

Tree species with potential of nitrogen fixation in agroforestry system adopted by farmers in semi-arid region of Southern India

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Abstract

In semi arid zone of southern Tamilnadu, India farmers are recognized that planting with multipurpose nitrogen fixing trees including medicinal plants in an agroforestry system for sustainable income generation. To identify the existing agroforestry system. A systematic survey was carried out to find out the nitrogen fixing trees planted in the agroforestry system revealed that a total of economically important 9 tree species belonging to 8 genus of 3 families were commonly cultivated without specific model. These multipurpose usable trees improve soil physical properties, maintain soil organic matter, fix the atmospheric nitrogen and promote nutrient cycling through high amount of litter production, which increase the main crop yield.

Introduction

Nitrogen fixing trees (NFTs) are often considered to be critical components of sustainable agroforestry systems. It is widely accepted that the N fixed by NFTs can be used to improve production of trees, crops and animals and to improve soil fertility. Agroforestry has been in practice in semi-arid zone of southern region of Tamilnadu since ages. Farmers retain local trees like *Acacia nilotica*, *Albigia lebbek*, *Sesbania grandiflora* in their farm land in rainfed conditions because legumes are rich in protein and make good feed for cattle. Collection of pods from the trees can be economically viable if the yield is high. These species can boost the productivity of the pastures not only by contributing feed, but also improve soil physical properties, organic matter and conserving soil, moisture, and promote nutrient cycling.

Traditional rainfed crops like sorghum and maize are cultivated with scattered trees. As irrigation facilities are increasing, people are retaining exotic species like *Casuarina*, *Leucaena leucocephala*, *Sesbania grandiflora* and other trees on the bunds only. In many parts of southern part of India, poles harvested from 3-4 year old trees is widely used for housing in rural areas and hence fetch a premium price even in rural markets. As these species grow straight with very few side branches, the trees planted in rows on field bunds serve as windbreaks for protecting arable crops from wind and hot weather without competing for sunlight and moisture.

By understanding the important of Agroforestry plants and plant parts utilized by people traditionally for various products available in the market and the raw material required for it, we can evaluate a system to grow them in farm lands in large scale, in turn this will reduce the pressure on the natural forest and there by conserve the bio-diversity and improve the socio-economics of the rural poor. Hence, the present investigation was carried out to identify and document the nitrogen fixing multipurpose trees adopted by farmers in agroforestry systems in different districts of Tamilnadu.

Nitrogen fixing non-legume tree

CASUARINACEAE

Casuarina equisetifolia Forst., Eng: Casuarina; Tamil: Savukku

Casuarina equisetifolia Forst. An evergreen multipurpose tree with leaves reduced to scales. Flowers unisexual, present in spikes. Fruit is a nutlet. Native of Malay islands, Australia. Elsewhere it is planted along the coast as a wind break. In southern India is commonly used for wasteland development, due to its ability to form symbiotic nitrogen fixing microorganism of Frankia and mycorrhizal association. The Farmers of Orissa, Andhra Pradesh, Karnataka, and Tamilnadu in the southern part of India have identified a large-scale cultivation of *Casuarina* in agro-forestry and farm-forestry. The main reasons for the preference of the tree species are that it is comparatively more profitable than the annual crops; it needs low water requirements, drought tolerance, easy management and minimum labour requirement for planting and maintenance. *Casuarina* poles are used for scaffolding, centering, roofing and also for mine props. Nitrogen fixing: Root nodules containing the actinorhizal symbiont Frankia enable *C. equisetifolia* to fix atmospheric nitrogen. It fixes the atmospheric nitrogen at the rate of 40 –80 kg/ha/year.

Casuarina in Agro-forestry in Tamil nadu

The farmers of Thanjavur, Trichy, South Arcot, and Chengalpet districts in Tamil Nadu, are cultivating annual food crops along with *Casuarina equisetifolia*. Farmers grow groundnut (*Arachis hypogea*) or melons on sandy soils. Sesame (*Sesamum indicum*) in red soil, Turmeric (*Curcuma sp.*) in heavy soil as an intercrop with *Casuarina* in the first year. When banana (*Musa sapientum*) and tapioca (*Manihot utilissimum*) are raised as intercrop under irrigated condition *Casuarina* added more nitrogen to soil, such intercropping is not possible beyond the first year of *Casuarina* growth due to over shading². However *Casuarina equisetifolia* can be intercropped with *Moringa olifera* alternatively at an espacement of 2 m up to the age of 3 years *Casuarina equisetifolia* reached a pole of 3-4 m height with a basal girth of 28 cm. Income from the *Casuarina equisetifolia* amounted to Rs 14966 and *Moringa olifera* Rs 38055 over the period of three years¹. Vinay Rai and Suresh³ showed that some fodder grasses registered an increase in growth when intercropped with *C. equisetifolia*.



Nitrogen fixing legume trees

FABACEAE

Sesbania grandiflora (Linn) Pers., Tamil: Agathy

A fast growing small tree, growing up to 15 m tall, with a trunk diameter of about 30cm. The bole is straight and cylindrical; wood white and soft; bark is light grey, deeply furrowed. Leaves feathery, pods long (up to 60 cm), The tree has extraordinarily high nodulation, fix the high amount of atmospheric nitrogen which help the soil improvement and rapid growth of tree. This tree is mainly cultivated in Southern Tamilnadu as a climber for betel wine.



Gliricidia sepium (Jacq.) Kunth ex Walp., Tamil: Pasumthalai

A large shrub or tree with odd pinnate leaves. Flowers in terminal racemes. Petals Pinkish-white typically like a bean flower. Fruit is pod. This plant is seen only in cultivation. A native of South America and now extensively cultivated in tropics as hedges plant and as well as shad and firewood, *Gliricidia* makes a very effective living fence while periodic trimming of these fences every month or two during the rainy season provides large amount of foliage for fodder or green manure. Some of the farmers in whose field boundaries these provenances have been planted use the foliage as green manure for rice. Because the usual fertiliser or manure application rates of these farmers are very small, they have been able to increase the rice yields by about 10% by green manuring with *Gliricidia* alone.

Pongamia pinnata (L.) Pierre. Tamil: Pongam

An evergreen tree. Leaves pinnately compound. Flowers in axillary racemes, purplish-white. Fruit is a pod with hard covering and indehiscent. Seed 1, yields an important fatty oil used in lubricants and also in domestic lamps. Commonly found along the river-banks and also planted in bunds of the agricultural field for shade and manure. Pongam oil is extracted from the seed which is used for medicinal purpose.



***Erythina indica* Lamk., Tamil: Kalyanamurungai**

Deciduous tree of up to 12 m tall. Long pods (10-15); seeds shiny and light red. It can be use fencing and medicinal purpose and this tree is distributed in southern part of Tamilnadu.

MIMOSACEAE

Acacia auriculiformis A. Cunn.ex Benth. is a multipurpose nitrogen fixing leguminous tree in the sub family mimosoideae. Its rapid growth, ability to fix nitrogen, tolerance to infertile, acid, alkaline, saline or seasonally waterlogged soils and tolerance of dry season and rainfall of 600-1000mm makes it potential tree species for agroforestry in semi arid tracks. The heartwood is suitable for attractive furniture, turnery, carving and also for construction work. The wood has high basic density (500-650/m³) and calorific value (4700-4900kcal/kg)and is ideal for firewood for firewood and charcoal. It is also good source of paper pulp. The tree produce large quantities of leaf litter enrich the soil nutrient. The tree also capable of fixing atmospheric N to the tune of approximately 207kg/ ha.

***Acacia nilotica* (L.) Willd.ex Del. Tamil: Karuvel**

A moderate – sized tree that can grow up to 20 m in good sites but usually less than 10 m high: could be a shrub in very unfavorable conditions. During the hot season the tree is in full leaf. Seeds blackish-brown, smooth, compressed, sub-circular. Trees coppice occasionally. Good firewood. Leaves and pods are good fodder, high protein value. This tree species is cultivated as a monoculture in Ramanathapuram, Sivagangai, and Madurai districts in the lake .It is also found in bunds of agricultural field in scatter.



***Albizia lebbek* (L.) Bentham. Tamil: Vagai**

A large deciduous tree with pinnately compound leaves. Leaves have glands at the base of the petiole. Flowers clustered in globose heads, White and fragrant. Fruit is a pod, straw coloured. This tree is cultivated in all the districts for Cattle feed. This tree has wide distribution in old tropics.



***Leucaena leucocephala* (Lam.) de Wit. Tamil: Soobabul**

BAIF, known for its work on cattle development, received attention among the forestry community in the country with its work with *Leucaena leucocephala* (subabul). The Hawaiian Giant type of subabul made an immediate impact on its introduction because of its unusually high rates of growth and biomass accumulation. The value of this biomass as fodder, wood and manure appealed to small farmers throughout the country. The K-8 variety of subabul adapted extremely well to semi-arid conditions and soon became one of the most popular species for all types of forestry programmes in India.

Unarmed tree/shrub. Leaves pinnately compound. leaflets small. Flowers in a inflorescence of white globose heads. Fruit is a pod linear and dehiscent. Seeds many. This plant is cultivated as a fodder species and for green manure. This is also cultivated as an energy plantation. Nitrogen fixing: Root nodules containing the rhizobial symbiont enable *L. leucocephala* to fix atmospheric nitrogen. It fixes the atmospheric nitrogen at the rate of 260 – 320 kg/ha/year.



Conclusion

Apart from the above species, there is much scope to cultivate many other nitrogen fixing plants in suitable for the agroforestry system in this agro-climatic region. To bring more plant species in to cultivation and for their increased productivity, further research is needed as regards systematic and scientific cultivation methods, which include organic farming, irrigation, harvesting and preservation and marketing. To enhance the economic condition of rural poor and progressive farmers, it is essential to impart necessary training to them in mass cultivation practices.

Adoption of improved agroforestry systems is yet to become widespread in southern District of Tamilnadu, India. Now farmers are recognized that planting multipurpose nitrogen fixing trees including medicinal plants in the agroforestry system will give sustainable income. However, Inadequacy of information about viable models is one of the constraints to successful implementation of agroforestry programmes. Hence, developing promising agroforestry models are emerging from many research institutions and universities. Field experiences of government departments, voluntary organisations and development agencies in implementing agroforestry and related programmes are also encouraging.

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