



2.3 The Perennial Sesbania Species

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- [Introduction](#)
 - [Origins and Botanical Description](#)
 - [Environmental Adaptation](#)
 - [Geographical Areas of Use](#)
 - [Establishment](#)
 - [Productivity and Management](#)
 - [Nutritive Value](#)
 - [Animal Production](#)
 - [Fuelwood and Timber](#)
 - [Soil Fertility Improvement](#)
 - [Other Uses](#)
 - [Conclusions](#)
 - [References](#)
-

Introduction

The perennial species of *Sesbania* establish easily, grow in difficult sites and do not require complex management to maintain productivity. They have many attributes that make them attractive as multipurpose plants and potentially useful species for agricultural production systems.

Gillett (1963) suggested that the chief economic value of the genus *Sesbania* is likely to be as a green manure and livestock forage as nearly all of the species are palatable to stock. This section describes the species and their origins, their utilisation, productivity, management and forage value with particular emphasis on the agriculturally most important species - *S. sesban* and *S. grandiflora*.

Origins and Botanical Description

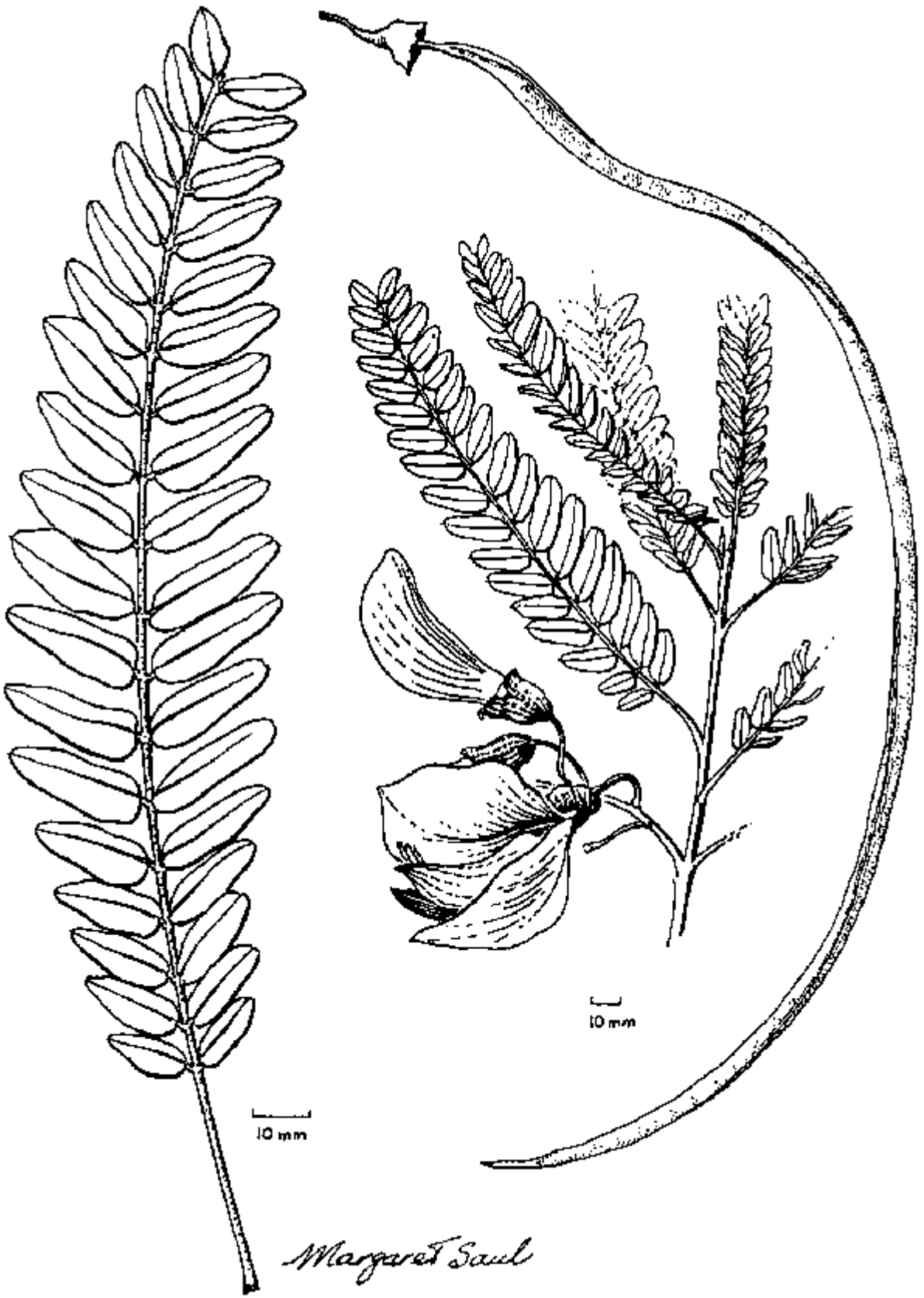
The exact origin of *S. grandiflora* is not known but it is considered native to many southeast Asian countries. A closely related species, *S. formosa*, is native to northern Australia (Burbidge 1965).

Sesbania grandiflora is a loosely branching tree up to 15 m tall. Its leaves are pinnately compound up to 30 cm long with 20-50 leaflets in pairs, dimensions 12 44 x 5-15 mm, oblong

to elliptical in shape. Flowers are large, white, yellowish, rose pink or red with a calyx 15-22 mm long. The standard has dimensions up to 10.5 x 6 cm. Pods are long (20-60 cm) and thin (6-9 mm) with broad sutures containing 15-50 seeds (Figure 2.3.1).

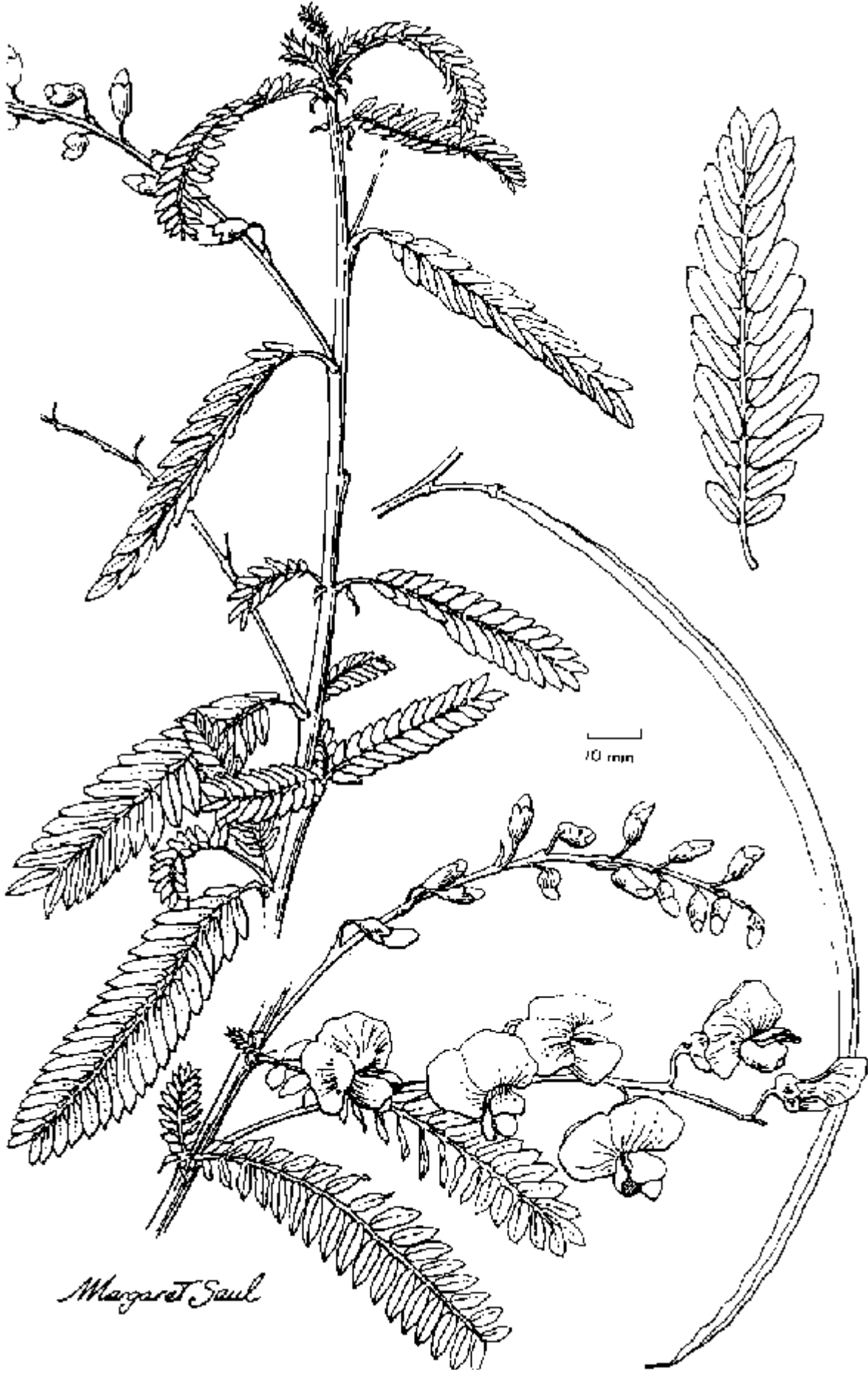
The origins of *S. sesban* are also unclear but it is widely distributed and cultivated throughout tropical Africa and Asia. It is a short-lived shrub or small tree up to 8 m tall. Its leaves are pinnately compound, 2-18 cm long with 6-27 pairs of linear oblong leaflets (26 x 5 mm). The raceme has 2-20 flowers which are yellow with purple or brown streaks on the corolla. Pods are subcylindrical, straight or slightly curved up to 30 cm long and 5 mm wide containing 10-50 seeds (Figure 2.3.2). Five varieties of *S. sesban* are recognised botanically but their differences do not correlate strongly with their agricultural value. *Sesbania sesban* var. *sesban*, *S. sesban* var. *bicolor* and *S. sesban* var. *nubica* are all similar and have been noted for their vigorous growth and high yields. The other lesser known varieties are *S. sesban* var. *zambesiaca* and *S. sesban* subsp. *punctata*. Unless otherwise stated, reference to *S. sesban* in this section will indicate the variety *S. sesban* var. *sesban*.

Fig. 2.3.1. Leaves, flowers and pod of *Sesbania grandiflora*.



Margaret Saul

Fig. 2.3.2. Leaves, flowers and pod of *Sesbania sesban*.



Margaret Saul

Environmental Adaptation

Sesbania grandiflora is well adapted to hot, humid environments and it does not grow well in the subtropics particularly in areas with cool season minimum temperatures below about 10°C (Wood and Larkens 1987). On the other hand, *S. sesban* shows some cool tolerance. It grows well in the subtropics and is significant in extending the nitrogen fixing forage trees into cooler, higher elevation regions of the tropics up to 2,000 m (Anon. 1987a). Both species are outstanding in their ability to tolerate waterlogging and are ideally suited to seasonally environments. When flooded, they initiate floating adventitious roots and protect their stems, roots and nodules with spongy, aerenchyma tissue. Evans and Macklin (1990) report the rainfall range of *S. sesban* as 500-2,000 mm while *S. grandiflora* is adapted to higher rainfall conditions of 2,000-4,000 mm but will grow in areas receiving only 800 mm. Thus both species show some tolerance of moisture stress.

Another outstanding feature of both species is their tolerance of both saline and alkaline soil conditions (Hansen and Munns 1985). However, their tolerance of highly acid, aluminium saturated soils is not known.

Geographical Areas of Use

Until recently, the use of perennial *Sesbania* species has largely been restricted to south and southeast Asia. In India, these species have had a long history of agricultural use, primarily as green manures and as sources of forage (Anon. 1924, Whyte *et al.* 1953). Most of the early research on the use of perennial *Sesbania* for forage production was conducted in India (Patel 1966, Kareem and Sundararaj 1967).

In northern Thailand, Holm (1973) reported that *S. grandiflora* was an excellent supplement to dairy cows fed predominantly grass hay. In central Java, Sumarna and Sudiono (1974), cited by Evans and Rotar (1987a), detailed a two-tier forage production system in which *S. grandiflora* was used in a mixture with other tree legumes. Nitis (1985) indicated that *S. grandiflora* is widely used in Bali and Lombok while Field (1989) reported it as the main source of high protein forage in Timor following the devastation of leucaena by the psyllid insect. Nao (1979) reported that leaves of *S. grandiflora* were used as a forage to supplement rice straw in animal diets and as a mulch for home gardens in the Mekong Delta of Vietnam.

The use of these species is now spreading to other regions. *Sesbania sesban* has shown particular promise in Ethiopia to altitudes of 2,000 m (Anon. 1987a). Dougall and Bogdan (1958) suggested that *S. sesban* is a useful browse in Kenya where it is commonly found growing on either stream banks or swamp edges. It is also reported to be cultivated for forage in Iraq (Townsend 1974) and west tropical Africa (Dalziel 1937). In coastal areas of the Chinese province of Liaoning, *Sesbania* species have been used for saline soil reclamation (den *et al.* 1965). *Sesbania grandiflora* has shown promise in Western Samoa (A. Ash, personal communication) and in the Solomon Islands. In a trial conducted in southeast Queensland where 71 tree and shrub species were evaluated, *S. sesban* was the most productive species in the first 18 months (Gutteridge 1990).

Establishment

The perennial *Sesbania* species are usually established from seed. There are reports (Evans and Rotar 1987a) that both *S. grandiflora* and *S. sesban* can be propagated vegetatively using stem cuttings but this is not a widespread practice. Seeds of *S. sesban* have a hard seed coat and scarification is recommended to ensure uniform seed germination. *Sesbania grandiflora*, however, is not hard-seeded and usually germinates well without scarification.

One of the major advantages of perennial *Sesbania* species over other forage trees and shrubs is their rapid early growth rates. Dutt *et al.* (1983) reported that *S. sesban* attained a height of 4-5 m in 6 months in India. In an experiment comparing the productivity of *S. sesban* and *S. sesban* var. *nubica* with 15 other trees and shrubs in northeast Thailand, Gutteridge and Akkasaeng (1985) found that they gave the highest yields (approximately 600 g edible dry matter/tree) in the first 6 months after planting. In southeast Queensland, shoot dry matter yield at 11 weeks after planting was 294, 239, 66, 25 and 21 g/m row for *S. sesban*, *S. formosa*, *Leucaena leucocephala*, *Acacia angustissima* and *Calliandra calothyrsus* respectively (Maasdorp and Gutteridge 1986). Woodhead (1992) also found that *S. sesban* established rapidly and grew much faster than six other tree legume species, reaching a height of 285 cm in 190 days. The rapid early growth rate of the *Sesbania* species could be exploited by combining them with other slower establishing species to provide earlier yield.

Productivity and Management

The yield potential of the perennial *Sesbania* species has been evaluated under a range of cultural practices throughout their area of use. Soil type, climate and management practices such as fertiliser use, height and interval of cutting as well as inter-cropping all affect yield.

High yields have been recorded under favourable growing conditions from a number of regions including Hawaii (Evans and Rotar 1987b), India (Gill and Patil 1983) and northern Australia (Palmer *et al.* 1989).

Cutting management has a very important influence on the productivity of perennial *Sesbania* species. *Sesbania grandiflora* cannot survive repeated cutting (Home *et al.* 1986, Evans and Rotar 1987a, Panjaitan 1988, Ella *et al.* 1989, Akkasaeng *et al.* 1989). Farmers in Lombok, Indonesia have devised a system where only the side branches of trees are cut for fodder leaving the main growing stem untouched. The trees are grown on rice paddy walls at 1.5-2 m intervals and forage is harvested in this manner for 3-4 years, yielding up to 2 kg dry matter per harvest per tree. When the foliage is no longer within easy reach the trees are felled and the long straight pole can be used for firewood or for construction (Gutteridge 1987).

By contrast, *S. sesban* thrives under repeated cutting and coppices readily with many branches arising from the main stem below cutting height (Figure 2.3.3). Cutting frequencies have generally been in the order of three or four cuts per annum but up to eight cuts per year have been taken in some areas (Gore and Joshi 1976). Yields have ranged from 4 to 12 t dry matter/ha/year depending upon location (Anon. 1924, Dutt *et al.* 1983, Galang *et al.* 1990).

Cutting height can also influence yield in *S. sesban*. Mune Gowda and Krishnamurthy (1984) reported higher yields at a low cutting height of 50 cm. However, in other reports, cutting at 76 cm was found to favour plant survival and productivity in India (Anon. 1924), while in southeast Queensland, a cutting height of 100 cm for *S. sesban* var. *nubica* gave higher yields than heights of 150 and 50 cm (Galang *et al.* 1990).

There are few studies on the reaction of perennial *Sesbania* species to direct grazing by livestock. There are several reports that both *S. grandiflora* and *S. sesban* are browsed (Gillett 1963, Lamprey *et al.* 1980, Dougall and Bogdan 1958) but no indication of their rate of recovery after browsing. P.R.D. Philp (personal communication) reported that young *S. grandiflora* trees were destroyed by goats grazing in the dry season in Sumbawa, Indonesia At Mt Cotton, southeast Queensland, goats grazed an 8 month old stand of *S. sesban* var. *nubica* that had reached a height of 3 m and 'ringbarked' the main stem 10-15 cm above ground level causing 75% plant mortality (Kochapakdee 1991).

The only long-term grazing study sighted was that of Gutteridge and Shelton (1991) in southeast Queensland. They reported the results of a 15 month cattle grazing study in which a 2 ha area of forage comprising 4 m wide rows of *S. sesban* interplanted with *Brachiaria decumbens* was grazed by belmont red heifers at 1.5 beasts/ha. Although excellent liveweight gains were achieved (Figure 2.3.4), the grazing cattle caused breakage and splitting of many side branches of *S. sesban* trees. This was due to the brittle nature of these branches and resulted in a shortened longevity of trees from 5-6 years in an adjacent cutting management trial (Galang *et al.* 1990) to 2-3 years under grazing management.

Nutritive Value

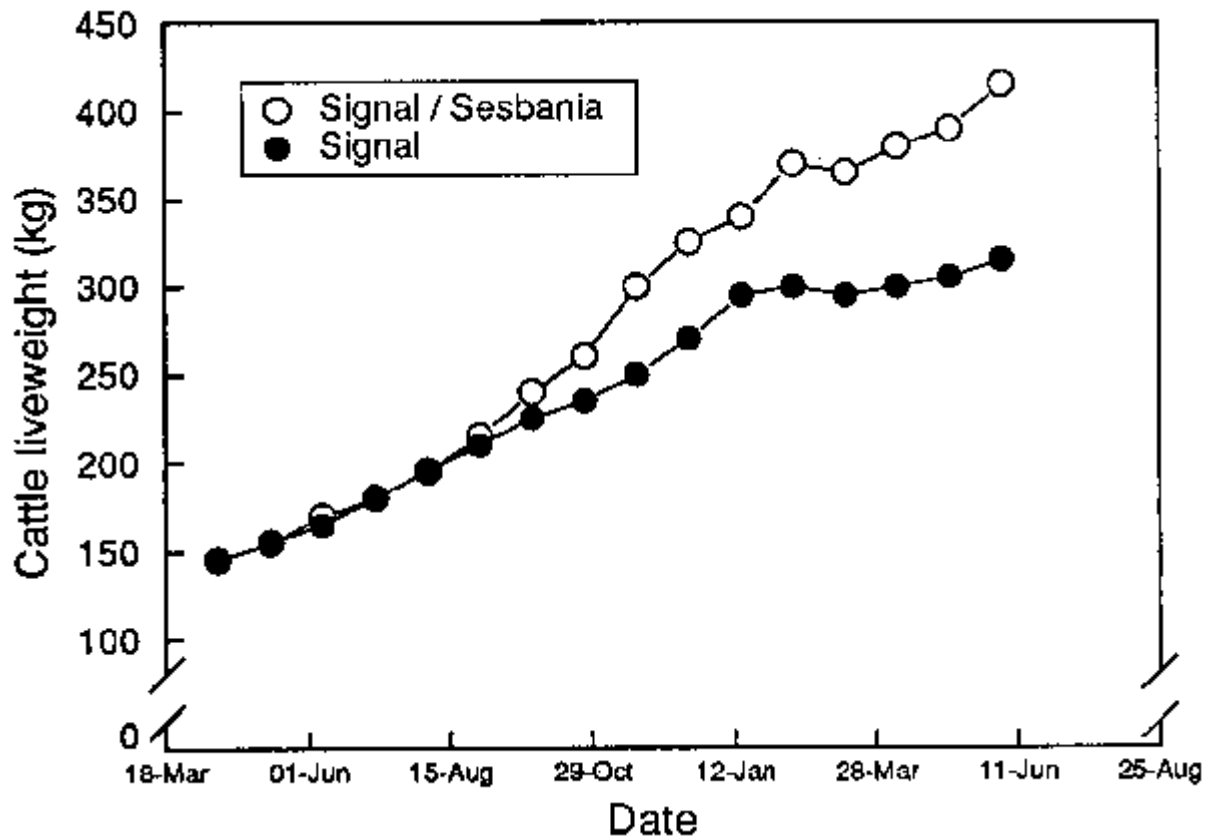
Many reports in the literature confirm that the leaves and young branches of both *S. grandiflora* and *S. sesban* are readily eaten by ruminants such as cattle and goats (Verboom 1966, NAS 1979, Gohl 1981, and Hutagalung 1981). P.R.D. Philp (personal communication) observed that smallholder farmers in Timor, Indonesia preferred *S. grandiflora* to *Leucaena* stating that the former was more palatable and more nutritious for their stock.

[Fig. 2.3.3. *Sesbania sesban* cut at 6 week intervals in southeast Queensland.](#)

<http://www.fao.org/ag/AGP/AGPC/doc/Publicat/Gutt-shel/x5556e02.jpg>

Most reports indicate that the crude protein content of both *S. sesban* and *S. grandiflora* foliage is generally greater than 20% and often above 25% (Table 2.3.1). Dry matter digestibility of *Sesbania* species is superior to that of most other tree and shrub legumes. In northeast Thailand, Akkasaeng *et al.* (1989) found that the *in vitro* dry matter digestibility of *S. grandiflora*, *S. sesban* and *S. sesban* var. *nubica* was 66, 75 and 66% respectively, all higher than that of 15 other tree legumes that were tested. van Eys *et al.* (1986) reported that *S. grandiflora* contained more crude protein but less fibre than *Gliricidia sepium* and *Leucaena leucocephala* while their *in vitro* dry matter digestibilities were 73.3, 65.2 and 62.2% respectively.

Fig. 2.3.4. Mean liveweight gain of heifers grazing *Sesbania sesban*/signal grass mixture or signal grass alone fertilised with 200 kg N/ha/year.



Singh *et al.* (1980), in a feeding trial with goats, reported dry matter digestibilities ranging from 66.5 to 71.4% for *S. sesban*. In an experiment reported by Reed and Soller (1987), *S. sesban* had the lowest acid detergent lignin (4% dry matter) and the highest N retention (1.2 g/day) of four browse species. Ahn *et al.* (1989) reported that the nylon bag dry matter digestibility and nitrogen digestibility of dried leaf of *S. sesban* was 90.7% and 96.7% respectively. The digestibilities of *S. sesban* were the highest of the 12 forage trees tested in the experiment.

These data together with the generally low crude fibre content and high phosphorous levels indicate the potential of these species as high quality forage sources.

Animal Production

Data from feeding experiments with perennial *Sesbania* species are limited. In most instances the herbage of *Sesbania* has been fed as a supplement to low quality straws or grasses and for relatively short periods.

Table 2.3.1. Chemical composition of *S. grandiflora*, *S. formosa* and *S. sesban* (% dry matter).

	CP	CF	Total CHO	Ash	P	Ca	Reference
<i>S. grandiflora</i>							
leaf	22.6	18.4	-	9.3	0.32	1.10	1
leaf	36.2	9.2	46.1	9.2	-	-	2
flowers	14.5	10.9	77.3	4.5	-	-	2
leaf	30.1	5.1	42.3	10.4	-	-	3
leaf	25.6	17.8	-	-	0.45	1.46	4
leaf	34.8	7.5	-	12.5	0.33	2.33	5
leaf	20.1	-	-	6.2	-	-	6
<i>S. formosa</i>							
leaf	21.3	-	-	6.5	-	-	6
<i>S. sesban</i>							
leaf	19.4	32.9	70.0	7.4	0.09	1.42	7
leaf	26.0	14.4	-	7.6	0.27	1.11	8
leaf	25.3	-	-	8.4	-	-	6
fresh leaf	21.3	15.3	-	8.0	0.25	-	9
dried leaf	26.4	16.6	-	7.7	0.24	-	9

CP = crude protein

CF = crude fibre

CHO = carbohydrate

References: 1. Devendra (1979); 2. NAS (1979); 3. Skerman (1977); 4. Hutagalung (1981); 5. Brewbaker (1986); 6. Akkasaeng *et al.* (1989); 7. Singh *et al.* (1980); 8. Gohl (1981); 9. Robertson (1988)

In experiments in Java, NAS (1979) reported that 1.8 kg of fresh *S. grandiflora* leaf fed daily to cattle on a rice straw diet achieved growth increases comparable to those obtained by feeding formulated diets. Robertson (1988) obtained a growth rate of 7 g/kg^{0.75}/day with goats fed dried *S. sesban* as a 30% supplement to rice straw over a period of 4 weeks. Singh *et al.* (1980) found that goats fed a diet of *S. sesban* forage *ad lib* for a period of 8 weeks gained an average of 17.1 g/head/day compared with 30.3 g/head/day when 20% of the forage was replaced with a concentrate mixture.

In the previously mentioned study of cattle grazing *S. sesban*, Gutteridge and Shelton (1991) reported liveweight gains of 0.7 kg/head/day over 15 months for young heifers grazing a mixed *S. sesban/Brachiaria decumbens* pasture in southeast Queensland. This compared with liveweight gains of 0.4 kg/head/day for similar cattle grazing *B. decumbens* alone fertilised with 200 kg N/ha/year (Figure 2.3.4). The heifers were at first reluctant to graze *S. sesban* but once they became accustomed to it they consumed it readily at up to 20% of their diet.

Even though the perennial *Sesbania* species have generally higher *in vitro* digestibilities and better apparent nutrient status than many other browse trees, the liveweight gains achieved in feeding experiments are often no better than for other tree forages. This may be associated with anti-nutritive factors in the *Sesbania* forage. When van Eys *et al.* (1986) fed goats *Gliricidia*, *Leucaena* or *S. grandiflora* as a 15% supplement to Napier grass hay, there was no difference between the legumes in intake or liveweight gain, which averaged 20 g/head/day.

When *Acacia seyal*, *A. nilotica* and *S. sesban* were fed as supplements to teff straw (*Eragrostis tef*) to both sheep and goats in Ethiopia, the growth rates of sheep fed the three supplements were 40, 42 and 35 g/head/day while those for goats were 19, 17 and 4 g/head/day respectively (Anon. 1987b). Even though the nitrogen digestibility and N balance of the *S. sesban* supplement were the highest of the three forages, lower growth rates occurred in both classes of animal. In contrast, Reed (1988) reported that sheep fed dried *S. sesban* as a supplement to teff straw gained weight at the relatively high rate of 48 g/day over 90 days. This was similar to weight gains of sheep fed vetch and more than double those fed *Acacia cyanophylla*, *A. sayel* or *A. sieberiana*. In Kenya, Semenyé *et al.* (1987) reported that young goats fed a sole diet of *Sesbania sesban* hay developed severe ill-thrift symptoms after only 2 weeks and by 4 weeks, two of the six animals had died.

Information on anti-nutritive factors in the forage of perennial *Sesbania* species is limited. An analysis of the phytochemical components of the foliage and flowers of *S. grandiflora* indicated the presence of sterols, saponins and tannins (Fojas *et al.* 1982). Ahn *et al.* (1989) found that *S. sesban* var. *nubica* contained no condensed tannins in fresh or oven-dried material but the concentration of total phenolics was 2.8% and 2.5% in the fresh and dried material respectively.

It appears that the most economically efficient and safest use of perennial *Sesbania* forage for ruminants is as a protein supplement to low quality roughages such as crop residues or dried grasses. This dilutes the effects of anti-nutritive factors and greatly improves the utilisation of the roughages. Gutteridge and Shelton (1991) found no toxic or anti-nutritive effects of *S. sesban* on the health of heifers grazing a mixture of *S. sesban* and the grass *Brachiaria decumbens* for a period of 15 months.

Perennial *Sesbania* forage is less suitable in the diets of monogastric animals. *Sesbania grandiflora* leaf meal progressively depressed chicken feed intake and body weight when incorporated at rates of 0, 5, 10 and 15% of the total ration (Prasad *et al.* 1970). Williams (1983), cited by Evans and Rotar (1987a), fed dried, encapsulated leaves of *S. grandiflora*, *S. formosa* and two varieties of *S. sesban* to week old chicks at 1% of body weight. All chicks died before the 5th day when fed *S. grandiflora* and *S. sesban* but no toxic signs were observed in those fed *S. formosa*. A. Ash (personal communication) reported high mortality of chicks fed *S. grandiflora* leaf meal in Western Samoa but Raharjo and Cheeke (1987) found that rabbits fed a concentrate diet with a supplement of *S. grandiflora* foliage gained 12.7 g/day with no apparent ill effects. Most of these reports indicate the need for caution before using perennial *Sesbania* species in the diets of monogastric animals.

Fuelwood and Timber

Information on the wood yields of the perennial sesbanias is limited. Onim *et al.* (1989) reported a yield of 16 t/ha of sun-dried wood from a 4 year old stand of *S. sesban* at a density

of 1,600 plants/ha in Kenya while much higher yields of 63.5 t/ha were reported for *S. sesban* grown under rainfed conditions in Haryana, India (Singh 1989).

Despite the lack of detailed information on yield, von Carlowitz (1989) pointed out that *S. sesban* is popular for fuelwood because it produces a high woody biomass in a short time which, though soft, is a relatively smokeless, quick, hot burning kindling. The wood of *S. grandiflora*, on the other hand, is not highly valued for cooking as it has poor burning qualities and produces much smoke. The density of *S. grandiflora* wood increases with ageing and the timber from 5-8 year old trees can be used in house construction or as craftwood.

Soil Fertility Improvement

Annual *Sesbania* species such as *S. cannabina*, *S. rostrata* and *S. bispinosa* are widely used in Asia as green manures in paddy rice cultivation because of their ability to withstand waterlogging. *Sesbania sesban* is used to a lesser extent in this context but probably because it is not as fast growing as the annual species. Sivaraman (1951) reported a 20-40% increase in rice yields with the use of *S. sesban* leaf as a green manure in southern India. In an upland crop of maize in Sri Lanka, Weerakoon (1989) obtained grain yields of 1.9, 3.9 and 4.4 t/ha for control, *S. sesban* green manure and 96 kg N fertiliser/ha treatments respectively. In the green manure treatment, 4.4 t dry matter/ha was incorporated after 84 days growth with an N equivalent of 83 kg N/ha.

Onim *et al.* (1987) speculated that the perennial *Sesbania* species could fix up to 600 kg N/ha/year. They felt this was possible because *Sesbania* roots are readily infected by the less specific cowpea types of *Rhizobium* giving large numbers of active nodules. Under experimental conditions they reported a total nitrogen yield of 448 kg N/ha from the aerial biomass of *S. sesban* var. *nubica*. This was higher than that from *Cajanus cajan* but less than that from *Leucaena leucocephala*. Incorporation of up to 13 t dry matter/ha of *S. sesban* mulch improved maize and bean yields by 78% and residual effects lasted up to 3 years (Onim *et al.* 1989).

Yamoah and Getahun (1989) suggested that *S. sesban* is a promising shrub for alley cropping because it is easy to establish, it grows rapidly, coppices readily and provides mulch of high nutrient content (particularly N). Prunings from *S. sesban* in combination with moderate amounts of N and P fertilisers, increased yields of maize and beans in alleys 6 and 8 m wide in Rwanda (Yamoah and Burleigh 1988). However, these authors cautioned that the species is relatively short-lived and susceptible to nematodes and some crop pests and therefore should be combined with a longer lived truly perennial species for best results.

Sesbania grandiflora was declared inappropriate for alley cropping in the lowland humid tropics of Nigeria because it showed a high mortality of up to 80% when coppiced and produced less biomass than leucaena and gliricidia (Duguma *et al.* 1988).

Other Uses

The flowers and young leaves of *S. grandiflora* are edible and are often used as a vegetable to supplement meals. Tender pods may also be eaten as string beans. The dried leaves of both *S. grandiflora* and *S. sesban* are used in some countries as a tea which is considered to have antibiotic, anti-helminthic, anti-tumour and contraceptive properties.

Bark exudate and seed endosperm gums are produced by many species of *Sesbania*, but are not seen as an alternative to gum arabic (Anderson 1989). The taller species of perennial *Sesbania* such as *S. grandiflora*, *S. formosa* and *S. sesban* can also be used as shade trees for coffee, tea and cocoa as well as living trellises for pepper and as windbreaks for citrus, bananas and coffee.

Conclusions

Although perennial *Sesbania* species play an important role as forage and green manure plants in a number of regions in the world, they are still relatively underutilised in many tropical and subtropical areas. There is scope for greater use of *Sesbania* species in ruminant feeding systems, particularly as high quality supplements to low quality roughages.

More research is required to determine appropriate management systems to maximise yields of edible material. More studies on the effects of direct grazing in extensive feeding systems are also warranted, particularly for *S. sesban*, to determine the effects of grazing on plant longevity.

It appears that the use of the perennial *Sesbania* species should be restricted to ruminants because of the deleterious effects often observed when they are used as feed sources for monogastrics. However, even with ruminants, there may be adverse effects on animal productivity and health when *Sesbania* comprises a high proportion of diets for long periods. Research is required to determine whether anti-nutritive factors are present in *Sesbania* forage and whether they can be controlled or reduced by management practices.

Greater use could be made of the ability of the perennial *Sesbania* species to grow in 'inhospitable' sites. Both *S. sesban* and *S. grandiflora* show some tolerance of soil salinity and alkalinity and both grow well in waterlogged environments. There are many situations in the tropics and subtropics where periodic inundation and/or saline encroachment severely restrict agricultural productivity. Perennial *Sesbania* species could be used to help reclaim some of these sites by providing green manure, mulch or high quality forage.

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