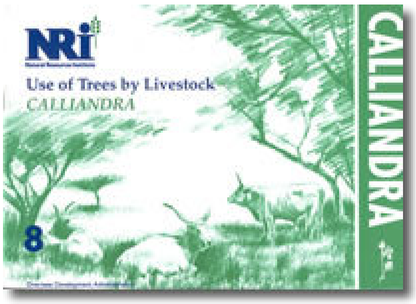

Use of Trees by Livestock: *CALLIANDRA*

Fodder characteristics

The species which has attracted most attention for its capacity to produce both fuelwood and foliage for either green manure or fodder is *C. calothyrsus*, a small tree which grows to about 10 m in height. It is of Central and South American origin, occurring naturally in moist, tropical regions up to an altitude of some 1500 m. While it grows up to 2000 m in Kenya, production is limited at this altitude, probably by the low temperatures (Lowry and Macklin,1988). It appears to do best with annual rainfall in the range of 2000-4000 mm (NRC,1983). While it will grow in areas that receive 700-1000 mm rain/year, productivity is reduced by low rainfall (Akkasaeng *et al.*, 1989). It is evergreen in humid environments but will shed its leaves during a long, dry season. Under conditions of severe drought, young stems and branches may die back, but they usually regrow when the rains return. Mature branches become brittle and may be easily broken by animals, although this is not a problem where judicious cutting is practised.

The palatability of the foliage appears to be variable but it is accepted, at least in limited quantities and when mixed with other feeds, by most livestock, including sheep, goats, cattle and water buffalo (Brewbaker *et al.*, 1983; NRC,1983; Baggio and Heuveldop,1984). It has been classified as unpalatable to rabbits, although they consumed significant amounts of it, when mixed with grass and herbaceous leaves. Foliage of other fodder trees such as *Leucaena leucocephala* and *Albizia falcataria* were eaten in much larger quantities (Raharjo and Cheeke, 1985). In Java, *Calliandra* leaf meal is used at levels of up to 5% in diets for chickens (Panjaitan,1988).

Until recently, most plantings of *C. calothyrsus* were based on seed from a limited number of provenances from poorly documented sites in Guatemala, Costa Rica and Honduras. In 1990, a programme was initiated by the Oxford Forestry Institute (based in UK) to collect seed over the entire natural range of this, and several other closely related *Calliandra* spp. The objective was to provide material both for testing in multi-locational trials for future breeding activities. Seed distribution for wide international assessment of provenances was expected to commence in 1993 (Macqueen, 1991; Pottinger, 1992), but was actually initiated in 1992 and greatly expanded in the following year (D. Macqueen, personal communication). Assessment is in the early stages but results of this work will become available in due course.

In Rwanda, infertile soils of pH 4.3 and 4.8, with low levels of aluminium saturation and rainfall of 1166-1564 mm/year, allowed satisfactory growth of *C. calothyrsus* in the absence of fertilizers, although there was a small positive interaction between applications of lime at 750 kg/ha and farmyard manure at rates of between 2.5 and 10.0 t/ha (Yamoah *et al.*, 1989). On acid (pH about 5), infertile soils with either high or low levels of aluminium saturation in both Australia and Indonesia, this species showed considerable promise when harvested at intervals of about three months, outyielding both *Leucaena leucocephala* and *Gliricidia sepium*, particularly in the absence of fertilizer application (Bray *et al.*, 1989; Palmer *et al.*, 1989). These results indicate the ability of *C. calothyrsus* to tolerate highly acidic and infertile soils.

In a pot experiment with soil limed at varying rates to adjust the acidity from pH 4.3 (no lime) to a maximum of pH 8.0, best growth of *C. calothyrsus* was obtained in the range of pH 6-8 (Hu *et al.*, 1983). Netera *et al.* (1992) showed considerable differences in growth characteristics between two lines of *C. calothyrsus* in a pot experiment on an infertile oxisol (pH 5 and aluminium saturation about 60%) from West Java. While these observations may indicate considerable genetic variation within the genus, the authors suggested that the line which showed poor adaptation to acid soil may be a species other than *C. calothyrsus*. They pointed out the need to detail the source of seed fully when quoting experimental results. This, however, is very rarely done at present.

In Java and Sumatra, at four sites between sea level and 920 m altitude, with soil pH at 5.6-6.9 and rainfall at 1200-3600 mm/year, *C. calothyrsus* produced higher yields of leaf material than seven other leguminous trees at the highest site, and was the second-best producer at two other sites (Panjaitan *et al.*, 1989). The *in vitro* dry matter digestibility as measured by the cellulase digestibility technique was relatively low however, ranging from 24.8% in a dry environment to 51.1 % at a site with good rains in all months of the year. Despite the poor levels of digestibility, it was rated as the most agronomically adaptable of the species tested, comparing well with *Leucaena leucocephala, Gliricidia sepium, Sesbania* spp. and *Albizia falcataria* in terms of growth and resistance to pests and diseases.

On the island of Sumba (Indonesia), at altitudes of 500-1000 m and with shallow, clay loam soils, a series of leguminous trees was tested as potential alternatives to *Leucaena leucocephala* where psyllid (*Heteropsylla cubana*) attacks were a recurring problem. With annual rainfall of about 1000 mm spread mainly over a 5 month wet season, *C. calothyrsus* was considered to be useful, even though growth slowed dramatically with the onset of flowering, about 2 months into the dry season. With slightly higher rainfall (1200-1500 mm), *C. tetragona* (syn. *Zapoteca tetragona*) was found to be a more productive species but no information is available regarding animal production (Rourke and Suardika,1990). In contrast to this report, NRC (1983) noted that *C. tetragona* was generally slower growing and less satisfactory than *C. calothyrsus* in Indonesia. More work is required to clarify the situation regarding the relative merits, and perhaps even the delineation of these and other species of *Calliandra*.

There are few results available for *C. calothyrsus* planted specifically for animal production, but in an alley cropping experiment in western Samoa, cutting at 1.5 m every 4-5 months gave slightly higher yields of leaf dry matter over 13 months (12.9 t/ha) than cutting at 1 m (10.4 t/ha). Total biomass production (21.4 t/ha) was the same from both treatments and cutting height had no effect on the nutrient content of the foliage (Tekle-Haimanot *et al.*, 1991) In a separate 4-year alley cropping experiment in the same region, on a moderately fertile soil receiving annual rainfall of about 3000 mm, yields of taro (*Colocasia esculenta*) were slightly better with *Gliricidia sepium* hedges than when *C. calothyrsus* formed the hedges, even though annual applications of mulch from the *Calliandra* (9.6 t/ha DM) averaged 11 % more than with the *Gliricidia* (Rosecrance *et al*., 1992). There were no significant differences between species in terms of their effects on the physical or chemical properties of soil. On a relatively infertile soil of pH 6.3 and annual rainfall of 1250 mm in southwestern Nigeria, *C. calothyrsus* produced some 6 t DM/ha in non-wood prunings (leaves and small twigs) in four clippings per year. This provided some 200 kg/ha of nitrogen for use by plants as the mulch decomposed (Gichuru and Kang,1989). The growth and performance of the *Calliandra* was comparable to that of *Leucaena leucocephala* as a hedge for alley cropping. It therefore represents a real alternative for regions where insect problems threaten the use of the better known species.

Crude protein (CP) contents of *C. calothyrsus* are often quoted at 20-22% (e.g. Ahn *et al.*, 1989) and some typical analyses are quoted in Table 1. In Sumatra, however, on an acid ultisol, Blair *et al.* (1988) obtained much lower CP values of 13.7%. The differences could be due to soil fertility, but they may be due to differences in accessions, or even species, of *Calliandra* since there is a degree of taxonomic confusion within the genus (Netera *et al.*, 1992). In common with several other tree genera on the acid soils of South Sumatra, the foliage of *C. calothyrsus* contained adequate levels of potassium, calcium and magnesium for animal production (Blair *et al.*, 1988), although it was poor in both phosphorus (0.11%) and sodium (0.01%). At three sites in Java, Jakarta and North Sumatra, however, phosphorus levels of 0.16-0.19% were recorded by Panjaitan (1987), levels which appear to be marginal for beef cattle (McDowell *et al.*, 1983).

Table 1 Proximate and fibre analyses of Dry *Calliandra calothyrsus*

	Dry matter	Crude protein	Ash	Ether extract	*In vitro* DMD	NDF	Source
LEAVES	39.0	21.6			35.4		1
EDIBLE STEMS	25.1	11.7			42.8		1
LEAVES		19.5	7.5	2.4		49.0	2
LEAVES		13.7	4.9			63.4	3
LEAVES and EDIBLE STEMS	39.0	24.0	8.0	4.1		24.0	4
LEAVES		23.0	4.9		35.9 (*in sacco*)		5
DRY SEASON		17.7	5.1		49.5	46.7	6
		15.8	5.2		45.7	48.4	6
WET SEASON		17.5	4.9		51.5	52.5	6
		14.0	4.7		44.5	44.5	6

Notes: DMD - dry matter digestibility, NDF - neutral detergent fibre.

Sources: 1 Baggio and Heuveldop (1984); 2 Evans and Rotar (1987); 3 Blair *et al.* (1988); 4 Mahyuddin *et al.* (1988);
5 Ahn *et al.* (1989); 6 Akkasaeng *et al.* (1989).

When wilted, fresh leaves and edible stems of *C. calothyrsus* were suspended for 48 hours in intra-ruminal nylon bags in steers maintained on a diet of Elephant grass (*Pennisetum purpureum*) and concentrates, DM disappearance was 51.0% (Mahyuddin *et al.*, 1988). When the material was dried, DM disappearance was reduced to 31.5-37.2% depending on the drying technique (either at differing temperatures in an oven, in the sun, or by freeze drying). Similarly, reductions in digestibility as a result of drying were measured using both *in vitro* pepsin-cellulase and rumen fluid-pepsin techniques. Oven-drying the fodder resulted in decreases in both total phenolic compounds and condensed tannins compared with freeze drying (Ahn *et al.*, 1989) and this was reflected in an increase in *in sacco* nitrogen digestibility in goats. Unfortunately, this work did not evaluate fresh, unwilted fodder.

In a recent, short-duration experiment using Merino wethers of about 27 kg liveweight, *C. calothyrsus* was fed as the sole dietary component. Daily DM consumption of fresh material (35% DM) was 5.9 kg/100 kg metabolic body weight and material wilted by a forced draught at ambient temperature (95% DM) was consumed at 3.7 kg/100 kg of metabolic body weight. These levels of voluntary intake are high, even for small ruminants, and indicate high acceptability of the foliage. In Droughtmaster steers, *in sacco* digestibility of wilted and oven-dried material was similar, and inferior to that of fresh foliage. Digestibility of fresh material was 60%, reducing to about 30% after only 6 hours of forced draught wilting (Palmer and Schlink,1992).

These studies would appear to explain some of the conflicting reports regarding the acceptability, digestibility and feeding value of *C. calothyrsus*. The results quoted above suggest that in order to obtain maximum benefit from the feeding of this species, it should be used as a protein supplement for poorer quality roughage, either browsed direct, or offered in limited quantities to animals as soon as possible after cutting, at which time it will compare well with other tree foliage in terms of feeding quality. The species appears to have little potential for use as dried leaf meal, at least where ruminant animals are concerned, because of the rapid loss of digestibility after cutting.