush (*Eremophila gilesii*).*

INTRODUCTION

As trees or shrubs increase in density pasture is reduced and a sustainable economic and ecological production base may be lost.

Five species have been identified as problem or potential problem species in central Australia. These are

a. ironwood (*Acacia estrophiolata*)
b. mulga (*A. aneura*)
c. witchetty bush (*A. kempeana*)
d. gidyea (*A. georginae*)
e. turkey bush (*Eremophila gilesii*).

Increases in native tree and shrub densities are thought to be triggered by exceptional rainfall, changed fire regimes, grazing, soil type and erosion, acting alone or in combination (Griffin and Friedel 1984; Friedel 1985; Friedel 1986; Hacker 1993). In response to the increasing woody weed problems in central Australia a number of producers implemented chaining and blade ploughing as control methods on limited areas (see Department of Primary Industry And Fisheries Agnote, Mechanical control of woody weeds). To determine the benefits of using either method a number of sites were selected and the effect on target species and pasture growth was examined.

METHODOLOGY

Site selection

Twenty six sites were selected on 5 participating properties north of Alice Springs within the following boundaries (136° 49'E, 23°11'S, 132°22'E, 21°07'S).

The sites were designed to measure the effect of chaining or blade ploughing on the target species and pasture species. The 150 m x 150 m sites were positioned so that one site was selected within the treated area, and another site was selected close by in a comparable untreated area. All sites were in paddocks grazed by cattle in a free range system.

In 1990, eight paired sites were selected. Each paired site consisted of one chained area and one corresponding unchained area. One paired blade ploughed site was established in 1991 and a further 4 in 1993. Response of the target and pasture species were recorded and compared in treated and untreated areas.

Treated and untreated areas were on uniform pasture type and land systems to allow meaningful comparisons of total pasture yield, pasture composition and tree densities. The sowing of the perennial grass seed buffel grass (*Cenchrus ciliaris*) was included in all blade ploughing operations.

Sites were identified with numbered steel droppers. Photographs were taken at each site from the same position annually to highlight visual changes in pasture yields and tree densities.

Tree counts

Tree counts were completed on the control sites at commencement of the trial to establish either percentage cover or number of trees/ha. Three straight line transects 150 metres long and 2 metres wide within the site were used. Tree numbers on the transects were recorded and grouped into species.

Pasture assessments

Pasture assessments were completed during the winter months each year. Total dry weight of pasture was estimated for each site by the comparative yield technique of Haydock and Shaw (1975) as improved by Friedel and Bastin (1988).

The dry-weight-rank method measuring botanical composition first developed by 't Mannetje and Haydock (1963) and later refined by Jones and Hargraves (1979), was used to determine botanical composition.

At the end of the study period the pasture composition of all the species were grouped together and the mean of the three major pasture components established for both the treated and the untreated sites for the purpose of comparisons.

RESULTS

1. Chaining

1.1 *Shrub density*

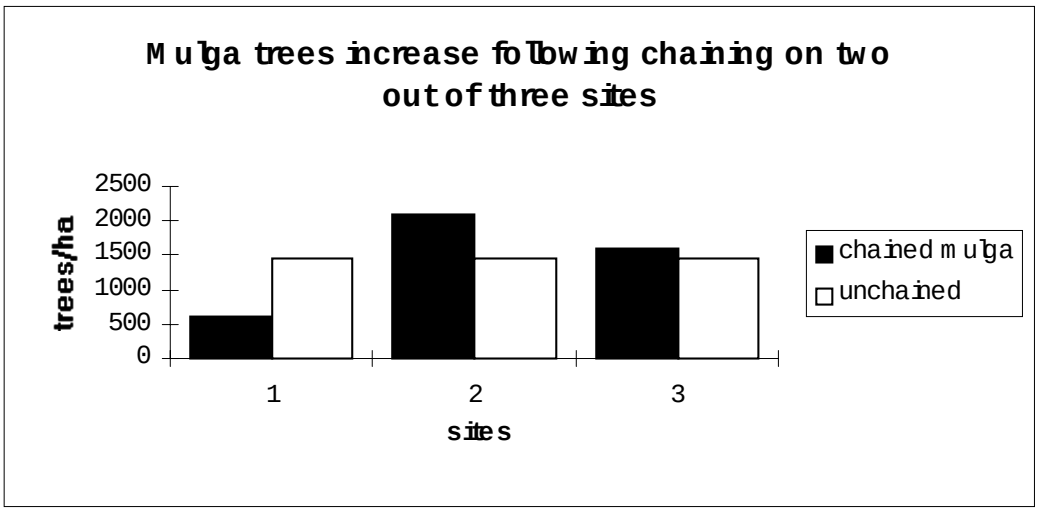
i) *Gidyea* (4 paired sites)
Chaining gidyea removed all mature trees. After 6 - 8 years there has been no obvious germination or suckering. Visual observations suggest the density of trees on the control area has not altered. Rainfall on the gidyea sites was average to above average.

ii) *Witchetty bush* (1 paired site)
Witchetty bush numbers were significantly reduced on the single site after chaining. There has been little recruitment since on both the treated and untreated site.

iii) *Mixed mulga and witchetty bush* (1 paired site)
Densities of mulga decreased from 1566 trees/ha to 730 trees/ha following chaining. In contrast witchetty bush density increased after chaining from 890 trees/ha to 1290 trees/ha.

iv) *Mulga* (3 chained sites 1 common unchained site)
Prior to chaining, densities of mulga on the untreated area were 1460 trees/ha. Following chaining there was a proliferation of juveniles on two of the three locations. Juveniles increased to a mean of 1855 trees/ha on the two sites. This is greater than initial densities (Figure 1).

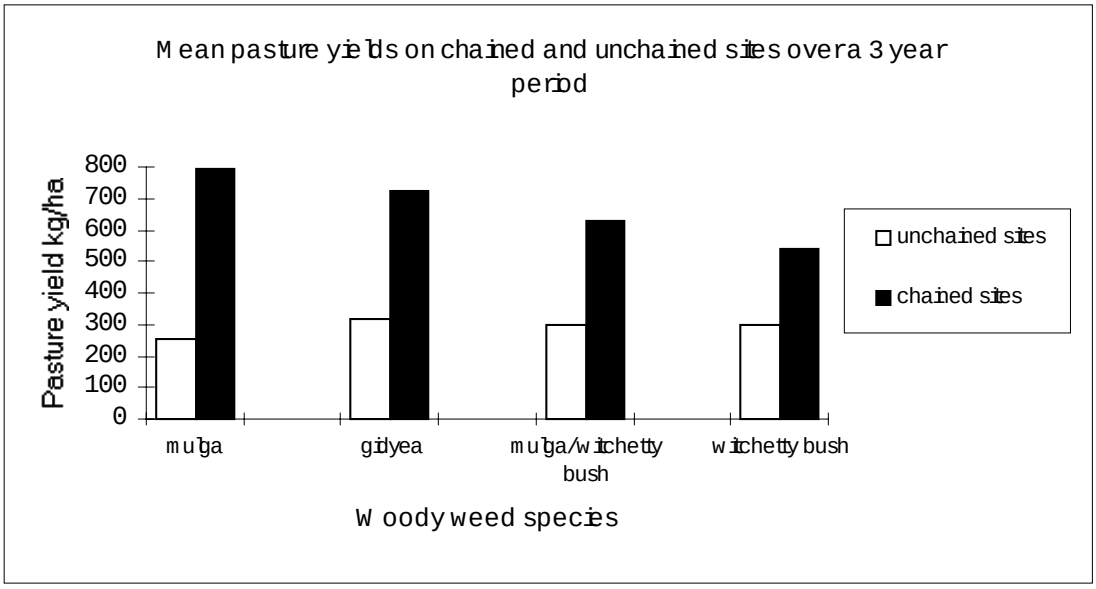
Figure 1: The number of mulga trees/ha following chaining



1.2 Pasture yield

Pasture yields differed significantly between the treated and untreated groups (Figure 2). Response has been variable with the seasons but substanially greater on all chained sites. Following the chaining of gidyea, pasture yield increased by a mean of 435 kg/ha over three years. Mean pasture yield on the chained mulga sites increased by 543 kg/ha. The quantity of pasture on the chained witchetty bush and mixed mulga/witchetty bush sites varied between a mean of 539 - 628 kg/ha. In contrast, the unchained sites realised a mean of 300 kg/ha over the same period.

Figure 2: Pasture yield in kg/ha with and without chaining *



* The mean yield figures were calculated from
4- gidyea sites on 2 properties
1- witchetty bush site
1- mulga/witchetty bush site
3- mulga sites on 1 property

1.3 Pasture composition

The composition of the pasture altered only slightly after chaining (Figure 3).

Figure 3: Composition of the pasture on chained and unchained sites

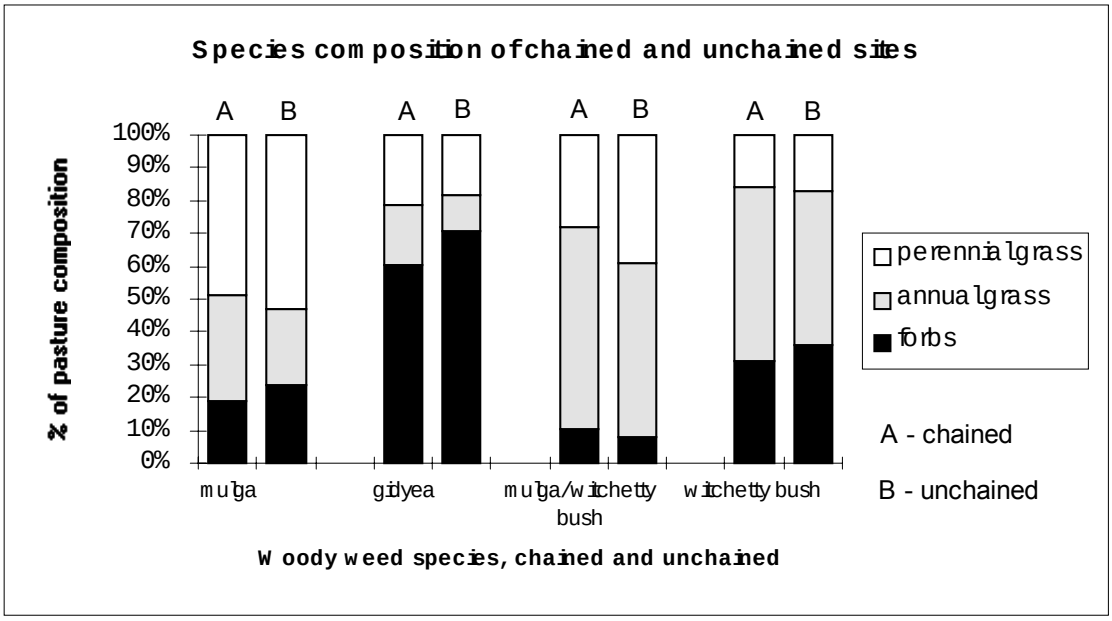


Table 1: Mean of species composition on all chained and unchained sites over the study period.

	annual grass %	perennial grass %	forbs %	total %
mean of unchained sites	33.5	31.75	34.75	100
mean of chained sites	41.5	28.5	30	100

2.Blade ploughing

There has been limited use of the blade plough in the Alice Springs area. Currently there are ten sites. Four have been in place for two years and the remaining six have been in place for three years.

2.1 *Shrub densities*

i) *Mulga*
To date the results have been positive with most or all of the target species removed in the operation. In some instances densities of mulga were as high as 5400 trees/ha prior to treatment.

ii) *Mixed mulga and turkey bush*
The initial density of mulga was around 5400 trees/ha and 290 turkey bush shrubs/ha. These trees and shrubs were removed by the blade plough and there are no obvious signs of regrowth or germinations.

iii) *Mixed mulga and spinifex*
Spinifex covered approximately 39% of the site and there were 1733 mulga trees/ha. Following blade ploughing, the mulga and the spinifex were controlled. Two years after blade ploughing with average to below average rainfall there has been no germination or regrowth of either species.

iv) *Ironwood*
Although only one site exists for blade ploughed ironwood the results have shown blade ploughing controls juvenile ironwood trees.

2.2 Pasture yields

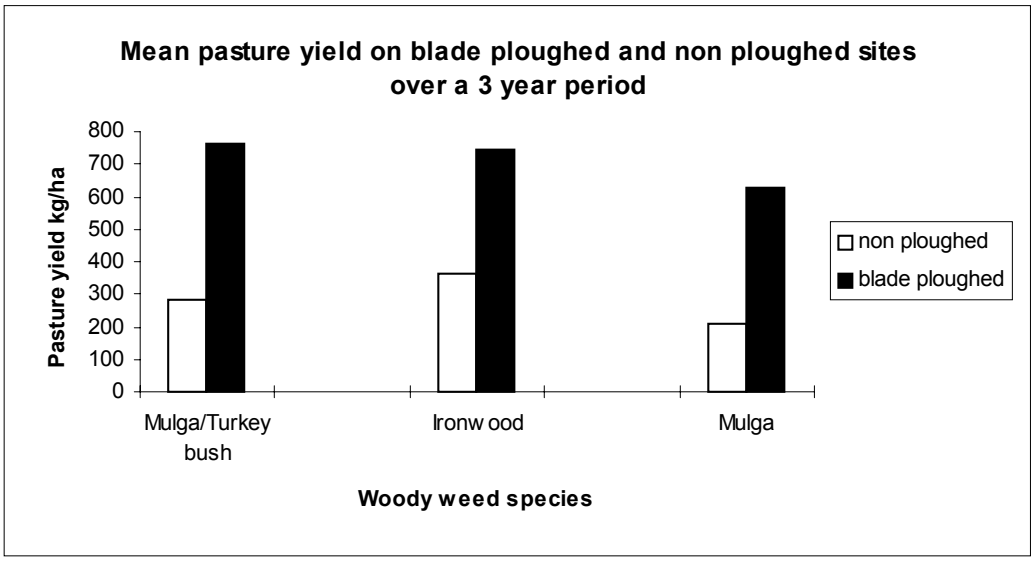
i) Mulga
The quantity of pasture on the mulga study areas between 1993 to 1995 was a mean yield of 630 kg/ha on the blade ploughed area and 212 kg/ha on the non ploughed site (figure 4).

ii) *Mixed mulga and turkey bush*
Blade ploughing mixed mulga and turkey bush resulted in a mean pasture yield of 765kg/ha over three years compared to a mean yield of 285kg/ha on the non ploughed area (figure 4).

iii) *Ironwood*
Following blade ploughing the mean yield was 746 kg/ha with the corresponding control recording a mean yield of 361 kg/ha (figure 4).

iv) *Mixed mulga and spinifex*
Within 12 months of blade ploughing mixed mulga and spinifex there was an increase in pasture yield of 390 kg/ha or (69%). In the second year this increase was 664 kg/ha or (90%).

Figure 4: Pasture yields on blade ploughed and non-ploughed sites*

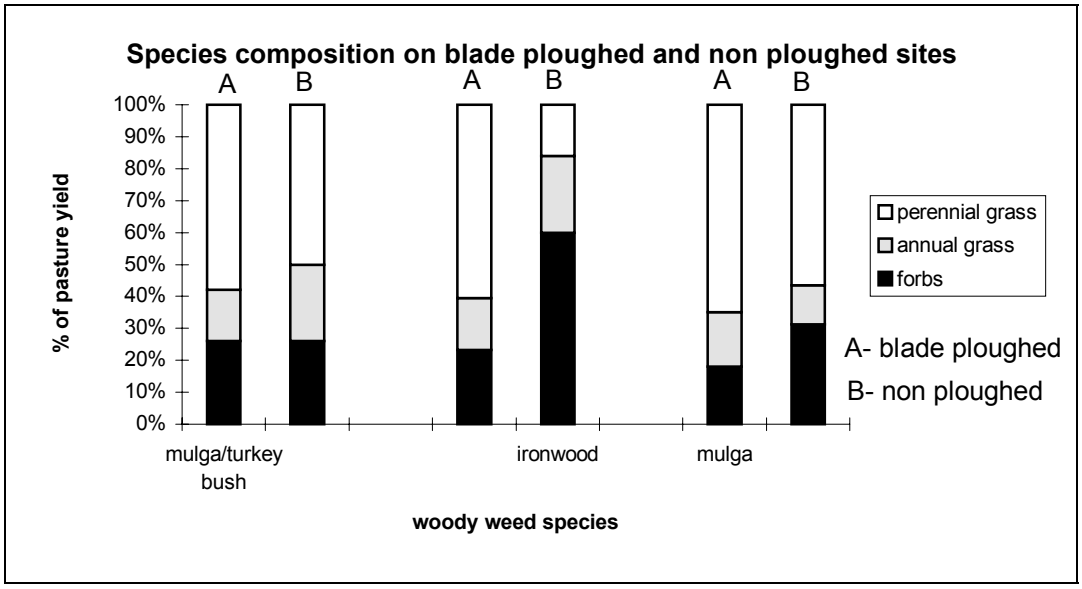


* The mean yield figures were calculated from
1- mulga/turkey bush site
1- ironwood site
3- mulga sites

2.3 *Pasture composition*

Perennial grass dominated pasture composition on blade ploughed and non-ploughed sites in all but one instance (Figure 5). The blade ploughed ironwood site was dominated by perennial grass (mainly buffel grass) for 3 years. On the remaining blade ploughed sites the species composition has been similar to the controls. The buffel grass established well from sowing and the mean frequency of occurrence was 71% on all treated sites.

Figure 5: Composition of the pasture on ploughed and non-ploughed sites



DISCUSSION

In the medium term both chaining and blade ploughing have proved to be effective methods of controlling woody weeds in the Alice Springs district. A high mortality has occurred immediately following treatment with most of the target trees and shrubs removed.

Removal of the woody weeds has allowed the pasture yield to increase on all sites. There is limited information available on the relationships between increased shrub density and reduced pasture productivity. Beale (1973) found herbage production to be inversely related to tree density, with lower tree density areas producing significantly more herbage. A link between increased shrub densities and a loss of pasture production has been confirmed in this study. The trial has demonstrated that densities of between 1460 - 5400 trees/ha have been responsible for losses in pastoral production.

Chaining

In central Australia chaining is the more widely used technique for mechanical control of woody weeds. This technique has been used with mixed success in the arid areas of other states for a number of years, on a number of woody weed species including *Acacia*, *Dodonaea*, *Cassia* and *Eremophila* species. Chaining is largely ineffective against young stands of woody weeds. Its use is best confined to old stands where a significant proportion of the shrubs are large enough to be pulled from the ground (Harland & Kelly 1993).

A number of factors will affect the success of chaining, including seasonal conditions prior to and during the chaining, and the presence of juvenile trees in respect to mortality rates. There was a mixed response to chaining by a variety of local woody weed species including gidyea, witchetty bush and mulga. In all instances following chaining however, the pasture yield was enhanced.

The data collected supports the use of chaining for removal of mature gidyea trees. Control has been achieved with minimal regrowth. Chaining to control dense stands of mature mulga trees has been successful but care needs to be taken when considering this as a control option. If there are a number of juvenile plants present at the time of chaining it is highly probable they will survive and proliferate.

Chaining of witchetty bush is applied with considerable risk. By the nature of witchetty bush it is possible for the chain to pass over the bush allowing the plant to bend over and not be pulled from the ground. This allows the plant to either spring back or grow back from the roots still in the ground. From our sites and local producer experience it is concluded that the initial reduction of the target shrub is often marred by the substantial regeneration which occurs in the years following treatment. Without knowledge of the conditions prior to and during chaining, it is difficult to propose a reason for the proliferation of the witchetty bush on some of the trial sites. There may have been a large number of juveniles present at the time of chaining.

Costs of chaining

"The cost per acre of the primary treatment is generally lower than other mechanical options on moderate and dense areas... When chaining is used on woody weeds that may regenerate from root suckers or seed... It is thought that there is invariably a need to apply a second treatment within a relatively short time" (Harland 1992). This will further add to the cost and increase the period that the paddock will be out of use. The cost of chaining will vary with target species, soil type, moisture content and tree size. In the Alice Springs district the cost of chaining in 1991 was estimated to be about $12 - 20 per hectare for a single pass. A survey of contractors in western NSW indicated the cost is likely to be between $15 - 25 per hectare for country largely dominated by woody weeds (Harland & Kelly 1993).

Blade ploughing

In Australia there is little published information on long-term responses of semi-arid vegetation to blade ploughing (Robson 1995). After three years most of the target species have been controlled on trial sites in the arid vegetation of the Alice Springs district. To date there is no evidence of germination from seed or regrowth following blade ploughing. The average to below average rainfall in the study area has made conditions unsuitable for germination.

Removal of woody weeds has in some instances allowed the pasture yields to improve up to 664kg/ha (90%). Sowing buffel grass in the ploughing operation has increased the maximum yield potential, and contributed to significant improvements of yields in the short term. Buffel grass contributed a mean of 61% to the total pasture yield after three years.

Experiences in other states suggests that pasture regeneration after ploughing is reliant upon the country being spelled for a period of time. This is necessary to allow establishment of either native and or introduced perennial pasture species (Harland 1993).

In western NSW exclosures were established to compare pasture responses of grazed and ungrazed areas after blade ploughing. In almost all cases pasture establishment was far greater on the ungrazed areas. In some instances it was found that after three years, native perennial pasture had failed to regenerate on ploughed areas that had been grazed (Harland 1993).

In the Alice Springs district all of the blade ploughed areas have been sown to buffel grass. It would be interesting to collect information on the ability of native pasture to rejuvenate after blade ploughing without buffel grass seed being sown. If successful this would remove the need to purchase seed, thereby reducing the costs. Interestingly, on the blade plough sites that were sown with a perennial grass seed the amount of perennial grass on all the treated sights only increased by a mean of 10% after a total of 3 years when compared to the non-ploughed areas. Our data suggests that season is the overriding influence on pasture response and composition. This suggests that if an area was blade ploughed and suitable conditions existed afterwards it would be reasonable to expect a good response from the native perennial seed in the soil and expect it to establish in much the same manner as the sown perennial seed.

Costs of blade ploughing

Blade ploughing is an expensive option and cost will vary between soil type and target species. On hard mulga country and mixed spinifex/mulga country, blade ploughing carried out in 1993 by a local pastoralist was estimated to cost between $74 - $79 per hectare. In western NSW experiences from trials indicate that cost varies between $40 - $85 per hectare (Harland 1993).

The high cost of blade ploughing will preclude its widespread use for control of woody weeds. Adoption of blade ploughing will be limited to the control of woody weeds in the smaller areas which are more intensively used such as holding paddocks, laneways, and dense isolated clumps. Its use will allow returns to be optimised in these areas.

Conclusions

The study indicates that

- Chaining will successfully control gidyea.
- Chaining mulga and witchetty bush can be successful but care needs to be taken when considering this option.
- The presence of juvenile trees or shrubs will lessen the success of the treatment.
- Pasture yield in the treated sites has in all instances far surpassed the untreated sites.
- Pasture species diversity has not altered greatly following chaining of gidyea, witchetty bush, or mulga.

The study also indicates

- Blade ploughing is effective in removing mulga, mixed mulga/spinifex, mixed mulga/turkey bush and juvenile ironwood.
- Blade ploughing the target species stimulated significant increases in pasture yield.
- Sowing buffel grass in the same operation has increased the maximum pasture yield potential by a mean of 10% of the total yield on the study area.
- Species diversity has remained mainly similar to the control sites indicating in most
- cases that season is the overriding factor in determining the pasture composition.

References

Bastin, G. (1989). Mechanical control of Woody Weeds. Agnote 343

Beale, I.F (1973). Tree density effects on yields of herbage and tree components in south west Queensland mulga (*Acacia aneura* F . Muell.) scrub. *Tropical Grasslands*. 7: 135-42.

Friedel, M.H (1985). The population structure and density of central Australian trees and shrubs, and relationships to range condition, rabbit abundance and soil. *Australian Rangeland Journal*. **7** (2): 130-39.

Friedel, M.H (1986). The interaction with climate, soil and land use, of central Australian tree and shrub populations. IN *Rangelands a resource under siege*. pp 45-6 Proceedings of the second international rangeland congress. Canberra: Australian Academy of Science.

Friedel, M.H. & Bastin, G.N. (1988). Photographic standards for estimating comparative yields in arid rangelands. *Australian Rangeland Journal.* **10**: 34-8.

Griffin, G.F. & Friedel, M.H. (1984). Effects of fire on central Australian rangelands. II Changes in tree and shrub populations. *Australian Journal of Ecology*. **9**: 395-403.

Hacker, R. (1993). Grazing management and woody weed control in the semi-arid woodlands. IN *Managing for woody weed control in Western NSW* pp 9.(R. Harland, ed) Dubbo, NSW Woody Weeds Task Force.

Harland, R. (1993). Blade ploughing for woody weed control. *IN Managing for woody weed control in Western NSW* pp 16-18. (R. Harland, ed) Dubbo, NSW Woody Weeds Task Force.

Harland, R. & Kelly, S. (1993). Chaining for woody weed control. *IN Managing for woody weed control in Western NSW* pp 26-7.(R. Harland, ed) Dubbo, NSW Woody Weeds Task Force.

Haydock, K.P. & Shaw, N.H. (1975). The comparative yield method for estimating dry matter yield of pasture*. Australian Journal of Experimental Agriculture and Animal Husbandry.* **15**: 663-70.

Jones, R.M. and Hargreaves, J.N.G. (1979). Improvements to the dry-weight-rank method for measuring botanical composition. *Grass and Forage Science*. **34**: 181-9.

Robson, A.D. (1995). The effects of grazing exclusion and blade-ploughing on semi-arid woodland vegetation in North-Western New South Wales over 30 months. *The Rangeland Journal*. **17**(2): 111-27.

‘t Mannetje, L. and Haydock, K.P. (1963). The dry-weight-rank method for the botanical analysis of pasture. *Journal of the British Grassland Society*. **18**: 268-75.