



ADAPTIVE MANAGEMENT FOR SUSTAINABLE HARVESTING OF NTFPS/MEDICINAL PLANTS

Cinnamomum malabratum (Burm.f.) Blume and *Cinnamomum sulphuratum* Nees

Fact sheet No.1 2006

An output of a collaborative study of FRLHT, India with ECI, Oxford University, UK



Botanical name: *Cinnamomum malabratum* (Burm.f.)

Blume

Family: LAURACEAE

Habitat: Moist deciduous to shola forests

Description: A medium to large sized tree, reaching 5-20m tall and 30-60 cm girth; Bark about 5 mm thick, gray to light brown, smooth, and smells like clove when cut; Berries ellipsoid, greenish pink ripening purplish brown

Distribution: Endemic to Western Ghats, India; Grows at an altitude of 600-1800 m; Found in semi-evergreen forest of Kerala, Tamil Nadu, Goa and Maharashtra

Parts used: Leaves, bark and buds

Medicinal Properties: Bark is carminative, antispasmodic, haemostatic, astringent, antiseptic, stomachic and germicidal

Propagation: Seeds, cuttings and divisions of old rootstocks



Fruiting twigs

Botanical Name: *Cinnamomum sulphuratum* Nees

Family: LAURACEAE

Habitat: Moist deciduous to shola forests

Distribution: Endemic to Western Ghats of Karnataka, Tamil Nadu and Kerala states of India

Description: A small to medium sized tree; About 8 m tall and 70 cm girth; Bark is smooth, reddish brown outside, dull red inside, and has strong aromatic smell; Berries are oblong ellipsoid, 1 X 1.5 cm, smooth, hairless, seated on about 1 cm across cup-shaped fleshy disc

Parts used: Leaves, bark and buds

Propagation: Seeds, cuttings and divisions of old rootstocks



New flush of leaves

Branchlet

ADAPTIVE PLANNING AND MANAGEMENT FOR SUSTAINABLE HARVESTING

Adaptive management explicitly addresses and reduces the uncertainty by evaluating the effects of management through participatory experimentation and monitoring. Local community has developed a methodology for participatory experimentation to demonstrate the 'best practices' that are known to be effective in achieving ecological and social sustainability.

COMMUNITY UNDERSTANDING

- ✎ **Season and pattern of harvest:** Generally, harvesting of *Cinnamomum* leaves is carried out during March. Only the matured individual leaves are plucked from tree. Due to rise in demand, collection of *Cinnamomum* leaves for commercial purpose gets started from December. The improper lopping of branches and twigs affects the tree growth, development and reproduction, moreover the harvest is of very low quality with immature leaves
- ✎ **Sustainability factor:** Quality harvest is hand plucking of individual mature leaves. Such harvest yields bigger and mature leaves with high quality essential oil content and medicinal properties. The quantity-oriented harvest involves collection of immature (young) leaves to mature (old) leaves. In this destructive harvest, the entire branch is cut to save time and energy in climbing the tree and to increase the quantity of leaves collected.
- ✎ **Trade:** Leaves are traded in local, regional and national markets. They are also sold as an admixture of several species of *Cinnamomum*.

This Fact sheet is an output of a research project funded by Forestry Research Programme of DFID, UK for the benefit of developing countries. The views expressed here are not necessarily those of DFID. R8295/FRP. We acknowledge the support and contribution of Karnataka Forest Department, Village Forest Committees of Savandurga & Agumbe, Karnataka, India

Assimilation of traditional and modern scientific knowledge

The assessment and assimilation of information related to focal species, timing and frequency of harvest, qualitative attributes etc, from traditional knowledge and modern scientific knowledge were merged to develop and evolve an adaptive management for sustainable harvesting of *Cinnamomum* spp. through participatory planning and monitoring protocols involving local community in Agumbe, Karnataka, India.

	Scientific knowledge	Traditional knowledge
Name	<i>Cinnamomum malabattrum</i> (Burm.f) Blume <i>Cinnamomum sulphuratum</i> Nees	Tamala patra, Lavanga patre, Kadu dalchini (Kannada); Pinga dalchini, Matta dalchini (Kannada)
Phenological patterns	Flowering and fruiting; <i>C. malabattrum</i> - December - June <i>C. sulphuratum</i> - December - May	Foliage and flowering during January – February; Fruiting in March-April; Trees under shade bloom later in the season than trees in direct sunlight; Flower buds are produced in fully matured 20 yrs old/1m girth trees; Tree takes 3-4 years to restore leaf production, after harvest
Medicinal uses	Bark is used for treating cough, diarrhea and dysentery; Oil from the root bark and leaves are applied externally in rheumatism; Spicy leaves and bark are substituted / adulterated for the commercial <i>C. zeylanicum</i>	Leaves are used as spice in cooking; Bark is used to cure cough, headache, spider poison and as a mouth refresher; Buds are also used in cooking
Method of harvest	Hand plucking of green leaves only for better development of growing trees	Only mature leaves are hand plucked during February-March; Excessive leaf collection impedes the flowering; Seeds, if produced, are washed away by the rains, since there is hardly any litter on the ground, which would act as mulching agent. Population is declining since ten years with more old and damaged trees and with few recruits

Harvest treatments and practices

Three harvest treatments were designed merging traditional and scientific knowledge viz. right harvest method (selective harvest); Business as Usual (BAU; current harvest method; destructive); and control.

Right harvest	BAU harvest
Collect the individual mature leaves by plucking from the mature trees (dbh>20cm)	Collect all the leaves from all trees at once by cutting twigs and branches



BAU harvest

The BAU harvest was done in the month of January, while the right harvest during February – March. There was no harvest from control method.

Processing and marketing

The reddish brown young leaves from premature harvest in BAU had higher moisture content that are prone to

fungal and bacterial attack and took longer time to dry. Some were dehydrated, charred and had lost the colour. The oil extracted from them was not of good quality and became rancid. Leaves from quality harvest retained same texture and aroma and had good quality oil. The BAU harvest was priced low in the market (Rs. 2 and Rs. 5-6 per kg of wet and dry leaves respectively). The demand for the leaves collected in right method of harvest was more and hence, higher price was fixed (Rs. 3-4 and Rs. 8 per kg of wet and dry leaves respectively) as compared to BAU.



Right harvest



Right Vs. BAU

Statistical relevance and conclusions

- Production of *Cinnamomum* leaves had a positive correlation with size of the tree ($r = 0.462$)

To infer from the results, the BAU harvest is ecologically destructive and socio-economically weaker than the right method of harvest.

For further details contact: G.A. Kinhal/R. Jagannatha Rao, Conservation Action and Research Group, Foundation for Revitalisation of Local Health Traditions (FRLHT), 74/2, Jarakabandekaval, Attur, Yelahanka, Bangalore 560 064, India.
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ADAPTIVE MANAGEMENT FOR SUSTAINABLE HARVESTING OF NTFPS/MEDICINAL PLANTS

Decalepis hamiltonii Wight & Arn.

Fact-sheet No.2 2006

An output of a collaborative study of FRLHT, India with ECI, Oxford University, UK

Botanical name: *Decalepis hamiltonii* Wight & Arn.

Family: PERIPLOCACEAE (Asclepiadaceae)

Habitat: Occurs in open rocky slopes and rocky cervices of dry to moist deciduous forests at an elevation of 300-1200m

Description: A large woody climber; Latex sticky and milky; Roots long, fleshy and aromatic; Branches jointed, slightly angled and with swollen nodes; Leaves opposite, egg-shaped to round shaped, about 7 x 5cm; Flowers yellow, small, arranged in 3-times branched cymes; Follicles cylindrically oblong, about 5 x 3cm and woody, when dry; Seeds many, egg-shaped, about 6 x 4mm, with long white silky hairs, promoting their widespread dispersal

Distribution: Endemic to central peninsular India; Common in the dry hill tracts of Eastern and Western Ghats in Andhra Pradesh, Karnataka, Tamil Nadu and Kerala

Parts used: Roots

Propagation: Seeds, stem cuttings and root suckers



Habit



Flower



Roots



Fruits

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COMMUNITY UNDERSTANDING

- ✎ **Season and pattern of harvest:** Generally, harvesting of *Decalepis* roots is carried out during September and October. Roots and tubers are collected from soil pits in the rocky areas.
- ✎ **Sustainability factor:** Quantity-oriented harvest involves cutting the branches and uprooting the stems to collect the whole root portion without leaving any roots for further growth in the following year. During the study, community members felt that harvesting of 50 percent of the roots in alternate years from good soil region would enhance the regeneration of roots.
- ✎ **Trade:** Roots are traded in local, regional and national markets. They are sold for a price Rs. 40 to 60 per kg in the national market. In southern India, plant is used as a substitute for Sarsaparilla (*Hemidesmus indicus*).

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Assimilation of traditional and modern scientific knowledge

The assessment and assimilation of information related to focal species, timing and frequency of harvest, qualitative attributes etc, from traditional knowledge and modern scientific knowledge were merged to develop and evolve an adaptive management for sustainable harvesting of *Decalepis hamiltonii* Wight & Arn. through participatory planning and monitoring protocols involving local community in Savandurga, Karnataka, India.

	Scientific knowledge	Traditional knowledge
Name	<i>Decalepis hamiltonii</i> Wight & Arn.	Magadi beru, Makali beru (Kannada)
Phenological patterns	Leaf fall: January New foliage: February - April Flowering: April - July Fruiting: August - November	Flowering: May - September Fruiting: October - November Dried fruits shrink and remains till next season
Medicinal uses	Roots are used as a coolant and blood purifier; Used to cure indigestion, dysentery, cough, bronchitis, leucorrhoea, uterine hemorrhage, skin disease, fever, vomiting and poisoning; Root powder is given to treat diabetes; Root pickle is used for reducing flatulence	Plant is used as a culinary spice due to its highly aromatic roots; Roots, as a coolant are used to prepare refreshing drinks and used as an appetizer; Roots are pickled and consumed locally; Roots are used to control stored grain pests
Method of harvest	Roots are harvested only from the mature climbers	Roots are collected from the soil pits in rocky areas

Harvest treatments and practices

Three harvest treatments were designed merging traditional and scientific knowledge viz. right harvest method (selective harvest); Business as Usual (BAU); current harvest method; destructive); and control.

Right harvest	BAU harvest
Collect roots from mature climber; Collect only half (one portion) of the roots in soil rich region	Collect all the roots from climbers through uprooting

The BAU harvest was done during the month of September, where as right method of harvest in October. There was no harvest in control method.



BAU harvest



Test harvest

Processing and marketing

Roots, collected from the right method of harvest were of good quality and can be stored for long time without decaying problem. It was priced high in the market. In BAU method of harvest, the roots were of small size and young that could not fetch more market value.

Statistical relevance and conclusions

- ✗ Production of *Decalepis* roots was significantly correlated with stem girth of the climber (r value = 0.32; $P = 0.015$), which indicated less root production from young plants
- ✗ Less growth of roots was noticed in the harvested portions of plants in all harvest treatments in second year. It was suggested for harvesting of *Decalepis* roots in alternate year from the same area
- ✗ However, the quantity of harvest was more in BAU harvest than right method of harvest, two year data are not sufficient to prove the changes in the yield due to harvest treatments over a period of time



Harvested roots



Root growth after harvest

Detailed discussions and field observations have led the community (Task Team) to revise the harvest treatments and they have decided to observe the individual climbers for one more year.

For further details contact: G.A. Kinhal/R. Jagannatha Rao, Conservation Action and Research Group, Foundation for Revitalisation of Local Health Traditions (FRLHT), 74/2, Jarakabandekaval, Attur, Yelahanka, Bangalore 560 064, India.
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ADAPTIVE MANAGEMENT FOR SUSTAINABLE HARVESTING OF NTFPS/MEDICINAL PLANTS

Garcinia gummi-gutta (L.) Robson

Fact-sheet No. 3 2006



An output of a collaborative study of FRLHT, India with ECI, Oxford University, UK

Botanical name: *Garcinia gummi-gutta* (L.) Robson

Family: CLUSIACEAE (Guttiferae).

Habitat: Semi-evergreen to evergreen forests.

Description: A medium-sized tree, 5-15m tall; Brown-coloured smooth bark (5mm thickness) exudes yellow gum, when cut freshly, blaze deep yellow; Mature branches are horizontal or drooping; Leaves opposite, 7-15 x 2-7cm, oblong, elliptic or lanceolate, margin entire and dark green; Male flowers are in group of 5-10 seen in leaf axils or on branches, orange-yellow in colour; Female and bisexual flowers are solitary or in clusters of 2-3 in terminal and axillary fascicles, orange, slightly larger than male flowers; Berries are pome-shaped, fleshy, shiny, hairless, with 4-10 vertical grooves and yellow after ripening; Seeds (4-10) are egg-shaped, about 3cm long, flat, brown, smooth, shiny, covered with fleshy, white or red aril.

Distribution: Endemic to Western Ghats of Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala states of India; Found at an altitude of 50-1800m in semi-evergreen to wet evergreen forests.

Parts used: Leaves, fruits and seeds.

Medicinal Properties: Leaves, fruits and seed oil are purgative, hydragogue and emetic; Hydroxy Citric Acid (HCA) is extracted from the fruit rind.

Propagation: Seeds, stem cuttings and grafts; Cultivated in many parts of southern India for its fruits; Germination hampered by ants.



Fruiting branchlet



Slashed bark



Fruiting twig



Habit

ADAPTIVE PLANNING AND MANAGEMENT FOR SUSTAINABLE HARVESTING

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COMMUNITY UNDERSTANDING

- ✗ **Season and pattern of harvest:** Generally, harvesting of *Garcinia* fruits is carried out during first and second week of July. Only the mature individual fruits are hand-plucked from tree without damaging the branches and fallen fruits on the ground are also collected.
- ✗ **Sustainability factor:** Quality harvest is hand picking of fully ripe yellow-coloured fruits that have good taste and medicinal value. While, the quantity-oriented harvest is collection of immature (young) fruits to ripe fruits. In this destructive harvest, the entire branch is cut as fruits are at the tip of branches and inaccessible. Unripe fruits are difficult to pluck, thus encouraging the cutting of branches.
- ✗ **Trade:** Fruits are traded in local, regional and national markets. Fruit rind is marketed in large quantities. They are mixed with *Garcinia indica* and sold as Kokam.

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Assimilation of traditional and modern scientific knowledge

The assessment and assimilation of information related to focal species, timing and frequency of harvest, qualitative attributes etc, from traditional knowledge and modern scientific knowledge were merged to develop and evolve an adaptive management for sustainable harvesting of *Garcinia gummi-gutta* (L.) Robson through participatory planning and monitoring protocols involving local community in Agumbe, Karnataka, India.

	Scientific knowledge	Traditional knowledge
Name	<i>Garcinia gummi-gutta</i> (L.) Robson	Upagi mara, Simai hunase (Kannada)
Phenological patterns	Flowering: December - February Fruiting: March - August Fruit bearing is high in alternate years	Flowering: January - February Fruiting: March - May Fruit production starts at the age of 10 years; Good rainfall during March - April increases fruit yield; Trees with canopy in open area produce good quality fruits; Fruits do not ripen at the same time
Medicinal uses	Useful in curing ulcers, inflammations, bleeding piles, diarrhea, dysentery, indigestion, hyperdipsia and particularly in dropsy and worm cases; HCA is extracted from fruits and used for treating obesity; Fruit rind used as condiment to flavour curries (substitute to tamarind)	Fruits used as culinary additive and fish preservative; Seeds obtained from ripe fruits are extracted for edible oil, which is cholesterol free and used as vegetable butter; Fruit juice and syrup are used as coolant; Consumption of seed oil, besides fruits and leaves helps in better digestion
Method of harvest	Collection of fallen mature fruits from the ground	Harvest only the fallen fruits after ripening or after primates have eaten the pulp and discarded the rind. This results in good quality rind

Harvest treatments and practices

Three harvest treatments were designed merging traditional and scientific knowledge viz. right harvest method (selective harvest); Business as Usual (BAU); current harvest method; destructive); and control.

Right harvest	BAU harvest
Collect only the ripe fallen fruits	Collect all the fruits at once by cutting twigs and branches

The BAU harvest was done during second and third week of June, whereas right method of harvest in first and second week of July. There was no harvest in control method.

Processing and marketing

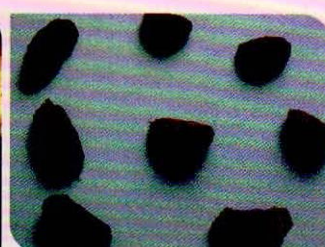
BAU harvest resulted in low quality fruit rind as fruits are not fully developed. In BAU harvest, it was difficult to break the fruit wall (endocarp) for deseeding, and for collecting the rind for drying. As seeds were undeveloped, sterile and small, they resulted in less oil extraction. The right harvest yielded naturally ripened fruits that were easier to deseed, and provided better quality rind in less processing time. The processed material from right harvest was easy to preserve for longer time as compared to BAU harvest. Rind from ripe fruits weighed more than unripe fruits and sold for about Rs. 5 to 10 more per kg than rind from unripe fruits.

Statistical relevance and conclusions

- ✗ The practice of cutting branches in BAU harvest has adverse effect on fruit production, as wet weight of *Garcinia* fruits was significantly correlated with canopy cover of the tree ($P = 0.004$)
- ✗ There was significant difference in dry to wet weight ratio of fruits across harvest treatments ($P = 0.003$). Dry/wet fruit ratio in right harvest was high (20%), where as in BAU harvest, it was 13%
- ✗ Regeneration in terms of number of seedlings was more in right method of harvest, as there was significant difference in regeneration pattern across treatments ($P = 0.01$)



Ripe fruit



Seeds

To infer from the results, the BAU harvest is ecologically destructive and socio-economically weak than the right method of harvest.

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ADAPTIVE MANAGEMENT FOR SUSTAINABLE HARVESTING OF NTFPS/MEDICINAL PLANTS



Gymnema sylvestre (Retz.) R.Br. ex Roem. & Schult.

Fact sheet No. 4 2006

An output of a collaborative study of FRLHT, India with ECI, Oxford University, UK

Botanical name: *Gymnema sylvestre* (Retz.) R.Br. ex Roem. & Schult.

Family: ASCLEPIADACEAE

Habitat: Dry to moist deciduous forests

Description: A large more or less pubescent woody climber; Leaves opposite, elliptic or ovate, 3.5-5.5 x 2.5-3.5 cm, rounded at base, subcoriaceous; Flowers minute in umbellate cymes, greenish-yellow; Follicles usually solitary, 6-8 x 0.8 cm, straight or slightly curved, terete, lanceolate, tapering, glabrous; Seeds brown, narrowly ovoid-oblong, 1.2 x 0.5 cm, glabrous, with a thin marginal wing or puff of hairs

Distribution: Found in Deccan Peninsula of India, extending to parts of northern and western India; Distributed across tropical regions of Africa and Asia

Parts used: Leaves, whole plant

Medicinal Properties: Plant is stomachic, stimulant, astringent, hypoglycemic, refrigerant, laxative and diuretic; Gymnemic acid is extracted from the leaves that possess the property of paralyzing the sense of taste for few hours for sweet substances; Roots are emetic and expectorant

Propagation: Through seeds and vegetative means



← Habit

↑ Branchlet



← Flowering twig



↑ Dehiscing fruit

ADAPTIVE PLANNING AND MANAGEMENT FOR SUSTAINABLE HARVESTING

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COMMUNITY UNDERSTANDING

- ✎ **Season and pattern of harvest:** Generally, harvesting of *Gymnema* leaves is carried out during the month of November and December. Only mature individual leaves are hand-plucked from the climber without cutting the branches and uprooting the stem.
- ✎ **Sustainability factor:** Quality harvest is hand plucking of fully mature leaves that contains more medicinal property. While, the quantity-oriented harvest is collection of young leaves by cutting the climber. In this destructive harvest, the entire climber is cut as stems are twinning around the host trees, in such a case, leaves at the tip of branches are inaccessible, thus encouraging the cutting of branches and uprooting the whole climber.
- ✎ **Trade:** Leaves are traded in regional and national markets. Nationally traded in the name 'Chakkarakolli'. Large scale extraction of *Gymnema* in India has been recorded in recent years.

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Assimilation of traditional and modern scientific knowledge

The assessment and assimilation of information related to focal species, timing and frequency of harvest, qualitative attributes etc, from traditional knowledge and modern scientific knowledge were merged to develop and evolve an adaptive management for sustainable harvesting of *Gymnema sylvestre* (Retz.) R.Br. ex Roem. & Schult. through participatory planning and monitoring protocols involving local community in Savandurga, Karnataka, India.

	Scientific knowledge	Traditional knowledge
Name	<i>Gymnema sylvestre</i> (Retz.) R.Br. ex Roem. & Schult.	Madhunashini, Madhunasha, Sannagerasehambu (Kannada)
Phenological patterns	Leaf fall occurs in January; New foliage during April – June; Flowering: November and December; Fruiting: January - March; Seed germination in February and March	Flowering: November - December Fruiting: February – March Good rainfall during June increases the fruit yield
Medicinal uses	Plant is used to treat somatic burning sensations, biliousness, hemorrhoids, urinary disorders, dyspepsia, constipation, jaundice, cough, asthma and bronchitis; Gymnemic acid from leaves has anti-diabetic property; Inhibits dental plaque formation	Leaves along with garlic and pepper are made into juice and used as an eye tonic for cattle; Root powder and its decoction are employed for snake bites; Leaves are used for treating diabetic complaints
Method of harvest	Collect only the fresh and full-grown mature leaves	Hand plucking of individual fresh and full-grown mature leaves

Harvest treatments and practices

Three harvest treatments were designed merging traditional and scientific knowledge viz. right harvest method (selective harvest); Business as Usual (BAU; current harvest method; destructive); and control.

Right harvest	BAU harvest
Collect the individual mature leaves by hand plucking	Collect all the leaves by cutting the branches or uprooting the climbers

The BAU harvest was done during the month of November and December, where as right method of harvest in January. There was no harvest in control method.



BAU harvest



Test harvest

Processing and marketing

The young leaves, collected in BAU harvest method had higher moisture content, took longer time to dry and while drying some were dehydrated and charred. The extracts from them are not of good quality. The right harvest yielded big-sized green leaves with more alkaloid contents and

easy to preserve for longer time as compared to the materials collected through BAU harvest. The material from right method of harvest was priced high in the regional market.

Statistical relevance and conclusions

- ✂ Leaf production (wet weight) in *Gymnema* was high in test harvest than destructive method of harvest, since all sized leaves are collected in BAU harvest
- ✂ However, there was a difference in *Gymnema* leaf production (wet weight) across two harvest treatments, it could not be proved statistically
- ✂ The negative impact of destructive harvest in regeneration pattern of *Gymnema* could not be statistically revealed as it requires long term observation



Processing in the field



Weighing of leaves collected in BAU

To infer from the results, the BAU harvest is ecologically destructive and socio-economically weaker than the right method of harvest.

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ADAPTIVE MANAGEMENT FOR SUSTAINABLE HARVESTING OF NTFPS/MEDICINAL PLANTS

Limonia acidissima L.

Fact sheet No.5 2006

An output of a collaborative study of FRLHT, India with ECI, Oxford University, UK

Botanical name: *Limonia acidissima* L. (= *Feronia elephantum* Corr.)

Family: RUTACEAE

Habitat: Dry to moist deciduous forests

Description: A small, spiny, deciduous tree with erect, cylindrical stem and grows about 9 m height; Leaves alternate, imparipinnate; Leaflets 3-9, opposite, subsessile, membranous, Pellucid-glandular, tip often crenulate; Flowers numerous, in lateral and terminal panicles, dull red or green colour, bisexual; Fruit is a berry with hard, woody pericarp, globose, brown or whitish upto 8cm in diameter; Seeds are numerous, oblong, white, embedded in sweat, aromatic and edible pulp; Cotyledons are thick and fleshy

Distribution: Native to India and Sri Lanka, found commonly in the wild in dry plains; Cultivated and naturalized in southeast Asia, Malaysia; Reported in all tropical belts

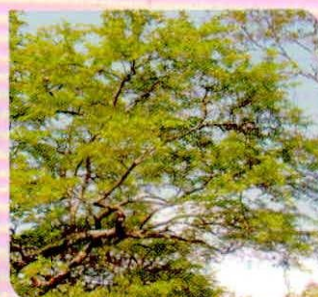
Parts used: Fruits, leaves, roots and wood

Medicinal Properties: Fruit is considered refreshing tonic, antiscorbutic, alexiformic, cardiacal and astringent (when unripe); Leaves are aromatic, carminative, astringent and yield an essential oil; Gum exudes from trunk and branches of the tree; Roots are used as purgative

Propagation: Seeds, root cuttings and air layering; Cultivated along roads, edges of fields and orchards



Habit



New foliage



Flowering branch



Fruiting branch

ADAPTIVE PLANNING AND MANAGEMENT FOR SUSTAINABLE HARVESTING

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Community understanding

- ✂ **Season and pattern of harvest:** Generally, *Limonia* fruits ripen between the last week of March to April. Only the mature fallen fruits on the ground are collected. Mature fruits are tested by dropping on to a hard surface from 1ft height. Immature fruits bounce, while mature ones do not.
- ✂ **Sustainability factor:** Quality harvest is collection of mature fallen fruits that are known to have good taste and medicinal value. While, the quantity-oriented harvest is collection of immature (young) fruits to ripe fruits. Young and unripe fruits at the tip of branches are inaccessible and difficult to pluck, thus encouraging the cutting of branches. For commercial purpose, entire fruits are collected from the tree, which leaves no seeds for germination on the ground.
- ✂ **Trade:** Fruits are traded in local, regional and national markets. They are sold for Rs. 1-2 per fruit in local market, where as in regional market for Rs. 5-8 per fruit based on the size.

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Assimilation of traditional and modern scientific knowledge

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	Scientific knowledge	Traditional knowledge
Name	<i>Limonia acidissima</i> L.	Bela, Belada mara (Kannada)
Phenological patterns	Leaf fall occurs during February-March; New foliage in March-April; Flowering: February-March; Fruiting starts in April and fruit matures in December to February of the next year	Flowering: February-April; Fruiting starts in April-May and ends in January-March of next year; Good rainfall during March – April is important for higher fruit yield in the next year; Fruit bearing is high in alternate years
Medicinal uses	Leaves are used to treat epilepsy; Fruit is used as live and cardiac tonic; when ripe, as an astringent halts diarrhea and dysentery; Fruits are used for treating hiccup, sore throat and diseases of the gums; Fruit pulp is applied externally as a remedy for bites of venomous insects and reptiles	Ripe fruit is eaten as such or with sugar; Fruit is used for removal of habitual constipation; Pulp is used in chutney, jelly and jam making; Juice of the fruit pulp is relished as coolant
Method of harvest	Collection of only big-sized and ripe fruits from the tree and from the ground	Collection of mature fallen fruits on the ground during the month of April

Harvest treatments and practices

Three harvest treatments were designed merging traditional and scientific knowledge viz. right harvest method (selective harvest); Business as Usual (BAU); current harvest method; destructive); and control.

Right harvest	BAU harvest
Collect only the mature fallen fruits	Collect all the fruits at once

The BAU harvest was done during the January month, where as right method of harvest in the third and fourth week of March. There was no harvest in control method.



Bau harvest



Right harvest

Processing and marketing

After the harvest, fruits were graded viz. into big, medium and small fruits according to the size using indigenously built iron wire sieve. Fruits were kept in the sun for full ripening. In BAU harvest, many fruits were small in size, unripe and hollow. Such fruits were priced low due to sour

taste, while bigger and fully ripe fruits from the right harvest fetch high price in the local as well as regional market.

Statistical relevance and conclusions

- ✗ Production of *Limonia* fruits has significant correlation with canopy cover of the tree ($P = 0.004$)
- ✗ High Proportion of big size fruits was recorded in right method of harvest than BAU method ($P < 0.001$). More than 60% are small fruits in quantity harvest, where as in quality harvest, it was less than 15%
- ✗ Mean fruit weight was 320gms in right method of harvest, whereas 110gms in BAU harvest
- ✗ Regeneration in the quality harvest was relatively more as compared to quantity harvest, in which no fruits were left for dispersal



Grading of fruits



Ripe fruit

The BAU harvest is ecologically and socially destructive than the right method of harvest.

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ADAPTIVE MANAGEMENT FOR SUSTAINABLE HARVESTING OF NTFPS/MEDICINAL PLANTS



Vateria indica L.

Fact sheet No. 6 2006

An output of a collaborative study of FRLHT, India with ECI, Oxford University, UK

Botanical name: *Vateria indica* L.

Family: DIPTEROCARPACEAE

Habitat: Moist deciduous to evergreen forests

Description: A large elegant, evergreen resinous tree, reaching 25m tall with about 3m girth size; Bark smooth, about 1cm thick, peeling off into round flakes; Blaze dull brown; Young branchlets drooping, with minute star-shaped hairs; Leaves alternate, elliptic-oblong, 10-25 x 5-10cm, margin entire, leathery, hairless, base rounded, apex acuminate; Stipules prominent; Flowers bisexual, about 2cm across, white, slightly fragrant, arranged in panicles; Panicles robust, multi-branched, up to 15cm long, drooping; Capsules egg-shaped, 4-6 x 2-4cm, pale brown, fleshy, hard when dry, splitting by 3-valves when ripe; Seeds single

Distribution: Endemic to Western Ghats of Maharashtra, Karnataka, Kerala and Tamil Nadu states of India; Found at an altitude up to 1200m; In Kerala, abundant near streams in moist forests, while common throughout coastal forests in Karnataka

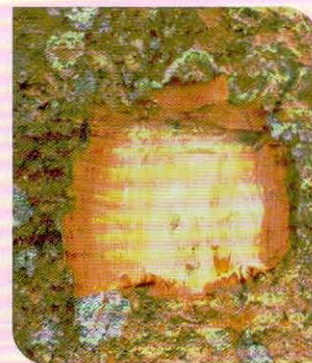
Parts used: Wood, Resin and fruits

Medicinal Properties: Resin is tonic, carminative and expectorant; Essential oil is antibacterial; Seeds yield dhupa fat; Bark is acrid, used as an alexipharmic

Propagation: Seeds; Hardly cultivated, but extensively planted along highways in Karnataka that has become naturalized with surrounding forests



Habit



Slashed Bark



Flowering twig



Fruits

ADAPTIVE PLANNING AND MANAGEMENT FOR SUSTAINABLE HARVESTING

Adaptive management explicitly addresses and reduces the uncertainty by evaluating the effects of management through participatory experimentation and monitoring. Local community has developed a methodology for participatory experimentation to demonstrate the 'best practices' that are known to be effective in achieving ecological and social sustainability.

COMMUNITY UNDERSTANDING

- ✂ **Season and pattern of harvest:** Generally, collection of *Vateria* fruits is carried out during the month of September. Only 50% of mature fruits that are fallen under the tree are hand-picked from the ground, while rest is left for regeneration.
- ✂ **Sustainability factor:** Quality harvest is hand picking of fallen fruits that have their outer coat broken and red pulp within. Such fruits yield high oil content. In quantity oriented harvest, the entire fruits are collected from the tree. Collection of fruits before maturity yielded fruits with sterile seeds.
- ✂ **Trade:** Traded in local and regional markets. Timber is traded for softwood industry and resin for medicinal industry as well as preparation of varnishes and incense. Resin is traded as White Dammar or Dhupa.

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Assimilation of traditional and modern scientific knowledge

The assessment and assimilation of information related to focal species, timing and frequency of harvest, qualitative attributes etc, from traditional knowledge and modern scientific knowledge were merged to develop and evolve an adaptive management for sustainable harvesting of *Vateria indica* L. through participatory planning and monitoring protocols involving local community in Agumbe, Karnataka, India.

	Scientific knowledge	Traditional knowledge
Name	<i>Vateria indica</i> L.	Bili dhupa, Dhupada mara, Gugguli (Kannada)
Phenological patterns	Leaf fall: March; New foliage: April – May; Flowering: January – April; Fruiting: May – July; Prefers light for good growth than extreme shade	Flowering: February and March; Fruiting: May and June; Fruits are viviparous; Bumper crop in every 3-4 years; Rain in March and April promotes good yield; Natural regeneration is good along the roadside forest strips
Medicinal uses	Resin is used for treating cough, asthma, leprosy, skin eruptions, wounds, ulcers, gonorrhoea, dysentery, anemia diarrhea and ringworm; Fatty oil from seeds is useful in controlling chronic rheumatism	Fruits used as a pain killer locally; Seed oil is used for preparing soap and candles; Seed cake after oil extraction is unpalatable to livestock and also used as manure in plantations; Juice of leaves is applied to cure burns; orally administered to prevent vomiting
Method of harvest	Collect the fallen fruits from the ground	Collect only the 50% of fallen fruits from the ground that have broken outer coat and red pulp

Harvest treatments and practices

Three harvest treatments were designed merging traditional and scientific knowledge viz. right harvest method (selective harvest); Business as Usual (BAU; current harvest method; destructive); and control.

Right harvest	BAU harvest
Collect only 75% of fruits fallen under the tree	Collect all the fallen fruits under the tree

The BAU harvest was done during August, where as right method of harvest in the month of September. There was no harvest in control method.



Collection of Fruits



Grading of Fruits

Processing and marketing

In BAU collected fruits, breaking the fruit wall and extracting pulp and drying was very tedious. The seeds were small and sterile that yielded less oil extraction. As broken fruits with red pulp were collected in right method of harvest, seeds are healthy, processing and oil extraction were very easy, required less manpower and yielded high

quality oil. The oil extracted from right harvest had good keeping quality.

Statistical relevance and conclusions

- ✗ *Vateria* trees, which are located in isolated places in the forests have good growth, however it could not be proved statistically as girth and canopy cover were not correlated significantly with yield of fruits
- ✗ The two year data were not sufficient to prove the changes in the yield over a period of time due to destructive harvest, as there was no significant difference in fruit yield across harvest treatments
- ✗ Regeneration in terms of number of seedlings was more in right method of harvest, as there was significant difference in regeneration pattern across treatments ($P = 0.01$)



Seedling from viviparous fruit



Seedling

To infer from the results, the BAU harvest is ecologically destructive and socio-economically weaker than the right method of harvest.

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