Productive life : 30-50years.

Harvesting :

C.arabica comes to harvest earlier than robusta. Arabica takes 8-9 months and ready for harvesting during Nov-Dec. robusta takes 10-11 months.

Harvesting is done by hand. Riped berries hand picked. All berries do not ripe at area So number of pickings will be more may be 5-6 pickings. Injured over riped fruits kept separately, dried separately used for making cherry coffee.

Types of picking in coffee :

Fly picking : I-picking in main season. It is selective picking during Oct-Feb. riped berries are collected.

Main picking : Bulk yields are obtained. Well developed, fully riped berries are harvested 4-6 times at 10-15 days interval, started from December onwards.

Stripping : it is the final harvest and all the left over berries on plant harvested irrespective of ripening.

Clearing : It is the collection of dropped berried from the plant.

000

MEDICINAL AND AROMATIC PLANTS

Common name	Botanical name	Family	Economic part
Medicinal			
Dioscoea	Dioscorea compositae	Dioscoreaceae	Tuber
Opium poppy	Paper somnifer	Apocyanaceae	Root
Sarpagandhi	Rauvolfia serpentine	Solanaceae	Bark
Solanum	Solanum kharianum		
Nuxvomica	Strychrus		Seed, root, bark

	nuxvomica	
Aromatic		
Palmarosa	Cymbopogon maitinii	Poaceae
Citronella	C,wubteruabuu	Poaceae

Advantages :

- Generate employment through the development of ancillary industries.
- High net returns compared to Agricultural crops.
- Foreign exchange through exports.
- Efficient utilization of …….. forces.
- Longer shelf life of end products
- Low incidence of pests and diseases.
- Crops can be grown in degraded and marginal problematic soils.
- Crops are theft proof.
- Crops not eaten by the domestic animals.
- Crops not damaged by the birds/
- Used in crude form (fresh juice, paste) but now used as decoratives, herbal teas and tablets, distillers.

Disadvantages :

- Indiscriminate harvest from wild leading to some plant ….. becoming extinct.
- Short supply of quality and raw materials.
- High price, short supply leading to adulterations.
- Unstable supply, unreliable botanical identification.
- Poor post harvest handling.

Institutions :

CPCRI	-	Central plantation crops research institution – Kesarghood, Kerala
IISR	-	Indian institute of spice research, Calicut
CFTRI	-	Central food technology research institute, Mysore

DCASD	-	Directorate of Cacao, arecanut and spices development
BIS	-	Bureau of Indian standards
ISO	-	International organization of standardization, Budapest, Hungary
CIMAP	-	Central institute for medicinal and aromatic plants, Lucknow, Bangalore and Hyderabad
AICIPS	-	All India co-ordinated improvement project, Kesarghood, Kerala
Spices board	-	Cochin (Ministry of commerce)
Cardamom		
CRS	-	Cardamom research institute, Pampadumpara, Kerala Agricutlural Colelge
BRS	-	Regional research station, Mudigore, University of Agricultural sciences – Karnataka
HRS	-	Horticultural research station – TNAU
Black pepper		
PRS	-	Pepper research station, …….. KAU, Kerla
PRS	-	Pepper research station, Chintapally, APHU, A.P.
PRS	-	Sirsi, UAS, Karnataka
Ginger and Turmeric		
HARS	-	High altitude research station, Pottangi, Orissa University of agricultural technology (OUAT), ICAR
DVCF	-	Department of vegetable ropos and floriculture, Solan, H.P. Agriculrura College, College of Horticulture, Vellanikkara, KAU, Kerala
Seed spices		
DSPC	-	Department of spices and plantation crops, Coimbatore, TNAU, Tamil Nadu
PARS	-	Regional agricultural research station, Lam, Guntur, A.P.

ARS	-	Agricultural research station, Jagudam, GAU, Gujarat
NBPGR	-	National bureau of plant genetic resources, New Delhi
MAPR	-	Medicinal and aromatic plant research station, Odakkali, Kerala

000

AROMATIC PLANTS

Aromatic plants are those possess essential oils in one or more plant parts.

Plant	**Part used**
Vettiver	Root
Sandal wood	Wood
Cassia	Bark
Geranium, Citronella	Foliage
Lemon grass	Foliage
Jasmine	Flower
Citrus	Fruit
Coriander	Seed

Essential oils : Present in oil glands.

- Essential oils have the smell or they are the complex mixture of odoriferous, steam, volatile.
- These are compounds deposited by plants in subcuticular spaces of granular air spaces or cell organelle/excretory cavity, canals especially in hard wood plants like sandalwood and red sanders.
- They do not have any specific functions in plant but when they come in contact with air, they evaporate and give pleasant fragrance. The main purpose is to attract the pollinating agents and repel the pests and animals and other natural enemies to avoid the damage.

- They give competitive advantages to producer plant and inhibit the growth of competitions to plants like needs.

Uses :

- To improve the flavour and food.
- Add flavour to industrial important products like spices, lemon grass, citronella oils, used in soaps, agarbattis, cosmetics, perfumery industry.
- Impart desirable smell to above products which used in drug and pharmaceutical industries manufacturing of pesticides, germicides, disinfectants due to their centrifugal, antiseptic and insecticidal properties.
- Used as laboratory reagents, solvents in paint industries.
- Important component of polishes.
- Left over material after extraction of essential oils used for manufacturing of card board, cheep paper and also used as packing material.
- Also used as fuel for distillation of aromatic plants.

Essential oils industry in India :

- Very old cottage industry in India.
- India is traditional producer of essential oils like palmanosa, lemon grass
- India is exporting these essential oils to other countries.
- Indians have habit of using essential oils in rituals, holy functions, religious ceremonies, agarbattis
- Aromatic plants placed in Indian medicine. Ex : Sandal wood, tulsi, mint.
- Distillation of essential oils is first Practiced in India. Ex : Distillation of rose flowers mentioned in Charaka Samhita and Sushruta.
- Moghul emperors used perfumes like Attar have been popularised since that time only exports are started.

Commercialization of crops is lagging because;

- Though agro climatic conditions are suitable, they have not achieved stron putting because farmers lack profitability of essential oils. Lack of marketing facility at farmers level.
- High initial investment for establishment of equipment and installation of distillation unit.
- Lack of availability of planting material.
- Price fluctuations due to changes in the world's supply and demand.
- Aromatic crops face competition for land from food crops.
- Lack of scientific knowledge about cultivation.
- Occurrence of diseases like spike diseases in sandalwood, fusarium disease n geranium
- No organised efforts to collect and maintenance of germplasms of essential oils bearing plants.
- Produce is priced/market value based on the presence of active principles in the crop.
- It is a risk element
- Attitude and demand of industries to have location purchase points at limited places is not materialized causing out off reach to the rural farmers.
- Lack of testing labs for essential oils, cheaper synthetics and substitutes are available in the market.
- Lack of trained persons in the field of medicinal and aromatic plants.

000

LEMON GRASS

(*Cymbopogan flaxuosus*)

F : Poaceae.

Origin : India

Cultivation is started 100 years back in Kerala. It attained plantation stage in Kerala in 100 years back.

Other countries : Haiti, Gautemala, West Indies.

Lemongrass oil is known as Cochin oil. Cultivated bulk in Kerala and J and K.

Annual production in India is 1000 MT. competition is from Gautemala

Uses :

- Important constituent is citroll/geraniol.
- Citral is used for manufacturing of Vit-A tablets.
- Oil has bactericidal, insecticidal and insecticidal, medicinal values.
- Oil is essentially used in soaps and detergents making.
- Spent grass act as cattle feed and can be converted into good silage.
- Used in manufacturing of card boards and paper and fuel

Species :

1. East Indian Lemon grass – *C.fleruosus*

Indigenous to Kerala

Grown in Kerala and near by states.

Oil is popular as Cochin oil, shipped through Cochin sea port.

2. West-Indian Lemon grass – *C.citratus*

Cultivated in Gautemala, Haiti and West Indies.

3. Jammu Lemon grass – *C.pendulus*

Resistant to frost

Growth period of crop is 8-9 months/year

Dormancy in between December-February

Cultivated in Jammu, Kangar valley (Palmapur)

Climate :

It is tropical plant requires hot humid weather, requires plenty sun light. Rainfall is 150-300 cm, uniformly distributed, mainly grown as rainfed crops.

Soils :

It is a hardy and drought resistant plant. Loam to poor lateritic soils, hilly slopes, marginal soils can be used. Ideal pH is 4.5-7.5, grown as vegetative cover in sloppy areas to control the soil erosion.

Propagation :

Propagated by seeds and slips

Clumps will be taken and separated as slips, cutted and used.

Time of planting :

Land should be ploughed thoroughly, layed out into ridges and ferons. Rooted slis and seedlings planted with onset of rains favouring the spacing of 60x45 cm.

2-3 slips/hill.

Manures :

FYM-10t/ha applied during last ploughing. General recommendation : 100-50-50 NPK/kg/ha.

P & K – Basal and

N – IN 3 splits

I split @ 30 DAP

II & III after each harvest

Irrigation :

Irrigation is not required when it is grown in high rainfall areas. In low rainfall areas, give irrigations at 10-12 days interval.

Weeding :

Maintain weed free upto 3-4 months. Plants should be earthened up after every weeding.

Harvesting :

I – harvesting : 5-6 months or 150-180 DAP

Comes early in Kerala; 90-100 DAP.

Subsequent cuttings after 3-4 months.

Grass is cut 10-15 cm above the ground level.

Delayed/early harvesting must be avoided as it effect the citedal content.

If any flower stalks observed in the field, they must …….. as it effects …….

During first year, 3 cuttings can take up

From second year 5-6 cuttings

Maximum yield obtains between 2-4 years

Plantation can be economic upto 5-6 years

Yield :

Herbage yield – 15 t/ha

After cutting, essential oils extracted by steam.

Distillation - ……Oil yield is 80-100 kg/ha **000**

CITRONELLA

(*Cymbopogon winterianii*)

F : Poaceae

Also known as Java citronella

Ceylone citrenll : *C.nardus*

Origin : Srilanka

Java citronella	Ceylone Citronella
Superior in oil	Inferior in oil
Alcohol 90-99%	Alcohol 60-70%

Active principle : Citronellol, Citronellal and Geraniol

Uses :

Used in soap, perfumery, cosmetics, flavouring industry

Hydroxyl citronellal is prepared from Citronella oil, most frequently used in flavouring perfumes

It is important mosquito repellent. Used in oils and mosquito repellent creams

It is cultivated in Germany, China, and Java. Other important countries are USA, UK, France, Japan, Hongkong. In India it is cultivated in Assam in tea gardens, Karnataka, T.N., A.P., U.P., Gujarat and Maharashtra. To some extent is Arunachal Pradesh, Mysore, Meghalaya, Nagaland and Tripura.

In India it is cultivated in 4500 ha area, giving 500 t of oil/year. In A.P., it is cultivated in Visakha, East Godavari, in an area of 750-1000 acres.

Climate :

Tropical and sub tropical climate is required. Requires abundant moisture and sun shine of 200-250 cm. high humidity is required as it influence the plant growth, yield and quality of oil.

In low rainfall areas – Irrigated crop.

Soils :

Sandy loam soils with abundant ……. is suitable. Soil pH is 5.6-8.0. pH = 6 in ideal. Grown in altitudes between 1000-1500 m above MSL.

Land preparation : Refer lemon grass

Beds of 6x6 m size. Prepare R&F by furrows at a spacing of 60 cm apart with a provision for irrigation channels.

Planting and propagation :

Propagated by seeds and slips – Refer record

Best time for planting slips in June-July. In A.P., July-August, slips planted with a spacing of 60 x 60 cm. seed rate is 22,000 slips/ha. in high fertile soils, in Assam spacing is 90x90 cm. slips should be planted on ridges to avoid water logging conditions. It takes 3-4 weeks for establishment.

Manures and fertilizers :

10 t FYM/ha - @ last ploughing

(800120) – 80-40 NPK kg/ha

P & K – Basal application and N – 4 to 5 splits (equal)

I split @ 30 DAP

II to V splits after each harvesting

In North India, follows 5 splits

South India 4 splits

CIMAL recommended 0.5% Fe through FeSO4 and …… which helps in checking the chlorosis.

Irrigation :

Sufficient moisture is essential for good growth. In high rainfall areas, no need of many irrigations but dry areas require 10-12 irrigations.

Overall 16-20 irrigations/year, frequently 7-10 days

Weeding :

Maintain weed free crop

After each harvest, weed out the field by manually or mechanically.

Harvesting :

I harvesting 9 MAP by using sickle.

Cut 20-45 cm above ground level.

In Karnataka harvested during March, June and September

Crop comes to maturity in October-November. Flowers mst be discouraed. If flower stalks are observed they should be knipped out otherwise life span will be reduced. It keeps the crop economically for 3-4 years.

After harvest, sent immediately for distillation – Refer record

Yield :

Herbage yield : 15-20 t/ha – I year

Oil yield : 100-150 kg/ha - II year

II year : Herbage yield 20-25 t/ha

Oil yield : 200-250 kg/ha

After 3-4 years, replace with the new crop.

000

PALMA ROSA

(*Cymbopogon martinil*)

F : Poaceae

Also called as Rusa/rusha grass

Oil called as 'Rusha oil'

Origin : Sub tropical India.

Important constituent is Geranial.

Palma rosa yielding high geranial content (70-75%). Oil is also called as East-Indian Geranium oil or Rusa oil.

Uses :

- Uses in perfume industry
- For flavouring tobacco and blending of soaps.
- Source for high grade geraniol
- Starting material for synthetic aromatic chemicals
- Geranyl esters giving rose odour

Soils :

Well drained loamy soils with pH 6-7. if pH is greater than 8.5, it will decrease the growth of plants and oil yield but quality of oil will not change. Provide good drainage.

Climate :

It comes up well in warm tropical climate. Elevation is 300 m, temperature is 36^0C, relative humidity is 150 cm. requires good sunshine. Frost areas are not suitable as plant kills the grass to reduce the oil content.

Land preparation :

Plough and hallowed till fine tilth is obtained.

Remove the stubbles and roots. At last ploughing, apply 10 t FYM.

It is propagated by seeds and slips – refer record.

Plant the seedlings 10-15 cm of 60x60 cm of spacing. Plant is well prepared beds in rainy season.

Manures and fertilizers :

No manuring is required in rich soils during 1-2 years. In deficit and poor soils, apply 20-50-40 kg NPK/ha. 40 kg N/ha must be applied in 3 splits additionally after each harvest to encourage the growth.

Weeding :

Flavour is important quality so essential oils to keep the field weed free, specially weeds having odour. Regular weeding is done. Care should be taken. Apply weedicide dichlom @ 1.5 kg/ha.

Harvesting :

Essential oil is distributed in all parts of plant. But flower head contain more quantity. Grass harvested when attain 4 months. Grass is cut 5-8 cm from the ground level. Whole plant is sent to distillation. Maximum oil can be obtained when field is in full flowering stage.

I year : First harvesting – One crop : Oct-Nov; II year : 2-3 harvestings can be taken

It is productive for 8 years. High oil yield upto IV year and later oil content decreases. So we can keep for 4 years. Oil is extracted by steam distillation method. – Refer record.

Yield :

Plant part	**Oil %**
Whole plant	0.1-0.4
Stalks	0.01-0.03
Flowering heads	0.45-0.52
Leaves	0.16-0.25

Rainfed crop :

I year	20 kg oil/ha
II year	60 kg/ha
III year	70 kg/ha
IV year	70 kg/ha

Irrigated crop :

I year	200-250 kg/ha

000

GERANIUM

(*Pelargonium groveolens*)

F : Geraniaceae

Also called as Rose geranium/Paneer patra

Origin : South Africa

Active principle : Citronellal/Geranial

Geranium is of two types

1. Rose Geranium : Yields C
2. Ornamental Geranium N

Oil itself is a perfume and blends with other perfume used for scenting the soaps

Used for isolation of 'Rodinal' which is the high grade perfume

India importing > 20 tonnes of oil/year

Soils :

Performing well in red lateritic soils with pH of 5.5-8.0. calcium rich porous soils are best suited.

Climate :

Requires temperate, tropical and sub tropical climate. 1000-2200 m above MSL, temperature 5-23^{0}C. if temperature is <3^{0}C, it kills the plant. Best climate is warm winter coupled with mild summer. Rainfall 100-150 water logging causes root rot and stunted growth. Grows n lower altitudes also. Tolerate a temperature of 43^{0}C.

Land preparation : Foam R & F with a spacing of 60x60 cm.

Seed rate : 28000-30000 rooted cuttings.

Irrigation :

Initially growth is very slow, later on growth picks up. Alternate days in the beginning of 10-15 days, later twice is a week.

During winter and summer, 7-10 days interval. Water logging must be avoided.

Weeding :

Weeding should be done periodically. Crop should be weed free in initial stages. It is intercropped with cowpea/blackgram.

Apply 10 t FYM @ last ploughing

35-35-35 NPK kg/ha

N – Urea; P-MOP; K-Super phosphate

Further N should be applied at each harvest

Total of 210 kg of N/ha/year

Zn is applied @ 20 kg as $ZnSO_4$

Boron W 10 kg/ha

Harvesting :

Comes to harvesting @ 4 MAP.

Harvesting indices : Leaves turn light green colour

Odour changes from lemon odour to rose odour

By using sharp sickles, harvest 3 crops/year

Crop is economic for 3-6 years

Oil content is high during summer, April-June

Terminal portion of 6-12 leaves contain more oil when compared to basal and medium leaves

Yield :

Herbage yield : 30-40 t/ha/year

Oil yield : 15 kg/ha/year

Oil content : 0.08-0.15%

Oil is extracted by steam distillation - Refer Record.

000

VETTIVER/KHUS

(*Vettiveria zizanoides*)

F : Poaceae

Origin : India

Also known as Khus-Khus/Aromatic root

Active principle : Vettivom and Vetirerone

Active principle vary in spices in some species *i.e.,* khusal and khusone

Vettiver is densely tufted with rough leaf, perennial grass, grown in different types of soils.

Economic part : It is underground root contain fine rootlets of light yellow or grayish to red colour depending on soil type. They contain aromatic viscous essential oil. Oil can be obtained by distillation method.

In the world, it is grown in India, Burma, Srilanka. In India; Kerala, T.N., U.P. and Rajasthan.

Uses :

- Fans are prepared
- Hanging curtain are prepared
- Used for s…….. the clothes by using sachet
- Making of baskets, mats
- When sprinkled with water gives cool air and emits pleasant odour
- I is important material for preparation of perfumes, cosmetics and soaps
- It also blends with other oils like sandalwood, rose oil
- It has medicinal value, acts as good stimulant, oil is used for relieving from body pains
- Tender leaves are used as fodder, for thatching purpose
- Inflorescence used for making brooms and ornamental baskets
- It is the best soil binder and controls soil erosion extremely in arid zone

Climate :

Requires moderate humidity and temperature of 21-44^{0}C. it is a tropical and sub tropical plant grows luxuriantly with annual rainfall of 1000-2000 m above MSL.

Soils :

Comes up well in al types. Light soils must be avoided and therefore gives less per cent of oil. Sandyloams to red lateritic soils which are rich in ….. having good drainage are ideal. Grows well in saline, alkaline soils with pH of 8.5-10.

Land preparation :

Plough upto depth of 20-15 cm repeatedly. During last ploughing apply FYM. Make R & F's and ……. of 10x10 cm plot size.

Propagation : Refer Record

Propagated by tillers and slips. Tillers take longer time to grow so slips are used. Slips are collected from previous crop.

Planting :

During June-July with onset of rains 2-3 slips/hill at a depth of 5-8 cm with a spacing of 45x30 cm.

Population required is 1.5-2.25 lakh slips/ha. after planting, give irrigation till the establishment.

Manures and fertilizers :

- FYM at 10 t/ha during last ploughing
- 25-25-25 NPK kg/ha, entire P and 1/2 N @ planting 1/2 N after 6 MAE
- 60-23-23 kg NPK/ha for Kerala region

Weeding :

- It must be done during new plantation.
- 3-4 weedings are required
- Once plantation is established, weeds are not a problem

Harvesting :

Root ready for harvesting after 18 months. Roots will be hard, skin will be peeled out easily. At this stage, they give bitter taste but have high per cent of oil.

Oil derived from very old root, is dark in colour. Harvesting must be done during rainy season because oil is easily diffuse from roots into soil. Therefore, decrease in oil content during this period when rain occurs, plant star giving new roots and synthesis of oil gets reduced.

Herbage portion is cut at a height of 15-20 cm above the ground. Dumps can be uprooted by digging roots can be separated and washed with water and dry under shade for about 1-2 days and sent for distribution of oil. Roots should not dry in sun, as oil will decrease.

Yield :

3-4 t/ha - Root yield

In NI, 14-18 t/ha

Oil percentage is 1%

Oil yield is 15-16 kg/ha.

000

DAVANA

(*Artemesia pallens*)

F : Arteraceae

Origin : Himalayan region

Active principle : Cis davanone

Uses :

Davaria is a annual aromatic herb valued for the delicate fragrance.

Oil content cost 15,000-18,000 Rs/kg

Tender shoots can be used in making garland, religious functions and ceremonies, high grade perfumes and cosmetics.

Oil contents : Hydrocarbons – 20%

Esters – 65% (odour)

Oxygenated compounds – 15%

In countries like USA, Japan used as flavouring of cakes, pastries, tobacco and beverages

Alkaloids contain are DAvana fuaris and Artemones

India is the only country cultivating Davana mainly in Karnataka and A.P.

In A.P.; Krishna, Cuddapah, Chittoor and Guntur districts.

Soils :

Sandy loams to medium black soils are the best soils. Fertile, well drained soils which are rich in O.M. are best suited.

Winter is the best reason for Davana growing as it gives high per cent of oil.

It requires bright sun shine, moderate rainfall, temperature 20-30^{0}C.

Planting :

Planted during first week of November for oil purpose as main crop. Ratoon crop taken upto April. High temperature, heavy rains at the time of flowering affects plant growth and reduces oil content leading to lone yield. Davana is propagated by seed; seedlings raised in beds. After 6-8 weeks when plant attains 10 cm, transfer to main plots.

Plot size is 3-4 x 1.5- 2m. Beds irrigated one day in advance. Transplant the seedlings with spacing of 15x7.5 cm. immediately give another light irrigation. Irrigated daily for 10 days and then alternate days.

Manures and fertilizers :

FYM @ 6 t/ha 2 last ploughing

120-40-40 kg/ha

P & K as basal, N in 3 equal split doses

I dose @ 10 DAP

II dose @ 25 DAP

II dose @ 40 DAP To encourage the herbage

Irrigation :

Give continuous irrigation upto 10 days and then alternate days; depending on the weather give a 4-5 days interval.

Maintain weed free crop. Requires 2-3 hand weedings during early period of growth.

Harvesting :

It should be done when reaching to 50% of flowering to get maximum yield.

Starts flowering 110-115 DAP; 50% flowering 120 DAP

Cut the plants at the base leaving stumps of 10 cm. again fresh growth appears. Ratoon crop can be taken up 2 months after first cutting, after crop is removed.

Yield :

Herbage yield is 10 t/ha

Oil yield is 10 kg/ha.

000

MEDICINAL PLANTS

ACORUS
(Sweet Flag)

S. name *Acorus calamus*

Family – Aeraceae

- ✓ Dried root (rhizome) – medicinal preparation flavouring liquors.
- ✓ Contains volatile – yellowish brown oil – pleasant – slightly sweet odour – steam distillation
- ✓ Calamus oil – composition – source of rhizomes
- ✓ Plant aromatic – Acorin
- ✓ Expectorant action – remedy for asthma
- ✓ Remedy – chronic diarrhoea

- ✓ Bach – prepared from rhizomes – medicinal properties

Botany

- ➢ Monocot plant – herb – narrow leaves
- ➢ Economic part – rhizome – horizontal – jointed – spongy texture – 1.5 – 2.5 cm thick

Species/Varieties

- ✓ *Acorus gramineus* – Japanese species
- ✓ *Acorus Calamus* – India and Srilanka

Soil

- ✓ Same way as rice – irrigation facilities
- ✓ Good and moist soil
- ✓ Clayey loam soil – light alluvial soils of river bank

Climate

- ✓ Hardy plant – tropical to subtropical climates
- ✓ Good-well distributed rainfall throughout year

Planting Season

- ✓ Best season March-April – Any time of year
- ✓ Plenty of sunshine – harvest –dry rhizomes

Propagation

- ✓ Live ends or tops of previous crop
- ✓ At harvest- mature portion of rhizome cut off for markable part
- ✓ Tender portion of growing and replanting
- ✓ Storage for one week- covering with straw or dried leaves
- ✓ Longer Keeping in open pits

Planting

- ✓ Recommended spacing 30 x 30 cm
- ✓ Rhizome pieces presses into mud – 5cm depth
- ✓ Rhizomes planted – plant in second row – between first row not opposite to it

Manures and Fertilizers

- ✓ Manured with green manure (10-12 t) – compest 15 t ha^{-1}
- ✓ 125 kg NPK/ha – 3 splits

Irrigation

- ✓ Regularly irrigated
- ✓ 5 cm water left standing is field – increased 10cm as plant grows

Harvesting and Yield

- ✓ After year – crop ready for harvesting
- ✓ Field partially dried-sufficient moisture – necessary deep digging
- ✓ Leaves turn yellow, dry-indicative of maturity

- ✓ Rhizomes depth 60 cm – 30-60 cm long- harvesting carefully
- ✓ Rhizomes cut into short lengths 5-7.5 cm – fibrous roots removed
- ✓ Pieces are washed – dried in sun
- ✓ Dried material in gunny- rubbed to free ocales
- ✓ Fresh aerial parts – 0.125% oil
- ✓ Yield 10 t ha^{-1}
- ✓ Indian roots – plains 3.1 % oil
- ✓ Kashmir valley not more than 1.4% of oil.

ALOE

S. name *Aloe vera and Aloe barbadensis*

Family – Liliaceae

Active Principles: Barbaloin

Origin: Eastern and Southern Africa

- ✓ Three important species A. barbadensis, Aloe vera (Curacao aloe, Indian aloe, Jaffarabad aloe or Barbadosalog and A. Perryi (scrotine aloe)
- ✓ Aloe – cutting leaves at base – let yellow bitter juice
- ✓ On heat – yield dark brown mass – drug aloe
- ✓ Two major products from leaves – yellow bitter juice specialized cells – beneath epidermis – yield drug aloe.
- ✓ Parrenchyma tissue – centre of leaf – mucilaging gel – yield aloe gel – obtained from A.barbdensis
- ✓ Anthro glycosides – Barbaloin – 4.5 to 25% aloin
- ✓ Other aloesin
- ✓ Aloe gel contain – gluco mannan – polysaccharide similar to guar
- ✓ Called burn, first aid or medicinal plant
- ✓ Laxative preparations
- ✓ Various cosmetics and pharma formulations.

Botany

- ✓ Coarse looking – perennial – shallow rooted- does not have true stem
- ✓ Multiple tuberous roots
- ✓ Male sterile- does not produce many viable Seeds

Species and Varieties

- ✓ Aloe vera var chinensis, and common

Soil

- ✓ Hardy grown on variety of soils
- ✓ Does well – sandy coastal – loamy soils – pH upto 8.5
- ✓ Water logged and problem soils not suitable

Climate

- ✓ Cultivated between March and June
- ✓ Wide adaptability – through out country
- ✓ Warm humid dry climate
- ✓ 150-200 cm to 35-40 cm yearly rainfall
- ✓ Dry region – protective irrigation

Propagation

- ✓ Root suckers or rhizome cuttings

Planting

- ✓ Spacing 60 x 30 cm or 60 x 45 cm
- ✓ 15-18 cm long root suckers – rhizome cuttings
- ✓ 2/3 portion under the ground

Manuring

- ✓ 150 kg/ha mixture of NPK

Irrigation

- ✓ After planting – one irrigation
- ✓ 4 to 5 irrigations / year
- ✓ No stagnation of water

Harvesting and Yield

- ✓ Eight months after planting
- ✓ Plants removed by manually or with tractor
- ✓ Broken rhizomes left in soil – succeeding crop
- ✓ Commercial yield from second – upto five years
- ✓ Fresh weight 10000 – 12000 kg/ha
- ✓ Chemically evaluated for aloin content and aloe gel.

AONLA

S. name : *Emblica Officinalis*

Phyllanthus emblica

Family : *Euphorbiaceae*

- ✓ Very rich in vitamin C medicinal and Ayurvedic
- ✓ Contain tannin – gallic acid, allagic acid, glucose in its molecules – retands oxidation of vitamin –C antisaorbustic in fresh and dried fruits
- ✓ Fruits useful in haemorrhaeges, dysentery, anaemia, jaundice, dyspepsia and cough
- ✓ Important in – Triphala – chavanaprash
- ✓ Used for preserve
- ✓ Great health vitality restorer

Botany

- ✓ Tree of medium height evergreen in tropics but deciduous in subtropics
- ✓ Phyllanthoid branching
- ✓ Flowers is axils of leaves – determinate shoots

Varieties

- ✓ Banarasi, chakaiya, kanchan, Krishna NA6, NA7, NA10, BSR-1, Anand-1, Sanshagold, francis

Soil and Climate

- ✓ Grows well in sandy loam to clay loam
- ✓ Tolerance to salinity and sodicity – pH 6-8
- ✓ Prefers subtropical – distinct winter and summer

Propagation

- ✓ Budding, grafting and seed

Planting

- ✓ Beginning of monsoon
- ✓ 8 to 10 m both ways
- ✓ 1 m pits
- ✓ After first rain plants are planted

Pruning

- ✓ Does not require much pruning
- ✓ Pruning early – proper shape – strong frame work – single stem – 1m height – primary branches regular spaces

Fertilizers

- ✓ Hardy stand well against drought
- ✓ Benefit – two irrigations at flowering and fruit set
- ✓ During summer – dormant

Intercropping

- ✓ Fast growing – initial – 3-4 years
- ✓ During summer dormant – only rainy season intercrops can be grown

Harvesting

- ✓ Vegetatively propagated – 6-8 years
- ✓ Seedlings – 10-12 years
- ✓ Productive life – 50-60 years
- ✓ Fruits – November /December
- ✓ Maturity – change of seed colour from creamy, white to black or translucent exocarp
- ✓ Maximum vitamin-C- mature fruits
- ✓ 60 to 70 kg fruits/tree
- ✓ 5 t /ha 20 t /ha^{-1}

ASHWAGANDHA

S. name : *W. Somnifera*

Family : *Solanaceae*

English name: Winter cherry

- ✓ Several alkaloids – withanine and somniferine are important
- ✓ Total alkaloid content in roots of Indian type 0.13-0.31%
- ✓ Used in ayurvedic and unani preparations

- ✓ Withaferine-A-antibiotic and antitumer properties
- ✓ Paste from leaves – curing inflammation of tubercular glands
- ✓ Roots skin diseases bronchitis and ulcers
- ✓ Roots- general and sexual debility
- ✓ Fruits and seeds –diuretic in nature
- ✓ Fruits and seeds – chest complaints
- ✓ Commercial drug – dried roots- small pieces 10-17.5 cm long and 6.12 mm in diameter
- ✓ Fruit is berry – turn orange red when mature

Varieties

- ✓ Jawahar asgandha -20- JNKVV mandsur

Soil

- ✓ Sandy loam or light red soils – good organic matter
- ✓ Easy to dig roots in this condition
- ✓ pH 7.5-8

Climate

- ✓ Subtropical climate
- ✓ Planted in rainy season – prefer dry weather
- ✓ 1-2 winter rains –roots to develop fully

Propagation

- ✓ Directly sowing the seed
- ✓ Raising seedlings

Direct sowing

- ✓ Seeds – directly – broadcasting
- ✓ Rainfed crop
- ✓ Monsoon – convenient size beds – second week of July
- ✓ Seed rate 10-12 kg/ha

Nursery raising and planting

- ✓ Seedlings are raised – raised nursery bed
- ✓ 5 kg seed to provide ha
- ✓ Seeds treated with fungicide
- ✓ Seeds sown in nursery spaced at 5 cm
- ✓ Germination in 6-7 days
- ✓ Six week seedlings – spacing 60 x 60 cm

Manuring

- ✓ Does not require heavy doses of manures

Interculture

- ✓ Directly sown crop thinned 25-30 days
- ✓ Population 20,000 to 25,000/ha

Harvesting and Drying

- ✓ Harvesting from January to March (150-170 days)
- ✓ Maturity drying of leaves – berries red
- ✓ Entire plant uprooted – roots separated by cutting 1-2 cm above crown

- ✓ Transversely cut into smaller pieces 7-10cm for drying
- ✓ Occasionally roots dried as whole
- ✓ Berries plucked from dried plants threshed to obtain seeds

Grading

- ✓ Dried whole roots undergo cleaning, trimming and grading

1. A-grade – roots pieces 7 cm length, solid 1-1.5cm dia -brittle -pure white inside

2. B-grade – Root pieces 5 cm length, solid, diameter less than 1cm, brittle, white inside

3. C- grade- Root pieces 3-4 cm length –diameter less 1 cm or less

4. Lower yield – Small root pieces – semi solid – very thin and yellow inside

Yield

Average yield 300-500 kg/ha dry roots 50-75 kg/ha- seeds

Belladonna

S.name: Atropa belladona, *A. acuminata*

Family : Solanaceae

Origin: Southern and Central Europe

Economic part: Leaves, roots flowering stalks

Active Principle: 1-hyoscyamine (major) Atropin (minor)

Belladonna commonly called deadly night shade plant.

Acuminata – Indian atropha or Indian belladonna

- In world - drug is from belladonna
- In India- mixture of belladonna and acuminata
- Leaves and roots contain alkaloid 0.13 to 0.7% (Average 0.45%)
- Acuminata leaves contain 0.45% hyoscyamine
- Roots 0.20 – 0.8% (0.4% average)
- Cultivation in UK, Germany, Poland, Hungary, USSR, USA, Rumania, Czechoslavakia, Algeria.

Uses:

- In India – Jammu and Kashmir
- Belladonna leaves – tinctures, extracts and plasters.
- Anti asthamatic and anti inflammatory
- Controls stomach disorders
- Cure over sweating, poisons like opium and floral hydrate
- Roots –Rheumatism and epilepsy.

Climate

- Temperate plant
- Perennial in temperate – more herbage and alkaloid yield
- In subtropical – winter crop – behaves annual – dies in summer – yield is poor
- Grown in open and partial shade

Soil

- Grows well in slightly acidic – deep fertile
- Rich in humus
- Avoid heavy and water logged soils

Land Preparation

- Repeated ploughings – fine tilth
- FYM 25 T/ha last ploughing

Propagation

- Seeds extracted from berries – September to November
- 4 kg/ha
- Germination is poor – 3-6 weeks for germination
- Seeds treated – 80% sulphuric acid at end – 2 minutes
- Stratification – 5 to 12^0C or - 2 to 2^0C for 10-40 days

Nursery

- Direct sowing treat nursery – best results

- Raised beds of 3 x 1m – well decomposed FYM top 10 cm soil

- Seed treatment

- Seed mixed with fine sand 1:40 – 200 g

seed /m^2

- seeds germinate in 3 week

- Seedlings will ready – height 15-20cm –

  8-12 weeks

Broad casting

- 20 kg/seeds/ha

Transplanting

- Planted at 50-60cm in rows 60-70 cm apart
- Better to plant on raised beds with 1 m wide strips
- Irrigation immediately after planting

Irrigation

- More water
- 6-7 irrigations – interval 10-15 days
- Avoid water stagnation

Manuring

- Exhaust crop
- NPK – 25-40 – 40-60 – 30-50 kg/ha – basal
- Additional – 60-80 kg N – 3-4 splits – monthly interval

Harvesting

- First harvest of leaves – 3 months after planting
- Initial yield poor – few leaves – later increases
- Harvesting – starting of flowering – alkaloid is high
- Leaves are cut- cutter (pruning scissor) – 30 cm ground level- 7.5 cm from ground level.
- First year – 3 to 4 crops
- Retained for 3-4 years

Drying

- Leaves dried immediately – shade or sun or wire racks- care remain green
- May also dried with artificial heat
- Spread in thin layer – tuned frequently
- Woody stems discarded
- Prolonged drying reduce alkaloid content
- Roots after 3 years
- Washed – cut to 4 inch long splits – shade or sun dried
- Dried crop stored in cool and dry place

Yield

- Ist year dry leaves – 6 q/ha
- IInd year dry leaves 12 q/ha
- IIIrd year dry leaves 15q/ha
- IVth year – roots yield – 1.7 – 3.35 q/ha
- Alkaloid content in leaves – 0.35%
  Roots – 0.5%

COLEUS

S. name *coleus bar batus*

Family – Limiaceae

- ✓ Tuberous roots are – rich source for forskolin (syn-coleonol)
- ✓ Drug for hypertension, glavcoma, asthma, congestive heart failures and cancers.
- ✓ Pashana bedi in Sanskrit – patharchur in hindi
- ✓ Tuber roots – resembles carrot in shape – brown in colour – commercial product

Botany

- ✓ Aromatic perennial herb – thick tubers showy bluish to pale lavender colour flowers
- ✓ Entire plant is aromatic (fresh or dried)

Varieties

- ✓ Karnataka – K-8- give 0.5% forskolin

Soil

- ✓ Best porus – well drained soils
- ✓ pH 5.5-7
- ✓ Marginal fertility – red sandy loams

Climate

- ➢ Crop of tropics
- ➢ Humid climate RH 83-95% and temperature 10-25^{0}C
- ➢ Annual rainfall 100-160 cm – June- September

- Perform well in less humid and warm regions irrigated crop.
- Propagated by seeds – stem cuttings
- Seed- difficult – breeding of new varieties
- Cuttings – easy- economical –raise crop on large scale

Nursery

- Viability poor (8-10%)
- 15-20 days for germination
- 45 days old seedlings – 8- 10 cm height

Vegetative propagation

- Through terminal cuttings – 10-12 cm long cuttings 3-4 pairs of leaves – prepare nursery beds
- No problem in rooting
- After month – sufficient rooting – main field

Planting

- June – July
- Ridges and furrows at 60 x 20 cm

Manuring and Fertilizers

- 40 kg N, 60 kg P_2O_5 and 50 kg K_2O /ha

Irrigation

- Immediately after transplanting
- Irrigation – one in three days – thereafter
  Weekly

Harvesting and Yield

- Flowers – nipped off – more bio mass
- Ready for harvest – 41/2 – 5 months after planting
- Plants loosened uprooted – tubers separated – cleaned sundried for extraction forskolin
- 1500-2000 kg/ha dry tubers
- 2500 kg/ha – proper cultivation

Diascorea

S.name: Diascorea floribunda

Others: D. *Composita*

D. *dettoidea*

Family: Diascoreaceae Origin: Mexico

Economic Part: Tuber

Active Principle: Diosgenin

- Also known as medicinal yam
- Dioecious plant – climbing habit – perennial- tuberous roots
- Steroid drugs 6% of pharma industry
- Costly and important – Anti fertility property
- Diosgenin – base chemical – steroid hormones like sex hormones – cartico steroids – oral contraceptives
- Rich in proteins, CHO and other alkaloids yamogenin, sofogenin and keptogenin
- Mexico is the largest producer

Species and cultivars

1. D. *deltoidea*

- Indigenous grown wild – north western

Himalayas

Slow growth -7-10 years

Not attractive to farmers

2. D.*floribunda*

- Native of mexico (central America) grown in Karnataka, Goa, Assam, Meghalaya and Andaman and Nicobar islands

- Easily propagated and dioecious

- Three varieties

- IIHR – FB (c) -1 and Arka upkar

- Pusa- 1 by IARI

3. D. *Composita*

- Native of mexico

-Robust climber – produce large thick leaves

- Propagated by seeds – rotting of tubers

Soils

- Light or sandy soils – heavy irrigation and fertigation
- Heavy clay soils – restrict tuber growth – water logging
- Best yields – medium loam and deep soils – rich in O.M
- Highly acidic and alkaline – avoided

Climate

1) D. floribunda, D. Compesitae — Grown in tropical conditions
2) D. deltoid — Temperate – Kashmir & Himachal Pradesh

Propagation

- Propagated by – seeds, rhizomes pieces of stem cuttings
- In India – tuber cuttings
- Seed progeny – variable – longer time to yield
- Choice – cost and prevailing climate of region

Tuber propagation

- Tubers divided – 50-60 g pieces
- Crowns (stem end) 2 Medious (middle) 3. Tips (distal end)
- Crowns germinate in 30 days – other 100 days
- Crowns contain less diosgenin-planting
- Sprouted planted in filed

Season of planting

- Tubers planted in February- March or June – July
- Median and tips early planting – more time for germination

Propagation by seed

- Successful in D. floribunds and D. composite
- Seed – wide membranous with – removed – without affecting germination
- Sown on raised bed
- Seeds germinate within three weeks – ready for transplanting 3-4 months

- Best season for planting start of rains i.e. June

Stem cuttings

- D. floribunds propagated by stem cuttings – 80% success
- One or two old month vires - single mode cutting – one leaf

Land Preparation

- Plough we1l, harrowed, conve nient size plots
- Drianage channels

Planting

- Sprout tubers planted at 5cm depth 30-45 cm apart
- Spacing of 60 x 30-45 cm
- After sprouting earthing

Stacking

- Vine need support – expose leaves to sunlight – photosynthetic activity more
- Reduces pest and disease problem – aeration
- Main support is given in the forms of trellies
- Trellies – stone pillars or iron poles – spaced at 10 m apart
- GI wires – four ends – interconnected with wires

Manures

- 30-150-150 kh/NPK/ha
- Entire P as basal
- N & K in 4 splits
- Each split – monthly – 2 MAP
- Increase tuber yield – S, Calcium and Magnesium

Irrigation

- Irrigation frequently
- Summer 4-5 days
- Winter 7-10 days

Inter cropping

- Intercropped with cowpea, cluster beans, kidney beans

Harvesting

- D.*floribunda* and D.*Compositae* – harvested after two years
- D. *deltoidae* – After 3 years
- Harvested in February-March
- Manually pickaxes – lifted
- Harvested in dormant stage – more diosgenin content

Yield

D.*deltoidae* – 15-20 T/ha – fresh tuber yield

Diosgenin content – 2.5 – 3% - Ist Year

3. 0 – 3.5% - IInd Year

GUGGAL

S. name *Commiphora mukul*

Family – Bureraceae

- ✓ Guggal or Indian bedellium – small tree
- ✓ Source for Indian bedellium – oleo gum resin – incision of bark
- ✓ Resin occur in vascular or stalactite pieces, pale yellow brown or dull green – bitter-aromatic taste balsamic odour.
- ✓ Oleogum resins mixtures of resin (61%) gum (29.3%), volatile oil (1.45%).
- ✓ Largely used in fixative in perfumes and medicines
- ✓ In medicine astringent, antiseptic, stomachic, carminative and digestant
- ✓ The oleo resin – increases leucocytes in blood

Botany

- ➢ Tree or shrub 3-4 high
- ➢ Branches crooked, knotty, aromatic-end in sharp spines
- ➢ Bark is papery and peels in strips – old part of stem

Varieties

- ➢ Marusudha- high yielder

Soil

- ➢ Not grown on commercial scale
- ➢ Naturally in western India – sandy – silt loam – poor in organic matter.
- ➢ Average soil suitable for cultivation

Climate

- Wide adaptability – arid regions – varying conditions
- Prefers a warm, dry climate – yield aloe resin gum

Planting

- Pits at a spacing 3 to 4 m in rows.

Cultivation

- Seeds – vegetatively – stem cuttings
- Air layering is successful

Seed

- Not a common method
- Poor germination – slow growth – hard seed coat
- Mechanically scarified – sand paper-running water (24 hours)
- Raised in poly bags

Stem cuttings

- 15-20 cm long and 10 mm thick semi hard wood cuttings
- Treated with GR(IBA or NAA) – planted in beds
- Cuttings sprout in 10-15 days – grow well – 10 -12 months
- Percentage of rooting 80-94%

Manuring

- Urea or Ammonium sulphate 20-50 g/bush- before irrigation.

Irrigation

- Light irrigation – summer – good growth of Plant

Gum tapping and Yield

- Normal height after 8-10 years – ready for tapping
- Tapping gum – balsam canals phloem
- Shallow incision on bark. Too deep – plant may die low yield next year
- Making incision – small quantity guggal gum mixed applied to incision place – using prick chisel
- Sharp and chisel dipped in guggal solution incision is made
- Incision is made after November – Before April
- Resin collected 10-15 days interval

- 700-900 g/plant

Separation of resin from gum

- Hot expression or solvent extraction at 120- 130^0C
- Purified resin – transparent – translucent – even opaque in built

ISABGOL (Plantago)

S. name : *Plantago ovata*

Family : *Plantaginaceae*

- ✓ Commonly known as Isabgol or blande psyllion Indian Plantago or Psillium
- ✓ Commerce seed and husks
- ✓ Boat shaped seeds
- ✓ Plantago – sole of foot-shape of leaf
- ✓ Psyllium-Greek-Flea-colour size and shape of seed (fleaseed)
- ✓ Husk is economic part – separated by physical process
- ✓ Husk – absorbing and retaining water-anti diarroheal drug
- ✓ Seed-cooling and demulscent effects
- ✓ Constipation and intestinal disorders works as calorie fibre food

Botany

- ✓ Stemless or short stemmed – highly cross pollinated –annual herb
- ✓ Attains 30-40 cm height

Varieties

- ✓ Gujarat Isabgol -1
- ✓ Gujarat Isabgl-2
- ✓ Niharika – CIMAP, Lucknow

Soil

- ✓ Irrigated crop – genus well in light soils
- ✓ Heavy soils – not conducive to good growth
- ✓ Silky loam – pH 4.7 to 7.7.

Climate

- ✓ Warm temperate regions
- ✓ Cool dry weather – winter months
- ✓ Sowing – I week of November best yields

Cultivation

- ✓ Five with for good germination
- ✓ 10-15 t FYM/ha
- ✓ Field – suitable plots
- ✓ Light soils – 8 x 3 m plots are prepared

Seeds and Sowing

- ✓ High percentage of germination – end of preceding season
- ✓ Older seed- loose viability
- ✓ Seedrate 4-8 kg/ha
- ✓ Seeds small and light – mixed with sand
- ✓ Seeds are broadcasted – swept with broom – to cover soil
- ✓ Followed by irrigation
- ✓ Germination – in four days

Fertilizer Application

- ✓ Does not require heavy doses
- ✓ 50 kg N: 25 kg P_2O_5 and 30 K_2O /ha

Irrigation

- ✓ Immediate after sowing – light – if fast seeds one side
- ✓ 6-7 irrigations

Harvesting and Processing

- ✓ Blooming- two months ready for harvest in February-March (110-130 days)
- ✓ Mature – turn yellow – spikes brown in colour
- ✓ Seeds shed – spikes pressed even slightly
- ✓ Harvest-atmosphere must dry – no moisture on plant considerable seed shattering]
- ✓ Harvested after 10 AM
- ✓ Plants are cut or uprooted
- ✓ Bundled in large cloth pieces – threshing yard
- ✓ Threshed – with tractor – morning – easy separation of seed from spathe
- ✓ Water sprinkled – heap-easy threshing

- ✓ Threshed – winnowed – seeds sieved
- ✓ Seeds may be marketed whole – husk may be sold separately
- ✓ To remove husk – cleaned seeds passed 6 to 7 times through stone grinders
- ✓ Highest quality husk-white- no particles of kernals
- ✓ Husk seed ratio in 25:75 by weight

Nuxvomica

Strychmus nuxvomica

Poision nut Snake wood

Mushini

Vishamushti

F: Loganiaceac

Active Principle:

It is perennial plant lines for 15-20 years

- Nuxvomica leaves, seeds, root and bark are useful parts.
- Leaves are used to control itching act as stimulant nervous disorder
- Root and bark used to control fever
- Seeds used to control dysentery, ulcers, and excitement.
- It is grown in natural forests of Eastern and Western Ghats in India.

Climate

- It is grown in Tropical and Subtropical climate
- Grown in full sunlight
- 100-200cm annual rainfall
- Temperature of 25-40^{0}C is ideal.

Soils

- Comes up well in clayey loam soils
- Ideal soil pH is 6.5 – 7.0
- Light soils must be avoided

Propagation : By seed

Field Preparation: Prepared well by deep ploughing level the land. Pits of 50 cm^3 should be dug out of 5x 5and left for weathering 6-8 months etc seedlings collected and planted in the centre of pit and watered immediately.

Irrigation:

- New plantation should be watered regularly till the establishment.
- Later the plants are irrigated at 7-10d during summer
- 15-20d during winter season.

Maturity & Fertigation:

- FYM @ 10 t/ha applied during the filling of pits after weathering
- Apply 50:30:30 kg of NPK/ha

P &K applied at the filth

Applied ½ dose at the filth

½ dose at the filth

The dosage must be given every year as the plant is growing.

Interculture: Keep the plantation weed free by regular weeding.

Harvesting : The plant comes to flowering and fruiting after 5 years

- The matured fruits change the co. from green to yellowish orange
- The seed can be extracted from the fruits by cutting and cleaning
- Seed yield – 4-5q/ha

OCIMUM

S. name *Ocium sanctum*

Family *Labiatae*

- ✓ Sacred basil or holy basil – biennial – triennial
- ✓ Leaves-steam distillation –yield bright yellow possess odour
- ✓ Plant contains phenols, Aldehydes, tannins, saponin and fats
- ✓ Essential oil components – Eugenol (71%) eugenol methyl ether (20%)
- ✓ Terpeneurobsolic acid anticancer properties – isolated

- ✓ Seeds – greenish yellow fixed oil contain – antistaply loceagulase – extracted with water and alcohol
- ✓ Plant pot herb – leaves condiment is salads.
- ✓ Leaves, seeds, roots- medicinally important.

Botany

- ✓ Erect, herbaceous, much branched softly hairy plant

Types and varieties

- ✓ Two types of O.Sanctum
- ✓ Green type (Sri tulsi) second (Krishna tulsi) – purple leaves

Soil

- ✓ Wide variety of soils – rich loam to poor laterite soils – saline, alkaline, slightly acidic.
- ✓ Well drained soil – good growth
- ✓ Water logging – root rot

Climate

- ✓ Grow partial shade also – less oil
- ✓ Flourishes well – high rainfall – humid conditions.
- ✓ Long days and high temperatures – favour Growth

Season

- ✓ Raised in third week of February –
  Transplanting in middle of April

Propagation

- ✓ Propagated by seeds
- ✓ Highly cross pollinated
- ✓ Fresh seed – pedigree block

Nursery

- ✓ Raised beds
- ✓ 200-300 g seeds/ha
- ✓ 2 cm deep in nursery beds

- ✓ Seeds germinate 8-12 days
- ✓ Seedlings ready 6 weeks 4-5 leaf stage

Transplanting

- ✓ Spacing 40 x 40 cm 40x 50 cm and 50 x 30 cm

Fertilization

- ✓ 120 kg N/ha 60 kg P_2O_5/ha

Irrigation

- ✓ Depend on soil moisture
- ✓ In summer 3 irrigations/ month
- ✓ 12-15 irrigations

Harvesting and Yield

- ✓ Harvesting – full bloom
- ✓ First harvest 90-95 after planting – after 65-75 days intervals
- ✓ Bright sunny days – good quality oil
- ✓ Cut 15-20 cm ground level
- ✓ Wilt in field for 4-5 hours – reduce moisture content and bulkiness
- ✓ About 5 t /ha twice or thrice year
- ✓ Whole herb contain 0.1-0.23% essential oil
- ✓ Oil yield 10-23 kg/ha

Opium

S. name: *Papaver somniferum*

Family: Papaveraceae

Origin: Western Mediterranean Region

- ✓ Outstanding medicinal plant – products opium and codeine used for analgesic and hypnotic effects.
- ✓ Semi synthetic drug from morphine known as heroin worldwide social problem
- ✓ Cultivation in Madhya Pradesh, Rajasthan and U.P
- ✓ Erect – rarely branched annual – height 60-120 cm
- ✓ Flowers large – bluish with purplish base or white purple or variegated.
- ✓ Capsular type of fruits – latex known as opium – lancing

- ✓ Fruits 2.5 cm diameter – globase in shape
- ✓ Seeds reni form – white or black in colour
- ✓ All parts – milky white latex unripe capsules – large amount

Climate and Soil

- ✓ Temperate climate – grown in winter sub tropical regions
- ✓ Cool higher yield – higher day/night – affects yield
- ✓ Frosty, desiccating, cloudy, rainy – reduce quantity and quality
- ✓ Prefers well drained, highly fertile. Light black loamy – optimum pH 7.0

Varieties

- ✓ Number of races by local names
- ✓ Talia, Dhola chola Gotia Ranghatak, MOP3, MOP16, Shama, Shwetha, BROP 1, Kirtiman, Chetak, Trishna, Jawahar, Aphium 16, Sujatha, Shubra

Sowing

- ✓ Land prepand – convenient size beds
- ✓ Seeds – broad casted – is lines
- ✓ Before sowing – treated with fungicide
- ✓ Mixed with sand – uniform spread
- ✓ Line sowing preferred
- ✓ Best time – October – November
- ✓ Seed rate 7.8 kg/ha for broadcasting – 4-5kg/ha line sowing
- ✓ Spacing 30 x 30 cm
- ✓ Germination 5 to 10 days
- ✓ Thinning – uniform growth and development
- ✓ Done at 5-6 cm height – 3-4 leaves
- ✓ Carried upto 14-15cm height – 3-4 weeks after sowing.

Manuring

- ✓ Improves yield and quality
- ✓ FYM 20-30 t/ha
- ✓ 60-80 kg/N and 40-50 kg P_2O_5 – no potash

Irrigation

- ✓ Careful irrigation schedule
- ✓ Light irrigation – after sowing – light irrigation after 7 days

- ✓ 12-15 days till pre flowering – reduced 8-10 days during flowering and capsule formation
- ✓ Moisture stress at fruiting and latex extraction – reduce yield

Lancing and Latex collection

- ✓ Starts flowering in 95-115 days
- ✓ Petals shedding – 3-4 days after flowering
- ✓ Capsules development – 15-20 days of flowering – lancing at this stage – maximum latex
- ✓ Stage judged by – compactness – change in colour from greenish to light green coloured ring in capsule – stage is called industrial maturity
- ✓ Skilled labour – on bright sunny day between noon and 4.00 pm
- ✓ Hottest day – pellicle is form on fresh latex due to hot sun- greater evaporation and quicker thickening. Prevents latex falling off the capsule
- ✓ Started at end of field – works backward to avoid contact with exuding latex
- ✓ Lancing instrument called nastar or naka comprises four lines – ordinary needles spaced at 1.5-2mm apart
- ✓ Nastar held carefully one holds a pencil incision is made swift by swift- down ward stroke starting just below stigmatic rays
- ✓ Depth is controlled – too deep latex exuded to interior
- ✓ If shallow- latex low
- ✓ Incision 0.4 cm ideal
- ✓ Immediately lancing latex exudes- initially milky and accumulated is outer wall of capsule
- ✓ Quickly darkens and dries – collected next day before 10 am- scraping with trowel called seeloah
- ✓ The semi dry blackish latex transformed to wooden trays
- ✓ Grades

  A= Morphine more than 12%

  D_1= Morphine 11-12%

  B_2= Morphine 10-11%

  B= Morphine 8-10%

Harvesting and Flowering

- ✓ Crop left for drying – 20 – 25 days – last lancing on capsule – stops exudation of latex
- ✓ Capsules harvested – plant is removed with sickles
- ✓ Harvested capsules dried is open yard – seeds collected by heating with wooden rod
- ✓ Yield of raw opium 50 to 60 kg/ha

Lancing and Latex collection

- ✓ Starts flowering in 95-115 days
- ✓ Petals shedding – 3-4 days after flowering

- ✓ Capsules development – 15-20 days of flowering – lancing at this stage – maximum latex
- ✓ Stage judged by – compactness – change in colour from greenish to light green coloured ring in capsule – stage is called industrial maturity
- ✓ Skilled labour – on bright sunny day between noon and 4.00 pm
- ✓ Hottest day – pellicle is form on fresh latex due to hot sun- greater evaporation and quicker thickening. Prevents latex falling off the capsule
- ✓ Started at end of field – works backward to avoid contact with exuding latex
- ✓ Lancing instrument called nastar or naka comprises four lines – ordinary needles spaced at 1.5-2mm apart
- ✓ Nastar held carefully one holds a pencil incision is made swift by swift- down ward stroke starting just below stigmatic rays
- ✓ Depth is controlled – too deep latex exuded to interior
- ✓ If shallow- latex low
- ✓ Incision 0.4 cm ideal
- ✓ Immediately lancing latex exudes- initially milky and accumulated is outer wall of capsule
- ✓ Quickly darkens and dries – collected next day before 10 am- scraping with travel called seeloah
- ✓ The semi dry blackish latex transformed to wooden trays
- ✓ Grades

  A= Morphine more than 12%

  D_1= Morphine 11-12%

  B_2= Morphine 10-11%

  B= Morphine 8-10%

Periwinkle

S. name *Catharanthus roseus*

Syn *Vinca rosea*

Family – Apocyanaceae

- ✓ Perennial ornamental herb
- ✓ Medicinal properties due to indole alkaloid Ranbasin (ajmalicine)
- ✓ Serpentine – roots – antifibrillic and hypertensive properties
- ✓ Leaves contain – vinblastine and vincristine – constituents of patented cancer drugs

- ✓ Vincristine –maximum in roots (0.75-1.20%) followed by leaf (0.60 – 0.65%)
- ✓ USA imports leaves – West Germany, Italy, Netherlands and UK imports roots
- ✓ Pink and white flowers
- ✓ Flexible long branches – flowers 2-3 cymes – fruits cylindrical follicle with may black seeds

Varieties

- ✓ No recognized varieties
- ✓ Three local types based on colour of flower alba – white, roseus –pink and rose coloured ocillata – white flowers with rose purple spot in centre.

Climate and soil

- ✓ No specific
- ✓ Tropical and sub tropical areas – natural environments
- ✓ Well distributed rainfall 100 cm or more
- ✓ Grows is any soil except alkaline or water logged
- ✓ Light sandy soils rich in humus preferred for large scale cultivation

Propagation

- ✓ Propagated from seeds
- ✓ Fresh seed – loose viability in long storage
- ✓ Direct sowing or nursery and transplanting
- ✓ Direct sowing – large area – reduce cost
- ✓ 2 to 3 kg/ha – mixed with sand 1:10
- ✓ Beginning of monsoon – 45 cm row apert
- ✓ Grow thinned 25-30cm apart
- ✓ Nursery – 500 g seed – 200m^2 bed – one has
- ✓ Seeds sown in bed – March April – 1.5 cm deep
- ✓ 10 days seed germinate - 2 months ready for transplanting
- ✓ Planted at 45 x 30 or 45 x 45 cm.

Cane

- ✓ Two weedings at 30 and 60 days
- ✓ Do not require much water
- ✓ Monsoon restricted – 4-5 irrigations – good yield
- ✓ No manuring for but good yield
- ✓ 15 T FYM 50:75:75 NPK/ha

Harvesting

- ✓ Roots ready for harvest – after one year
- ✓ Two leaf strippings – one after 6 months – second after 9 months – third stripping – after one year
- ✓ For seed – mature fruits – hand picked – dried in shade – threshed lightly – shade drying – thresh lightly – germination poor
- ✓ Usual – uprooting – shade drying – thresh lightly – germination poor
- ✓ Roots – crop cut 7.5 cm above ground – dried for stems leaves and seeds
- ✓ Field is irrigated – ploughed- roots collected
- ✓ Roots washed – dried in shade – bundles – Marketing

Yield

- ✓ Rainfed – 0.75 T roots – 1.0 t/ stems – 2 T leaves (dry wt)
- ✓ Irrigated – 1.5 T each roots and stems 3 T leaves / ha.

Sarpagandha/Rauvolfia Serpentina

Apocynaceae

Origin: South East Asia

Active Principle – Reserpine

Part- Root

- It is the important native medicinal plant in India.
- It has a history of 400 years using the roots in treatment of snake bite, insect, stings, nervous disorders, epilepsy, skin disorders, excess sweating and itching.
- Used in treatment the hypertension
- It's importance in modern medicine (Allopathy) was recognized in 1952 of the isolation of alkaloid reserpine from the roots used for control of hypertension and sedation.
- In India it is grown in Punjab, Sikkim, Assam, Eastern ghats, Western ghats, some parts of Central and Southern India and Andaman, Goa, Coorg in Karnataka, Kerela, Orissa, Andhra Pradesh and Madhya Pradesh.

Soils:

- Grows in wide variety of soils from sandy alluvial loam to red lateritic loam
- It prefers clay or clayey loam with high % of human
- It pH is >8 growth is not good.
- So the ideal pH is 4.6-6.2

Climate:

- It grows well in hot humid conditions grown in sun and partial shade
- Prefers tropical and sub tropical belt
- Temperature of 10-30^{0}C is well suitable
- High rainfall of 250cm/year is good also comes up well even if reference is --- upto 500 cm
- Plant sheds the leaves during the cold months in localities with severe winter
- Frost kills the top tender green twigs

Propagation by seed, stem cuttings, root cuttings, not stump

Field Preparation: Deep ploughed during may (summer, ploughing)

- When rains come apply FYM 25-30t/ha and mix well with the ploughed soil
- Level the land make into beds with the irrigation channels.

Planting:

- Seedlings of 7-15 cm height with 4-6 leaves planted with a spacing of 45-60x30cm spacing

- Immediately after planting, the field is irrigated

Irrigation:

- Newly planted field should be irrigated frequently
- Please irrigation at an interval of 7-15 d during summer

5-20 d during winter

Manuring & Fertigation

- 'N' application inclusive the vegetable growth but ---- the not growth
- Com—of N with P give better not growth
- FYM 25 – 30t/ha applied during last ploughing
- 20:30:30 kg of NPK/ha applied
- Top dressing of N @ 20kg/ha done twice

Inter cultivation

- 2-3 weeding done in the 1st year one flowering done during February-March for good development of—
- The heavy rainfall areas, the plant must be earthed up to facilitate drainage

Harvesting

- The roots will be ready for harvesting from 15-36 m depending on cultivation
- In Indore the crop is ready for harvest in 18 months
- In Dehradun the crop is ready for harvest in 18 months
- Maximum root yield obtained when the age is q8 months
- The plant is defoliated completely during winter roots drying up and light irrigation is given, roots lifted by digging the soil.
- Do not damage the bark of the root as high alkaloid is resent in the bark 40-50% contribution in from bark only
- Roots washed to remove the soil during dried to reduce the moisture to 8
- Maximum alkaloid present in bark
- Total alkaloid present in bark

Yield

- The plant raised from seeds gives maximum yield of roots than vegetable raised cuttings.
- Seedling yield air dried roots of 1175 kg/ha.
- Stem cuttings air dried roots of 175 kg/ha
- Root cuttings air dried roots 345 kg/ha
- 2nd year- 2200 kg/ha

- 3rd year – 3300 kg/ha

Senna

S. name *Cassia angustifolia*

Family: Leguminosae

Origin: South Africa

- ✓ Leaves and pods – sennosides of A B C D
- ✓ Preparation of laxatives and purgatives
- ✓ India holds leading position
- ✓ Senna leaves exported London market
- ✓ Mainly in southern states – Tamilnadu
- ✓ Erect shrub – 70 cm height
- ✓ Flowers – brilliant yellow – racemose inflorescence
- ✓ Pods – flat – 5-7 dark brown seeds
- ✓ All plants contain but leaves and pods rich for sannoside
- ✓ India 1.5 -3% - Alexandria senna 4.45%

Climate and Soil

- ✓ Legume – no nodules
- ✓ Sandy loam soils pH a 7 to 8.5
- ✓ Sensitive to waterlogging – heavy rainfall low temperature

Land preparation and sowing

- ✓ Land is ploughed – outlet for excess rain water
- ✓ Seed rate 5kg/ha
- ✓ Treatment with fungicide – optimum time –depth important
- ✓ Seeds in line 30-40 cm apart 1.5 – 2.0 cm depth
- ✓ Germination in 13-15 days – one week Hard seed coat remain in hot weather – once germination – sufficient moisture in soil
- ✓ Thinned at 30 days – distance of 30cm

Manuring

- ✓ 4 to 5 cart loads of FYM
- ✓ 80 kgN: 45 kg P_2O_5

- ✓ 40 KgN – 35 – 40 days – 80-85 and 105-110 days (after Picking of leaves)

Harvesting

- ✓ Young senna leaves and pods – high sennoside
- ✓ Sold on basis of weight – balance between weight and content – choose stage of harvest
- ✓ First picking 50 -70 days – second 90-100 days
- ✓ Third picking 130-150 days – entire plants removed – harvested material (leaves and pods together)
- ✓ Roots contain sennoside – not as trade
- ✓ Harvested crop – thin layer in open – to reduce moisture
- ✓ Further drying – well ventilated drying sheds
- ✓ 3 to 5 days dry in sheds
- ✓ Dried produce – 8% moisture
- ✓ Properly dried – light green – greenish yellow colour
- ✓ Improper drying – black or brown luncus sennoside reduce price.
- ✓ Seeds no sennoside – add weight to produce

Solanum/medicinal solanum/steroid bearing solanum

Solanum Khasianum Syn to S. *Viarum*

F: Solanaceae

Origin: India (Assam)

Economic Part: Fruit

Active Principle: Solasodine

The genus Dioscorea tubers are the raw material for production of steroid 'Diosgenin". The plant growth is very slow prolonged maturation period and difficulty in cultivation a search for an alternate crop was made. A new source for 'Diosgenin' was made Solanum Khasianum. It is quick growing, low initial investment for commercial cultivation. It yields a glycoalkaloid "Solasodine" which is nitrogen analogue of Diosgenin.

- Solasodine is converted to testosterone and methyl testosterone and corticosteroids like predinisolone and hydrocortisone.

- These steroids used in anti-inflammatory and antifertility properties. They have large scale usage in health and family planning programme.
- Used for acute rheumatoid arthrite, asthma, leukemia and skin disorder.
- In India – Maharashtra, Central India, Sikkim, West Bengal, Orissa, Nilgirihills.

Soils:

- It is a hardy plant cultivation on a wide range of soils and under different agroclimati conditions
- Water logging is avoided
- Succesful cultivation is in red lateritic soils with organic matter
- Clayey soils are not suitable.

Climate

- It is a long day plant
- It requires sunny weather conditions
- It grows up too elevated of 2000m above MSL
- Growth and development is best under mild conditions.
- Maximum temperature of 35^0C and minimum temperature of 20 ideal

Propagation:

By seed 1.25kg seed rate/ha

Land preparation

- The field is prepared thoroughly
- Apply 25 T FYM/ha during last ploughing
- Divide the field into convenient size plots.

Planting

- The seedlings of 10-12 cm, height, 4-5 week old are planted into plots
- Spacing varies 50 x 50, 75 x 75 and 90 x 120 cm depending on the location/region.
- Irrigate the plots immediately after planting.

Maturity and Fertigation

- A dose of 100: 60: 40 kg of NPK/ha applied
- A dose of ½ N+P+K – basal dressing at land preparation.
- A dose of ½ N – when the plants start flowering.
- Green manuring before planting improve the yield by 20%
- A dose of 65:40:40kg of NPK/ha – Bangalore region

Irrigation

- In high rainfall areas – solanum is raised as rainfed crop
- Irrigation given once in a week during the first month
- Later irrigated once in fortnightly

Weeding

- After 3-4 weeks weeding or hoeing done
- When plant growth to 2-3 months age another weeding is done

Flowering and harvesting

- Solanum though it is a perennial herb grown a annual herb and remain in the field for 6 months
- Plant come to flowering 55-60 DAP
- Fruit take 65-70 days for maturity
- Fruit colour change in 80-90 days after pollination.
- Harvesting of berries is a labour intensive operation
- The spines present o the plant hamper the easy harvesting
- Use the gloves for easy and quick harvesting of berries
- Solasodine content is maximum when the green fruits start turning to yellow colour
- All the fruits do not mature at one time
- More no of pickings are done which will spread for 2 months.

Processing of berries

- Lot of care is required
- Fresh berries contain 80% of moisture
- Moisture reduced to 10% to avoid the degradation of alkaloid
- The berries are cut into two halves and spread in thin layers
- Cut berries are turned frequently for uniform drying
- Sundrying give bright yellow color to dried product
- The dried berries give cracking sound and there they are packed in bag for storage.
- 60% of the alkaloid is in seed
- 40% of the alkaloid is in pericarp.

Yield

- Fresh berries – 8000 to 10000 kg/ha – 10t/ha
- Dry berries – 1800 to 2000 kg/ha – 2t /ha
- Solasodine content – 2.5%

STEVIA

S. name : ***Stevia rebaudiana***

Family : ***Asteraceae***

- ✓ Sweet, perennial herb
- ✓ Leaves are mid green and intensively sweet
- ✓ Compounds in leaves – **sterioside and rebaudioside** fresh – 30 times (fresh) and 200 times more sweet than sugar (refined)
- ✓ Healthy alternative sweetener to sugar
- ✓ Used in tonics for diabetic patients
- ✓ Antifungal and anti bacterial property
- ✓ Cooling effect on eyes
- ✓ Good for wrinkles – skin care

Botany

- ✓ Short day plant
- ✓ Height 45 cm within 3 months
- ✓ Stevioside more – long day

Soil and Climate

- ✓ Red sandy loam soils with 6-7 pH best
- ✓ Heavy soils not suitable
- ✓ Grows best in subtropical climate
- ✓ Sunny climate – semi shade best

Propagation

- ✓ Seed germination poor
- ✓ Vegetatively – stem cuttings and tissue culture

Planting

- ✓ Forming raised beds
- ✓ 15cm height 60cm width
- ✓ Distance between plants 23 cm -30000 plants /acre

Irrigation

- ✓ Ample supply of good water – all year round
- ✓ Frequent irrigation – micro sprinklers

Fertilizers

- ✓ 110 : 45: 45 kg NPK/ha
- ✓ N must for production of dry matter

Harvesting

- ✓ Timing of harvest – No flowering reduces Stevioside content
- ✓ Leaves plucking – entire plant with side branches leaving 10-15 cm from ground
- ✓ First harvesting – 4 to 5 months after planting subsequent every three months
- ✓ 3000 kg leaves/acre
- ✓ After harvesting – drying of leaves
- ✓ Leaf 10-12% Stevioside on dry weight