Management of *Calliandra calothyrsus* for fodder production in Jamaica

*Michigan State University, Department of Forestry, East Lansing, Michigan, USA*

Abstract

A trial was established to examine the harvest potential of *Calliandra calothyrsus* for fodder. An established plantation was subjected to 2 cutting heights (75 and 150 cm) and 2 cutting intervals (9 and 12 weeks) for a period of 12 months. Yields per annum were greater under longer cutting intervals. Cutting height had no impact on annual yields. Dry matter yields of up to 12 t/ha/yr were achieved with a combination of 150 cm cutting height and 12-week cutting interval. Cutting interval had an effect on the proportion of usable fodder with 78.7 and 72.3 percent of the total biomass being usable fodder with the 9- and 12-week intervals, respectively. Yields of individual scheduled harvests decreased over the cutting period. At the end of 12 months of regular harvesting, plots were left uncut for a period of 6 months. Final evaluation of the plots after the 6-month recovery phase showed that the management regimes imposed may exceed the regrowth capacity of the calliandra plantation at this site.

Introduction

*Calliandra calothyrsus* (calliandra) is a species which has been widely documented as a useful component in agroforestry systems (Palmer et al. 1994). It has been used as a valuable firewood species in Indonesia for several decades (Palmer et al. 1994), and is being investigated in many other regions. Although adapted to a wide variety of conditions, it is most appropriately used in regions with greater than 1000 mm of annual rainfall, and mean annual temperatures greater than 20°C (Palmer et al. 1994). It is a valuable fodder species for ruminants (Devendra 1989), with a crude protein content of 22 percent (Anon. 1983). The in vitro dry matter digestibility of leaves, green stems and woody stems has been reported as 35, 43 and 28 percent, respectively (Baggio and Heuveldop 1984). In Indonesia, rural communities frequently cut calliandra for forage, and the plant is often browsed by livestock (Palmer et al. 1994). It should be noted that the advantages of calliandra as a forage can be limited by high tannin content (Lowry 1989).

Optimal management of fodder tree production involves the regulation of key factors including cutting height, cutting frequency and tree density (Horne et al. 1985). The majority of reported management studies have tested *Leucaena leucocephala* (leucaena), but several studies have reported on the management of calliandra. Results vary, but it is clear that row spacing and planting density have an effect on both leaf and wood yield, with greater densities producing higher yields (Ella et al. 1989, 1991a; Rosecrance et al. 1992). Cutting interval is also an important factor, with longer intervals producing higher yields (Ella et al. 1989, 1991a; Krecik 1993). Leaf and wood yields of an initial cutting of calliandra increased with increased plantation age at the initial harvest (Ella et al. 1991b). Varying cutting height has less effect on leaf production than wood production (Catchpoole and Blair 1990). These findings agree with results reported for leucaena (Guevarra et al. 1978; Ferraris 1979; Krishna Murthy and Mune Gowda 1982; Horne et al. 1985; Duguma et al. 1988).

Calliandra fodder yield was approximately 4 times that of both *Glyricidia* (glicidia) and leucaena planted at a 1.5 × 1.5 m spacing at the same site in St Ann Parish, Jamaica (Krecik
Managing calliandra for fodder

1993). However, aggressive growth eliminated grass competition and the combined yield of grass and tree fodder on glicidia and leucaena plots was greater than the total production on the calliandra plots.

Research on *Calliandra calothyrsus* in Jamaica is limited. Four species (*C. pilosa*, *C. portoricensis*, *C. comosa*, and *C. paniculata*; Adams 1972) are reported to occur in Jamaica, but are not used in agroforestry systems. *C. calothyrsus* has been planted in Jamaica for land restoration and wood production (R. Brown, personal communication; L. Knight, personal communication). Trials in Moneague, St Ann Parish, have shown that *C. calothyrsus* can be established by seedlings (Roshetko 1991), and that it can be pruned repeatedly for fodder production (Krecik 1993). The study described here is a continuation of an earlier study by Krecik (1993) and examines the effect of cutting height and cutting interval on calliandra fodder production and plantation longevity.

**Materials and methods**

**Study site**

This trial was carried out near Moneague, St Ann (18°16'N, 77°07'W) on Alcan Jamaica’s RioHoe Farms. Site elevation is 500 m and annual temperatures range from 15–25°C. The mean annual precipitation of 2000 mm falls during 2 rainy seasons from April–June and August–November (Roshetko 1991). Soil water deficits normally occur during July, and December through late March (Anon. 1982). Soil type is a Bonneygate-St Ann clay loam which is low in moisture supplying capacity and low in natural fertility (Anon. 1982). A pH of 7.48, total nitrogen of 0.42%, available phosphorus of 7 ppm, and available potassium of 95 ppm have been reported (Roshetko 1991). Predominant grass species are *Panicum maximum* and *Brachiaria mutica*.

**Trial establishment**

In September 1990, calliandra seedlings were transplanted on a 1.5 × 1.5 m spacing in 17 rows of 17 trees. The planting area had a finished size of 25.5 × 25.5 m with a total of 289 trees. Seedlings were inoculated with rhizobium in the nursery and a check of root systems at planting indicated the presence of functioning nodules. Monthly weed control was carried out for 6 months after establishment (Roshetko 1991).

In November 1991, a 2 × 2 factorial set of treatments were applied to the calliandra plantation in a split-split block design. The plantation was subdivided into 4 blocks with a border row of trees separating blocks. Blocks were then split and one of 2 cutting height treatments (75 and 150 cm) randomly assigned to the same half of each block. The split-blocks were further subdivided for the establishment of cutting interval treatments (9 and 12 weeks). Measurements were taken from four 9-tree measurement plots within blocks. Measurement plots were surrounded with unmeasured tree rows retained as common borders between plots.

**Fodder harvest**

All trees were cut at the prescribed height and interval beginning in November 1991. Fresh weight of harvested fodder for each sample tree was recorded in the field. Random samples of the harvested material were collected in each plot for dry matter determination, and estimation of the proportions of woody material (diameter > 5 mm) and foliage (diameter < 5 mm) (Krecik 1993). Regular harvesting continued until the beginning of the winter dry season in the first week of December 1992. Trees recovered with the onset of spring rains in March 1993 and the final harvest of all plots occurred on June 21, 1993.

Yield differences between cutting dates were compared using a Wilcoxon signed rank test, and differences among treatments were compared using a Kruskal-Wallis one-way analysis of variance (Hollander and Wolfe 1973). Non-parametric statistical methods were used because of the lack of randomisation of cutting interval treatments within blocks.

**Results**

Fodder yields for each harvest and all treatments exhibited a general decrease throughout the cutting cycle (Figure 1). This decrease was particularly evident in the 9-week treatment, where mean fodder dry matter yields dropped from 1.8–2.7 t/ha for Cut 1 to below 0.10 t/ha for Cut 6. A decrease was also noted in the 12-week
cutting cycle, with fodder dry matter yields dropping from over 3.3 t/ha for Cut 1 to approximately 1.8 t/ha for Cut 4. These decreases were shown to be statistically significant (P<0.004).

All treatments recuperated following a rest period from December 1992–June 1993. The mean dry matter yield from all plots from the final cutting in June 1993 was 4.4 t/ha. The yield for the 6-month regrowth was nearly 70 percent of the mean cumulative yield of all previous cuts for the 75 cm-9 week treatment (Table 1). The yields for the 6-month regrowth for all treatments ranged from 3.4–6.0 t/ha (Table 1) and this variation was found to be non-significant. For all treatments, the cutting in June 1993 exceeded all previous individual harvests by at least 12 percent, but up to 73 percent for the 75 cm-9 week treatment.

Cutting cycle dry matter yields ranged between 6.4–12.1 t/ha (Table 1). Total cumulative yield over the course of the experiment ranged from 10.7 t/ha for the 75 cm-9 week treatment, to 16.0 t/ha for the 12 week-150 cm treatment. The overall estimated mean annual dry matter yield based on all observations was 8.5 t/ha/yr.

The mean usable fodder proportion (material less than 5 mm in diameter) of the harvested biomass was determined as 75.5 percent. While cutting height did not affect the proportion of usable fodder, cutting interval did have a significant effect. The 9-week and 12-week treatments yielded 78.7 and 72.3 percent usable fodder, respectively, a significant difference (P<0.05). This resulted in a cumulative fodder dry matter yield of 7.1 t/ha/yr for the 9-week treatments and 9.8 t/ha/yr for the 12-week treatments.

Visual evaluation showed a decline in survival

**Table 1.** Dry matter yield (kg/tree; kg/ha) for the 12-month cutting cycle (Nov 1991–Dec 1992), the final harvest (June 1993), and the cumulative total (Nov 1991–June 1993).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cutting interval — 9 weeks</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cutting height</td>
<td>Total biomass</td>
<td>Usable fodder</td>
<td>Cutting height</td>
<td>Total biomass</td>
<td>Usable fodder</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>75 cm</td>
<td>150 cm</td>
<td>per tree</td>
<td>per ha</td>
<td>per tree</td>
<td>per ha</td>
<td>per ha</td>
<td>per tree</td>
<td>per ha</td>
<td>per tree</td>
<td>per ha</td>
<td>per tree</td>
<td>per ha</td>
<td>per ha</td>
</tr>
<tr>
<td>Cutting cycle (Nov 91–Dec 92)</td>
<td></td>
<td>1.45</td>
<td>6440</td>
<td>1.93</td>
<td>8560</td>
<td>7500</td>
<td>5900</td>
<td>2.10</td>
<td>9300</td>
<td>2.72</td>
<td>12100</td>
<td>10700</td>
<td>7700</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final cutting (June 93)</td>
<td></td>
<td>0.95</td>
<td>4230</td>
<td>0.77</td>
<td>3390</td>
<td>3800</td>
<td>3000</td>
<td>1.36</td>
<td>6020</td>
<td>0.89</td>
<td>3900</td>
<td>5000</td>
<td>3600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative total (Nov 91–Jun 93)</td>
<td></td>
<td>2.40</td>
<td>10670</td>
<td>2.70</td>
<td>11950</td>
<td>11300</td>
<td>8900</td>
<td>3.46</td>
<td>15320</td>
<td>3.61</td>
<td>16000</td>
<td>15700</td>
<td>11300</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
during the final third of the harvest phase (Figure 2), but following the 6-month recovery phase, stems which had previously been incorrectly evaluated as dead had established new shoots from the root crown. Thus, the estimates of survival increased in the final phase of the experiment for the 9 week-150 cm treatment and the 12 week-75 cm treatment. The final mean survival rate after 1.5 years of harvest was 71 percent.

Discussion

In our experiment, the primary factor influencing yield was cutting interval. Over 18 months, the management regime resulting in the greatest overall yield combined a longer cutting interval (12 weeks) and a greater cutting height (150 cm). This confirms the findings of Ella et al. (1989; 1991a), that longer cutting intervals result in higher annual leaf and wood yields than shorter intervals. Additionally, Catchpoole and Blair (1990) found that, as cutting interval increased, wood production increased, although leaf production was unchanged.

Cutting interval also had a significant effect on the proportion of leaf material (usable fodder). In this study, increasing harvest interval from 9 to 12 weeks decreased the proportion of usable fodder in dry matter produced, and increased the proportion of wood. Catchpoole and Blair (1990) showed that increasing harvest interval from 7 to 15 weeks also reduced the proportional leaf yield from approximately 70 to 50 percent. Nevertheless, a 12-week harvest interval produced more usable fodder than a 9-week interval in this study. This suggests that a harvest interval of greater than 12-weeks will increase total biomass yield, and, if the decrease in the usable fodder proportion is small, also increase usable fodder yield.

Our study does not indicate if a cutting interval of greater than 12-weeks will improve the rate of survival. The pattern of decline in Figure 2 suggests that continuous periodic harvesting exceeded the regenerative capacity of calliandra under the observed growing conditions. Repeated removal of nutrients from the site in the fodder harvests may be contributing to the decline over time. Balasubramanian and Sekayange (1991), pruning C. calothrysus 4 times per year in Rwanda, found a mean survival rate of 94 percent after 1 year and 72 percent after 4.5 years. This compares with a survival rate of 71 percent in our study after 1 year of regular harvest and a 6-month recovery phase. To accurately quantify survival, proper cutting interval and resultant fodder yield, a more extensive and long-term experiment, testing a greater range of cutting intervals and the effect of fertiliser on the sustainability of various cutting regimes, is required.

Cutting height had no overall effect on dry matter yields. Although the 150 cm cutting height produced greater yields initially, at the 18-month cutting, treatments subjected to the 150-cm cutting height were the lowest yielding. One explanation may be the proximity of new buds

![Figure 2](attachment:image.png)

*Figure 2.* Percent survival of *Calliandra calothrysus* cut at 9-week and 12-week intervals at 2 cutting heights from November 1991–December 1992, with a final harvest in June 1993.
to roots and root hormones (Blake 1983), which may affect the regrowth potential of woody plants.

A realistic strategy for fodder bank management is to maintain the trees intact until fodder supply becomes critical (Paterson et al. 1987). The results of this experiment suggest that a strategy of this type would be suitable for these seasonally dry conditions. Trees should be allowed to grow until periods of fodder shortage occur, and then be harvested on an intense cutting cycle. Following this phase, trees could then be left intact or harvested intermittently to maintain a shrub-like habit, until the next seasonally induced fodder shortage. This system would permit extraction of high fodder yields during periods of greatest need, and the subsequent rest period would allow a restoration of growth capacity. According to our results, yields remained at an acceptable level for 24–30 weeks, and a 30-week rest phase allowed a full recovery. This coincides well with the seasonal drought-induced, pasture grass shortages that occur throughout Jamaica and the Caribbean Basin.


Acknowledgements

Appreciation is expressed to the Jamaican Agricultural Development Foundation, especially Dr George Wilson and Dr Lyndon McClaren, for their financial support and to Alcan Jamaica for their cooperation in providing the trial site. Many thanks to those who provided assistance in harvesting the plots: R. Garrick, Z. Campbell, D. Kelly, G. Haye, T. Tucker, S. Mackenzie, and O. Grant. Thanks are also due to Dr T.J. Blake, University of Toronto, and Dr M.S. Allen of Michigan State University, for their review and insightful comments on the manuscript.

References


(Received for publication May 6, 1994; accepted June 20, 1995)