4. Sesbania sesban (L.) Merr. Sesbania grandiflora (L.) Pers.

1. Introduction and Main Uses

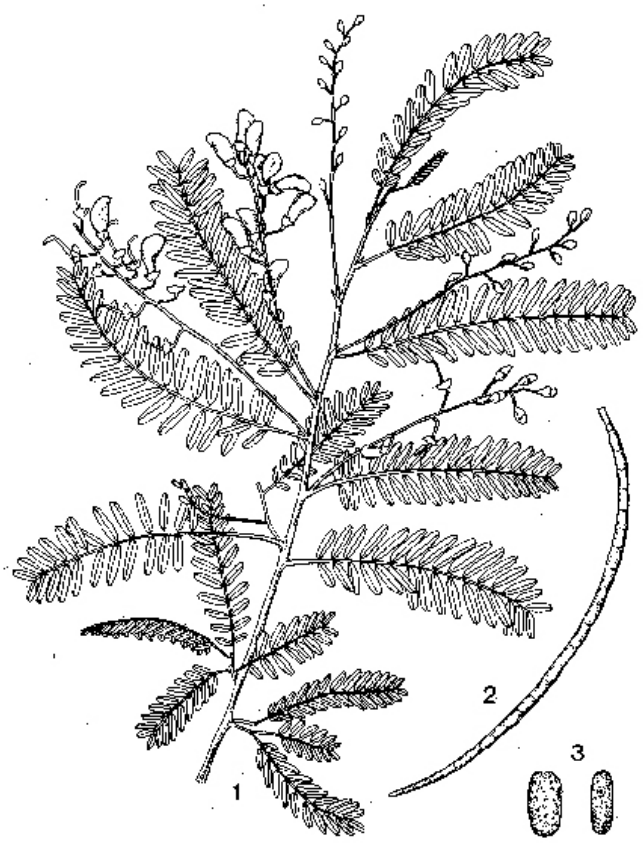
Sesbania sesban and *Sesbania grandiflora* are important agroforestry species. The Genus is within the family *Leguminosea* and therefore they have the ability to improve soil through the fixation of atmospheric nitrogen. The original home of these species is open to conjecture but *S. seban* is thought to be native to Egypt. It has the common name of Egyptian pea or River hemp. The following synonyms apply to *S. sesban*: -

- *Aeschynomene sesban L.*
- *Emerus sesban (L.) Kuntze*
- *Sesban aegyptiaca Poiret*
- *Sesbania aegyptiaca Poiret*
- *Sesbania confaloniana (Chiov.) Chiov.*
- *Sesbania pubescens sensu auct*

S.grandiflora has the common names of Agati, Corkwood Tree and West Indian Pea.

S.sesban is very common throughout Africa and in Asian countries such as India, Malaysia, Indonesia and the Philippines where it is commonly seen growing on the dikes between rice paddies, along roadsides and in backyard vegetable gardens. Members of the genus *Sesbania* spp can be described as soft, semi or slightly woody, 1-8 m tall perennial nitrogen fixing trees. *Sesbania sesban* can grow up to 8 metre and obtain a diameter of up to 12 cm. Growth is extremely rapid, on the right sites it can reach 4-5 m in just 6 months.

The species has been widely planted and has a long history throughout Africa and Asia including India. *Sesbania sesban* has proved to be extremely popular due to in part to its fast growth and also because of its wide use as fuelwood and for fodder. It has also proved to be extremely tolerant of a wide range of sites including those which can be regarded as difficult such as saline, waterlogged. Being a legume, the tree fixes nitrogen and has proved to be popular as a fallow species and as a agroforestry species



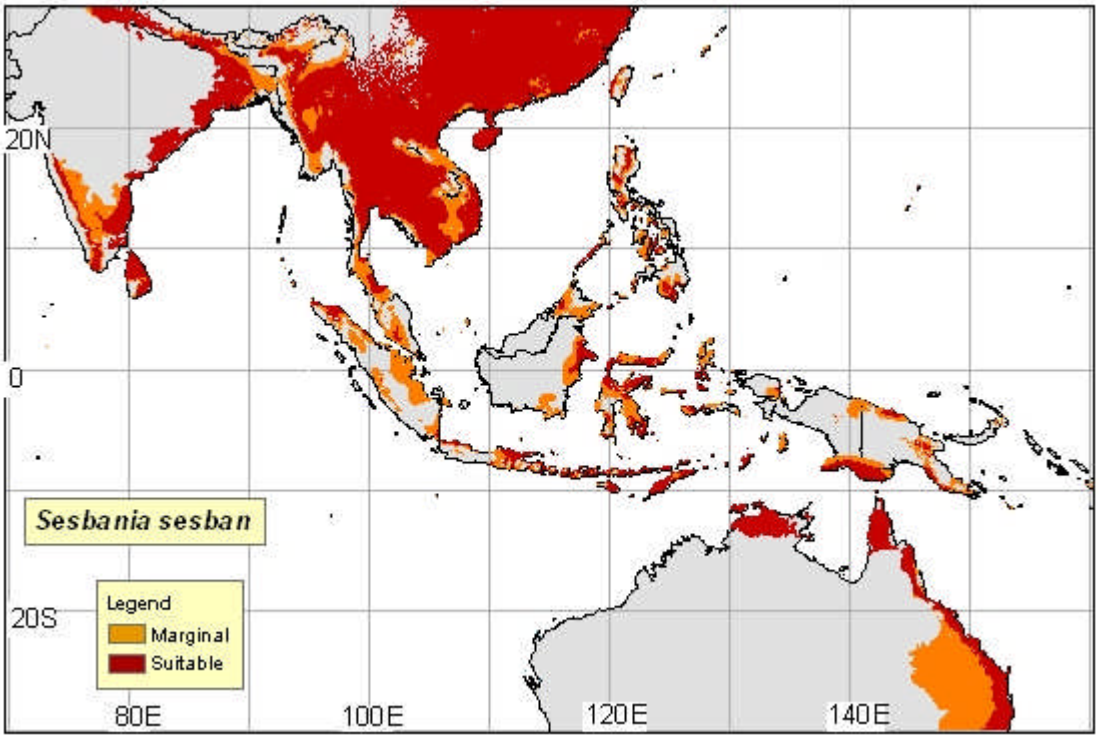
Sesbania sesban (L.) Merrill – 1, flowering branch; 2, fruit; 3, seeds.

The leaves are compound 12-18 cm long made up of 6-27 pairs of leaflets. 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.
S. grandiflora has similar leaves of 15–30 cm long, with 16–30 pairs of linear oblong leaflets. Racemes 2.5 cm long. Flowers 2–4, white to pink and can be as much as 10 cm in diameter. The pods are longer and within the range of 50–60 cm.

2. Site Requirements

Sesbania sesban is most suitable for altitudes between 200-500 m but will tolerate a wide altitude range and in Kenya it has demonstrated acceptable growth on sites in excess of 2,000 m. In broad terms, *S. sesban* is more suitable for the drier sites, whereas *S. grandiflora* is more suitable for the wetter/humid sites. *S. sesban* is outstanding in its ability to tolerate water-logging and is ideally suited to seasonally waterlogged environments. When flooded, it initiates floating adventitious roots and protects its stems, roots and nodules with spongy, aerenchyma tissue. The acceptable rainfall range for *S. sesban* is wide between 500-2,000 mm. Another outstanding feature is its tolerance of both saline and alkaline soil conditions. However, its tolerance of highly acid, aluminium

saturated soils is not known. *S. grandiflora* shows the same wide tolerance of soils and



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Map extracted from Tropical Forages Factsheet

site; compared to *S. sesban*, it is more tolerant of humid conditions and is considered for sites between sea level and 800m.but again it has demonstrated acceptable growth up to 2,000 m. It can be considered for sites where rainfall is within the range 1,000 – 2,000 mm and there is a minimal dry season

3. Seed sources

Sesbania species tend to seed prolifically and from an early age. It is thought that *Sesbania sesban* is pollinated by bees, whilst the larger flowers of *S. grandiflora* are pollinated by birds. The seed can be easily harvested and can be grown without problems from both seed or from cuttings. There has been breeding work carried out on various *Sesbania* species but more from the viewpoint of improving the quality of the fodder rather than the level of production of fuelwood.

4. Nursery Practice

Seeds of *S. sesban* have a hard seed coat and scarification is recommended to ensure uniform seed germination, though it would appear that this is not essential and adequate germination is possible without special treatment. Where scarification is to be carried out this can be done using either acid or abrasion techniques.

If it is intended to raise the crop using seedling stock then it is normal to use container stock made from standard plastic sleeves or bags (lay-flat 7.5 x 10 or 10 x 15 cm). Seeds can be directly sown into the tubes or an intermediate germination bed can be used, from which the germinated stock are pricked out into the tubes. The soil used for the containers should be freely draining (avoid heavy clays) ideally with a pH of between 6-8. Since *Sesbania* species are legumes, soil inoculation with the right strain of *Rhizobium* is desirable if the crop is going to develop to its full potential. Domergues et al (1998) recommend inoculation with the appropriate strain of *Sinorhizobium teranga* when the natural rhizobial population is inadequate for *S. sesban*, however again the need for this treatment is questionable and in most cases, adequate rhizobial populations are available within the planting site. The seedlings grow quickly in the nursery and should have obtained a suitable size for planting out (20 cm) within 2-3 months, providing the nursery is subject to moderate-high temperatures

5. Site Preparation

The site should be cleared and prepared well in advance of the likely planting date. It should be prepared to agricultural standards with all competing weeds removed. If possible, the site should be ploughed and harrowed where there is the opportunity of having recourse to the use of agricultural machinery. Following the onset of the rains and the wetting of the upper 30 cm of soil, planting can commence. If tubed stock is being used, the plastic sleeves should be carefully split using a sharp knife to avoid distortion of the roots. When establishment is being made using cuttings a quarter of the stem should be inserted into the ground and firmed into position.

Planting pits of adequate dimensions to take the tube should be dug in advance of planting. For biomass production under a SRC management regime, the espacement will be of the order of 1 x 1 metres or 1 x 2 metres (10,000 – 5,000 sph). Where *Sesbania* is being established along with another crop in an agroforestry or mixed cropping management system, then the planting design will vary with the overall management objectives. It is popular as an agroforestry crop with such crops as cotton, maize and vegetable crops since it provides green manure and useful shade and wind protection. and in such circumstances can be grown as an alley crop.

Sesbania sesban growing as an agroforestry crop (from Tropical Forages Factsheet)

Direct sowing into the planting site can be successful and avoids the cost and work associated with nursery management, where the trees are to be used as shade trees for coconut then this method has been used to good effect; however it is not a technique to be recommended for plantations being established for energy production since gaps are inevitable and in addition there will be a need for more intensive weeding.

Management Practice

Biomass Production. *Sesbania* demonstrates good coppicing ability and therefore for biomass production, this is the preferred method of management. The crop is coppiced at intervals of no more than a few years depending on the size of material required. A balance is needed between very frequent coppicing which tends to direct too much energy into leaf production compared to useful biomass. However the first coppicing should be carried out within a year after planting in order to encourage a greater number of growing shoots and lead to higher yields in the future. The main advantage of *Sesbania* is its extremely rapid growth in the first year, canopy closure should therefore be realized within months and weeding will no longer be required. However prior to this being achieved, the crop should be kept well weeded to ensure good establishment and minimal losses.

It is found to be beneficial if the first cut is carried out after just one year as this promotes the production of multiple stems and tends to improve overall productivity. Normally with coppicing, the cut is made at a height of around 20 cm; however in Sri Lanka, there has been found to be a good response to pollarding at waist height with other SRC (particularly *Gliricidia sepium*). The regrowth is then cut at short intervals as it reaches the minimum required size. This technique could be tried with *Sesbania.* In India it is

recommended that *Sesbania sesban* plantations for fuel or pulpwood production should be harvested in the second year after planting and coppiced annually for 2-3 years.

The wood has a low- medium density with a specific gravity of 0.40-0.45 at 12% moisture content. This is rather low for high quality fuelwood, however *S. sesban* is popular for fuelwood because it produces a woody biomass in a short time which, though soft, is a relatively smokeless, quick, hot burning kindling. Similarly *S. grandiflora* is also grown for fuelwood widely within Asia.

Other Products

Sesbania whilst being grown for biomass as the main product will also provide substantial leaf material that can be used as a green manure or as an animal fodder. Both species can be used for fodder, though there are indications that *S.grandiflora* is less acceptable due to the possible bitterness of the leaves and pods. If fodder is to be the main product then the management regime would be modified for that used to grow fuelwood. Cutting management has a very important influence on productivity. *S. sesban* thrives under repeated cutting and coppices readily with many branches arising from the main stem below cutting height. In India cutting frequencies have generally been in the order of three or four cuts yearly but up to eight cuts per year have been taken in some. Yields have ranged from 4 to 12 t dry matter/ha/year depending upon location (Suttie, FAO).

Duke (1983) reports that *S. grandiflora* planted in India at 90 cm intervals, yields 4.5–9.1 kg leaves/yr, which translates to around 12,000 plants per hectare yielding 50–100 MT leaves per year per hectare; since about 75% is water, he estimates that the DM yield would be of the order of 12–25 MT/ha. He also reports that Indonesian workers in Java have obtained 55 MT green matter per ha in 6–7 months. On a black, poorly structured clay, of pH 8.5 in Australia, Agati outgrew all other species tested, attaining 4.3–5.5 metres in one year's growth

The crude protein content of both *S. sesban and S. grandiflora* foliage is generally greater than 20% and often above 25%. 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. sesban* and *S. sesban* var. *nubica* was 75 and 66% respectively, all higher than that of 15 other tree legumes that were tested.

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. However it is stressed that the use of these perennial *Sesbania* species should be restricted to ruminants because of the sometimes negative effects 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. As a fodder, it

should therefore be regarded as an additive rather than a major component of livestock feed.

Soil Improver

The positive effect that *Sesbania* species can have on soils has been noted due to it nitrogen fixing properties and its ability to grow on a wide range of often difficult sites. It has been suggested that these perennial *Sesbania* species could fix up to 600 kg N/ha/year since they tend to form large numbers of active nodules. Field measurements reported a total nitrogen yield of 448 kg N/ha from the aerial biomass of *S. sesban* var. nubica

In Zambia, ICRAF researchers found that growing *Sesbania* in depleted agricultural fields or on fallow lands for 2 or 3 years and then introducing a hybrid maize crop after the fallow period produced exciting and encouraging results. Without N fertilizers, maize yields were 2.3 t ha^{-1} after 1 year of *Sesbania* fallow; 5.6 t ha^{-1}, after 2 years; and 6.0 t ha^{-1}, after 3 years. Continuous maize crops gave only 1.5 t ha^{-1}.

6. Productivity

In Kenya, FAO reports a yield of 16 t/ha of sun-dried wood from a 4 year old stand at a density of 1,600 plants/ha while much higher yields of 63.5 t/ha were reported for *S. sesban* grown under rainfed conditions in Haryana, India. If planted at spacings close to 5,000 sph, farmers should expect yields comparable to that for *Gliricida* i.e. 20 tonnes/ha/annum

7. Income Generation

Some estimates have been made for income generation from the growing of *Calliandra* in Sri Lanka. The species is clearly suitable as a component of a mixed farming enterprise, providing fodder for livestock and green manure for food crops. It has a particular role in SALT type land management. It is also suited to the small-scale farmer as an energy crop if a suitable market or collection point is within an economically acceptable transportable distance. Models have been derived for a range of potential farm conditions to provide guidance on the sort of returns that might be expected. These are appended to this information sheet. The variables that need to be considered by an individual farmer or association of growers are the following:-

1. Area of land that can be dedicated to energy crops. It is suggested that to make it a worthwhile exercise around 1 ha should be set aside for this activity. Useful supplements to household income can be derived from small areas i.e. the collection of small diameter material from hedges, but this would only equate to a relative minor part of the total farm income.
2. Site productivity – a combination of factors related to rainfall, soil fertility and depth, altitude etc

3. Distance to collection point or market.
4. Reliability of the market - is the demand still going to be there in 5 years?
5. Is there sufficient spare labour either within the family or available for hire to meet the demands of establishment and harvesting. The table below provides an indication of the levels of labour that might be expected for the main tasks. One of the advantages of growing energy crops is that there is some slight room for modifying the calendar of activities to fit into demands for other crops.

Fuelwood Establishment Costs based on planting density of 10,000/ha												
Model 1 Annual harvesting of small diameter material (Gliricidia/Calliandra/Sesbania)											Labour Cost =	2.35
											Wood Value =	20
Estimated Labour inputs (man-days per ha) by years												
Activity	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Yr 6**	**Yr 7**	**Yr 8**	**Yr 9**	**Yr 10**		
Site Preparation	50											
Planting	25											
Filling blanks (beating up)	10											
Weeding (1)	30											
Weeding (2)	20											
Year 2 operations												
Pollarding		40										
Weeding		25										
Harvesting		65										
Year 3+ operations												
Harvesting			65	65	65	65	65	65	65	65		
Subtotals for labour input	135	130	65	65	65	65	65	65	65	65		
Subtotal for labour cost	317.25	305.5	152.75	152.75	152.75	152.75	152.75	152.75	152.75	152.75		
Materials												
Purchase of improved cuttings	300											
Total Costs	617.25	305.5	152.75	152.75	152.75	152.75	152.75	152.75	152.75	152.75		
Yields (dry tonnes/ha)		4	6	10	12	15	15	15	15	15		
Value		80	120	200	240	300	300	300	300	300		
Total Income	-617.25	-225.5	-32.75	47.25	87.25	147.25	147.25	147.25	147.25	147.25	-4.75	

The above simple table illustrates that on the basis of good-average production of 15 tonnes/ha/annum and at a current value of $20/tonne a farmer over the first 10 years would just about break even if he costs his labour at around $2.35/man day. The table below considers the discounted value using a more realistic current value of labour at $3.50/day over a production rotation of 20 years. This would provide a positive return at a discount rate of 15%.

Fuelwood Establishment Costs based on planting density of 10,000/ha																					
Model 1 Annual harvesting of small diameter material (Gliricidia/Calliandra/Sesbania)											Labour Cost =	3.50	US dollars	perday							
											Wood Value =	20.00	US dollars	per tonne							
Estimated Labour inputs (man-days per ha) by years																					
Activity	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr11	Yr12	Yr13	Yr14	Yr15	Yr16	Yr17	Yr18	Yr19	Yr20	
Site Preparation	50																				
Planting	25																				
Filling blanks (beating up)	10																				
Weeding (1)	30																				
Weeding (2)	20																				
Year 2 operations																					
Pollarding		40																			
Weeding		25																			
Harvesting		65																			
Year 3+ operations																					
Harvesting			65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	
Subtotals for labour input	135	130	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	
Subtotal for labour cost	472.5	455	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	
Materials																					
Purchase of improved cuttings	300																				
Total Costs	772.5	455	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	227.5	
Yields (dry tonnes/ha)		4	6	10	12	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	
Value		80	120	200	240	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	
Total Income	-772.5	-375	-107.5	-27.5	12.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	
Discount rate (8%)	1	0.9259259	0.8573388	0.7938322	0.7350299	0.6805832	0.6301696	0.5834904	0.5402689	0.500249	0.463193488	0.4288829	0.3971138	0.3676979	0.340461	0.3152417	0.2918905	0.270269	0.250249	0.2317121	
Discounted value (8%)	-772.5	-347.22222	-92.163923	-21.830387	9.1878732	49.342282	45.687298	42.303054	39.169494	36.26805	33.58152789	31.094007	28.790748	26.6581	24.683425	22.855024	21.162059	19.594499	18.143055	16.799125	-768.39691
Discount factor (10%)	1	0.9090909	0.8264463	0.7513148	0.6830135	0.6209213	0.5644739	0.5131581	0.4665074	0.4240976	0.385543289	0.3504939	0.3186308	0.2896644	0.2633313	0.239392	0.2176291	0.1978447	0.1798588	0.163508	
Discounted value (10%)	-772.5	-340.90909	-88.842975	-20.661157	8.5376682	45.016796	40.92436	37.203964	33.821785	30.747077	27.95188848	25.410808	23.100734	21.000668	19.091516	17.355924	15.778112	14.343738	13.039762	11.854329	-837.73409
Discount factor (15%)	1	0.8695652	0.7561437	0.6575162	0.5717532	0.4971767	0.4323276	0.375937	0.3269018	0.2842624	0.247184706	0.2149432	0.1869072	0.162528	0.1413287	0.1228945	0.1068648	0.0929259	0.0808051	0.0702653	
Discounted value (15%)	-772.5	-326.08696	-81.285444	-18.081696	7.1469156	36.045313	31.343751	27.255435	23.700379	20.609025	17.92089119	15.583384	13.550768	11.783277	10.246328	8.9098502	7.7476958	6.7371268	5.8583711	5.0942358	150.16561
Discounted factor (20%)	1	0.8333333	0.6944444	0.5787037	0.4822531	0.4018776	0.334898	0.2790816	0.232568	0.1938067	0.161505583	0.134588	0.1121567	0.0934639	0.0778866	0.0649055	0.0540879	0.0450732	0.037561	0.0313009	
Discounted value (20%)	-772.5	-312.5	-74.652778	-15.914352	6.0281636	29.136124	24.280103	20.233419	16.861183	14.050986	11.70915476	9.757629	8.1313575	6.7761312	5.646776	4.7056467	3.9213722	3.2678102	2.7231752	2.2693126	-1006.0688

7. References

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