DRAFT ON

MARKETING MODELS FOR RED SANDERS GROWN ON PRIVATE LANDS

A small introduction to the species:

Survival of this species is dependent on massive plantations as Red Sanders is peculiar as it has a xenogamous seed production mechanism (where pollen from one flower transfers directly to the flower on another tree), which is dependent on the overall population size as well as the availability of superior pheno/genotypes for production of good quality seeds. Thus, the reduction in population size and lack of good-quality individual plants puts the continued survival of the species at risk.

One more interesting point to mention is that— it was very difficult to raise seedlings from the seeds, but due to a technique developed by one British Forest Officer by the name **Mr Yarde** with certain improvements is still in use for raising seedlings of Red Sanders in the Nursery.

The Tree:

A deciduous medium-sized tree, that grows up to 12 mts. Stem erect and dense, rounded crown, bark blackish brown, exuding a copious red gum. The bark is deeply cleft into rectangular or square-shaped plates (cork cells); it resembles that of a Crocodile's skin in appearance.

Branchlets drooping, glabrous. Leaves imparipinnate, leaflets three, rarely four or five, broadly ovate or orbicular, apex obtuse or emarginate, margin entire, shiny and glabrous. The tree becomes leafless during January – March.

The plants attain fertility when there is age about 16 to 17 years and Seeds can be preserved good for one year, after that they lose the most of their vitality.

Flowers are yellow, bisexual, axillary, in simple or sparingly branched racemes, and fragrant. Flowering occurs in April to June months with individuals flowering intermittently for three periods, sometimes recalling in mass blooming. The fruiting period is from September to February.

Pollination activity in Red Sanders is limited to moonlight nights and early morning hours. **6% of the quantum of its flowers turns to fruits**. **Only xenogamous fruits reach maturity**, dropping autogamous and litinogamous fruits. The low possibility of energy investment in Red Sanders is due to climate and natural limiting factors. During seeding progressive elimination of poor seeds arising out of self-pollination happens. There is a low probability of out-crossing due to low population size, poor pollinator viability in this species.

Pods obliquely orbicular and flat. Seeds 1 or 2, reddish-brown, with a smooth leathery taste. Reddish-brown winged pods are formed after 11 months of flowering and have 1 or 2 seeds each. Blooms once a year during the dry season from late March to late May. Reddish brown winged pod

The heartwood of this plant is bright orange-brown or dark red; upon exposure to air, it turns into very dark brown or black colour. The heartwood is quite heavy and sinks in water (Dutt, 1928; Neginhal, 2004; Sarin, 2008).

The deep colour of Red Sanders can range from purple cum black and its compact grain gives it a metalistic and smooth feel, to retain and display its natural properties Red Sanders must only be treated with colourless hot vax.

Etymology:

The generic name '**Pterocarpus'** is derived from the Greek root words, 'pteron' means a wing, and '**karpos'** means a fruit, referring to the

winged pot or feathery fruits. The specific epithet '**santalinus'** is derived from noun base '**Sandal'** and Latin adjectival suffix '**inus'** means like, which hints that this plant is possessing the characteristics of or resembling to that of Sandal or Sandalwood (Stearn, 1983). The homonym of Pterocarpus Santalinus L.f. is Pterocarpus santalinus. Its synonyms are Pterocarpus lignum, Santalum rubrum, Lingoum santalinum.

Vernacular Names

Botanical name is Pterocarpus santalinus L.f. Its vernacular names in different languages are: Yerra Chandanam in Telugu, Sivappu Chandanam in Tamil, Raktha Chandan in Sanskrit, Lal Chandan in Hindi, Kempu gandha in Kannada, Red Sandalwood in English, Zitani in China, Sandaku in Burmis language, Sandalo Rojo in Spanish.

Distribution of Red Sanders:

Pterocarpus is a well-recognised tree and distributed in three tropical regions namely Geotropic, Tropical Africa, and in Indo-Malaya region (that is Indian subcontinent and Maly peninsula).

Though this genus consists of 35 to 40 species, only 4 species are found in India, they are- **Pterocarpus dalbergioidos, P. indicus, P. marsupium, and P. santalinus**. Among these 4 species, the most important species that needs to be paid immediate attention to is Pterocarpus santalinus. It is an endemic species narrowly confined to the Southern parts of the Eastern Ghats of India**.** Red Sanders prefers the Eastern slopes of stony hills and is to be found at an altitude of 900 to 2000 feet. Red Sanders stock is more prevalent on the lower slopes where it is densely populated with less of other vegetation**. As the altitude increases the percentage of stock declines but the quality improves. The largest and best trees are to be found in the upper limit of the Red Sander zones.**

As an introduced species occurrence is also reported in the countries like China, Sri Lanka, Pakistan and Taiwan.

Ecological Niche of Red Sanders:

Ecosystem is the biological community of interacting organisms with physical environment. In the natural habitat of Red Sanders, the temperature varies from 11 degrees C to 46 degrees C and rain fall ranges from 100 to 1000 mms, which is indicative of extreme year-long climate.

Hilly terrain, hilly slopes, shallow, poor, stony and well drained soils are preferable conditions for Red Sanders growth. The natural population, to the extent of 82%, occurs in the subsurface formation of quartzite, revealing the soil preference for its growth. It demands heavy light and avoids waterlogged areas.

Growth of the Red Sanders Plant

The tree does not grow rapidly and it is fit for felling or logging only after 40 years, attaining the age of maturity. When green it resists forest fire and is impervious to attacks of insects and white ants. Deer and cattle have a peculiar liking for the leaves of young trees.

Red Sanders grows very slowly with the thickness of the tree increasing by around 3.3 centimeters every year to 10 years. The wood can be used when the diameter of the tree is above 16.5 centimetres.

Substitutes and adulterants of Red Sanders:

Heartwood of Adenanthera pavonina Willd. (Family: Mimosaceae) known as ‘Ranjana’ and ‘Raktakambal’ in West Bengal and ‘Bari Gumchi’ in the Northern parts of India, is often sold as a substitute for red sanders. Artificially coloured wood shavings and saw dust from some other trees is also sold in the market as cheap substitutes (Sarin, 2008).

Uses of Red Sanders:

(A) Medicinal Uses:

- A decoction of the fruit is used as an astringent tonic in chronic dysentery. An infusion of the wood is used in the control of diabetes.
- The wood of P. santalinus is considered astringent, tonic and diaphoretic.
- A paste of the wood is used to give cooling effect, applied externally for inflammations and head-ache.
- It is useful in bilious affections and skin diseases.
- The wood is bitter in taste with a flavour, anthelmintics, aphrodisiac, alexiteric useful in vomiting, thirst, eye diseases, cures diseases of the blood vata and kapha, mental aberrations and ulcers.
- The wood is in treating headache, skin diseases, fever, boils, scorpion sting and to improve sight.
- The wood and fruit is used in treating diaphoretics, bilious infections and chronic dysentery.
- The lignan isolated from the heartwood is known to inhibit tumor necrosis factor alpha production and T-cell proliferation.
- The heart wood contains isoflavone glucosides and two anti-tumour lignans, viz., savinin and calocedrin.
- A triterpene is reported from the callus of stem cuttings.
- Ethanol extract of stem bark at 0.25 g/kg body weight was reported to possess anti-hyperglycaemic activity.
- The stem bark extract was shown to contain maximum activity against Enterobacter aerogenes, Alcaligenes faecalis, Escherichia coli, Pseudomonas aeruginosa, Proteus vulgaris, Bacillus cereus, Bacillus subtilis, Staphylococcus aureus.

- The leaf extract showed maximum activity against Escherichia coli, Alcaligenes faecalis, Enterobacter aerogenes and Pseudomonas aeruginosa.
- The ethanol extracts of Pterocarpus santalinus L.f. (Fabaceae) at a dose of 50-250 mg/kg showed a gastroprotective effect in reserpine-induced, pyloric-ligated experimental rats.

(Source: IWST, Bengaluru)

(B) Musical Instruments and Furniture:

Wavy or ripple-grained Red Sanders wood is of superior quality when compared to its straight-grained wood. This wood is exported to Japan for manufacturing especially a a musical instrument named "**Shamisen**", since this kind of wood has superior acoustic qualities.

Buddhists prefer this wood for cremating dead humans. The strait grain inferior Red Sanders wood is used for carving idols and toys.

(C) Dyes:

Red dye is extracted from the heartwood of Red Sanders. This is a natural dye, and especially vegetable colorant used in dying of textiles-cotton, silk, wool and nylon. Two colouring components reported in Red Sanders wood are santalin and Dioxin santalin being the main colouring component.

Besides dyeing textiles, extracted colouring components from Red Sanders are also used in coloration of foodstuffs and paper pulp.

Old wood of Red Sanders is employed as dye stuff since young wood contains very little colouring matter. The colouring matter of this wood was first examined by Pelletier in 1814 and distinguishes it by the name of santalin.

(D) Industrial Uses:

. It is used as cooler in nuclear reactors; this is the reasons why the South-East Asia is most preferred destination of the Red Sanders. Through biogeochemical research uranium and thorium treasure were observed in Red Sanders leaves and woods. Thus Red Sanders has wide potential as an alternative nuclear fuel source. Red Sanders is also used in the manufacture of alcoholic beverages.

Varieties:

In nature, two types of red sander trees are observed they are wavy grained, and straight. The wavy-grained wood is more in demand in trade and is preferred for commercial plantations. No commercially released varieties are available.

A.N. Arunkumar and G. Joshi in their paper titled: Pterocarpus santalinus (Red Sanders) an Endemic, Endangered Tree of India: Current Status mentioned that:

Studies on the genetic ***basis of wavy grain in Red Sanders*** *and methods to increase the frequency of trees with wavy grain- were initiated at Forest Research Institute, Dehra Dun. It was reported that lumen diameter was an* ***important anatomical trait in screening for wavy grain at the sapling stage*** *(Kedharnath and Rawat, 1976). Some of the traits differentiating the wavy grain from the straight grain were* ***the presence of tyrosine in the vascular cambium, pericarp venation, seed and cotyledon shape, and stomatal number*** *(Das and Dayanand, 1983; 1984).* ***It was also found that seedlings raised from wavy-grained trees were slow-growing compared to that of straight-grained trees****. The seedlings had short internodes, smaller and greener leaves, petioles, and more compact crowns, and concluded that these traits were distinct, and could be used for segregating the seedlings* *(Rawat and Uniyal, 1996). Kedarnath (1984) found significant*

variation in waviness intensity from the pith to the periphery within and between trees. Raju and Srinivasalu (2008) suggested that wavy grain trees have a preference for friable soils and are absent in compact soils or soils devoid of any soil cover.

The occurrence of both normal and wavy-grained trees in a similar area suggests that genetic factors play a significant role along with environmental interactions. As the number of wavy-grained trees are low, it is possible that the gene for this character must be occurring in low frequency in the population or is controlled by polygenes.

So, collecting seeds from the trees that exhibit physical traits like. **trees with short internodes, smaller and greener leaves, petioles, and more compact crowns** may help in propagating the wavy-grained red sanders, which has a lucrative market.

Artificial Regeneration:

Seed:

The seeds retain their viability for about one year under normal storage conditions and are the best propagation material. Fruits are collected in March for the extraction of seeds. Seedlings or stumps prepared from two-year-old nursery seedlings are used for planting in the field.

Seed Collection:

Dry pods are collected from trees in February-June, then dried in the sun for 3 days and stored in bamboo baskets or gunny bags till required. There is no loss of viability for at least 8 months. It loses its viability definitely if kept for more than one year.

Pretreatment:

Soaking of pods in cold water for 3 days increases the germinative capacity very much, also if the pods are immersed in cow dung slurry for 48 hrs before sowing.

Sowing Method:

Raised or flat nursery beds with well- drained soil is prepared. The soil should be dry to 30 cms deep and clods broken to powder. Farm yard manure is mixed with soil. Standard size beds of 12x1.2 m, raised above the ground are prepared. The entire pod with wing as collected are sown. Pretreated pods is sown per bed and is covered by a thin layer of soil or hay and profusely watered.

Sowing Season: During July-September

Germination Duration: Germination takes 15 to 20 days.

Germination Percent: Germination percent varies from 10 to 80 percent

Nursery Technique:

March, April or May months are suitable for raising nursery from seeds. Mature and healthy pods are chosen to collect the seeds; these are sown in raised nursery beds. It takes 10-15 days for the germination to complete.

Pretreated seeds (10-12 kg) are sown per bed (10 m-1 m) of sandy loam or loamy soil in April and covered with a thin layer of soil or hay. After one year, stumps can be prepared, which are planted in polybags in February to March, to be utilized after four to five months as stump-sprouted seedlings.

Pre-Treatment: About 1 kg seeds are needed to raise seedlings for 1 hectare of plantation. Seeds show only about 50%-60% germination and about 40% plant survival. Seed treatment with GA3 (gibberellic acid) +BA (benzyladenine) @250 PPM (parts per million) helps in early and optimum germination. Alternatively, seeds can be soaked in cold water for 72 hours or in cow dung slurry for 72 hours. 10 to 15 Kgs of pretreated seeds are sown per bed (12 x 1.2 mts) of sandy loam or loamy soil in April and covered with a thin layer of soil or hay. After one year, stumps can be

prepared which are put in polybags in February to March, to be utilized after 4-5 months as stump sprouted seedlings.

Vegetative Propagation:

It is done through cuttings. Cuttings are planted in polythene bags with sandy-loam soil mixed well with FYM, watered daily and kept till they are one year old.

The seedlings when 4 to 10 cm high are transplanted into polythene bags and the bags are kept under shade, duly watered for a month. Then the shade is removed and watering continued for another 3 to 4 months daily. At the end of this period, roots develop and are 20 to 30 cm long. These are planted out during rainy season. One year old cuttings are field planted at a spacing of 3.5 to 4.5 m in 30 cm3 pits.

Water logged sites and areas that are overshadowing by other trees must be avoided. One or two hoeings around the plant to 1 m radius and 15 cm depth are done in the first two years.

Soil:

It grows well on rocky soils consisting of quartzite shales, lime stone and laterite. The tree grows well particularly in laterite loam, requires perfect drainage and hence it is found mainly on stony or gravelly soil. Under water logged conditions the trees fail to stand stiff.

Planting in the field:

The land is ploughed and harrowed repeatedly and soil is brought to a fine tilth. Pits of size 45 cm x 45 cm x 45 cm are dug at a spacing of 4 m x 4 m. The pits are filled with topsoil mixed thoroughly with 10-15 kg FYM (farmyard manure) and 10 g lindane dust to protect the planting stock from soil-borne fungi.

Transplanting and optimum spacing:

The best time for planting the crop in the field is end of May to June, that is, onset of rainy season. Generally, the stump-raised seedlings or stumps obtained from two-year-old nursery plants are transplanted.

Intercropping system

No particular intercropping system has so far been studied in this crop; however, **to increase the income of the farmers, other multi-purpose Tree species can also be interplanted, so that the farmer keeps on getting intermediary income till the red sander trees get matured for felling.**

The following table gives a comparative advantage of timber species over the horticulture species. The timber species with an inter-cropping of annual and bi-annual food species will help them to improve their financial returns from their agricultural fields.

Red Sanders Vs Teak Vs Sandal Wood Vs Eucalyptus Vs Mango

S. No	Criteria	Timber Plants				Horticulture plant
		Red Sanders	Teak	Sandal Wood	Eucalyptus	Mango
1	Supply condition	Medium	High	Medium	High	High
2	Cost of Production	Low	Medium	Medium	Medium	High
3	Subsidies	No	Medium	High	Medium	Low
4	Environmental benefits	Benefits	Benefits	Benefits	Damage	Benefits
5	Water use efficiency	High	Low	High	Low	Low
6	Risk of drought	Low	High	High	High	High
7	Price sensitivity	Low	Medium	Medium	Medium	High

Intercultural and maintenance practices:

About 10-15 kg FYM per plant per year and 150:100:100 g NPK (nitrogen, phosphorus, and potassium) per plant per year are required for at least five years. Fertilizer should be applied 15-20 cm deep in the circular trenches dug around the plant at a distance of 60 cm. A full dose of P and K along with one-third of N should be applied at the end of February. The remaining N should be applied in two split doses during June-July and October-November. The application of inorganic fertilizers should always be followed by irrigation. Gap filling is done one month after planting.

Weeding is done manually as and when necessary, particularly just before manuring. The soil around the basin is loosened frequently by hoeing.

Irrigation practices:

The plants are irrigated immediately after transplantation. Thereafter, irrigation is done on alternate days up to 15 days. After the seedlings get established, irrigation may be done at an interval of 10-15 days, depending on the weather conditions.

Diseases and pest control:

Not many disease-causing agents attack the Red Sander plants. Leaf-eating caterpillars have been found to damage the crop during April-May. These can be controlled by spraying 0.2% Monocrotophos twice at weekly intervals.

Literature mentions the occurrence of the following attacks by disease-causing agents:

S. No	Name of the Insect	Season	Attacked Parts	Reported Area
1	*Caterpillars (Pyralidae*	up to April	Poles (30-38 cm girth size wood)	Chittoor

2	*Bostrychidae-Sinoxylon anale Linn.*		Partially dead and dried wood	Kodur Plantation
3	*S. crassum*		Partially dead and dried wood	Kodur Plantation
4	Caterpillar	Up to April	Leaves (Kesava Reddy 1988)	Chittoor

Red Sanders and its other threatened associates in the nature

Red Sanders bearing forest represents several narrow endemic species like Cycas beddomei Dyer (Cycadaceae), Boswellia ovalifoliolata Balakr. & Nayar (Burseraceae), Decaschistia cuddapahensis Paul & Nayar, Shorea tumbaggaia Roxb. (Dipterocarpaceae), Syzygium alternifolium (Myrtaceae), Terminalia pallida Brandis (Combretaceae) and Pimpinella tirupatiensis Balakr. & Subram. (Apiaceae) which are edaphically and climatically adapted to occur in small ecological refugia.

So, it is the solemn duty of us to protect the species and its highly endangered other associate species, which are naturally flourishing in the habitat of RS. One way of doing it is to take the species into the farm lands in a big way.

Marketing of Red Sander Wood:

Grading of Red Sanders:

Based on research by the Department of Agriculture, Botany, S.V. Agriculture College, Tirupathi in collaboration with Andhra Pradesh Forest Department Red Sanders, the grading rules were framed by the State of Andhra Pradesh.

General standards for grading Red Sanders include:

(i) logs dressed neatly up to heartwood;

(ii) top-end girth of the log be ≥ 36 cms, and

(iii) logs be straight or nearly straight.

The greater the intensity of the wavy grain present in the dressed red sanders wood logs, the greater the market price it fetches.

Red Sanders logs are classified top-down into 3 grades.

1. ‘**A’ Grade**:

Red Sanders with excellent wavy grain has the following characteristics.

i. Short and deep wavy grain prominently visible;

ii. Generally log surface gives ripple reflections; and

iii. Logs free of defects or with very few defects

2. **‘B’ Grade**:

Logs also with excellent wavy grain, satisfy the following criteria set for this grade.

i. Medium long and medium deep wavy grain, clearly visible;

ii. Logs with some or no defects, that is, semi-sound; and

iii. Semi-sound “A‟ grade logs with few more defects and A grade logs ≥ 10 bends.

3. **‘C’ Grade:**

C grades are with straight grains, meeting the following.

i. Long and shallow wavy grain or straight grain;

ii. Logs sound or semi-sound with some or no defects;

iii. Unsound but utilizable “A‟ grade logs with many defects Unsound but utilizable “B‟ grade logs with a few more defects; and

iv. B-grade logs with ≥ 10 bends.

4. **Non-grade:**

Rejected logs are un-utilizable logs of all the grades

Threat due to over-exploitation

Trade in Red Sanders Red Sanders wood has been extensively used as a tradable commodity since the 16th century when it was being exported to European countries. Trade records mention that in the year 1882-83 red sanders worth half a million rupees were exported to the United Kingdom (12,782 tonnes), France (1,116 tonnes), and Sri Lanka (1,687 tonnes). **TA Whitehead**, a Forest Officer in Cuddapah raised his serious objections on how Red Sander trees are exploited and mentioned that "*not only the stems and branches but even the roots were extracted and is to be wondered at, that the tree has survived total extinction*". This observation has relevance even in the present days too. As mentioned earlier, the demand for wood is greater in international markets.

Initially, in the sixteenth century, it was exported to European countries as a source of natural dye which subsequently reduced as the synthetic dye came into the market, but a Japanese merchant in 1931 approached the Forest Department of Andhra Pradesh, rekindling the wood value in the international market.

Even though, P. santalinus has been documented in China by the Jin dynasty scholar Cui Bao (265-340 AD), it was regarded as a rare and precious lignum as expensive as gold. The heavy demand in the international market for many centuries suggests why Red Sanders has been over-exploited through illegal harvest. Year after year a large number of seizures of illegally felled wood, and vehicles is taking place and several people involved in the felling of and transporting of the logs are arrested and the numbers are skyrocketing.

Initiatives to safeguard the species from becoming extinct

(A) **At the country level**:

To curb this menace, the State of Andhra Pradesh from time to time formulated rules for safeguarding the red sanders, they are (a) Red Sanders have been declared as a reserved tree under the Andhra Pradesh Preservation of Private Forest Rules, 1978, (b) Red Sanders and Sandalwood Transit Rules of the Andhra Pradesh Forest Act, 1967 (c) Andhra Pradesh Sandal Wood Possession Rules, 1969, (d) The Andhra Pradesh Sandal Wood and Red Sanders Wood Transit Rules,1969, (e) Andhra Pradesh Red Sanders Wood Possession Rules, 1989, (f) Government of India, kept under negative list of exports notified by Govt. of India (Notification 2 (RE-98) dt 13.4.98, 1997- 2002).

(B) At International level

Considering the **wood in high demand, restricted distribution, possibly muted regeneration of the species, illegal harvest, trade, and habitat destruction**, the species has been categorized as endangered by the IUCN, and based on a proposal from India, Pterocarpus santalinus is the only species of Pterocarpus that has been listed in Appendix II of CITES on 16th February 1995.

Appendix II includes all those species which although not necessarily now threatened with extinction may become so unless trade in specimens of such species is subject to strict regulation to avoid utilization incompatible with their survival. The listing was annotated to cover – logs, wood chips, and unprocessed broken material which were subsequently modified at **CITES COP 14** as logs, wood chips, powder, and extracts. **Even though this species was included in Appendix II of CITES IN 1995, export was banned only in the year 2004**.

In 2010, when the CITES was planning to suspend the trade of red sanders obtained from India, the government submitted a **Non-Detriment**

Finding (NDF) report (BSA prepared this report) saying it must be allowed to export from cultivated sources. Based on the plea of the Government of India, **in the year 2012, the CITES secretariat granted an export quota under which the country could export 310 tonnes of red sanders obtained from "artificially propagated" sources (grown on farms) and 11,806 tonnes of wood from seized sources**.

CITES kept the species and our country under a category of **Review of Significant Trade (RST) in the year 2004.**

This species was once again classified as '**near threatened'** in 2018 and has now joined the '**endangered'** list once again in 2021. This step is based on the assessment made by IUCN that: "*Over the last three generations, the species has experienced a population decline of 50-80 per cent. It is assessed as Endangered"*.

New Policy Initiatives:

1. On February 18, 2019, the Directorate General of Foreign Trade revised its export policy to allow the export of red sandalwood timber obtained from cultivated land
2. The 77th meeting of the Standing Committee of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) held in Geneva in November 2023, decided to remove this species and our country from the category of **Review of Significant Trade (RST) for Red Sanders**, this step can act a major boost to farmers who grow Red Sanders for export on their farmlands.

What can be done to make the species flourish:

P. santalinus is a resilient species and its survival amidst over-exploitation over the past few centuries indicates that it is necessary to seriously think about its revival strategies.

Some of the best ways of conserving Red Sanders is

1. To raise large-scale seedling-based plantations in its natural habitats and in other regions that have related geological features and have similar growing conditions which would ensure that genetic material is safe for posterity.
2. These plantations outside the forests can act as a source of plant material for initiating further tree improvement strategies.
3. While growing Red Sanders outside the forest area, it is very important to educate the tree growers about the long gestation periods of the crop.
4. Maybe a sustainable wood trade policy encompassing the stakeholder's perceptions will help in the propagation of this species outside the forests in good numbers.

   (***Credit**: Some of the information given above is adapted from an article Pterocarpus santalinus (Red Sanders) an Endemic, Endangered Tree of India: Current Status, Improvement and the Future A.N. Arunkumar and G. Joshi of Tree Improvement and Genetics Division, Institute of Wood Science and Technology, Bangalore, India)*

Marketing of Red Sanders Grown on Private Lands:

As discussed above, there is no doubt that this species has been under severe attack of saw since last many centuries. Smugglers are ready to go the extra mile for cutting and smuggling this species. With time, they have become ruthless too.

Despite this species which is localized to a very small geographical area of the country, thanks to this species' highest resilient capacity, it is still able to survive. To protect this species and prevent from it being extinct, the State Government, the Government of India, and CITES have taken measures, as explained above.

The government is well aware of the importance of this species, the need to increase its numbers (both geographically and in abstract numbers), improve the genetic quality of the species, and the economic importance of the species, simplified the earlier restrictions imposed on export and due to its persistent efforts, now this species is out of RST regime of the CITES. **These measures will species to spread out of its natural range into the fields of farmers**.

To understand the relevance of this species as a potential marketing material, let us examine the Strengths, Weaknesses, Opportunities and Threats enjoyed by this species.

SWOT Analysis of Read Sanders:

Strengths of Red Sanders:

S.No.	Perceived Internal Strength Factors
1	Conducive to cultivation in dry farmlands
2	Grows well in dry degraded land. Can grow well in areas that receive 200-800 mm annual rainfall
3	Withstands worst drought conditions
4	Prefers hot climate with 25 - 45 c

5	Water-use efficiency is high as it does not use ground water
6	Grows in 32 - 60 humidity conditions
7	Rain-fed and needs no chemical and pesticides
8	Regenerates through coppices
9	Red Sanders grown from coppices matures early
10	Impervious and survives fire
11	Sequesters about 1000-ton CO2 sink per acre
12	Grows well with other timber and horticulture plants
13	Farm-grown RS wood is comparable to that of nature-grown RS

Weakness of Red Sanders:

S.No.	Perceived Internal Weakness Factors
1	Is an endangered species, that is, with the possibility of extinction, so lots of restrictions
2	Limited cultivation of RS on farmlands. Now only this species is getting prominence.
3	Quality of RS cultivated in farm land is not good in high rainfall conditions and in irrigated lands
4	RS grown with coconut does not yield heart wood
5	Limited RS plantations by forest department due to difficulty of protection
6	Risk of long-term gestation
7	Farm-land grown RS is exposed to smuggling risks

External Opportunity

S.No.	Perceived External Opportunity Factors
1	Multiple uses across the world over centuries
2	RS value-added products are allowed to export under restricted category
3	Increased employment opportunities for RS handicraft artisan groups
4	CITES encouraging RS cultivation on farm lands, which amounts to conservation of RS in natural forests
5	RS may help 1% increase in forest cover
6	High prices of RS in the international markets

7	In future, the farm grown RS wood also may get an opportunity under export quota (now the quota is there only for Government held quantities)

External Threat Factors

S.No.	Perceived External Threat Factors
1	Restricted exports under EXIM policy
2	Complex procedures-administrative, customs, revenue, and Forest
3	Restricted export of RS and its products by CITES
4	Demand is met by illegal felling and smuggling
5	At present not many value-adding Indian companies
6	No incentives for cultivation of RS
7	Limited patents for India, one only as compared to 47, 14, and 10 patents for U.S.A., Japan and Korea respectively
8	No proper policy, marketing setup, future price information

Strategic Planning Matrix

TOWS Matrix:

The **TOWS Matrix** is an acronym for Threats, Opportunities, Weaknesses, and Strengths. The matrix is a variation on the SWOT Analysis, and it seeks to address criticisms of the SWOT Analysis regarding its inability to show relationships between the various categories.

TOWS Matrix can be defined as the tool to analyze, generate, compare, and select the business strategies to attain the overall goals and objectives. TOWS Matrix is the tool for strategy generation and selection.

Limitations of TOWS Matrix:

- It doesn't follow the real steps that are mandatory to follow and achieve a competitive advantage in the market.

- Many a time, the analytical approach of TOWS Matrix does not consider the changing competitive environment that is one of the biggest threats to the business in attaining its objectives of higher sales, elevated profits, and enhanced brand value.
- It doesn't show and highlight the interrelationship between the internal and external factors that affect business operations and strategies

Internal / **External**	**Strengths** • Conducive to cultivation in dry farmlands • Grows well in dry degraded lands • Withstands extreme conditions of weather • Water-use efficiency is high • Sequesters about 1000 tons of CO2 per acre • Farm-grown RS wood is comparable to that of nature-grown RS	**Weaknesses** • Is an endangered species, so lots of restrictions on harvesting and trade • Limited cultivation of RS on farmlands • Quality of RS cultivated in farmland is not good in high rainfall conditions and in irrigated lands • RS grown with coconut does not yield heartwood • Limited RS plantations by forest department due to difficulty of protection • Long Gestation • Risk of theft
Opportunities • Multiple uses • RS value-added products are allowed to be exported under a restricted category • Increased employment opportunities for RS handicraft artisan groups • CITES encouraging RS cultivation on farmlands, which amounts to conservation of RS in natural forests • RS may help in increase of forest cover by 1% • High prices in international Market	**SO Strategies** • Take full advantage of the short supply of Red Sanders in the market and grow more wood in the AF Systems. • Dry lands are the most suitable for RS, so maximise the use of these lands • Precision silviculture will help in the amelioration of soils, • Farmers will get extra income from their fields. • Relaxed export regimes will help in exploring new markets,	**WO Strategies** • For getting wavy grain RS, seeds collected from such trees will help in improving the quality of RS. • Organized growers can demand and get QPMs, good prices for their goods • Having regional inventories and wood-flow plans helps in better understanding of the forces of market and can forecast wood availability in the coming years and accordingly planning can be made.

	from where the farmers can get more money for their produce.	
Threats • Restricted exports under the EXIM policy • Complex procedures-administrative, customs, revenue, and Forest • Demand is met by illegal felling and smuggling • At present not much value-adding Indian companies • No incentives for cultivation of RS • Limited patents for India, one only as compared to 47, 14, and 10 patents for U.S.A., Japan and Korea respectively • No proper policy, marketing setup, future price information	**ST Strategies** • Success stories will make other farmers venture into this sector • Changing the mindset of growers will help in opting for long rotations. Making the farmers compare the long rotation activity to their Fixed deposits. • Market research trends in the industry will help in overcoming the uncertainties related to future market and profitability • Research and patents will help the sector many folds	**WT Strategies** • Governmental initiatives like creation of institutions like RS board will help the growers • Organized Growers' Association will help in understanding and countering the forces of the market

What further can be done?

TSFDC is aiming to grow beyond the domain of Government Forest Lands and venturing into the domain of Agroforestry. It can help the farmers in the following manner:

- To propagate Red Sanders successfully, it is crucial to obtain high-quality root stock sourced from plus trees. Coordinating with the Forest department can facilitate the collection of such root stock.
- Before planting Red Sanders saplings in the field or forest, it is essential to provide sufficient nursery care and implement effective plant protection measures.

- It is recommended not to harvest Red Sanders saplings for the purpose of using them as building and construction materials, such as poles.
- To promote further propagation and sustainable management of Red Sanders, awareness about this species has to be promoted.
- To ensure the scientific cultivation, protection, conservation, extraction, and sustainable management of Red Sanders, the knowledge and skills of farmers are to be effectively upgraded.
- Women's groups and youth groups can benefit from learning about the scientific methods of extracting essential oil, grading, packaging, and marketing of Red Sanders. This can help them to participate effectively in the value chain of Red Sanders and contribute to its sustainable management.
- To ensure that farmers receive a fair price for their Red Sanders produce, State agencies should establish market linkages. This can help create a transparent and efficient value chain that benefits both producers and buyers.

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