

saline, and from sands to clays. It has a 50% decrease in growth in soils with an EC_e of 13 decisiemens per metre (Sandhu and Haq 1981).

Other comments on adaptation

S. bispinosa is native to Pakistan and India. It is commonly grown in Pakistan in the plains and foothills of all four provinces. It is drought resistant and grows from March to September/October. It grows up to an altitude of 1200 metres and within a rainfall range of 550 to 1100 millimetres. It grows vigorously after the plants are established and reaches a height of about 2 metres in 3 months.

Uses

S. bispinosa is used for green manuring and fodder production.

- *Green manure* — it is one of the best available green manuring crops and is widely used in the reclamation of salt-affected soils. It fixes large amounts of nitrogen; a good crop can add 5000–7000 kilograms of organic matter and 85–110 kilograms of nitrogen per hectare. The root system greatly helps in opening up the soil and acidifying the root environment through the production of carbon dioxide and acidic exudates.
- *Fodder* — it is a high-quality fodder rich in protein (18%) and minerals (9%). Animals relish it because of its succulence and large foliage. It sells at high prices during *Eid-ul-Azha* for the feeding of sacrificial animals.
- *Other uses* — the sticks of *dhanca* are extensively used for roofing mud houses and as a fuelwood.

Propagation and management

The seedbed is prepared by levelling and cultivating the land twice. The crop is sown at a rate of 50–60 kilograms of seed per hectare (by broadcasting or drilling). When broadcast, the seed should be mixed into the upper 5 centimetres of the soil with a light ploughing. In dense salt-affected soils, the seed may be broadcast into standing water after irrigating the prepared seedbed.

The crop can be sown from March to June. For green manuring before rice cultivation, the crop is sown at the end of February to early March and ploughed



Photo 6.15. *Sesbania bispinosa*. (A) Whole shoots. (B) Detail of leaves. [PHOTOGRAPHS: S. NAWAZ]



Photo 6.16. *Sesbania sesban*.
[PHOTOGRAPH: S. NAWAZ]

under at the flowering stage. For green manuring before planting wheat, *dhanca* is sown in June or July and ploughed under in August or September.

For better yields, urea (50 kilograms per hectare) and single superphosphate (250 kilograms per hectare) are recommended at sowing. The first irrigation is given 25–30 days after sowing, and the crop matures with two or three irrigations.

For forage production, the crop should be harvested after two and a half months. For green manuring, the crop is ploughed under at flowering. It is firstly knocked over using a heavy plank, and then incorporated using a disc harrow followed by a rotavator. These steps are followed by a heavy irrigation.

Productivity

From salt-affected soils about 2.5–4 tonnes per hectare of green manure can be obtained, while 1–1.5 tonnes per hectare of seed are obtained at maturity. In Italy, a yield of 15 tonnes per hectare per year has been reported (National Academy of Sciences 1980, p. 60).

6.2.11 *Sesbania sesban* (L.) Merr.³³

Description

Sesbania sesban (L.) Merr., also known as *Sesbania aegyptica*, is a member of the Fabaceae family. It is known locally as *jantar*.

S. sesban is a small to medium-sized leguminous tree (height of 6–8 metres; see Photo 6.16). It is more or less evergreen and very fast growing (a stem growth of 5 metres height in 1 year has been reported). The raceme bears 4–20 flowers. The petals of the flowers are pale yellow, usually with purple streaks and spots. Flowering occurs in the spring and autumn. Pods are slightly twisted, up to 25 centimetres long, and each contains 20–30 seeds.

Tolerance to salt and waterlogging

S. sesban can tolerate waterlogging, salinity and alkalinity (pH values as high as 10). Experiments in which plants were grown in sand cultures irrigated with water of different salinities show that:

- 46% decreases in stem diameter can be expected at an electrical conductivity of 16 decisiemens per metre (calculated from Ahmad et al. 1985);
- 15–22% decreases in height and stem diameter can be expected at electrical conductivities of 9–10 decisiemens per metre (Ahmad 1987, p. 153).

Other comments on adaptation

S. sesban is adapted to a range of climatic conditions. It is widespread in the tropics of Asia and Africa and has been introduced into tropical America and elsewhere. In general, it grows at low elevations (300–500 metres), although some varieties have become naturalised to cooler high elevation regions (e.g. as high as 2000–2300 metres in East Africa). It grows in semiarid to subhumid climates with annual rainfall ranging from 500 to 2000 millimetres. It can tolerate drought. It is planted extensively in the Punjab and North West Frontier Province (NWFP) in Pakistan.

³³ These notes were adapted from Quraishi et al. (1993) p. 106; Sheikh (1993) p. 125; Evans and Macklin (1990) pp. 1–41.

Uses

S. sesban is used as a fodder, source of wood and landcare species.

- **Fodder** — *Sesbania* has high protein concentrations (17–30% on a dry matter basis), and a dry matter digestibility exceeding 60%. It is a good fodder for cattle, sheep and goats. It is used as a supplement for feeding to ruminants. The diet may contain 15–30% *Sesbania* with the balance consisting of high-energy roughages such as rice straw and maize. The fodder can be fed fresh, wilted or dried. Saponins have been reported in leaves of some genotypes.
- **Wood** — the wood can be used for fuel; it is fast burning and can be handled easily. Stems (poles) can be used for the roofing of huts and animal sheds and may last up to 6 years. The wood can be used as support stakes for vegetables. The wood can also be used for pulp production for the manufacture of paper.
- **Landcare role** — it makes good windbreaks. In some cases, it is used in alley farming (Evans and Macklin 1990). It is also used to improve the soil because of its nitrogen-fixing properties. It can be grown as shade trees.

Propagation and management

S. sesban can be planted through direct seeding. Germination is increased by scarifying the seed by dipping it into hot water (just below boiling point) for 30 seconds, or into water at 80°C for 10 minutes (see Box 6.1). Seeds are planted at a depth of 1–2 centimetres in well-prepared soil. Seeds germinate rapidly; plants can be 10 centimetres high in 20 days, and up to 2 metres high in 12 weeks. Plants can also be established in the nursery by planting seeds in planter bags. Young plants must be protected against grazing.

Moderate doses of farmyard manure and phosphate help growth. Plants for fodder should be established in rows 1–2 metres apart, with 25–50 centimetres between plants. The species coppices well but can die if proper care is not exercised in cutting. It may be harvested up to five times per year if growth is good; fodder yields are maximised if cut at 75–100 centimetres above the ground; if the plants are cut

below 50 centimetres or too frequently, there may be increased mortality. For wood production, the plants should be cut at least 50 centimetres above the ground. When pruning, 5–25% of the foliage should be left on the plant. A number of fungal diseases and insects can attack the species, but no serious pests have been reported in Pakistan.

Productivity

For wood, block plantings on fallow soil or sloping land can produce 15–20 tonnes dry weight per hectare per year. Even higher production is possible with reduced plant spacing (1 metre × 1 metre). For fodder, 20 tonnes dry weight per hectare per year can be harvested from plantings with rows 1–2 metres apart, and plants 25–50 centimetres apart within rows.

6.2.12 *Tamarix aphylla* (L.) Karsten³⁴

Description

Tamarix aphylla (L.) Karsten, also known as *T. articulata* or *T. orientalis*, is a member of the Tamaricaceae family. Its common name is tamarix or salt cedar, and locally it is known as *frash*, *pharwan* (Punjabi), *laljhau*, *chotimain* (Urdu), and *shakarghaz*, *siaghazz* (Balochi).

T. aphylla is a heavily branched large shrub or a small 'coniferous-looking' tree, which grows to a height of 10–15 metres (Photo 6.17). It has an erect trunk with rough bark. The leaves are reduced to tiny 'scales' that ensheath the wiry twigs. It excretes salt; salty 'tears' drip from the leaf glands at night. The minute flowers are white or pink, bisexual or unisexual, and are borne on spikes. Flowering occurs between April and September. Seeds mature between December and January.

Tolerance to salt and waterlogging

T. aphylla can tolerate high levels of salinity and sodicity. It is a common tree of salt-affected wastelands. Studies at the University of Agriculture Faisalabad show it to be highly tolerant to salinity and waterlogging (Qureshi et al. 1993). There are reports of its survival when irrigated with water of electrical conductivity 56 decisiemens per metre (Aronson 1989).

³⁴ These notes were adapted from National Academy of Sciences (1986) p. 74; Sheikh (1993) p. 128; Quraishi et al. (1993) p. 106; Baquar (1995) p. 444; Qureshi et al. (1993) p. 266.



Photo 6.17. *Tamarix aphylla*. (A) Whole tree in flower. (B) Detail of leaves. [PHOTOGRAPHS: S. NAWAZ]

Other comments on adaptation

T. aphylla is a versatile species which grows well on drained sandy soils. It is native to Pakistan and the Middle East. It can stand prolonged drought and temperatures up to 50°C. It grows well with an annual rainfall of 300–500 millimetres. It prefers arid to hot subtropical winter monsoon conditions. It is usually insect free. It is frost hardy and coppices well. The species is commonly grown on the plains of all four provinces. It has been planted extensively on the sand dunes of the Thal Desert.

Uses

- *T. aphylla* has value as a fuelwood, as a timber and as a shelter plant.
- *Fuelwood* — tamarix is slow to catch fire but has good burning quality. The wood can be used to prepare charcoal. Leaf litter and small branches will not burn because of their high salt content.
- *Timber* — the timber is good for making agricultural implements such as ploughs and Persian wheels, and is good for turning.
- *Shelter* — the trees have value as shelterbelts (windbreaks), for erosion control and sand dune stabilisation. Washing the salt off the surfaces of the leaves tends to kill vegetation beneath the trees; rows of tamarix can therefore be used as firebreaks.

Propagation and management

T. aphylla can be easily propagated through nursery-raised seedlings (raised from seed)³⁵, stem cuttings and root suckers. It reproduces well naturally in the field.

Seeds are small and are mixed with ash or sand for sowing in nursery beds. For plantations into saline–sodic soils, cuttings should be planted into and established in plastic bags (in a manner similar to seedlings), and then transplanted into the field once they have been hardened. Plants are established in rows 3 metres apart, with plants at 2 metres apart within the rows. Under natural conditions, the crop is harvested in a 20-year rotation. However, under irrigated conditions, this time can be reduced to 10–12 years.

³⁵ There are reports that tamarix seeds rapidly lose viability (National Academy of Sciences 1980). Seed should therefore be used immediately after collection.

Productivity

Wood production of 5–10 cubic metres per hectare per year has been reported. In one study on a saline–sodic soil near Faisalabad, wood yields of 35 kilograms per tree were reported after five and a half years of growth. The gross value of this production was estimated at about 7860 PKR per hectare per year (Qureshi et al. 1993, Tables 5A, 5B and 7).³⁶

6.3 Salt-Tolerant Fruit Trees

6.3.1 *Grewia asiatica* L.³⁷

Description

Grewia asiatica L. is a member of the Tiliaceae family, and is known locally as *phalsa* (*falsa*).

There are more than 100 species in the genus *Grewia*. The cultivated form of *phalsa* is the species *G. asiatica* which is considered to be native to the Indo–Pakistan subcontinent.

G. asiatica is a deciduous bush which grows 3 or 4 metres high (Photo 6.18). It has greyish-white to grey–brown bark. The branchlets and underside of leaves vary from being hairless to densely covered in soft short hairs. The leaves are broad with five (sometimes four) basal nerves; they vary from being heart to egg shaped, with a more or less distinctly toothed leaf margin. The fruits are globular, with an outer fleshy layer overlying an inner hard seed. The fruits have a pleasantly acid pulp. *Phalsa* flowers in late March and April, varying with the time of pruning. The fruit ripens in May–June in Hyderabad Division and June–July in the submountain areas. If the plants are pruned in summer (July), a second crop occurs in November–December.

The fruit is borne in the axil of leaves in the later half of the current year's growth. It is borne in clusters of 18–24 fruits. Innumerable shoots (sometimes over 100) are borne on a plant, each bearing 9–15 clusters.



Photo 6.18. *Grewia asiatica*. (A) Whole tree. (B) Detail of leaves. [PHOTOGRAPHS: S. NAWAZ]

³⁶ Specific details of this investigation were as follows:

Soil conditions. EC_e and SAR values averaged over the upper 90 cm of the soil were 15 decisiemens per metre and 34 respectively.

Planting density. The trees were planted at 2500 stems per hectare. There was 71% survival after five and a half years.

Financial calculation. The calculation assumed the wood to have a value of 0.50 PKR per kilogram. A stocking rate of 1000 trees per acre (2470 plants per hectare) was assumed.

³⁷ These notes were adapted from Ginai (1968) pp. 233–236, Food and Agriculture Organization (1982) pp. 91–94.