

PROJECT PROFILE
ON
CULTIVATION OF HERBS

MONTH & YEAR
JULY 2011

PREPARED BY
TANSTIA – FNF SERVICE CENTRE
B – 22, INDUSTRIAL ESTATE,
GUINDY, CHENNAI – 600 032

This publication is supported by

Friedrich Naumann
STIFTUNG **FÜR DIE FREIHEIT**

HERBAL CULTIVATION

AMLA CULTIVATION

1. Introduction

Aonla (*Emblica officinalis*) is very hardy, prolific bearer and highly remunerative even without much after care. Aonla is the richest known natural source of vitamin. Its juice contains 20 times as much vitamin C as orange juice. Aonla is known for its pharmaceutical properties.

It is a wonder herb and one of the precious gifts of nature to man. It is the best of all acid fruits and most useful for health and body rejuvenation and prevents aging. It's mineral and vitamin contents include calcium, phosphorus, iron, carotene, thiamine, riboflavin and to vitamin C. Its calorific value is 58. 100 g of fruit provides 470 to 680 mg of vitamin C. The dehydrated berry provides 2428 to 3470 mg of vitamin C per 100 g.

It is largely cultivated in Uttar Pradesh (Azamgarh, Pratapgarh, Varanasi and Bareilly districts), Gujarat, Maharashtra and Karnataka. In view of its diverse uses, its cultivation is increasing fast and the crop is becoming popular with the orchardists.

2. Uses

The use of aonla in such ayurvedic preparations as Chyavanprash, Triphala and Ashokrishta is age-old. The fruits can be made into preserves, sauce, dried chips, tablets, jellies, pickles, toffee, powder etc. It is also used in pharmaceutical and cosmetic products such as hair oil, shampoos, chavanprash, etc. The ascorbic acid and other constituents are well retained even in dried form of amla fruits.

It boosts immune-system; The most important ingredient of century-old Ayurvedic medicines; fresh fruits rich in vitamin C are good live tonic, refrigerant, cooling, blood purifier and anti-diabetic; useful in jaundice, anemia, heart complaints, dyspepsia and indigestion; seeds used to treat diabetes, asthma, bronchitis and stomach disorders.

Medical Action: Aonla is good for almost everyone on a regular basis. It reduces or eliminates the risk of environmental pollutants, normalizes cholesterol, reduces unwanted fat, cures ulcers, prevents cancer, detoxifies the body, regulates digestion, has inhibiting effects against the HIV virus, promotes metabolic function and can produce these results in a dried, natural, unprocessed form. The only thing that could possibly be better than amla for a daily herbal supplement is the Triphala formula, of which aonla constitutes one third.

3. Varieties

There has been no standardisation of varieties of aonla and they are mostly known on the basis of size, colour and also names of places. The important varieties are Banarasi, Deshi, Chakaiya, etc. of which Banarasi is the most important variety for commercial purpose. The fruits are fairly large and very good for making preserves. It is an early bearer having good keeping quality. Another important variety is Anand - 2 grown in Gujarat.

4. Climate

It is found growing in different states up to elevation of 1,500 meters from sea level. It is sub-tropical fruit but can be cultivated successfully in tropical climate as well. The plant is not very much influenced either by hot wind or frost. The mature trees can tolerate temperature as high as 460 deg.

5. Soil

The tree could be raised even on marginal lands and is capable of withstanding adverse conditions. Amla can be grown in light as well as heavy soils, however, well drained fertile soils are preferred. The plants adapt to dry regions and can also tolerate moderately alkaline soils.

6. Propagation

Shield budding is commercially followed for propagation. Proper selection of mother plant is very critical for commercial cultivation on large scale. The mother plant should be highly fruitful of known variety and the bud should be taken from the branch with good number of female flowers otherwise the plant will be unfruitful.

7. Planting

Healthy budded plants are planted during rainy season. In dry areas where mortality after transplanting is very high, the seedling root stocks can be raised *in situ* for budding with superior variety.

8. Spacing and Plant Population

Pits of about 0.75 cum should be dug during May-June at a distance of 7 m x 7 m accommodating 204 plants in one ha.

9. Orchard Establishment and Care

As the branches of aonla often break off carrying heavy crop load the plant should be trained to develop a low headed one. The framework should be developed by encouraging growth of 4-6 well spaced branches with fairly wide angle. The pruning of the bearing plants can be done after the harvest of the crop every year.

10. Irrigation

Aonla plants hardly require any irrigation except during the spells of dry period. The young plants require water in summer at fortnightly intervals till they are firmly established. Watering of mature bearing plants is also necessary for better fruit development and to arrest fruit drop.

11. Plant Protection

There are no major pests and diseases affecting aonla. The major ones are bark eating caterpillar among pests and aonla rust among the diseases. Spraying with neem oil and some herbal preparations is recommended.

12. Harvesting

The budded plants used in commercial cultivation start bearing from the fourth year onwards. Amla can give economic yields for around 25 years.

13. Yield

A full grown aonla plant can yield up to 200 kg fruits per year. The productivity levels could touch a high of 20 MT per ha from the seventh year of planting. Average yield can be around 100 kg per tree.

14. Market

Aonla has in recent years gained prominence as a crop of economic importance because of its therapeutic properties. Aonla fruits can be processed into various products such as pickle, chutney, sauce, preserve, syrup, powder and digestive chewing nuts.

Average market price is Rs. 12 per kg.

The fruit is mainly marketed in Mumbai, Amritsar, Kolkata, Delhi, Hyderabad and Patna markets. Pratapgarh near Faizabad in UP contributes to nearly 80 per cent of the total amla production in the country. The fruit from Tamil Nadu finds its way to the Mumbai market, apart from being marketed at Chennai, Bangalore and Kochi. At present there is a mismatch in the demand-supply chain of aonla.

15. Financial Viability

The viability of plantation is worked out based on the economic life of plant. The BCR and NPW are found to be 1.63, Rs.35049 respectively. The Internal Rate of Return on 10 year basis is worked out as above 25% owing a high degree of financial viability.

16. Repayment Schedule

Repayment schedule is worked out on the basis of 90% of loan amount at 12% interest rate. As the income from 1st 6 years is enough to make repayments, it is suggested to provide the grace period of 6 years for principal amount. Repayment may be allowed from 7th year in graded installments, which will be repaid fully by the end of tenth year.

17. Insurance Coverage

The crop may be insured against damage by natural calamities for which the financing bank may stipulate the special terms and conditions as per rule of General Insurance Company.

Farm Model for Aonla (*Emblica officinalis*)

Planting material: Budded plants Spacing: 7m X 7m

No. of plants/acre: 80

Wage rate: Rs. 100/ manday

1	Land preparation	800	0	0	0	800
2	Digging of pits of 75cu em & filling back	1486	0	0	0	1486
3	Planting material incl. transportation cost (10% extra for meeting mortality@ Rs,40 Per building)	3520	0	0	0	3520
4	Planting & staking	700	0	0	0	700
5	Uve hedge / Fencing	2400	0	0	0	2400
6	Manures & Fertilisers & Application	2500	3000	3000	4000	12500
7	Irrigation	1500	2400	3000	3000	9900
8	Plant protection chemicals & application	1000	1000	1000	1500	4500
9	Orchard management	1200	1800	2400	2400	7800
10	Harvesting / Packing	0	0	0	800	800
11	Contingencies	1511	820	940	1170	4441
	Total Cost	16617	9020	10340	12870	48847

		4	5	6	7	8	9	10-25
1	Yield - kg/acre	400	1200	2000	3200	4000	4800	6000
2	Gross Income @ Rs. 12 per kg	4800	14400	24000	38400	48000	57600	72000
3	Net Income	-8070	1530	11130	25530	35130	44730	59130

** Considering the economic life of aonla, a regular income of Rs. 72000 per annum will be available from 10th year onwards.

Aonla Cultivation - Financial Viability

Aonla Repayment Schedule

Unit cost -Rs 48847

Bank Loan-90% 43962

(Amount in Rs.)

Year	Total Cost	Margin Money @10%	BL Disb. During the year	Loan O/s at the end of the year	Interest @ 12% pa	Maintenance for subsequent years	Gross Income	Repayment		Net Surplus
								Interest	Principal	
1	16617	1662	14955	14955	1795	0	0	1795	0	-179
2	9020	902	8118	23073	2769	0	0	2769	0	-276
3	10340	1034	9306	32379	3885	0	0	3885	0	-388
4	12870	1287	11583	43962	5275	12870	4800	5275	0	-47
5				43962	5275	12870	14400	5275	0	912
6				43962	5275	12870	24000	5275	0	1872
7				33962	4075	12870	38400	4075	10000	2432
8				23962	2875	12870	48000	2875	10000	3512
9				13962	1675	12870	57600	1675	10000	4592
10				0	0	12870	72000	0	13962	5803

Year								Discount at 12%		
	Annual cost	Interest	Total cost	Total benefits	Net benefit	Total benefit				
	1	16617	1795	18412	0	-18412	-16617			0
2	9020	2769	11789	0	-11789	-9020	0.893	-8054		
3	10340	3885	14225	0	-14225	-10340	0.797	-8243		
4	12870	5275	18145	4800	-13345	-8070	0.712	-5744		
5	12870	5275	18145	14400	-3745	1530	0.636	972		
6	12870	5275	18145	24000	5855	11130	0.567	6315		
7	12870	4075	16945	38400	21455	25530	0.507	12934		
8	12870	2875	15745	48000	32255	35130	0.452	15891		
9	12870	1675	14545	57600	43055	44730	0.404	18066		
10	12870	0	12870	72000	59130	59130	0.361	21323		
			158966	259200		25%		53461		
						IRR		NPV	35049	
BCR	1.6305									

HERBAL CULTIVATION

ASWAGANDHA

Ashwagandha (*Withania somnifera*), also known as Indian ginseng, is an important ancient plant, the roots of which have been employed in Indian traditional systems of medicine, Ayurveda and Unani. It is an erect branching undershrub reaching about 1.50 m in height. It grows in dry and sub-tropical regions. Being hardy and drought tolerant species with its enormous biocompounds, its usage is forever regarded and continuous to enjoy the monopoly in many parts of India, particularly in Madhya Pradesh. It grows in dry parts in sub-tropical regions. Rajasthan, Punjab, Haryana, Uttar Pradesh, Gujarat, Maharashtra and Madhya Pradesh are the major Ashwagandha producing states of the country. In Madhya Pradesh alone it is cultivated in more than 5000 hectare. The estimated production of Ashwagandha roots in India is more than 1500 tonnes and the annual requirement is about 7000 tonnes necessitating the increase in its cultivation and higher production.

Medicinal properties and use

Ashwagandha is considered to be one of the best rejuvenating agents in Ayurveda. Its roots, seeds and leaves are used in Ayurvedic and Unani medicines. Ashwagandha root drug finds an important place in treatment of rheumatic pain, inflammation of joints, nervous disorders and epilepsy. Dried roots are used as tonic for hiccup, cold, cough, female disorders, as a sedative, in care of senile debility, ulcers, etc. Leaves are applied for carbuncles, inflammation and swellings. Leaf juice is useful in conjunctivitis. Bark decoction is taken for asthma and

applied locally to bed sores. Ashwagandha and its extracts are used in preparation of herbal tea, powders, tablets and syrups.

Soil

Ashwagandha grows well in sandy loam or light red soil having pH 7.5 to 8.0 with good drainage. Black soils or such heavy soils are suitable for cultivation.

Climate

It is grown as late rainy season (kharif) crop. The semi-tropical areas receiving 500 to 750 mm rainfall are suitable for its cultivation as rainfed crop. If one or two winter rains are received, the root development improves. The crop requires relatively dry season during its growing period. It can tolerate a temperature range of 20°C to 38°C and even low temperature as low as 10°C. The plant grows from sea level to an altitude of 1500 meter above sea level.

Varieties

The Jawaharlal Nehru Krishi Vishwavidyalay, Madhya Pradesh, has released one high alkaloid variety "Jawahar" which is short in stature and most amenable for high density planting. The variety yields in 180 days and yields a total withanolides content of 0.30 per cent in dry roots.

Nursery raising

It is propagated by seeds. Fresh seeds are sown in well prepared nursery beds. Although it can be sown by broadcast method in the main field, transplanting method is preferred for better quality and export purpose. For export, a well maintained nursery is a prerequisite. The nursery bed usually raised from ground level is prepared by thorough mixing with

compost and sand. About 5 kg of seeds are required for planting in 1 hectare of the mainfield. Nursery is raised in the month of June-July. Seeds are treated in carbendazim to control wilt and seed borne diseases. Seeds are sown just before the onset of monsoon and covered thinly using sand. The seeds germinate in 5 to 7 days. About 35 days old seedlings are transplanted in the main field.

Field preparation

2 to 3 ploughing and discing and /or harrowing should be done before rains. The land is well ploughed and pulverized and brought to a fine tilth. 10 to 20 tonnes farm yard manure is applied. Field is then levelled.

Transplanting

After the manures are incorporated in the soil, ridges are prepared at 60 cm spacing. Healthy seedlings are planted at 30 cm spacing. In some places, 60 cm x 60 cm or 45 cm x 30 cm spacing is also followed. However, a spacing of 60 cm x 30 cm with a plant population of about 55000 seedlings per hectare is considered optimum.

Seed rate and sowing method

A seed rate of 10 to 12 kg per ha is sufficient for broadcasting method. They can be sown in lines also. Line to line method is preferred as it increases root production and helps in performing intercultural operations smoothly. The seeds are usually sown about 1 to 3 cm deep. Seeds should be covered with light soil in both the methods. Line to line distance of 20 to 25 cm and plant to plant distance of 8 to 10 cm should be maintained. According to soil fertility, in fertile soil, distance can be extended.

Seed treatment

Seed should be treated with thirum or dithane M45 (Inofil M45) at the rate of 3 g/kg seed before sowing to protect the seedlings from the seed borne diseases.

Thinning and weeding

Grown up seedlings raised by sowing by broadcasting method or in line in furrows should be thinned out by hand 25 to 30 days after sowing the seeds to maintain a plant population of about 30 to 60 plants per sq.m. The plant density to be maintained finally may depend on the nature and fertility of the soil. On marginal soil, the population is maintained high. If some fertilizer is applied, the population should preferably be kept at lower level. Generally two weedings are required to keep the field free from weeds, the first within 20-25 days of sowing the and the other seeds after 20-25 days of the first weeding.

Manures and fertilizers

The crop does not require heavy doses of manures and fertilizers. It responds well to organic manures and addition of 10 tonnes FYM / 1 tonne vermicompost per hectare is recommended. Application of 15 kg of Nitrogen and 15 kg of Phosphorous per hectare is beneficial for higher production.

Irrigation

Excessive rainfall or water is harmful for this crop. Light shower after transplantation ensures better establishment of seedlings. Life saving irrigation may be applied, if required. Under irrigated conditions, the crop can be irrigated once in 10 days.

Pests and diseases

No serious pest is reported in this crop. Whenever the crop is damaged by insect, 2 to 3 sprays of rogor or nuvan should be applied @ 0.6%. A combination of 0.5% malathion and 0.1% - 0.3% kelthane as foliar spray at 10-15 days interval was found highly useful for

Harvesting

Maturity of the crop is judged by drying out of leaves and yellow-red berries. Flowering and bearing of fruits start from December onwards. The crop is harvested for roots by digging in January to March i.e. 150 to 180 days after sowing. There should be moisture in soil at the time of digging. Roots are dug out or ploughed using power tiller or a country plough. The tap root should be carefully pulled out not damaging even the small lateral roots.

Post-harvest handling

The roots are separated from the aerial portion by cutting the stem 1 to 2 cm above the ground. After digging, the roots are washed, cut into 7 to 10 cm small pieces and dried in sun or shed. Roots should be dried to 10 - 12 % moisture content. Root pieces can be graded in following 3-4 grades as per its length and thickness:

- i. A grade root** : Root pieces upto 7cm and diameter 1.0 - 1.5 cm, solid, bright and pure white.
- ii. B grade root** : Root piece upto 5 cm and diameter 1 cm, bright and white.
- iii. C grade root** : Root pieces upto 3-4 cms in length, diameter less than 1 cm, solid, side branches.

iv. Lower Grade: Small root pieces, semi-solid, very thick, yellowish, chopped.

The superior grade has stout and long root which fetches premium price. To avoid moisture and fungal attack on the dried roots, it should be stored in tin containers.

Berries are hand plucked separately. They are dried and crushed to take out the seeds.

Yield

On an average, the yield from 1 hectare of commercial cultivation is approximately 3 to 5 q./ of dry roots and 50 to 75 kg of seeds. A maximum yield can be procured upto 6.5 to 7.0 q/ha. There are instances where farmers have achieved root yields as high as 1 tonne. Commercially, 6 to 15 mm diameter and 7 to 10 cm length root species are better. Alkaloid percentage in roots ranges from 0.13 to 0.31%.

Marketing

The Neemuch and Mandasaur markets of Madhya Pradesh are popular world over for Ashwagandha. Importers, buyers within the country, processors, traditional practitioners, Ayurvedic and Siddha Drug manufacturers through these markets for procurement of Ashwagandha roots every year. The domestic demand for Ashwagandha roots as stated earlier is about 7000 tonnes annually. As the production is much less (around 1500 tonnes) in India, the internal market itself is highly potential. Other major marketing centres of medicinal and aromatic plants are presented in Annexure-I.

Unit cost

The unit cost for development of 1 ha transplanted Ashwagandha cultivation is Rs.22, 400/-. The details are presented in Annexure-II. The yield and the income parameters assumed are also presented in the Annexure.

Income

		(Rs./ha)
	From roots	70000
	From seeds	7200
	Total gross income	77200
	Cost	44740
	Net income	32460

Institutes / organisations to be contacted

1. National Medicinal Plants Board, Department of ISM&H, Ministry of Health & Family Welfare, Government of India.
2. Central Institute of Medicinal and Aromatic Plants, Lucknow, Uttar Pradesh.
3. Regional Research Laboratory, Jammu Tawi, Jammu & Kashmir, and other RRLs.
4. Agriculture College, Indore, Madhya Pradesh.
5. Utthan Centre for Sustainable Development & Poverty Alleviation, 18-A, Auckland Road, Allahabad-211001, Uttar Pradesh.

6.State Agricultural Universities such as Kerala Agricultural University, Jawaharlal Nehru Krishi Vishwavidyalaya (MP), University of Agricultural Sciences (Karnataka), etc.

7. National Research Centre for Medicinal and Aromatic Plants, Anand, Gujarat

Annexure I	
MAJOR MARKETING CENTRES OF MEDICINAL & AROMATIC PLANTS	
State	Districts / Places
Rajasthan	Kota, Jhalawar, Jaipur, Ajmer, Jodhpur, Udaipur, Bharatpur
Punjab	Amritsar, Ludhiana, Hoshiarpur, Ropar, Jalandhar
Delhi	Delhi
Haryana	Ambala
J & K	Jammu, Srinagar, Rajouri, Baramula, Udhampur
Uttar Pradesh	Allahabad, Lakhimpur, Saharnpur, Bijnor, Agra, Varanasi
	Rishikesh, Lucknow, Areilly, Kanpur
Himachal Pradesh	Kallu, Kinnour, Joginder Nagar, Chamba, Mandi, Shimla,
	Solan, Una
Madhya Pradesh	Gwalior, Katni, Bhopal, Indore, Jabalpur, Bilaspur, Dhamtari,
	Shivpuri, Neemuah
Assam / North	Guwahati, Shillong, Udaypur (S.Tripura), Dimapur, Kohima,
Eastern States	Kerang, Aizwal, Saiha (Mizoram), Silchar, Lakhimpur, Dhimaji,

	Pasighat, Darang, Tinsukhia, Shibsagar, Agartala, Dualgahi
Gujarat	Ahmedabad, Baroda, Rajkot, Bhavanagar, Surat, Junagarh,
	Jamnagar, Sidhpur
Maharashtra	Nasik, Mumbai, Dhule, Jalagaon, Akola, Nanded,
	Ahmednagar, Aurangabad, Nagpur, Kolhapur, Pune, Kannad,
	Kopergaom, Thane, Satara
Bihar	Kodarma Garwa, Gaya, Daltongang, Patna, Sasaram,
	Munger, Nawada, Rajgeer, Nalanda, Biharsharif, Bhagalpur
West Bengal	Calcutta, Kharangpur, Siliguri, Malda
Andhra Pradesh	Hyderabad, Anantpur, Kareem Nagar, Elluru, Cuddappa,
	Vizaywad, Guntur
Karnataka	Cochin, Ernakulam, Palaghat, Trichur, Aluva, Tuticorin
Tamil Nadu	Chennai, Salem, Madurai, Virudhnagar
Orissa	Behhrampur, Puri, Bhubaneswar, Cuttack, Bolangir
Chhatisgarh	Jagdulpur, Raipur
Uttaranchal	Dehradun, Hardwar, Ramnagar, Tanakpur
Jharkhand	Ranchi, Dhanbad
U.T. Chandigarh	Chandigarh
	Source : Demand study for selected Medicinal Plants (Vol.I) CERPA, New Delhi (2002)

Annexure-II

COST OF CULTIVATION OF ASHWAGANDHA (TRANSPLANTED)

Unit Size: 1.0 ha.

Figs. in Rs.)

Items

I.	<u>MATERIALS COST :</u>	
	Seeds	600
	FYM	6,000
	Fertilizers	900
	Seed treatment chemicals	600
	Plant protection chemicals neem cakes	1000
	TOTAL (I)	9,100
II.	<u>LABOUR COST :</u>	
	Land preparation	7,800
	Nursery bed preparation, raising and maintenance	1200
	Transplanting	6,600
	Application of manures and fertilizers	600
	Spraying of plant protection chemicals	480
	Irrigation	2,400
	Interculture	2,160
	Harvesting berries, crushing to take out seeds, digging roots, washing, cutting into pieces, drying berries and roots, grading, storing, packing, etc.	14,400
	TOTAL (II)	35,640

	GRAND TOTAL (I+ II)	44,740
		44740
	Unit Cost	44740
	Bank loan (90%)	40266
	Margin money (10%)	4474

Technical Parameters		
	Variety	Jawahar
	Spacing	60 cm x 30 cm
	Plant population	55000 / ha
	Seed rate	
	Broadcasting method	10-12 kg/ha
	Transplanting method	5 kg / ha
	FYM	10 tonnes/ha
	Fertilizers	
	N	15kg/ha
	P2O5	15 kg/ha
	Yield estimate (kg / ha)	
	i) Dry roots	500
	ii) Seeds	60
Financial Parameters		
		(Rs.)
	Cost of seeds / kg	120
	FYM cost / tonne	600

	Fertilizer cost / kg	
	N	10.5
	P2O5	19
	Wage rate / manday	120
	Sale price / kg	
	i) Roots	140
	ii) Seeds	120

-		
		(Rs.)
	Cost of seeds / kg	120
	FYM cost / tonne	600
	Fertilizer cost / kg	
	N	10.5
	P2O5	19
	Wage rate / manday	120
	Sale price / kg	
	i) Roots	140
	ii) Seeds	120

NEEM CULTIVATION

Introduction:

Neem (*Azadirachta indica*) A. Juss

Family: **Meliaceae**

Neem (*Azadirachta indica*) is one of the most suitable and valuable tree species found in India. It can grow on wide range of soils upto pH 10 which makes it one of the most versatile and important trees in Indian sub-continent. Due to its multifarious uses, it has been cultivated by Indian farmers since vedic period and it has become now part of Indian culture. In India, it occurs throughout the country and can grow well in every agro-climatic zones except in high and cold regions and dam sites. In fact in India, Neem trees are often found growing scattered in the farmers fields and on the boundaries of fields without much affecting the crops. Farmers practice this system just to meet the local demand for timber, fodder, fuelwood and also for various medicinal properties. Due to its deep tap root system, it does not compete with annual crops for scarce soil moisture.

Neem tree can be labelled as wonder tree for its multi purpose uses in real sense. This has been used as a medicinal plant for long time and provides almost all the requirements of rural areas - be the **timber, fuelwood, fodder, oil, fertilizers, pest repellent or the ubiquitous 'datun'**.

Today, it has been recognised as the most potential tree of India due to its ever green nature (deciduous in drier areas) and ability to grow in even the most arid and nutrient deficient soils as well as for its many commercially exploitable by-products and environmentally beneficial characteristics (it has therefore been labelled as tree of the future). If plantation of this tree has to be taken up on large scale, it has to be integrated as an important component of agriculture under various agro-forestry systems.

It has been estimated that India's Neem bear about 3.5 million tonnes of Kernels every year. From this about 7 lakh tonnes of oil might be recovered. The annual production in the late 1980's was only around 1.5 lakhs tonnes. To increase the amount of oil harvesting, Khadi and Village Industries Commission (**KVIC**) has pioneered various aspects of processing the fruit and seeds of neems over the past two decades. The major difficulty as observed in most of the tree borne oil seeds including neem is that neem fruits must be harvested during the wet season. Without locally available drying facilities the fruit and seeds rapidly deteriorate and become contaminated with aflatoxin. Ideally, the fruits should be depulped without delay and the seeds have to be thoroughly dried. **KVIC** has popularised simple methods for depulping, drying and decorticating neem products even in the rearmost villages of the country. The sales and turnover of neem seeds in India has been estimated by various agencies. Based on random survey at major neem seeds market by independent agencies the quantity of neem seed sold during 1996 was 5.5 lakh tonnes with turnover of Rs.137 crores.

Distribution

:

It is grown from the southern tip of Kerala to the Himalayan hills in the tropical to sub tropical and semi arid to wet tropical regions and from the sea level to about 700 m elevation. It has been widely cultivated in India

and African countries. In India, it occurs throughout the larger parts of the country in the states of Uttar Pradesh, Bihar, West Bengal, Orissa, Delhi, Maharashtra, Gujarat, Andhra Pradesh, Tamil Nadu. The tree is mostly evergreen except in dry localities where it becomes almost leafless for a short period during February - March and the new leaf appears immediately. Flowering spread over January - March in the southern parts of the country and later towards the north. Neem is a light demander and in the young stage it grows very fast. It is hardy but frost susceptible and cannot withstand excessive cold especially during seedling and sapling stage. In the international and national provenance trials raised by Arid Forest Research Institute, Jodhpur it was observed that all neem trees had branches near the base because of frost damage. It coppices well and produces root suckers and withstands pollarding well.

Description:

A large evergreen tree, 12 to 18 meter in height and 1.8 to 2.4 meter in girth with a straight bole and long spreading branches forming a broad crown as much as 20 metres across, commonly found throughout greater parts of India.

- **Bark** Grey or dark reddish brown with numerous and scattered tubercles. The bark exudes a gum known as East India gum. Leaves alternate 20 - 30 cm long, leaflets 8 - 19 alternate or opposite ovate glossy, bluntly serrate.
- **Flowers:** white or pale yellow, small, scented, numerous on long axillary panicles, have a honey like scent and attract many bees.
- **Fruit:** Fruit is a ovoid bluntly pointed, smooth drupe green when young and turns yellow with a very thin epicarp, mesocarp with scanty pulp and a hard bony endocarp, enclosing one seed.

- **The timber** is relatively heavy with a specific gravity varying from 0.56 to 0.85 (average 0.68) when freshly cut, it has a strong smell.

The flowering season of neem varies from place to place. Generally it flowers from January to May and the ripening time of fruits is from May to August. The fruit pulp is edible.

Uses:

Neem extracts as insecticides. Neem products are unique in that they are not outright killers. Instead, they alter an insects behaviour or life processes in ways that can be extremely subtle. Eventually, however, the insect can no longer feed or breed or metamorphose & can cause no further damage.

- **Azadirachtin:** One of the first active ingredients isolated from neem, Azadirachtin has proved to be the trees main agent for battling insects. It appears to cause some 90% of the effect on most pests.
- **Fungicides:** Neem has proved effective against certain fungi that infect the human body. Such fungi are an increasing problems & have been difficult to control by synthetic fungicides.
- **Antibacterials :** In trials neem oil has suppressed several species of pathogenic bacteria including Staphylococcus & Salmonella spp.
- **Antiviral agents:** In India, there is much interesting, but anecdotal information attributing antiviral activity of Neem. Its efficacy particularly against pox viruses is strongly believed, even among those of advanced medical training. Small pox, chicken pox has traditionally been treated with a paste of neem leaves - usually rubbed directly on to the infected skin.
- **Dermatological Insects:** In India, villagers apply neem oil to the hair to kill head lice, reportedly with great success. Neem seed oil

and leaf extracts may be the wonder cure for psoriasis. It relieves the itching and pain while reducing the scale and redness of the patchy lesions.

- **Dental Treatments:** In India, millions of people use twigs as "**tooth brushes**" every day. Dentists have endorsed this ancient practice, finding it effective in preventing periodontal disease.
- **Malaria:** Practitioners of the Indian Ayurvedic Medicine system have been preparing neem in oral doses for malarial patients for centuries. Neem's antimalarial activity was reported in Ayurveda books as far back as 2000 BC (by Charaka) & 1500 BC (by Sushruta).
- **Pain Relief & Fever Reduction:** Neem may also be a ready source of low cost analgesic (pain relieving), or antipyretic (fever reducing) compounds. In trials, positive results have been obtained for significant analgesic, antipyretic & anti-inflammatory effects.
- **Contraceptive Agents :** Indian scientists from the Defence Institute of Physiology & Allied Sciences (**DIPAS**) have applied for patents on chemicals isolated from the neem oil which have proved to be promising contraceptive agents which are **DK-1 & DNM-5**. A third active agent coded as **DNM-7** acts as an abortifacient causing abortion if administered orally after implantation has already occurred. A Neem oil formulation called "**Sensal**" is now sold in India for contraceptive purposes.
- **Veterinary Medicine:** Ancient practice & initial testing of neem derivatives against various livestock pests indicated that this is an area of particular promise for the future. Insects of veterinary importance are obvious targets for neem products.
- **Cosmetics:** Neem is perceived in India as a beauty aid. Powdered leaves are a major component of at least one widely used facial cream. Purified neem oil is also used in nail polish & other cosmetics.

- **Lubricants:** Neem oil is non drying and it resists degradation better than most vegetable oils. In rural India, it is commonly used to grease cart wheels.
- **Fertilizers:** Neem has demonstrated considerable potential as a fertilizer. Neem cake is widely used to fertilize cash crops particularly sugarcane & vegetables. Ploughed into the soil, it protects plant roots from nematodes & white ants, probably due to its contents of the residual limonoids. In Karnataka, people grow the tree mainly for its green leaves & twigs, which they puddle into flooded rice fields before the rice seedlings are transplanted.
- **Other products**
- **Resin:** An exudate can be tapped from the trunk by wounding the bark. This high protein material is not a substitute for polysaccharide gum, such as gum arabic. It may however, have a potential as a food additive, and it is widely used in South Asia as "**Neem glue**".
- **Bark:** Neem bark contains 14% tannins, an amount similar to that in conventional tannin yielding tree (such as *Acacia decurrens*). Moreover, it yields a strong, coarse fibre commonly woven into ropes in the villages of India.
- **Honey:** In parts of Asia neem honey commands premium prices & people promote apiculture / apiary by planting neem trees.
- **Neem fruits:** The fruits are recommended for urinary diseases, piles, intestinal worms, leprosy etc. The dry fruits are bruised in water & employed to treat cutaneous diseases.
- **Soap:** India's supply of neem oil is now used mostly by soap manufacturers. Although much of it goes to small scale speciality soaps, large scale producers also use it, mainly because it is cheap. Generally, the crude oil is used to produce coarse laundry soaps.

- **Neem Leaf Tea:** Several companies have started processing neem leaves for Tea production and selling as neem leaf Tea. Although it tastes bitter, in the long run it may catch up with the masses especially to the health conscious people.

Agro-climatic Requirements

It generally performs well on areas with annual rainfall varying from **400 - 1200 mm**. It thrives under the hottest conditions where maximum day temperature reaches **500 C**. But it cannot withstand freezing or extended cold.

Soil

Neem grows on almost all kinds of soils including clayey, saline and alkaline soils but does well on black cotton soils. It thrives better than most other trees on dry stony saline soils with a waterless sub-soil or in places where there is a hard calcareous or clay pan near the surface. It does not tolerate inundation. It has a unique property of calcium mining which changes the acidic soil into neutral. Neem also grows well on some acidic soil. It is said that the fallen neem leaves which are slightly alkaline are good for neutralising acidity in the soil.

Nursery Practices

Nursery Site: Nursery could be either a temporary or permanent one. Site in either case should have a perennial water source and located on a flat ground with well drained soil. On a hilly site, a moderate slope preferably on the northern aspect has to be chosen.

Seed collection and storage

Only fruits at the yellow green colour stage are pricked from the branches by hand or by using ladder. After collection the fruits are depulped immediately. Soaking in cold water for a few hours helps in removing pulp. Fruits are then rubbed over a coffee weir and floated in water to separate seed from pulp. Storing neem seed for 5 months at 40% natural moisture content at 16 degree centigrade is possible. For short storage the seeds are closed in polythene bags and exposed to air once in a week to keep them viable. Long term storage of Neem seeds for more than 10 years is done at 4% moisture content and -200 Centigrade temperature. For this purpose seeds are dried very quickly i.e. within a few hours after depulping in a mono layer at temperature more than 20 degree centigrade to prevent chilling damage under a fan. Shade drying and storage of seed in cloth bags at a temperature upto 4 o Centigrade is also done to improve seed viability. Storage of seed in earthen pot containing wet sand (30% moisture) helps to retain viability upto 60% at the end of 3 months. On an average 5000 seeds weigh one kilogram.

Sowing of Seeds

Germination rate of Neem varies between 15% (stored seeds) and 85% (fresh seeds). Hence, to ensure higher viability of the seeds, their immediate sowing in nursery is recommended. Pre-soaking the seed for 24 hours in cold water and removal of the endocarp or cutting of the seed coat at the round end with a sharp knife also increase its germination capacity. Examination of seeds at the time of sowing is also necessary. Seeds are cut across with sharp blades and the cotyledons are examined. If the cotyledons are found green, seeds are sound and suitable and if they are yellow or brown, then seeds are not suitable for sowing .

Sowing of seeds in nursery beds made up of fine river sand is done in drills 15 c/m apart. Seeds are sown 2.5 cms deep at distance of 2 to 5 cms in the lines and lightly covered with earth to safeguard against birds

and insects which often eat radicles of the germinated seeds on the surface. The beds are sparingly watered to prevent caking. Alternatively seeds can be sown directly into pots. Germination occurs in 1/2 weeks time. Once the hypocotyl is erect the seedling is transplanted into the containers. Seeds are sown 3 / 4 months before planting date. Potting mix comprises of 50% sandy loam, 40% river sand and 10% compost by volume.

Pricking:

Seedlings are pricked out at 15 cms x 15 cms when about 2 months old. They do not require any shade. Soil working and weeding are very beneficial. In frosty localities plants are protected by means of screen. When the seedlings are 7 to 10 cm tall with tap root about 15 cm long, these are transplanted with balls of earth around them. In dry areas, it is necessary to plant larger seedlings of at least 45 cm height since smaller ones are unable to tide over the drought period. This is the reason why seedlings are kept in the nursery beds for another year before planting in the next range.

Planting Techniques:

Neem can be easily raised through direct sowing, entire / polypot seedlings or root-shoot cuttings. For degraded areas direct sowing is more successful and economical provided adequate protection is given during early stages. Entire / polypot seedlings or root-shoot cuttings are more relevant for agro-forestry / silvi pasture and road side avenue plantations. Direct sowing is done either by dibbling in bushes, broadcast sowing, line sowing, sowing on mounds or ridges, sowing in trenches in sunken beds in circular saucers or by aerial sowing. The choice varies with edaphic, climatic, biotic and economic conditions of the site. Planting in pits is carried out by using 20 to 45 cms tall

seedlings. Taller ones promise better survival. Planting of stumps prepared from a year old seedlings in crowbar holes also gives good results.

Dibbling in bushes:

In Ajmer Neem seed is successfully dibbled in Euphorbia bushes. For this purpose, small pits are made and 3 to 5 seeds sown in each pit and covered.

Broadcast sowing:

This is generally done on ploughed land. Very good results are obtained by ploughing of the ground twice. In Tamil Nadu, early ploughing during premonsoon showers gives better results than ploughing after monsoon has set in. In arid areas ploughing is done in early spring when the soil is just moist after winter rain.

Sowing in lines:

In Maharashtra, Neem is grown along with Babool in line sowings in combination with field crops. Here Neem is used as a buffer species to control the insect attack to which Babool is susceptible.

Sowing on mounds and ridges:

This is prescribed for heavy soils. In Maharashtra, sowing on mounds (about 70 cm high 60 cm dia. at the top and 2 mtrs dia at the base) in poor soil on trap formation has given satisfactory results. The plants reached 90 cm height 16 months after sowing. In Karnataka, sowing on mounds 3.7 x 1.2 mtr x 46 cm in rows 2.7 mtr apart on black cotton soil

has been successful with plant attaining a maximum height of 1.4 mtr in one year after sowing.

Sowing in Trenches: On dry sites for conserving moisture continuous or interrupted trenches are made on which direct sowing is successful. In Tummala method of Tamil Nadu, the trenches are aligned at an angle of 45° to the contours. Similarly, sunken beds are in vogue in Karnataka and Saucer Method in Andhra Pradesh and Tamil Nadu.

Entire / polypot planting:

Seedlings which have attained 20-25 cm height by the beginning of the rainy season are planted out in pits of 30 cu. cm at a spacing of 3x3 mtrs. or any other spacing depending on the purpose of plantation. Pruning of leaves except at the tip and roots has been proved successful in Nagpur district of Maharashtra. In Tamil Nadu, plants of 45 cm height are used for this purpose, since smaller plants are found incapable of bearing the stress of drought period. Planting is, however, done during the rainy season.

Planting Root-shoot cuttings:

The stumps are prepared from 12-13 months old seedlings, keeping 2.5 cm of shoot portion and 23 cm of root and are planted in crow bar holes at the break of rains. In Tamil Nadu stumps from two years old plants have given higher survival and better height growth than one year old root stock. 53% success from root-shoot cuttings has been reported from Maharashtra. The success of root-shoot cuttings depends upon rains, prolonged drought may affect survival to a great extent.

Irrigated Plantation:

In desert areas of Rajasthan, Neem has been planted along with canal area and watered for the first 5-7 years. Under Saudi-Arabian Arid condition, Neem is usually watered for the first 10-12 years, after which it taps ground water.

Farm forestry plantations:

For raising a block plantation under farm forestry a closer espacement of 5m x 5m accomodating 400 trees per ha may be followed. This may vary from field to field and also depending upon the objective. The wider espacement of 7m x 7m accomodating about 200 trees per hectare may be on the broader side where Agro-forestry can also be practised.

Viable unit for small farmers:

At least 100 trees should be raised by the farmers interested to avail of micro credit. For this about 1 acre land is required.

Care of Young Plantation:

Strip weeding of young plantations has a positive effect on health and survival. Two weedings are sufficient in the first year and one weeding during the second year. First mechanical thinning in the case of transplanted seedlings is done at the age of 5 years. In arid region Neem planted along the canals are watered for the first 5-7 years.

Plantation Growth:

The rate of growth of Neem in plantation varies with the quality of soil. It is fairly rapid upto the age of 5 years after which it slows down. The plant attains a height of 4 m at 5 years and 10 m at 25 years. The mean annual girth increment is 2.3-3.0 cm. More rapid growth is attained

under favourable conditions. In Karnataka naturally grown Neem trees of 10 years age give an average height of 6.58 m and girth of 68.1 cm.

In alkaline soils of U.P. Neem attains an average height of 170 cm at the end of first season and 264 cm at second season. Seven month old root suckers give the average height of 65.7 cm. Because of its international importance, there have been many provenance trials at several places. In 1993, the first international consultation on Neem was held in Bangkok where a panel was formed to aid and co-ordinate the work for genetic improvement of Neem. At Arid Forest Research Institute, Jodhpur in 1992 a provenance trial of the Indian Provenances of Neem was established in the experimental fields. The provenance trial was supported with additional investigations like the seed characteristics and storage priorities of Neem seed. The trial which is established very well at Jodhpur consists of 40 provenance representing 10 states of India wherein effort has been made to successfully represent other agro-climatic zones of India. Preliminary results on the trials have indicated that there is immense variation and hence, scope of selection and breeding for genetic improvement of Neem. The Institute hopes to utilise both sexual and asexual methods of selective propagation.

Variation in seed characteristics of Neem:

It is essential to identify the best provenance (seed origin) suitable for cultivation in a particular agro-climatic region. Since neem seed is the main constituent for its cultivation, studies have been initiated by various research organisations of the country. Study of seed characteristics was made in 10 provenances collected from Karnataka and AP which indicated that there were wide variations in seed length, seed width and weight. The data was analysed statistically and the following observations were recorded. It showed that Ramnagar "H" provenance represented highest value of range and lowest of C.V. for all

the three characters studied. The highest C.V. of seed length was recorded in Ramnagar - "Y" provenance (73%) for seed width and seed weight, it was Hosakote provenance. Details of the provenances are given below:

Provenance	Neem Seed - Mean length (mm)	Neem Seed - Mean width (mm)	Mean 100 seed weight (mg)
Warangal	13.4	0	193.0
Tirupati	13.1	6.3	190.0
Hyderabad	14.7	6.7	240.0
Rajamundry - A	15.5	6.5	279.5
Rajamundry - B	14.8	6	255.5
Rajamundry - C	14.2	6	216.5
Ramnagar - Y	15.2	5.6	163.5
Ramnagar - H	16.7	6.5	374.1
BR Hills	14.3	6.3	263.2
Hosakote	14.1	10.9	235.5

Plant Protection: Pests & Diseases: Tip borer (*Laspeyresia koenigiana*), **Tea mosquito bug** (*Heliopeltis antonii*) affect seedlings and young plants. **Pulvinaris maxima** is a scale insect now regarded as key pest & **Heliothrips haemorrhoidalis** a potential pest of neem.

Neem seedlings get severely affected by damping off *Rhizoctonia* leaf web blight, leaf spot & blights induced by **Colletotrichum**, **Alternaria** & **Pseudocercospora**.

Environment:

Considering the versatile nature, uses & growing global importance of neem the United Nations declared it as the "**Tree of the twenty first century**". Its large scale production promises to help alleviate several global environmental problems: deforestation, desertification, soil erosion & perhaps even global warming (If planted on a truly large scale). Its extensive, deep root seems to be remarkably effective at extracting nutrients from poor soils. Large scale neem plantations can help in rehabilitation of degraded forest lands & vast tracts of wastelands & greening the environment.

Neem in Agro-forestry

The tree component in the agro-forestry systems is preferred to be of local use, easily marketable with good economic value. Although Neem is not considered as the best tree species under agro-forestry systems nevertheless, in many parts of India it has been found to be suitable as agro-forestry species. In semi-arid conditions at Indian Grassland and Fodder Research Institute, Jhansi, Neem alongwith other tree species increased the productivity of a silvicultural system upto 8.5 tonne / hectare. It has been reported that the fodder production can be increased from 0.5 to 3.6 tonne / hectare in arid zone of Thar Desert by growing suitable grasses and legumes along with Neem and several other tree species.

Neem is one of the tree components used in "**Taungya system**". In Maharashtra, Neem is grown alongwith Acacia in lines in combination with agricultural crops like cotton, sesamum, arhar, etc. Here neem is used as a buffer to control insect attack on Acacia. Neem tree is also planted on farm lands in Karnataka, AP and Tamil Nadu. It has been reported that reduction in grain production under Neem during 2nd and 3rd year varied from 13 to 33% while this reduction under Subabul varied from 66 to 99% for 3rd year. Under semi-arid conditions at Hyderabad, grain yields of Sorghum was the maximum under Neem. Neem has been found to be very effective in wind break /shelter belts in dry areas particularly on sandy soils to protect the crops. It has been reported that three rows of Neem Tree 250 to 300 km long have been planted in West Africa to check the advance of Sahara desert. Neem has also been extensively planted in and around the desert areas of the Holy places of Mecca in Saudi Arabia. Neem is known to increase the soil fertility and water holding capacity as it has a unique property of calcium mining which changes the acidic soil into neutral ones. It has been recommended to plant Neem trees with intercrops for the management of effected soils. Above experiments have shown that Neem might be a good agro-forestry species, however much more experiments with large number of agricultural crops are necessary.

Neem as a Timber Tree

Neem is a large ever green tree 15 to 20 M. high with semi-straight and straight trunk 30 to 80 cm in diameter and spreading branches forming a broad crown. It has a long life of 100 years. Neem tree has several economic advantages over other multi-purpose tree species grown in India. Although the main use of the tree is for production of seeds for extracting oil, the tree can be harvested for timber after 35 to 40 years of planting. The sap wood of Neem is greyish white and heart wood is red to

reddish brown resembling Mahogany. The wood is aromatic moderately heavy with uneven grains, durable and not easily attacked by insects. Timber is medium refractory and seasons well even when swan wet. It is easy to work with the timber but does not take good polish.

Wood is used for **building houses, as posts, beams, door / window frames, furnitures, carts, axles, yorks, naves, ship and boat building, helmes & oars, oil mills, cigar boxes, carved images, toys and agricultural i mplements**

Export Potential:

Among the forest produce, Neem is perhaps the only tree that has potential of producing several items that can be exported, besides of course few medicinal plants obtained from forest. That is why many developed countries like USA, Japan, Germany, France and Netherlands which do not possess much Neem wealth have developed research laboratories exclusively for Neem. On the contrary, India has a very high resources of Neem wealth with millions of trees scattered throughout the country but we are yet to start Neem research systematically except that some sporadic research are being carried out in several laboratories.

Main active principle of Neem is Azadirachtin which is obtained from open column chromatography or pressure liquid chromatography. Maximum yield from Neem seeds is 3 gm. Azadirachtin per kg of Neem seeds. Neem is advocated to be a potential export item, yet not much attention has been paid to the tree for its improvement specially on per kg. yield of Azadirachtin and other components. In India, Neem cultivation is still in its infancy. Hardly small few plantations have been raised here and there. Whatever Neem seeds are available, those are collected from individual trees through unorganised sector. Hence, it is highly advocated that government organisations like **ICFRE, ICAR,**

Agricultural Universities and NGOs must come forward to undertake coordinated research on all aspects of the tree and its products to reap the benefits from huge export market.

Cost of cultivation:

The cost of cultivation will depend upon the extent of the area to be planted. The cost of cultivation for one hectare at an espacement of 5m x 5m i.e. 400 plants/ha has been worked out at **Rs.65186 / ha** which is given below:

Cost of Neem cultivation in one Hectare:

PLEASE SEE TABLE ATTACHED

Espacement: 5M x 5M Wage Rate: Rs. 100 / MD

No. of Trees / Ha: 400 Casualty Replacement: 20%

Survival / Ha: 320

Harvesting, Yield & Returns

Neem starts bearing fruits after 3-5 years and comes to full bearing at the age of 10-12 years. Fruit yield is 10-25 kg per tree per year in the initial years. A mature tree produces 35-50 kg fruit/year. Oil yield varies from 40-43% of seed on dry weight basis. Highest oil content has been reported from Banswara region of Rajasthan (43.2%), while the lowest oil yield of 32.4% has been reported from Jaisalmer region. It has been

observed that as rainfall in an area increases oil content also increases. Among the International provenances tested, Bangladesh provenance has yielded maximum oil content (48.6%). However we presume a conservative yield of 5,7,10,15, 20 kg/tree respectively from 5th year onwards. Yield generally stabilises from 9th year. Sale price of the seed may be considered @ Rs.3/kg.

Irrigating the young stock, keeping the field clear from competing weeds & soil loosening have been reported to produce good results in neem.

Neem seed price is projected to be **Rs.10000 / ton** in the near future. So, it is high time to exploit the potential of this hitherto neglected tree & to manage neem for higher economic returns to farmers. It has been estimated that 10 yr old tree can yield a timber of 5-6 c.ft / tree.

Economics:

The financial analysis with the above parameters of the investment cost and yields, the IRR works out to 28% which is given below:

Economics of Neem plantation in one Hectare:

rest can be repaid in 10 years from planting.