SIMAROUBA GLAUCA DC

(Paradise tree)

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Simarouba natural regeneration in UAS, Bangalore, India

Simarouba plantation UASB, India

Simarouba canopy cover, UASB, India

Fruitlets of Simarouba glauca

Black fruits of Simarouba

Simarouba glauca plantation UAS Bangalore, India

Simarouba unmindful of termite attack

INTRODUCTION

Tropics endowed with infinite quantity of solar energy are the fountainheads of biodiversity. Some of the tropical regions with fertile soils, receiving good rainfall, have rich rainforests with a great treasure of flora and fauna. Agriculture is lucrative in these regions and here the farmers are generally happy and love farming.

However, there are less privileged geographical regions in the tropics, which receive low and erratic rainfall that cannot support good vegetation even though they are blessed with plenty of sun light. Cultivation of traditional crops adopting recommended packages is very much uneconomical and often disastrous to agriculturists in these regions. Since agriculture is not sustainable, the farmers as well as the landless laborers of these regions are migrating to the urban areas in search of better livelihood opportunities leaving the farm lands fallow.

Several measures are suggested for mitigating this problem. Among them, recommending a low cost input technology for cultivating hardy perennial crops that can grow well even with erratic and low rainfall, still giving assured returns is of great significance. In this context, cultivation of ***Simarouba glauca*** **DC.**, **paradise tree, Lakshmi taru, aceituno**, a multipurpose tree that can grow well under a wide range of hostile ecological conditions, offers a great hope.

Simarouba glauca is an important tree species growing in the forests of Central and South America. National Bureau of Plant Genetic Resources first introduced it in 1960s in the Research Station at Amravathi, Maharashtra. This was brought to the University of Agricultural Sciences, Bangalore in 1986 and systematic Research and Developmental activities began from 1992 onwards.

BOTANICAL FEATURES

Simarouba is a medium sized evergreen tree (height 7-15 meters) with tap root system and cylindrical stem. The plants are polygamodioecious with about 5% of the population producing exclusively staminnate (male) flowers and 40-50% producing mainly male flowers and a few bisexual flowers (andromonoecious) while the remaining 40-50% produces only the pistillate (female) flowers. Flowering is annual beginning in December and continuing upto following February. The trees start bearing when they are 4-6 years old (grafts begin to do so in 3-4 years) and reach stability in production after another 4-5 years. The drupelets are blackish purple in **Kaali** genotypes and yellowish green in **Gauri** genotypes and they are ready for harvesting by April/May.

USES OF PARADISE TREE

All parts of the plant namely, **seed, shell, fruit pulp, leaf, leaf litter, unwanted branches, stem, bark,** and **root** generate **products** that are useful in the production of **food, fuel, manure, timber, medicine** etc.

FOOD

Oil. Simarouba **seeds** contain 60-75% **oil** that can be easily refined, bleached, deodorised and fractionated. It is suitable for edible and non-edible purposes.

Edible uses

The **oil** is extracted from the seeds in the existing oil mills and processed by adopting conventional methods. Each well-grown tree yields 15 to 30 kg nutlets equivalent to **2.5-5 kg oil.** This amounts to nearly **1000-2000 kg oil/ha/year (400-800 kg/acre/year)** (with 500 plants/ha; 200 plants/acre).

From 1950 onwards, in El Salvador and other Central American countries the oil is marketed for edible purposes under the trade name **"MANTECA VEGETAL NIEVE", (Manteca = butter; Vegetal = vegetable; Nieve = snow).**

Physico-chemical properties of simarouba fat (Armour, 1959)

Free fatty acid		0.06%
Iodine value (WIJS)		53.8
Saponification value		191.0
Unsaponifiable matter		0.40%
Refractive index at 25^0 C		1.4556
Titer		47°C
Congealing point		20^oC
Smoke point		138°C
Melting point		27°C
Colour(lovibond)	Liquid	10 Yellow – 0.8 red
	Solid	Snow white
Flavour		Very good
Texture		Excellent
Plasticity		Excellent
Keeping quality		At least 6 months

COMPOSITION OF ACEITUNO FAT

Oleic acid	59.10%
Linoleic acid	3.30%
Linolenic acid	0.35%
Diene	0.13
Triene	0.002
Palmitic acid	10.90%
Stearic acid	25.60%






In other developing countries, also it can be used to manufacture vanaspati**, vegetable butter and/or margarine.** The **RBD oil** is further **fractionated** to separate the liquid and solid fractions. The **liquid fraction** with very high oleic acid content (about 85%) is **comparable** to **olive oil** in its chemical composition. **This oil is free from bad cholesterol** (free fatty acids 0.06%)**.** The **solid fraction** rich in stearic and palmitic acids can be used as **coco-butter substitutes (CBS) or coco-butter extenders** in confectionery and bakery industries. The palmito-stearin fraction is also useful in the preparation of ice cream and mayonnaise.

Beverages and jam from fruit pulp

The fruit pulp contains about 11% sugars. The pulp **(about 8-10 tons/ha/year)** can be used in the preparation of **squash, beverage** and **jam,** which are very well accepted because of their attractive natural color, flavour, and good taste. The fruits can be a source of natural colourant.

FUEL

The **filtered crude oil** can be used to **blend with diesel @ 5-10%.** The surplus oil produced can be subjected to trans-esterification to manufacture **biodiesel,** a 100% substitute for diesel (1000–2000 kg/ha/year).

The sugar rich **fruit pulp** can be used in the manufacture of **ethanol** (800–1000 litres/ha/year)**.**

The **oil-cake, fruit pulp, leaf litter,** and **unwanted wood** can be used to generate **biogas.** The **shell** and **waste wood** can be used in **thermal power** generation.

The **lignocellulose** contained in the huge amount of **biomass** produced (about 15 tonnes/ha/year) **can be used as feedstock** for manufacturing **second generation biofuels.**

MANURE

Aceituno press cake. The press cake (1,000-2,000 kg/ha/year) is rich in nitrogen (7.7 - 8.1%), phosphorus (1.07%) and potash (1.24%). There are also traces of calcium, magnesium, and sodium. It is valuable **organic manure**. **Leaf litter** (20-40 kg / tree / year) (10,000-15,000 kg/ha/year) makes good **manure,** improving the fertility status of the soil. As earthworms relish it very much, it can be valuable in the manufacture of **vermicompost.** The addition of leaf litter also increases the organic carbon content of the soil.

In case it is not possible to use the fruit pulp for preparing squash, beverage and/or jam, the fruit pulp may as well be used in the production of **vermicompost** of excellent quality.

MEDICINE

The chemicals present in leaf, fruit pulp and seed are known to possess the medicinal properties such as amoebicide, analgesic, anthelmintic, antibacterial, antidysenteric, antileukemic, antimalarial, antimicrobial, antitumorous, antiviral, astringent, cytotoxic, emmenagogue, febrifuge, skin hydrator, stomachic, sudorific, tonic, vermifuge. **They are useful in curing amoebiasis, gastritis, ulcers in the alimentary system, diarrhea, chikun gunya and malaria.**

TIMBER

The main trunk of a ten-year old tree has 5 – 10 cubic feet of wood. The **wood** is light, attractively grained, moderately strong, generally less preferred by wood eating insects; hence useful in making yoke for oxen, light furniture, toys, packing material, pulp (for paper industry) and matches. Waste wood is good fuel.

OTHER USES

Non-edible uses of the oil. The oil and its derivatives are useful for making pharmaceuticals, surfactants, detergents, soaps,

shampoos, cosmetics, plasticizers, stabilizers, lubricants, grease, emulsifiers, paints, varnishes, candles etc.

The shells (endocarp) **(about 4.5 – 9.0 tons/ha/year)** can be used in **particleboard industry**, in **activated charcoal industry**, in the manufacture of briquettes to use as **fuel**. They can be pulverised and added to enrich the compost since they contain about 1.24% potash in them. They can be also used to heat the boilers, as they possess high calorific value. The resultant ash can be put back to soil to enrich the potash content. The smooth ash blended with a little soap can be also used in the manufacture of **dishwashing powder.**

The paradise tree also improves soil health. This ecofriendly tree is ideal for watershed areas, well suited for soil and water conservation and wasteland reclamation.

The annual returns (in kg/ha) from a moderately well managed 10-year old plantation of simarouba is as follows:

OIL	**1000-2000**
OIL CAKE	**1000-2000**
FRUIT PULP (Fresh Weight)	**8000-10000**
LEAF LITTER	**10000-15000**
SHELL	**4500-9000**

CULTIVATION ASPECTS

Requirements in the habitat

Its cultivation depends upon the rainfall distribution, water-holding capacity of the soil and possible sub-soil moisture and a temperature range of 5^0-45^0C. Lakshmi taru can be cultivated in tropical regions all over the world. It grows from seacoast to an elevation of 1500 meters above sea level.

The paradise tree can adapt itself to varying soil conditions, from sandy, lateritic, gravelly to black soils and with a pH ranging from 5.0 to 8.5. It can grow in degraded soils which are very poor in nutrients and too dry and unsuitable for cultivation of other crops. It can grow in all types of soil with moderately good porosity (proper drainage). Topographically, it can grow in planes, hill slopes with shallow soil (with a minimum of 1.0 metre depth), undulating terrains unsuitable for cultivation, of course with a proportionate variation in its yield potentialities. Smarouba requires 700-1000 mm rainfall for normal growth, even though it can manage well in areas with even 300 mm rainfall. The crop can withstand 6-8 months of dry spell in a year.

Table 1. ECONOMICS (for a single plant)-*to farmers employing family labour*

COST	**Indian Rupees**
Amount needed to raise to establish one cluster of plants (2-3)/pit)	1.00
BENEFIT	
Amount got by cutting and selling 1-2 (extra) low yielders / pit, after 5/6 years.	100.00
Annual income by selling the produce (nutlets, vermicompost etc.) / tree.	100.00
Income by felling a 10 year old tree* for fuel	100.00 to 500.00
*for quality timber	1,000.00 to 5,000.00

*The coppice grows fast and is ready for felling subsequently once in every 7-8 years (with good maintenance)

(1 US dollar = INR 44; 1 Euro = INR 64)

CULTIVATION

In dryland locations, at least 2-3 month old saplings have to be used for transplanting. However, in places with sufficient soil moisture direct seeding is done in pits in the main field.

Nursery management

Cover size: 12 x 20cm**. Filling material:** Sand, compost and soil in equal proportion. **Nutlets (*Seeds*):** One kilogram contains about 1000 nutlets.**Sowing:** Four nutlets per cover; depth 1.0 cm below the soil surface. Seeds have short viability. **To get good germination (about 60%) freshly harvested and dried nutlets (in April/May) have to be sown immediately (within a fortnight after harvesting). Further, every month's delay reduces the germination by about 20%.** Watering once in a day with proper drainage is ideal. **Excess water causes damping off disease.** Seeds germinate in 25-35 days. Sedlings that are 2-3 month old are fit for transplanting.

Table 2. ECONOMICS (*To farmers employing family labour, from 10th year onwards*)

From Alley cropping with 500 plants/ha and with regular crops in interspace)

Items	Returns / tree (Rs.)	Returns / ha (Rs.) (500 trees/ha)
Nutlets	10kg @ Rs.4/kg	20,000.00
Vermicompost	20kg @ Rs.2/kg	20,000.00
Value of wood	1000.00 x (for 25 trees)	25,000.00
Gross income (Total) (A)		65,000.00
Expenditure (B)		15,000.00
Net income (A-B)/ha		**50,000.00**
Per Acre		**20,000.00**

The income is regular and assured for a period of about 60 years.

From Block planting, boundary planting and bund planting. Felling of one tree and selling it by 10th year

a. for fuel purpose fetches about Rs.100 - 500/tree OR

b. for timber purpose Rs 1000-5000/ tree.

Subsequently well-grown coppices can be harvested once in every 7-8 years.

Planting and aftercare

Pit size: 45 x 45 x 45cm

Filling material: Mainly top soil. **Optional:** 500 g coconut coir, straw or any leafy matter + 500 g manure

Planting pattern

Simarouba can be cultivated profitably in alley cropping, boundary planting, bund planting, as plantations, or as avenue trees. They can be also planted as dooryard trees.

1. Alley cropping with regular crops in interspace

Spacing: 2 m (East – West) X 10 m (North – South) (500 plants/ha or 200 plants/acre). Planting a **cluster of 2-3 seedlings in a pit** is done during monsoon. While planting, **SIM-FUN micro-irrigation technique** may be adopted. In the first and second summers, 2-5 litres of water per plant/week is given through **SIM-FUN.** Trenches and basins prepared regularly facilitate proper rainwater harvesting.

Mulching of organic matter around the plant is done during post-monsoon period.

Lateral bud pruning is done till the saplings grow to about three metres height so that the trees grow tall and straight; it also facilitates easy movement in the field.

Timely weeding, and manure application improve the growth.

After 5-6 years, the high yielders are retained, the low yielders are cut and the wood is marketed as quality timber.

Regular hoeing and manure application improve the yield.

By **top working** and **crown grafting *in situ*** with the scions of high yielders the low yielders can be successfully transformed into high yielders. The final population is maintained at 500/ha (200/acre). **Farmer continues to grow the traditional crops while introducing simarouba as an intercrop in alley cropping method.** Crops of the area may be grown as **intercrops** until the canopy begins to cover the open space. Once the canopy spreads, shade loving crops or fodder crops may be grown as intercrops to get additional income and to prevent weed growth. **Pruning** of unwanted and criss-cross branches is done in June-July months to get better yield.

The fruitlets are gathered, depulped, nutlets are washed, dried and may be stored in gunny bags up to one year before sending for oil extraction.

The oil is extracted in the existing oil mills and processed following conventional methods.

For oil production with no intercropping a spacing of 4 m (East-West) x 5 m (North-South) may be given.

High yielding andromonoecious plants planted at a distance of about 30 m from each other, among the pistillate plants facilitates proper pollination and in turn good fruit/seed setting.

2. Block planting for timber purpose in marginal/wasteland

Spacing: 2 m (East-West) X 4 m (North-South); 1250 plants/ha (500/acre) **or** 2 m X 2 m; 2500 plants/ha (1000/acre)

3. Boundary planting and Bund planting: Spacing: Plant to plant 2.0 m.

4. Avenue planting: Spacing: 5.0 m between the plants.

In the beginning 2 healthy seedlings are planted per pit for **Block planting, Boundary planting and Avenue planting**. After five years, plant that is more vigourous is retained and the other one is cut and sold for timber purpose.

For quality timber purpose first harvesting is done by about tenth year. The coppice is allowed to grow and subsequent harvesting is done once in 7-8 years.

Planting material

The grafts of high yielding selections of 7-8 months age and seedlings of 8-12 weeks age are used for field transplanting at the onset of monsoon.

Table 3: ECONOMICS: To an industrialist (Minimum estimate) For processing 1000 kg (one ton) depulped dry nutlets

GROSS INCOME (A)

	Oil	Oil cake	Shell
Quantity (kg)	180	120	700
Rate (Rs./kg)	30	5	1.50
Amount (Rs.)	5400	600	1050

GROSS INCOME	**Rs.7050 (A)**

EXPENDITURE

Cost of nutlets @ Rs.4/- per kg	Rs.4000
Collection and transport charges	Rs.500
Processing and marketing	Rs.1000
TOTAL EXPENDITURE	**Rs.5500 (B)**

NET PROFIT (A-B) Rs.7050-5500 = Rs.1550

Marketing

There is a ready market for its wood for timber purpose. There is also a huge demand for the vermicompost prepared by mixing leaf litter and fruit pulp which amounts to more than 10 tonnes/ha.

The industrialists in Maharashtra, Gujarat and Andhra Pradesh are ready to buy the entire produce as it is very lucrative and helps them in capacity utilization of their oil mills.

BENEFITS OF SIMAROUBA CULTIVATION

1. Benefits to economy

At *microeconomics* level farmers, owning the marginal and wastelands in semi-arid zones, start getting some income after five years of planting. They get a regular income of Rs 65,000/ha/year (Rs 20,000 from nutlets + Rs 25,000 from timber+Rs 20,000 from vermicompost) (Rs.26,000/acre/year), from 10th year onwards, regardless of vagaries in rainfall pattern.

At *macroeconomics* level, nations attain self-sufficiency in the production of edible, industrial oils, biofuels and timber on a long-term basis. Cultivation of simarouba saves huge amount of foreign exchange every year by solving the energy crisis to a considerable extent.

2. Benefits to society

Employment generation. Simarouba cultivation generates on farm employment to crores of farmers (@ 365 labor days/ha) especially rural women (about 80%). The establishment of industries such as oil, biofuel, timber, particleboard, activated charcoal etc. in the rural areas, generates agro-industry based off-farm employment in the villages. At global level, simarouba project provides livelihood to about 30% of the population.

Lakshmi taru cultivation helps in the **poverty alleviation** of small and marginal farmers owning unproductive lands all over the tropical world.

Education security. The villagers may be persuaded to invest the additional income in establishing standard educational institutions at rural level so that by spending very little money their children will have access to good education. Awareness has to be created among the children about the ill effects of unchecked population growth, pollution

and global warming with the ultimate aim of motivating them to effectively check these maladies

Infrastructure development. The villagers may also be persuaded to invest in infrastructure development such as sanitation, roads, water supply, medical facilities, electricity supply etc through their own organizations so that the villages will have all the facilities of the urban areas without the hassles of the urbanites. Such a progressive development leads to the savings on education, health care, transportation etc. to the entire society in due course of time.

Self-governance. With sufficient economic security they can as well plan to have their own self governance and need not look to any external agency or government for subsidy and grants.

Self-sufficiency. With assured income, with ready access to good education, with the best and easily manageable infrastructure and with self-governance the villages will become self-sufficient units. Such an environment encourages the hard working impoverished rural folk to pursue agriculture with renewed zeal.

Checking migration to urban areas. Thus, Lakshmi taru cultivation effectively prevents the rural people from migrating to the urban areas in search of earning, education and infrastructural facilities. All these are hoped effect the overall rural development. There is no wonder if the reverse migration process, from urban areas to rural areas, becomes operative in due course of time.

3. Benefits to environment

This ecofriendly tree with well-developed root system and with evergreen dense canopy efficiently **checks soil erosion,** recharges groundwater, supports soil microbial life, and improves soil fertility. The addition of biomass to wasteland @ 10-15 tonnes/ha/year helps in the **improvement of soil health and fertility** in a natural course.

Lakshmi taru has a wide range of adaptability. It grows reasonably well in areas with more than 300 mm erratic rainfall and withstands summer temperatures up to 48-50^{0}C. It can grow well in soils with 5.5-8.5 pH without any amendment. Its cultivation effectively **combats desertification** of wasteland. By improving the bioproductivity and economic productivity, it facilitates **wasteland reclamation.** It can be introduced in marginal and wastelands in semi arid and arid tropics all over the world including central African and gulf countries.

The cultivation of Lakshmi taru does not require excessive application of chemical fertilizers. It is a tree with no major pests and diseases and thus requires no pesticide application. Thus its cultivation does not add harmful agrochemicals to the environment.

It **evergreens the gray soil surface,** harnesses abundantly available solar energy (which is otherwise going waste now) and converts it into biochemical energy all round the year. Simarouba checks overheating of the soil surface all through the year and particularly during summer.

Large scale planting of simarouba in the marginal/wastelands utilizes harmful green house gases, checks their accumulation in the environment and **helps enormously in reducing global warming.**

For a long-term strategy, cultivation of versatile tree simarouba, Lakshmi taru is advocated in the abundantly available marginal/wastelands in arid and semi-arid tropics and its implementation shall be economically viable and ecologically sustainable.