PROFESSOR JAYASHANKAR TELANGANA STATE AGRICULTURAL UNIVERSITY

DA 201

CROP PRODUCTION II

3 (2 + 1)

By

Smt.G.Vijaylaxmi
Assistant Professor (Agro)
APT, Basanthpur

Sri.T.Laxman
Assistant Professor (Agro)
APT, Basanthpur

Dr.M.Madhavi Latha
Professor (Agro) & Pincipal
APT, Malthummeda

Lecture No	Topic
1	Importance of Oilseeds – Area, Production and Productivity in Telangana and India – Economic importance – Climate
2	Groundnut –Soils, land preparation, time of sowing, varieties, seed rate, seed treatment, dormancy, spacing, method of sowing, Fertilizer management
3	Groundnut – weed management, water management, cropping systems, maturity symptoms, harvesting, storage, reasons for low yields in Groundnut
4	Castor - Area, Production and Productivity in Telangana and India – Economic importance – Climate, soils, land preparation, time of sowing, varieties, seed rate, seed treatment, dormancy, spacing, method of sowing
5	Castor - nutrient management, weed management, water management, cropping systems, maturity symptoms, harvesting, storage
6	Sun flower – area, production and productivity in Telangana and India, Economic importance, favourable conditions for cultivation - Soils, land preparation, time of sowing, varieties, seed rate, seed treatment, dormancy, spacing, method of sowing
7	Sun flower – nutrient management, weed management, water management, birds control, cropping systems, maturity symptoms, harvesting, storage
8	Sesamum - Area, Production and Productivity in Telangana and India – Economic importance – Climate, Soils, land preparation, time of sowing, varieties, seed rate, seed treatment, dormancy, spacing, method of sowing, nutrient management, weed management, water management, cropping systems, maturity symptoms, harvesting, storage, profits in Sesamum cultivation
9	Safflower - Area, Production and Productivity in Telangana and India – Economic importance – Climate, Soils, land preparation, time of sowing, varieties, seed rate, seed treatment, dormancy, spacing, method of sowing, nutrient management, weed management, water management, cropping systems, maturity symptoms, harvesting, storage
10	Commercial crops – Cotton - Area, Production and Productivity in Telangana and India – Economic importance – Climate
11	Cotton - Soils, land preparation, time of sowing, varieties, seed rate, seed treatment, dormancy, spacing, method of sowing, fertilizer management
12	Cotton - weed management, water management, reasons for flower and boll dropping, precautions to be taken while picking, cropping systems
13	Cotton – Quality parameters, areas of cultivation
14	Cotton – reasons for low yields
15	Sugarcane - Area, Production and Productivity in Telangana and India – Economic importance – Climate
16	Sugarcane – planting time, soils, land preparation, selection of seed, types of seed material
17	Sugarcane – seed rate, planting methods, planting time, gap filling, fertilizer management

18	Sugarcane –trash twist propping, earthing up, water management, cropping systems, maturity symptoms, ratooning
19	Sugarcane – jaggery preparation, crop logging, classification of sugarcane varieties
20	Tobacco - Area, Production and Productivity in Telangana and India – Economic importance – Climate, types of tobacco
21	Tobacco – nursery raising, main field preparation, transplanting, fertilizer management
22	Tobacco – weed management, topping and desuckering, water management
23	Tobacco – maturity, curing methods
24	Tobacco – cropping systems, yield parameters
25	Chilli - Area, Production and Productivity in Telangana and India – Economic importance – Climate, soils, seasons, nursery raising, seed treatment, seed rate
26	Chilli – main field preparation, fertilizer management, transplanting, spacing, weed management, cropping systems, harvesting
27	Chilli – drying, parameters while exporting, yield
28	Turmeric - Area, Production and Productivity in Telangana and India – Economic importance – Climate, soils, seasons, varieties, sowing time, land preparation, seed treatment
29	Turmeric – transplanting methods, weed management, water management, mulching
30	Turmeric – cropping systems, crop rotation, curing, polishing, grading, packing
31	Turmeric – storage, yield
32	Coriander - Area, Production and Productivity in Telangana and India – Economic importance – Climate, soils, seasons, varieties, sowing time, land preparation, seed treatment, weed management, water management, storage, yield.

IMPORTANCE OF OILSEED CROPS

The crops that are cultivated for the production of oils are known as OILSEED CROPS. These are the most important commercial crops in India. Edible oils are next to food grains in Indian diet.

Edible oil seeds:

1. Rapeseed and Mustard
2. Sesamum
3. Sunflower
4. Safflower
5. Linseed
6. Soybean
7. Niger
8. Groundnut and
9. Castor are the most important oil seed crops of India.

Non edible oil seeds: Castor, Linseed etc.

Under horticultural crops : Coconut and Oil palm

IMPORTANCE:

India is one of the major oilseed producing countries in the world accounting for about 13% of the area and 7% of world oilseed production. But the productivity is 935 kg, world wide it is 1632 kg. Edible oils are next to food grains in Indian diet. In India oil seeds occupy nearly 13% of country's gross cropped area and contributes to 3% of the GNP and 10% of the value of the agricultural products.

It is estimated that in India 14 million people are engaged in oilseed production and one million in their processing.

The oilseed scenario in India had undergone dramatic change with the initiation of TMO (Technology Mission on Oilseeds) in 1986 (May). The highest oilseed production was achieved by 27.45 Mt during 1998-99 against 10.3 Mt during 1985-86. In post WTO regime, there is a great need to adopt multifaceted strategy for improving oilseed production through increase in area (2.7%) and productivity improvement (1.8%) including processing facility.

On Global basis, India ranks first in the production of castor, safflower, sesame and niger, second in groundnut, rapeseed and mustard, third in linseed, fifth in soybean and sunflower. Under TMO a national level research center on oilseed was established as Director of Oil seed Research (DOR) now it's named as Indian Institute of Oil seed Research (IIOR) at Rajendranagar, Hyderabad to conduct the experiments on oil seeds on National wide

GROUNDNUT

Botanical name : *Arachis hypogaea*

Family : Leguminosae

Common name : Groundnut, Peanut, Monkey nut, Earth nut, Manila nut,moong fali (Hindi)

In Greek language 'Arachis' means legume and 'hypogaea' means below ground, referring to formation of pods in the soil.

Morphology

The groundnut is a member of the pulse or leguminocase family. It is a herbaceous annual with a more or less upright central stem and with numerous branches that vary from prostrate to almost erect depending upon the variety. The groundnut has a taproot with its lateral covering a depth of 35-40 cm and a spread of 30-35 cm of radius. The roots bear nodules which appear on the 15th day of germination and they are of the pin head size at this stage. The groundnut stem is cylindrical, hairy and becomes more or less angular with age. The stem is covered with small hairs though the degree of hairines. The flowers are yellow, complete, papilonate and sessile. Usually flowering takes place between 24 to 30 days after sowing. The flower opens between 6 to 8 a.m. ground nut is self polinated and fertilization is completed before mid-day after which the flower droops, the corolla closes and the calyx-tube bends down by 4 pm and the flower withers within three days.

ORIGIN:

Center of origin of G.nut is South America i.e., Matograsso a place in Brazil. At the beginning of 16th century, groundnut was introduced into India.

AREA AND PRODUCTION:-

India ranks first in area. But in productivity it ranks 10^{th} place.

Economic uses :

1. Groundnut oil is the cooking media for preparing different food items. It is the primary source of vegetable oil requirement to the Asian people
2. The groundnut seed contain 45% oil and 26% protein
3. The groundnut kernels are good source of all B-vitamins except B12 and vitamin E.
4. Groundnut kernels are rich in P, Ca & Mg including micronutrients like Fe, Zn.
5. G.nut oil is a major source of edible oil in India. The inferior quality oil is used for making soaps, detergents, Cosmetics, paints, candles, Lubricants and some of the medicines. 8. G.nut oil is used
6. Hand picked selections (HPS) are exported to other countries.
7. The oil cakes are used as valuable organic manures & feeding material for live stock. It consists of 7-8% N; 1.5% P2O5 & 1.2% K2O.

8. The peanut haulms are used as cattle feed either in fresh or in dried stage or preparing hay or silage.
9. Suitable crop for crop rotation.
10. G.nut crop add sufficient quantity of organic matter to the soil as most of the leaves are shed just before harvesting. In some areas, G.nut is used as a green manure crop
11. Nearly 81% of the kernels are used for oil extraction
    12% used for seed purpose
    6% - raw materials
    1% - exported in terms of Hand picked selections (HPS).
12. G.nut is able to fix atmospheric nitrogen @ 60 – 100 kg N /ha within one season.

Climate:

Groundnut is predominantly a crop of the tropics. The approximate limits of present commercial production are between latitudes 45˚N and 30˚S and up to an altitude of 1000 m, where rainfall during the growing season between 500-1000mm.

Rainfall:

Rainfall should be adequate during flowering and pegging stages. Ideal RF for successful groundnut crop would be 100 mm during summer to facilitate preparatory cultivation, 150 mm at sowing, from flowering to peg penetration 400-450 mm. Rainfall is the most important factor limiting the productivity of rainfed groundnut due to variability in amount and distribution of RF. Continuous rains leads to excessive vegetative growth resulting in poor pod yield.

Temperature:

Soil temperature <18C delays emergence of seedlings.

Groundnut performs well in dry temperature range in 27-38C at vegetative stage, 24-27C at reproductive stage. >30C at reproductive stage will effect the yield.

SOILS :

Groundnut can be grown on all types of soils such as sandy, sandy loam & heavy black soils. It thrives best on sandy loams.

Most suitable soils for groundnut production are well-drained light sandy loams with an ample supply of calcium and moderate organic matter. Heavy and stiff clay soils are not desirable as they tend to become hard during dry weather thereby interfering with peg penetration into the soil and also make the harvest extremely difficult. Groundnut is one of the most acid tolerant crops with a critical P H range of 5.0 – 5.5. If the soil moisture tension will exceed 3 bars the peg penetration will be difficult. And also the soil should have the bulk density of 1.5 g/cc. So to improve the physical condition of the soil, apply powdered ground husk @ 5t/ha or FYM @ 10t/ha or gypsum @ 1t/ha.

The soils should have the EC of 3200 micro mhos/cm and good drainage facility.

SEASONS:

The crop growing season should be ideal for growth and development of crop for opt. yield. Kharif :- 90% area is under groundnut is during kharif under rainfed conditions. Average yields are comparatively low due to erratic behaviour of monsoon i.e late onset of monsoon, dryspell during critical crop growth stages, heavy rains at later stages or early withdrawl of monsoon. Pest & disease incidence is also high in kharif. Groundnut cultivation distributed all over India. In Southern India, cultivation done in three seasons.

Optimum time of seeding:

Place	Kharif	Rabi
North Coastal	June-July	Nov 1 – Dec 15
Northern Telangana	June-July	Sep 15- Oct 15
Southern Telangana	July-August 15	Oct 15- Nov 30
Rayalaseema	July-August 15	Nov –Dec 15

Varieties:

Seed rate:

Seed rate mainly depends on seed weight and spacing.

Variety	Kharif	Rabi
JL 24, K3,4,6 , Vemana, TPT3,4,5 , Narayani, ICGS-44, Abhaya, Kalahasti, Prasuna.	60	75
TMV-2, TPT1,2, K5, ICGS 11, JCG 88, TG 26, DRG 12,17, TAG 24.	50	60

TILLAGE:-

Optimum depth of ploughing is 15-20 cm. If too deep ploughing is done, it leads to development of pods in deeper layers which makes the harvesting difficult.

Seed selection:-

Germination < 85% is not considered satisfactory. Selected pods are should be uniform in color. Ruptured seed coats and broken seed s are not used in seeding.

Seed treatment:-

Seed treatment against seed and soil born diseases is essential for stand establishment by preventing damage to seeds and seedlings emerging from soil. Seed treatment with Thiram @ 3g/kg, Bavistin (2g/kg) or DM – 45 (3g/kg)is effective. In the areas, where root grub problem was there treat the seed with chloripyriphos 6.5 ml or imidacloprid 2ml/lit water.

Most of the chemicals used for seed treatment against fungal & bacterial diseases also affect Rhizobium, thus rendering the inoculation in effective for a short time. When both seed treatment & inoculation are essential, seeds may be treated with fungicides & rhizobium culture is sprayed into seed rows & covered with soil.

Removal of dormancy:

The seed to be soaked for 12 hours in Etherel 5ml/10 lit solution to break dormancy and after that shade dried.

Spacing:

Variety	Kharif	Rabi
Bunch type (K 4,5,6 ; vemana, TPT-1, JL 24, JCG 88, abhaya, prasuna)	30 x 10cm	22.5 x10 cm
Semi spreading & spreading type (ICGS 11,44, K 1,3, TPT 3)	30 x 15cm	22.5 x 15 cm

Method and depth of sowing:

Groundnut seed can sown either by using mechanical or bullock drawn seed drill or by dropping the seed in plough furrow behind the country plough. Hand dibbling is also adapted to a limited extent.

In light, soils, the seeds are sown to a depth of 5 -7 cm and in heavier soils to a depth of 4 -5 cm. For every quintal of production about 4.38kg N, 0.4 kg P, 2.6kg K, 1.23 kg Mg and 4g Zn is essential. Apply 4-5t well decomposed FYM and incorporate it into soil just before the onset of monsoon.

Nutrient	Kharif	Rabi
N	8	12
P	16	16
K	20	20
Gypsum	200	200
ZnSO4	10	20

In general, 20 kg N /ha – entire dose as basal is recommended for rainfed G.nut 30 Kg N/ha – in 2 equal splits at seeding & 30 DAS – irrigated crop. However the nitrogen fixation process of plant starts working at about 20-30 days after sowing, when the nodule apparatus is fully formed. Till that time to meet the requirement for plant growth, an initial boost as starter dose of 10 kg/ha is necessary for rainfed groundnut. Depending on the number of nodules, another 10 kg/ha at 30 DAS can be top dressed depending on the rainfall.

As most of the Indian soils are rich in K, groundnut in general will not show any significant response to applied potassium. ‡ There is no necessity for potassium application to rainfed gr oundnut yielding around 1 t/ ha. Response is observed only when the available potassium in soil is < 150 kg/ha. For rainfed groundnut - 40 kg/ha For irrigated crop - 50 kg K2O/ha provided N is applied at recommended rate.

Calcium & sulphur:- These two nutrients are absorbed by pegs & developing pods and the common source of supply is gypsum. · Adequate calcium is essential in root and pod zones for yield and quality of kernels. Calcium deficiency leads to unfilled pods called pops and darkening of plumules of embryo. · Sulphur is highly essential as it is directly involved in the biosynthesis of oil. It improves nodulation of Rhizobium and prevents the premature leaf fall & increase the pod & oil yield. Ca & S are supplied to crop through cao or gypsum & it has been observed to increase the yield by more than twice depending on its availability in the soil.

Micro nutrient deficiencies:

ZINC: Zn def. is common on sandy & sandy loam soils. The critical limit of available Zn in soil is <0.6ppm. Application of Znso4 @ 2 kg /ha once in 2 years corrects the deficiency. If it is observed in standing crop, foliar application of 0.2% ZnSO4 along with 0.2% lime can correct the deficiency.

BORON: 'B' def. leads to HOLLOW HEART. Deficiency has been reported in light soils ofPunjab & T.N. The threshold level of boron is 0.25 ppm. Deficiency can be corrected by soil application of 5–10 kg/ha of boron. In standing crop, corrected by 0.1% borax spray.

IRON: Iron chlorosis is largely due to its reduced availability in the soil. Immobilization of iron in the soil may be due to high levels of lime, high PH (>7.6) or high levels of bicarbonates in soil or irrigation. spraying of ferrous sulphate mixed with 1% of ammonium citrate around 50 DAS corrects iron deficiency.

WEED MANAGEMENT:

Weed competition is critical upto 35 DAS. Yield losses may be to the extent of 70%. ,especially under rainfed conditions. When once pegging begins (40 DAS), there should not be any disturbance to pegs through manual or mechanical weeding. Hand weeding is done twice, first around 20 DAS & 2nd at about 35 DAS. Inter cultivation usually starts around 10 days after emergence & continues upto 35 DAS at 7 – 10 days interval till pegging begins. Cost effective weed management under rainfed conditions is, repeated intercultivation (harrowing) upto 35 DAS followed by hand weeding.

Herbicide	Dosage	Time of application
Pendimethalin 30%EC	1.3-1.6 l/acre	1-3 DAS
Butachlor 50%EC(Pursuit)	300ml/acre	21DAS
Quizalofop ethyl 5%EC	400ml/acre	21DAS

Water management:-

Water requirement for groundnut is 400-450mm. The period from peak flowering to early pod development (45 – 75 DAS) is the most sensitive to soil moisture stress. In other words, flowering, peg penetration and pod development stages are the 3 moisture sensitive stages for pod yield. Very early growth phase (up to 20 DAS) is least sensitive.

Moisture conservation under dry farming:

- After the germination and in between 15 – 20 days after sowing ground nut shells husk should be spread in between the rows as mulching for moisture conservation.
- During the drought situations foliar spay of dry lime @ 50 grms/liter for conservation of moisture as it reduces the transpiration of moisture from the leaves.
- Foliar spray of Urea @ 20 grms/ lit water during the dry spell.

Harvesting:

Generally bunch and semi- spreading type comes to maturity by 100 – 105 days where as spreading type it is 125 -135 days. The prominent symptoms of maturity. Yellowing of leaves. Necrotic spotting on the leaves. Dropping of older leaves / leaf fall. The pods become very hard & tough, they give cracking sound when split open with fingers. The inside of the shell turning dark, with netted venation. Seed coat develops pink or red colour (normal colour of the varities). Raising of the soil to the base of the stem is observed. Generally harvesting is done by pulling or lifting the plants from the soil with pods intact. If soil moisture is adequate, then hand pulling. If soil is dry, tractor or bullock drawn blades are used for lifting the vines with pods. Harvesting before maturity reduces yield & oil % & seeds are highly susceptible to afflotoxins. If delayed, results in increased incidence of stem rot, weakening of gynophore/peduncle & some of the pods may remain in soil itself at the time of harvesting.

Drying should be done rapidly to prevent fungal moulding. Sun drying is the usual method of drying. Summer g. nut should be dried in shade to prevent loss of viability, if it is for seed purpose. If the seed moisture content is above the critical level of 9% then Aflatoxin production due to Aspergillus flavus just before the post – harvest drying & mould growth at later stage takes place.

INTERCROPPING:

Imp. Cereal crops grown with g. nut are pearlmillet, sorghum & maize. Other long duration crops grown with g. nut as intercrops are pigeonpea, cotton and castor. short duration intercrop with g. nut are sesame, sunflower, cowpea, green gram, black gram. Suggested intercropping systems in A.P. ‡ G. nut + pigeon pea ‡ 7:1 to 15:1 + Cowpea ‡ 6:1 + Castor ‡ 5:1, 7:1 + Pearlmillet ‡ 3:1.

Quality considerations for export:

For easy marketing of pods & kernels the grading is done. Pods are graded into 3 categories & kernels into 4 categories based on size.

PODS	KERNELS
1) Large/bold	1) Extra large
2) Medium size	2) Large
3) small size	3) Jumbo(shrivelled)
	4) Splits(ill filled)

Varieties:

Vemana, Kadiri -4,5,6,7,8,9, Narayani, abhaya, JCG-88, TMV-2

Export Quality:

- Selection of Aspergillus resistant varieties otherwise the afflotoxins levels should be less than 30 PPB
- Bold varieties are more prepared for export
- Selection of such varieties suitable for preparation of value added products like peanut butter, peanut milk and peanut biscuits.

Rhizobium Inoculation

Inoculation of groundnut seed with efficient strains of nitrogen, fixing bacteria is recommended for areas where groundnut is not generally grown. Response to inoculation of groundnut seed is not obtained in areas where groundnut is traditionally grown. In such areas the soils have usually the necessary nodule bacteria and inoculation has no effect on yield.

Most of the chemicals used for seed treatment to prevent fungus and bacterial diseases also kill the inoculating bacteria, thus rendering artificial inoculation ineffective.

Seed inoculation and seed treatment with fungicides, therefore, tend to be mutually exclusive. When both are essential, the seed may be treated with fungicide and the rhizobium culture can be sprayed into the seed row and then covered with soil.

Granulated rhizobium strains can also be sown with seed. This is done by applying a granular inoculum to seed, the granules being made by inoculating 1-2 mm sand particles with peat inoculum using methyl cellulose as sticker.

Inoculation of seed with rhizobium can be done by the following methods:

Slurry method :

Slurry of 5 per cent jaggery is prepared by dissolving 5 g of jaggery in 95 ml of water. For treating 100 kg of seeds about 800 ml of slurry is necessary.Two hundred grams of peat based rhizobium culture is added to the cold slurry. Seed is evenly spread on a slab or cemented surface and the slurry are poured uniformly on the seed and spread gently on the seed without rupturing the seed coat.

Then the seeds are dried in the shade and not in the sun. The seeds can be used immediately after they are thoroughly dried.

Pelleting

About 200 g of peat based culture is added to 800 ml of 5 per cent cold jaggery slurry and mixed. This is adequate to treat 100 kg of seed. The slurry is poured over uniformly spread seed and the seed rolled to give a coating of slurry. When the seed is still wet, 200 g of finely powdered calcium carbonate is spread over the seed and rolled evenly to get uniform coating. Pelleted seed can be dried in shade and used.

Trickle method

About 400 g of peat based rhizobium culture is suspended in 50 litres of water and the suspension trickled into seed rows using a hopper and bamboo tube. About 50 litres will be adequate per hectare.

Steps in Increasing the Productivity :

- Bringing more area under irrigation. (as drip & sprinkler irrigation)
- The good quality seed of recommended varieties for the specific area & situations should be chosen and cultivated.
- Strengthening of research and extension system.
- Strengthening of processing facilities as crushing, solvent extraction, oil refining and hydrogenation for value addition to products in the context of WTO.
- Provision of favourable Govt. policies such as price and credit policies etc. strenghthening of farmers support system through supply of all inputs.

Groundnut Varieties and their characteristics

Name of the variety	Season	Characters	Shelling %	Oil %	Yield (kg/acr)

Name of the variety	Season	Characters	Shelling %	Oil %	Yield (kg/acr)
TMV2	Kharif Rabi	For all areas, especially for low rainfall areas, Non dormant, Susceptible to leaf spot diseases.	76.0	49.0	580-600 1200-1400
JL-24	Kharif Rabi	Suitable for areas with assured rainfall and irrigation facility. Bold seeded and uniform maturity. Not suitable for low rainfall areas.	75.0	47.0	600-720 1400-1520
Kadiri-3	Kharif Rabi	Suitable for assumed rainfall areas. Tolenant to Budnecrosis. Dormancy exists.	75.0	49.0	600-840 1400-1600
Vemana (K-134)	Kharif Rabi	Spanish bunch variety, tolerant to drought and leaf spot diseases. Having dormancy. Pegs are strong. More haulms weight.	77.0	49.0	720-1040 1400-1600
Kadiri-4 (K-150)	Rabi	Plant is short and pods around main root. Non dormant. Suitable for Rabi. Short duration.	70.0	48.0	1400-1600
Tirupati-1	Kharif Rabi	In areas with minimum rainfall in place of T.M.V-2 this can be cultivated suitable for rainfed conditions. Small seeded bunch variety.	76.0	49.0	800-1000 1400-1600
Tirupati-2	Kharif Rabi	Tolerant to kalahasti malady caused due to nematodes. Suitable for areas having irrigation facility. Pegs are strong and hence can be cultivated in black soils.	76.0	49.0	800-840 1400-1600
Tirupati -3	Kharif Rabi	Bunch type. In place of bunch varieties which are susceptible to kalahasti malady this can be cultivated where irrigation facilities are available.	76.0	53.0	800-1000 1400-1800

Name of the variety	Season	Characters	Shelling %	Oil %	Yield (kg/acr)
Tirupati-4	Kharif Rabi	Kernals are bigger in size than TMV 2 and Tirupati-2 varieties. Drought tolerant.	75.0	49.0	800-1000 1400-1800
I C GS-11	Rabi	Tolerant to Bud necrosis disease.	70.0	48.0	1200
JCG-88	Kharif Rabi	Semi spreading. Tolerant to leaf spot disease.	74.0	48.0	1200
Kadiri-5	Kharif Rabi	Semi spreading. Tolerant to leaf spot diseases. Short duration. Strong pegs and drought tolerant.	72.0	48.0	720-920 1400-1600
Kadiri-6	Kharif Rabi	Semi spreading type. Suitable for Rabi Short duration variety.	72.0	48.0	800-880 1520-1680
Narayani	Kharif Rabi	Semi spreading type. Tolerant to leaf spot disease.	76.0	49.0	800-1000 1400-1800
Kalahasti	Rabi	Can be cultivated in place of bunch varieties susceptible to kalahasti melady.	76.0	52.0	1800-2000
ICGS 11	Rabi	Dark green leaflet, compact plant, pod 2 seded constriction and reticulation less prominent & beak absent.	70.0	48.7	2000
Abhaya (TCGS 25)	Kharif Rabi	Semi spreading. Tolerant to tikka leaf spot disease.	76.0 to 77.0	52	900 - 1000 1400-1600

CASTOR

Scientific name: (*Ricinus Communis*)

Family : Euphorbiaceae

Known as Erand in Hindi "Amudam" in Telugu plays an important role in country's Vegetable oil economy. Castor is one of the ancient important non-edible oil seed crop which has industrial and medicinal value. Ricinus is derived from latin term " Dog's Tick" because of the resemblance of mottling on the seed to the common pests of dog. Castor oil can tolerate up to -165^{0C} and cannot freeze that's why it is used as a lubricant in high-speed engines and aeroplanes. Oil cake is used as manure with 5.5 % N, 1.8 to 1.9% P and 1.1% K . Stalks used as fuel and thatching purpose and leaves used for rearing silk worms. Castor oil is used and resins in Surface coating to household articles, furniture, refrigerators. Base materials for several paints, enamels & varnishes and manufacture of leathers, adhesives, synthetic perfumes & flavors.

A native of Africa and Asia, and is now naturalized in Australia. It is abundantly seen along with courses and flood plains, disturbed or wasteland, and road sides. Castor cultivation
Confines to 40o latitude from equator on either side (N&S). India is the principal global producer of castor followed by China and Brazil. In Andhrapradesh cultivated in 1.99 Lakh hectares with a production of 1.29 lakh tones and the productivity is 654 kgs. In area AP stands 2nd place and in productivity 5th place. In AP the districts of Mahabhoobnagar, Nalgonda, Kurnool, Rangarredy , Karimnagar and Prakasham districts.

Climate ·

Basically a warm season crop grows in temperate and tropical regions throughout the world. Can be successfully grown from 300 -1800 m above sea level · Castor production lies between 40o N and 40o S · In India successfully grown up to 1500 m ·

Temperature:- Requires moderately high temp of 200 -260 C with low humidity throughout growing season to give high yields. Low temperature extends emergence, making more liable to attack by fungal diseases & insects. High temperature 41 C results in blasting of flowers & poor seed set. A frost free growing period between 130-190 days depending on cultivar is necessary for satisfactory yields.

Rainfall :- 500-700 mm rainfall is required. For optimum growth and development - 100 mm evenly distributed rainfall in first few months period is desirable.

Soils · Grows on any type of soil, well drained, sandy loams will produce optimum yields. Crop is sensitive to excessive moisture. · In Andhra Pradesh grown in sandy loams and shallow black soils. Prefers slightly acidic pH of 5- 6.5, but can also grow up to pH 8.

Tillage / and land preparation

As castor crop is deep rooted plant with the trap root system extending beyond 2-3 meters for extraction of soil moisture from deep layers, deep plouging (<45cm) and chiseling I shallow soils with sub surface hard pan adopted to support deep root system, reducing weeds.

Seasons and sowing time:

Kharif : June 15 – July 31

Rabi : September 15 to October 15·

Seed rate and Spacing:

Situation	Varieties/Hybrids	Seed rate	Spacing
Heavy soils with heavy rainfall	Variety	2-2.5kg/acre	90 X 60 cm
	Hybrid	1.5-2kg/acre	90 X 90 cm 75 X 75 cm
Light soils with less rains	Variety	4kg/acre	90 X 45 cm
	Hybrid	2-3kg/acre	90 X 60 cm
Irrigated	hybrid	2kg/acre	90 X 90 cm

Seeds will germinate in 7 to 10 days.

Nipping:

This method is mainly followed in Aruna verity. Nipping is removal of all auxiliary buds as and when they emerge. This technique is preferred in intensive cultivation of seed plots and also when castor is grown as an off-season crop. The primary raceme first appears in the form of a bud and develops in about 10 to 15 days. Nipping facilitates synchronous flowering and capsule development and therefore, helps in easy harvest besides reducing maturity period in intensive cropping systems under irrigation.

Nutrient management:

Fertilizer/Nutrient	Kg/acre	Time of application
FYM	2000	At the time of last ploughing
N (For varieties)	24	12kg at sowing, 6 kg 30-35 DAS, 6kg 60-65 DAS
Hybrids	30	as same as varieties and an extra dose of 6kg at 90-95 DAS
P	16	At the time of last ploughing
K	12	At the time of last ploughing

Water management

Castor is drought tolerant rainfed crop but responds well to irrigation. Water requirement of castor crop is 500 mm. Flowering and seed development stages are more sensitive for moisture stress.

In Rabi, first irrigation should be given at 50 DAS after sowing, followed by irrigations at an interval of 20 days.

Weed Management ·

Castor crop is highly susceptible to weed competition in initial stages, has the growth of castor is slow initially and larger area is exploited by weeds. Critical period for weed free competition is 45-50 days.

For rainfed castor : 2-3 intercultivation with blade harrow ,starting from 20 DAS along with manual weeding is ideal. · For irrigation castor : 2-3 hand weedings at an interval of 15 days starting from 15 DAS is ideal.

Pre emergence herbicides: Pendimethalin 30%EC 1.3-1.6l or Alachlor 50% 800ml in light soils, 1l in heavy soils.

Harvesting ·

Harvesting castor spikes should be done at right time · 15-20% of yield is lost in the field due to dehiscence of capsules under rainfed conditions of A.P waiting for all the spikes to come to maturity for single harvesting. · On an average, castor plant produces 4-5 sequential order spikes over a span of 120 – 280 days. · Main spike is ready for harvest within 100 days after seeding, subsequent harvest can be done at 30 days interval in improved cultivars. Optimum stage for harvest is capsules turning yellow and starts drying. Dried capsules on the spike are plucked, /collected and threshed instead of cutting the entire spike from the plant. · Harvested spikes are usually placed in heaps around one week and then sun dried for a couple of days. · Threshing is done by beating with the sticks or trampling under the cattle feet or tractor or power operated threshers. · Castor seed can be stored in gunny bags without loss for three years.

Intercropping:

Castor + Red gram 1:1

Castor + Cowpea 1:2

Castor + Groundnut 1:5 or 1:7

Castor + Green gram 1:2

Varieties:

S.No	Variety	Season	Duration	Yield (q/acre)	Characters

1	Kranti (P.C.S 4)	Kharif / Rabi	90-150	5.6-6.4	Drought tolerant bold seed. Suitable for late sown conditions.
2	Haritha (PCS-124)	Kharif / Rabi	90-150		Wilt tolerant
3	Kiran (PCS 136)	Kharif / Rabi	90-150	5.2-6.0	Drought tolerant, escapes botrytis to some extent
4	Jyothi (DCS 9)	Kharif/Summer	90-150	4.8-6.0	Wilt tolerant
5	Jwala (48-1)	Kharif	150-180	4.0-4.8	tolerant to wilt and botrytis
6	G.C.H. 4	Kharif	150-210	5.6-7.2	Tolerant to wilt and root rot. Tolerant to drought.
7	D.C.H 177	Kharif / Rabi	90-180	6.0-7.6	Drought tolerant

Indications for high yields at low cost in castor:

- The good quality seed of recommended varieties for the specific area & situations should be chosen and cultivated.
- The seed should be treated with fungicide, bactericide etc. as recommended before sowing of seed in the field.
- Adoption of improved crop production technologies.
- The recommended doses of fertilizer for the specific crop should be applied at appropriate time.
- The protective irrigation should be provided wherever possible during kharif season and irrigation should be applied at critical stages for rabi / summer crop.

* The plant protection measures should be under taken, if needed.
* Harvesting should be done at right time to avoid capsule shattering and reduction in oil content of seed.

SUNFLOWER

Scientific Name : *Helianthus annus*

Family: Asteraceae

It is an important oilseed crop contributes 14% of the total oilseed production from nine major oil seed crops. The genus Helianthus (Helio=Sun, anthus= flower). Sunflower is known as a "suryajmuki" as it is grown for ornamental purpose. It is the third most important oilseed crop of world after soybean, Rape seed& Mustard in India. The helio tropic movement is of great importance.

The area and production of sunflower crop significantly increased due to following merits of the crops.

1. Short duration (90-100 days) as it is fit well in multiple and intercropping systems.

2. Photo insensitivity of crop enables its cultivation in all seasons i.e kharif, rabi and summer

3. Wide adaptability: it comes well up in any type of soils.

4. Drought and saline tolerant: suitable for the best component crop in dry land farming.

5. High productivity per unit area per unit time with respect to yield of oil.

6. High seed multiplication ratio (1:80) with low seed rate requirement.

7. It is the best substitute for groundnut crop in contingency crop planning.

8. Due to cross pollination nature, there is a great scope for evolution of high yielding composites and hybrids.

9. Good quality oil with high level of poly unsaturated fatty acids (PUFA) content i.e linoleic and oleic acids. Llinolenic acid is absent.

10. Availability of good quality of hybrid seeds and varieties.

11. It is the best catch crop when the land is left otherwise fallow between two seasons.

Demerits of the crop:

1. Improper seed filling

2. Birds damage.

USES/ECONOMIC IMPORTANCE

1. The oil content varies from 48-53% and it is premium oil with pale yellow in colour used for cooking and margarine.
2. Sunflower is a rich source of linoliec acid (64%) which helps in reducing the cholesterol deposition in the coronary arteries of the heart. All most of 90% fat is good for human.
3. Oil cake contains 40-50% high quality protein and it is ideally suited for poultry and livestock.
4. The roasted kernels are used as food for human beings.
5. Sunflower is grown as green manure, fodder crop.

AREA AND PRODUCTION

Sunflower is grown in Russia, America, Argentina, Rumania and Spain. In India it is mainly grown in states of Maharashtra, Karnataka, AP, parts of UP, Gujrat, Tamilnadu, MP, Orrisa and Punjab. In AP it is cultivated in 4.26 lakh hectares with production of 4.37 tonnes and productivity is 1028 tonnes.

CLIMATE:-

- Basically sunflower is a temperate oil seed crop but it is adapted to tropical and subtropical climate.
- The crop requires a cool climate during germination seedling growth and warm weather from seedling to flowering.
- Warm and sunny days during flowering to maturity are most favourable.
- Lenoleic levels decreases at higher temperature at maturity.
- The crop is photo insensitive as it flowers at wide range of photoperiods. Optimum day length for better yield should be 12 to 14 hours.
- High humidity accompanied with cloudy weather and rainfall at the time of flowering results in poor seed set.

SOILS:-

Sunflower can be grown on wide range of soils but it does best in medium black to black soils with high moisture retention capacity. Sunflower does not with stand water logging. Good drainage is preferable for cultivation of crop. Yield and quality is drastically reduced when soil salinity reaches 10 to 12 ds/m. Optimum soil pH for sunflower in 6.5 to 8.5.

Field preparation:

Sunflower requires a well pulverised seed bed for better germination and growth. One/two ploughings with soil turning plough (or) M B plough followed by 2-3 harrowings and planking are sufficient to bring desired soil tilth.

Seeds and sowing:

For quick germination, under rain fed condition the seed should be soaked in fresh water for about 14 hours followed by shade drying as sunflower seeds have thick hulls and imbibes water at slow rate. This process is called seed hardening. Sunflower seeds cannot be used as seed, immediately after harvest of crop since seeds will have dormancy period ranging from 40-50 days. To overcome the dormancy, treat the seed with ethereal solution for 6 hours.

Time of sowing:

Sunflower being a photo insensitive can be grown irrespective of the season.

Kharif : Light soils – June 2nd fortnight – July 1st fortnight

Heavy soils – August 2nd fortnight

Rabi: Rainfed –September

Irrigated – October 2nd fortnight – January 1st fortnight

Summer – Irrigated – January 2nd fortnight – February 1st fortnight

Seed rate: 2kg/acre

Spacing:

Soils	Spacing(cm)	Plant density (acre)
Light soils	45 X 30 cm	29,600
Heavy soils	60 X 30 cm	22,000

Optimum depth of sowing is 2 - 3 cm. Thinning is done at 15 DAS to avoid competition and to maintain single plant/ hill.

Seed treatment: Captan/ Dithane M- 45 @ 3g/kg seed.

Manures and fertilizers:

FYM @ 5-10 t/ ha 2-3 weeks before sowing.

Soils	Nitrogen		Phosphorus		Potassium
	varieties	hybrids	varieties	hybrids	

Kharif	24(12+12)	24(12+12)	24	24	12
Rabi (heavy soils)	24(8+8+8)	30(10+10+10)	24	36	12
Rabi (red soils)	12(6+6)	24(8+8+8)	24	36	12

Phosphorus and Potassium should be applied as basal. Nitrogen is most limiting element in sunflower production. So nitrogen application will be in three splits.

50% at the time of sowing

25% at 30DAS

25% 50-60 DAS (at flower opening)

Sulphur is essential for increasing oil yield; addition of elemental sulphur at 25 @ kg ha^{-1} is recommended to soil at last ploughing. The response of sulphur is 13 kg seed/ kg sulphur applied. Synergistic interaction was observed between sulphur and nitrogen. SSP is the best source for phosphorus as also supplies required sulphur. In Zinc deficit soils, foliar spraying of ZnSO4 @ 1% is beneficial. Borax @ 0.2 % to Capitulum at ray floweret opening improves the seed filling and oil content.

Irrigation:

In light soils irrigate the field within 6-10 days interval, in heavy soils within 15-20 days interval.

No. of irrigations as follows:

Kharif: Light soils 3-4
Medium soils 2-3
Heavy soils 1-2
Rabi : Light soils 4-6
Medium soils 3-4
Heavy soils 2-3
Summer : Light soils 6-8
Medium soils 4-5
Heavy soils 3-4

The critical stages for moisture in Bud initiation (30 DAS), flower opening (45-50DAS) (most sensitive to moisture stress) and seed filling (60-75 DAS)

Weed control: Sunflower has slow growth rate during 4-6 WAS hence weed free condition during the period results in better yields. The crop weed competition in sunflower is 30-45 DAS i.e. 4-6 WAS. · Two inter cultivations or hand weedings at 15 & 30 DAS is recommended.

Pre emergence application of Pendimethalin @ 1 kg a.i. ha-1 or Alachlor @1-1.5 kg a.i ha^{-1} at one day after sowing.

Hand Pollination:

For obtaining optimum seed set hand pollination is a must. During the flowering period (2

weeks) on every day between 8 and 11 AM hand pollination should done with smooth cloth at 10 days interval for 5 to 6 times during the pollination which encourage the self poolination. It was also reported that hand pollination during the flowering in sunflower increase the yield 20 – 25 % higher than normal yields.

Harvesting:

1. The sunflower crop is ready for harvesting when the moisture content of seed is 20%. The sunflower head is mature physiologically at 35-40 Days after flowering.

2. The heads are ripe when back of the head turns yellowish brown and lower leaves become brown to dark brown.

3. The harvesting should be done with the help of sickle by removing the head. The harvested head should be thoroughly sun dried and threshed by beating the centre of the head with small stick or threshers are also useful. Then winnowing, drying and storage of seeds.

4. Delay in harvesting leads to losses due to birds and shattering in the field itself.

Intercropping:

As sole crop.

Groundnut + sunflower – 4:2

Red gram + sunflower – 1:2

Varieties:

Morden, DRSF-108

Hybrids:

KBSH-1, DRSH-1, NDSH-1

Seed setting constraints

In sunflower more ill-filled grains are formed due to poor seed setting since this is highly a cross pollinated crop. The main reasons for poor seed setting are;

- Use of impure and qualities seed.
- Due to less population of honey bees impairs cross pollination.
- Due to heavy rains at flowering stage and high humidity pollen grains are washed off.
- Because of high temperatures prevailed at the time of pollination the pollen grains will be dried up.
- Due to lack of sufficient soil moisture at seed setting.
- Due to deficiency of phosphorus and micro nutrients.
- Excess nitrogen application.
- Due to insect, disease and bird damage.

- In sunflower, seed setting starts from periphery to centre of flower, which normally completes in 10 days. As seed setting is progressing the non-availability of both macro and micro nutrients is required proportions is one of the reason for poor seed setting.

Steps to be taken up for proper seed setting

- Decide optimum seeding period in such a way that the flowering should not coincide with extremes of temperature, heavy rainfall and fog.
- Use only pure and quality seed of high yielding varieties or hybrids.
- Follow only recommended fertilizer schedule.
- Avoid excess use of nitrogen, see that there is no phosphorus deficiency. At the crop age of 30 days there should not be any deficiency of N. Rectify the deficiency of micro nutrients if observed.
- If sunflower is grown as rainfed rabi crop in heavy soils grow nearby fields of safflower or safflower as intercrop so that the activity of honey bees can be increased.
- Honey bees are attracted by yellow flowers and the honey dew available in flowers of niger. Hence grow niger around the field of sunflower so that fertilization can be improved.
- Establish more plant population per unit area, otherwise large sized flowers are produced cause poor seed setting in the centre of the flower.
- Grow the crop if possible east to west to avoid shading of one row on the other.
- Keep 2-3 honey bee colonies to activate honey bee activity and to increase crop pollination. It also gives additional income from honey.
- See that there should not be any moisture stress from bud formation to flowering and milking of seed stages.
- From flowering on wards necessary plant protection measures are to be taken and also bird scaring.
- During flowering period spray insecticides mostly during evening periods.
- Spray cycocel 50 ppm at 40 and 60 days age of crop to increase yield through better seed setting.
- Rub the flowers of opposite lines at flowering period between 8-11AM and 3-5 pm to obtain more cross pollination.
- Rub the flower with smooth cloth or cotton at flowering time between 8-11 am on every day or on alternate days for 10-15 days to increase cross pollination. This operation give 25% higher yield. At the time of rubbing if tobacco caterpillar or gram caterpillar observed on flowers better pick then and destroy to reduce the crop damage.

Sunflower Varieties

Name of the varieties	Duration	Yield (Kg/Ha)	Characteristics
Desi			
Modern	75 – 80	600-800	Plants grown at a height of 90-120 cm with oil % 30-38 and it can grown all the states of India and suitable to all cropping systems.
DRSF-109	90 -95	1400-1600	With oil content 40%
Hybrids			
KBSH 1	90	1200-1500	Recommended variety for all India. High yield and high oil content with wide adaptability. With oil content 41-14%
DRSH-1	95	1300-1600	Resistant to downy mildew with oil content 41-43%

NDSH-1	80-85	1200-1500	High yielding with high oil recovery.

SESAME

S.N: *Sesamum indicum*

Family : Pedaliaceae

It is Very ancient crop and regarded as queen of oilseeds because of its quality (fatty acid composition). Its resistance to oxidation and rancidity. India is considered as basic centre of origin with 36% area and 25% Production.

In Andhrapradesh its cultivated in 1.13 lakh hectares with production of0.27 lakh tones and productivity is 235 kgs with oil recovery of 46 to 52% and it contains 20 -25% proteins, vitamins, amino acids and poly unsaturated acids. In AP districts of costa, rayalseema and Telangana it's cultivated.

ECONOMIC IMPORTANCE

- 38-54% high quality oil Containing 1-15% protein
- 75% sesame is used for oil purpose
- 20% for domestic including sweets, candies and condiments
- 2-3% for next sowing
- It is nourishing food, as flavoring agent and for medicinal purpose
- Manufacture of soaps, cosmetics, perfumes, insecticides & pharmaceuticals
- Sesame cake is good livestock feed also an ingredient to poultry feed and as manure also with 6% N, 2.2% P, 1.2%K.

AREA & PRODUCTION:

In India MP places first place, UP and Rajasthan places second and third place respectively. In production Orissa places first place with UP 2nd and MP 3rd place where as in productivity west bengal 1st and Orrisa 2nd place.

In Andhrapradesh Adilabad, Warnagal, East Godhavari districts places first, Second and third places respectively under area where as in production West Godhavari, Adilabad district are first and second places and in productivity west and east Godhavari districts are first and second places respectively.

CLIMATE:-

Sesame is essentially a tropical crop grown in arid and semi-arid areas. Þ It is generally cultivated in tropical and sub-tropical countries. Its altitude range is normally below 1250 m although some varieties locally adopted up to 1500 m. Generally, it requires fairly hot conditions during growth for optimum yield. Ideal optimum temperature for growth is 25-27 C .Extremely low temperatures of 18 C, there is a complete ceasing of growth. Temperatures >40 C seriously affect the pollination when there is less number of capsules. Sesame is a short day plant. High light intensity increase number of capsules per plant.

SOILS:-

Sesame comes up well on soils with slightly acidic (or) neutral reaction. It can be grown on well drained soils and performs well in light loamy soils. It is highly sensitive to water logging. Very sandy, saline and alkaline soils are not suitable.

SEEDS AND SEEDING:

SEED RATE:

	Rainfed	**Irrigated**
Under broadcasting (Kg/Ha)	6	5
Row seeding (Kg/Ha)	5	4
Mixed (or) Intercropping	1 Kg/Ha	

SPACING:- 30 X 15 cm with 2 – 3 cm depth of sowing.

SEED TREATMENT:-

Seed treatment with Thiram (3g/kg) is effective against seed borne diseases.

Season and time of sowing:

Place	**Early kharif**	**Late kharif**	**Rabi/summer**
Krishna, Godavari Delta, North coastal	May 15-31	-	Dec 15-Jan 15
Rayalaseema	May, June	-	Jan 2nd , 3rd weeks
Northern Telangana	May, June	July 2nd fortnight-August 1st fortnight	Jan 2nd fortnight-Feb 1st fortnight
Southern Telangana	May, June	August 2nd fortnight	Jan 2nd fortnight

VARIETIES:-

1. Gauri, Madhavi,YLM-11, YLM-17, Chandana (ICS-94). These brown seeded varieties are suitable for kharif. Duration is 70-90 days. Yield 250-400 kg/acre.oil % 50-51%.
2. Rajeswari, Swetha til, Hima. These white seeded varieties are suitable for rabi.

3. For late kharif : Rajeshwari, Swetha til.
4. High yielding varieties : Chandana,Hima.

MANURES $ FERTILIZERS:-

N-P-K REQUIREMENT:-

	Rainfed	**Irrigated**
N	40	60 (½ basal, ½ (30-35 DAS))
P	60	60
K	40	40

Application of sulphur @ 50 Kg/ha increases the yield if soils are deficient in sulphur.

METHOD OF APPLICATION:- Placement of fertilizer at seeding using seed drills is more effective than. broadcast application.

IRRIGATION:- Water requirement is 500 mm. For rabi crop 5-6 irrigations are required.

CRITICAL STAGES FOR IRRIGATION:- For rabi / summer sesame, a presowing irrigation is necessary for optimum seed germination and adequate stand establishment. Flower initiation and capsule filling stages are most sensitive to water deficits.

WEED MANAGEMENT:-

Use of Herbicides:-

Herbicides use, especially under rainfed conditions, is very limited due to low yield, which may not compensate for the cost of herbicides. If necessary, Alachlor (1.0kg/ha) or Thiobencarb(2.0kg/ha) can be used as pre emergence spray for effective control of weeds. Use of pre emergence herbicides followed by one hand weeding around 30 DAS is the most appropriate way of weed management in sesame.

HARVESTING:-

Depending on the variety, sesame crop takes 80-150 days for maturity. The crop is harvested when the leaves, stems and capsules begin to turn yellow and the lower leaves start shedding. To

prevent shedding of seed, the crop should not become dead ripe in the field. The ripe plants are cut at the ground level carried to threshing yard, stacked for a week in the sun with the cut ends upwards.

CROPPING SYSTEM

- As pure crop
  - Rice-gingelly
  - Sesame-wheat
  - Sesame-chickpea/ rapeseed/lentil/pearlmillet

- Mixed / inter crop
  - Yield is poor but area is more
  - Sesame +mungbean
  - Sesame +groundnut
  - Sesame +maize

Sesame Classification based on crop varieties :

Based on seed color, growing season, maturity and depending on the number of fruits it is divided into

1. Seed Color : White, Black and Brown color seeded
2. Growing season : Kharif and Rabi
3. Number of fruits : Bicarpilatum and quadricarpilatum
4. Based on maturity : Early and Late maturity

Yield attributing characters:

1. No.of plants per m^2
2. No.of fruits/ capsules per plant
3. No.of seeds per capsules
4. Test weight
5. **Yiled**: No.of plants per m^2 X No.of fruits/ capsules per plant X No.of seeds per capsules X Test weight

Sesame varieties

Name of the varieties	**Season**	**Duration**	**Yield kg/ha**	**Oil content**	**Characteristics**
Gowri	Kharif	90	250	50	Brown seeded recommended for costal region and tolerant to Kodu ega pest
Madhavi	Kharif	70-75	200	50-51	Light brown color seed suitable to all cropping systems.
Yellamanchali-11	Early kharif	80-85	360-440	52.5	Brown seeded scencronous maturity
Yellamanchali-17	Early kharif	75-80	340	52.5	Light brown color seed tolerant to downy mildew and leaf spot
Yellamanchali-66 (Sharadha)	Kharif Rabi	75-80	350-400	52.5	Light brown color seed tolerant to downy mildew and leaf spot
Rajeshwari	Late	80-90	200-300	50	White seeded recommended for

	Kharif Rabi				Telangana tolerant to stem rot and downy mildew
Swethathil	Late Kharif Rabi	85-90	250-450	51-52	White sedded recommended for Telangana tolerant to stem rot and high export quality
Chandana	Kharif Rabi	85-80	250-480	50-51	Brown seeded suitable to all season and recommended for Telangana

SAFFLOWER

Botanical name - *Carthamus tinctorius*

Family – Compositae

Safflower is an ancient oilseed crop grown in India for the orange red dye (Carthamin) extracted from it bright coloured florets as well as seed oil. Due to the availability of synthetic dyes at present, it is used for extraction of oil only.

The cultivated *Carthamus tinctorius* in supposed to originated either from
Carthamus lanatus - Saffron thirstle
Carthamus oxycantha- Wild Safflower

Safflower was known to ancient India and the poet laurate kalidas compared safflower to the "sakhis of shakuntala" as kusum (or) kusumba in Sanskrit literature. Carthamus is derived from Arabic word "Quartum".

ORIGIN:

Decondolle – Arabia. Vavilov – India

Spiny type of Safflower is having higher oil content than non spiny type. Yellow coloured flowers yielded higher oil content. It is a xerophytic in nature.

AREA AND DISTRIBUTION:

India, China Mexico, USA, Ethiopia, Argentina and Australia are the major growing countries. China mostly grown Safflower for medical purpose. Safflower occupies seventh place in the area among nine oilseed crops. In India 98% of the area comes from three states viz- Maharashtra, Karnataka and A.P. it is cultivated with an area of 3.00 L.ha and production of 1.89 L.tons with a productivity of 630 kg/ha. India is the largest producer of Safflower with 54% area and 40% production.

Maharashtra and Karnataka are the first and second with reference to area and production where as productivity is highest in Gujarat (1000 kg/ha) followed by Karnataka (2008-09).
In A.P., it is cultivated in Ranga Reddy, Medak, Mahaboobnagar, Adilabad, Kurnool, and Naziabad.
AICRP on safflower – Sholapur (Maharashtra).ARS in Andhra Pradesh – Thandur.

USES :-

1. Safflower oil is rich in poly unsaturated fatty acids as linoleic acid up to 78% which play an

important role in reducing cholesterol content and it is a drying oil. It contains 24-35% oil. So, it is also recommended for heart patients.

2. The oil is used in the preparation of "ROGHAN" which is used for preservation of leather and production of water proof cloth. It is also used in manufacturing soaps and varnishes.
3. Safflower oil is the healthiest oil of all vegetable oil and its value is increased when it is blended with rice bran oil.
4. The Safflower cake is used as cattle feed which contain 20% protein.
5. Safflower was recognized as it remedies Rheumatism.
6. Dry petal is used in the preparation of herbal medicine and drugs. The Safflower also used to provide resistance to inflammation.
7. The yield of floret ranged between 70-100 kg/ha and it contains two colouring materials. Water soluble yellow pigment "carthamidin" and orange red dye (2%) which is insoluble in water but readily soluble in alkaline solution is known as "CARTHAMIN". Carthamin is of commercial importance and is used as additive in food, beverage, cosmetics.
8. Safflower is grown as border crop to protect the main crop of wheat in North India and is also green manure crop at young stage.
9. The safflower cake is used as cattle feed which contains 20% protein but low in lysine. It is consumed domestically and hardly enters international market.

CLIMATE:

Safflower is well adapted to wide range of climatic condition.Temperature is the most important climatic parameter as it is thermo sensitive and it is mainly grown as rabi oil seed crop. Optimum temperature of soil for seed germination 15-16°C. It may tolerate to temperature of 49° C, if sufficient soil moisture is available. It is a drought resistant and susceptible to water logging. It comes up well with a rainfall of 500-600 mm. It cannot withstand excessive soil moist/ humidity at any stage due to damage from fungal diseases.

SEED AND SOWING:

Season – Telangana- Sep 2nd fortnight – Oct 1st fortnight

Coastal and Rayalaseema - October

If the crop is delayed, Aphid damage is more common.

Seed Rate –- pure crop 4kg/acre.

Intercrop : 1.5kg/acre

Spacing - 45×20 cm.

Method of sowing – Broadcasting, behind the plough (pora method) and seed drill.

Depth of sowing – 4-5 cm (Normal). 7.5-10 cm (dry Land).

SOIL:

Being a drought resistant, it is cultivated in all type of soils, but well drained, fertile and deep soil with high water holding capacity are the best. Safflower is mostly grown on residual soil moisture.

LAND PREPARATION:

Safflower requires fairly pulverized seed bed free from clods. Being a deep rooted crop it requires deep ploughing. Crop raised for dye purpose require more and fine tilth than oil crop. One deep ploughing with M.B. plough is sufficient followed by 2-3 harrowings with planking.

WATER MANAGEMENT:

Water requirement 250-300 mm. Safflower is generally grown as rainfed in residual soil moisture and it is highly drought tolerant as it is a deep rooted crop. The crops have the ability to extract moisture from deeper layer of the soil. In light soil, 2-3 irrigations are given where as in vertisol residual soil moisture is sufficient. One life saving irrigation should be given when drought condition occur. Rosette stage (Early vegetative stage) is the most critical stage of safflower i.e. 21DAS or 4-6 leaf stage and yield can be increased by 40-60%.

WEED MANAGEMENT:

The growth habits of safflower make it extremely susceptible to weed competition. The critical period of crop growth competition is Rosette stage to flowering stage.

Pendimethalin @ 0.75 kh/ha + one hand weeding provides weed free environment and cost effective. Safflower is sown in wide rows. So, intercultivation implements can be used for weed control. Two harrowings at 25-30 DAS & 45-50 DAS in combination with one hand weeding in between them can effectively check weed growth.

CROPPING SYSTEMS :

Chickpea + safflower - 3 : 1 or 2 : 1

Wheat + safflower - 3 : 1 or 2 : 1

HARVESTING:

The crop comes to maturity within 110-120 days. As soon as the leaves and most of the bracteoles except a few of last formed become brown and seeds are dried and easily separated from the head. The crop is harvested either by uprooting the plant or cutting at the bottom. Plants are thorny and harvesting is taken up at the early hours of the day and to be completed before 10.00 am when the spines will be soft. As the day advanced, spine becomes stiff causing inconvenience to harvesting. The harvested plants are heaped for a day or two in the field and threshed by beating with stick, cleaned, dried and stored at 8% moisture content. Combined harvesters used in wheat could also be used for harvesting and threshing.

Varieties:

TSF-1, Manjeera, Sagara mutyalu, Naari-6, DSF-414, Naari NH 1

Varieties of Safflower

Name of Variety	Duration	Yield (Q/Acr)	Characteristics
TSF -1	135	7.0	White seeded high yielding variety Resistant to wilt and tolerant to Jassids with oil content 28 – 30%
Manjeera	115-120	3-4	White seeded with oil content 27-30% starting flowers in yellow then turns in orange color
Sagarmuthyalu (APRR -3)	115-125	4-5	Yellow color flowers, small white seeded with oil content 27-32% and Tolerant to rust disease and high response to high nitrogen doses.
Nari-6	135	6.0	Non spine variety easy to harvest with 30 % oil content and dried flower petals are red in color tolerant to thirps and Alterneria disease
PBNS – 12	130	7.0	Suitable to irrigated areas with 30% oil recovery
JSF -414 (pule kusuma)	135	8.0	Suitable to irrigated areas with 28% oil recovery
Nari N H – 1	130	7.2	Non spine variety Suitable to irrigated areas with 29% oil recovery wilt resistant
DSH -129	130	7,2	Wilt resistant with 31% oil recovery

COTTON

Scientific name: *Gossypium hirsutum*

Gossypium barbadense

Gossypium arboretum

Gossypium herbaceum

Family: Malvaceae

- Cotton is one of the oldest and the most important commercial crop of the world and forms the most important fibre crop.
- Cotton textile industry is the oldest Agricultural industry of India.
- The fibre obtained from seed is used for variety of purpose. But major use of fibre is manufacturing of textiles which provide clothing to the mankind.
- Ever since the dawn of civilization, cotton served the purpose of providing this need and even today it dominates despite of the production and marketing of many synthetic fibres Cotton is referred to as " King of Fibres "and also known as "White Gold" Cotton is also used for several other purposes like making threads, for mixing in other fibres and extraction of oil from the cotton seed.
- Oil content ranges from 15-25 percent. Cotton seed cake after extraction of oil is good organic manure contains 6.4% N, 2.9% P2O5 and 2.2% K2O.
- Cotton seed and pulp obtained during oil extraction and cotton meal are good concentrated feed for cattle.

Origin and History:

Cotton has been used as a fabric in India from time immemorial. It has been cultivated in the Indus Valley for more than 5000 years before. The excavations of Mohen – jo- daro indicates a high degree of art in spinning and weaving with cotton at that time. It finds mention in the Rigveda, the oldest scripture of the Hindus. Manu also refers to it in his Dharma Shastra. India appears to have been the centre of an important cotton industry as early as 1500 B.C. The cultivation of Cotton spread from India to Egypt and then to Spain and Italy. Every available evidence proves that India is the original habitat of Cotton.

The cultivated Species are divided into two groups.

They are Old world cotton:

India is the major cotton growing country, growing all four species of cotton commercially.
India is considered as centre of origin of old World cotton and believed that two Species (arboretum and herbaceum) belonging to old world cotton have spread along the commercial routes to several countries in the East and also to the Northern countries like Africa to Egypt and other Mediterranean regions through trade and business.

New World cotton:

Cotton belonging to species barbadense are derived from a perennial cotton, a native of Peru called Tangins. This variety was introduced into USA and by selection a new type of annual cotton was developed known as Sea Island Cotton which was the longest and finest fibre of all the cultivated cotton. Hirsutum species is the native of Central Mexico and spread to other parts of USA, Asia, Africa etc from native place.

Area and distribution:

Cotton is the most important fibre crop of the world cultivated over an area of 34.5 ha with a total production of 54.5 mt.

The important cotton growing countries are India, USA, Russia, China, Brazil, Egypt, Pakistan, Turkey, Mexico and Sudan. These ten countries account for nearly 85% of the total production.

In our India 1564 ginnings mills and factories are there in which almost 10 lakhs people are getting employment directly and indirectly more than 25 lakhs getting employment.

Climate:

- It is a tropical crop and thrives well in hot and humid climate. It is heat loving and sun loving (heliophyte) plant.
- A daily minimum temperature of 16C is required for germination and 21 to 27oC for proper vegetative growth. It can tolerate temperature as high as 43oC, but does not do well if the temperature falls below 21oC.
- Abundant sunshine during the crop growth period particularly the period of boll maturation and harvesting is essential to obtain a good quality produce.
- Successfully grown in areas receiving an average annual rainfall ranging from 500mm, of which 175-200mm should be received during crop growth period. If, during the fruiting period heavy showers of rain occur or heavy irrigation is applied, shedding of the flowers and young bolls results.
- At harvesting also high rainfall is not desirable since it not only affects the quality of lint but also delays harvesting and makes the harvesting difficult.
- Cotton is highly sensitive to frost occurrence. Even for short period, frost will result in killing of plant cells and severe frost situation, death of entire plant occurs. For successful crop, it

requires a frost free period of a minimum of 180-200 days, starting from the emergence of the plant.

Soils:

Cotton is a deep rooted crop. As the tap root extends even up to a depth of 200-250cm deep soils are ideal for better root penetration and development. Soils should have good water retention capacity as most of the cotton is confined to rainfed conditions. Soils must be well drained and well aerated since the crop is sensitive to water logging. Crop can tolerate P H of 5.5 to 8.5.

Land Preparation:

The field, after the harvest of the preceding crop, should be ploughed 15-20cm deep with mould board plough. There after two to four harrowings depending upon the soil type are done. After each ploughing, planting is essential to make soil pulverized, levelled. No stubbles of the previous crop should be left in the field. For irrigated crop, particularly in North, the field should be prepared by applying heavy pre-sowing irrigation.

Seeds and Sowing :

Time of Sowing:

Place	Sowing time	Seed rate(kg/acre)	Spacing	Method of sowing
Daesi types				
Mungari(Rayalaseema)	May 2nd fortnight –June 1st fortnight	4-5	60 X 22	By seed drill
Hingari (Rayalaseema)	Aug 15-Sep15	4-5	60 X 22	By seed drill
Rayalasema western region	Sep 15	4-5	60 X 22	By seed drill
Adilabad Gaurani region	June-July	4-5	60 X 30	By seed drill
American types				
Red soils of Coastal Andhra	June15	3-4	90-150 X 45-60	By marker
Black soils of Coastal	July-Aug	3-4	90-150 X 45-	By marker

Andhra			60	
Hingari (Rayalaseema)	Aug-Sep	4-5	60 X 30	By seed drill
Telangana mountain area	June-July	4-5	75 X 30	By seed drill
Telangana Sriram Sagar ayacut area	June-July	4-5	90-105 X 45-60	By marker
Nellore, Prakasham	Feb	3-4	60-75 X 45-60	Ridge and furrow method
Hybrids				
Red soils of Coastal Andhra	June15	0.75-1	120 X 60	By marker
Black soils of Coastal Andhra	July-Aug	0.75-1	120 X 60	By marker
Black soils of Rayalaseems	July-Aug	0.75-1	120-150 X 45-60	By marker
Telanagana	June-July	0.75-1	90-120 X 60-90	By marker

Seed treatment :

The seed of the most of the cotton varieties particularly of American types is covered by short fibre called Fuzz. The fuzz makes the seeds cling together, thus hampering their free passage through the seed hopper and tubes of the seed drill or they are not easily separated for sowing by dibbling. The fuzz also interferes with the absorption of the water by the seed and delays germination. For 1 kg seed 100ml H_2SO_4 poured on seed and simultaneously wash the seed with fresh water followed by lime water again with fresh water to neutralize the acid residues. The fuzz gets burnt and immediately washed 3- 4 times in water and dried under shade. This is called delinting. Delinting can be done mechanically in the cotton gin or chemically or the seed is rubbed with mud or a mixture of earth and fresh cow dung. By this treatment, the fuzz on each individual seed becomes pasted on the seed itself and the seeds no longer cling to each other. In order to control the seed borne diseases the seed is treated with 0.01% Streptomycin Oxytetracyclin (Paushamycin or Agrimycin) and with 0.1% Systemic fungicide like carboxin (vitavax) solutions for 6-8 hours. The treated seed should be dried in shade before sowing.

Manures and Fertilizers:

15 to 20 t FYM/ha should be incorporated into the soil at last ploughing. Recommended dose of fertilizers depends on the variety grow n, whether rainfed or irrigated and the nutrient supplying capacity of the soil recommended dose is not uniform in all the cotton growing regions.

Fertilizers /acre(kg)

Place	**N**	**P**	**K**	**Method of application**
Coastal region				Entire P205 should be applied as a basal dose at last ploughing and duly incorporated in the soil. Nitrogen and Potassium divided into three splits and apply at 30, 60 and 90 DAS.
American types	36	18	18	
Hybrids	48	24	24	
Rayalaseema				
Daesi type	8	8	-	
American types(rainfed)	16	8	8	
American types(irrigated)	36	18	18	
Hybrids	48	24	24	
Telangana				
Daesi	16	8	8	
American	36	18	18	
Hybrids	48	24	24	
Paddy fields after harvesting the crop				
varieties	54	18	18	
Hybrids	60	24	24	
Daesi	16	8	8	
American types	36	18	18	
Hybrids	48	24	24	
In paddy field after harvesing				
Varieties	54	18	18	
Hybrids	60	24	24	

Micronutrient Deficiency in cotton :

Magnesium (Mg)

The uptake of Mg is similar to that of Ca. Due to cationic competitive effects, uptake of Mg is lower than K or Ca. The most important function of Mg is its occurence in the centre of the chlorophyll molecule. Inadequate levels of Mg in the plant can inhibit CO2 assimilation. It plays an important role in N metabolism. Mg helps in translocation of cellulose and determines fibre quality.

Deficiency symptoms :

Presence of high Ca may induce Mg deficiency leading to ‘"reddening" of leaves. In contrast to Ca, deficiency symptoms are initially observed in the older leaves. The reddening occurs due to reduced photosynthetic activity if1 the plant, which may be due to immobilization of Mg in cotton.

Management : When reddening occurs in leaves apply 5% MgSO4 Urea (1.0%) and ZnSO4 (0.10%) as foliar spray on 50th and 80th day to correct this malady. In Mg deficient areas apply MgSo4 @ 20 kg/ha basally.

Zinc (Zn)

Zinc is a metal components of several enzymes (carbonic anhydrase, aldolase ect.) It is alson involved in the auxin production and synthesis of RNA.

Deficiency Symptoms: Zinc d eficjency is commonly observed in light sandy soils and calcareous soils (antagonistic effect of Ca and other cations on Zn uptake). The deficiency symptoms are manifested as:

- bronzing of first true leaves and pronounced interveinal chlorosis
- shortening of internodes (gives the plant a bushy appearance "rosetting")
- drastic decrease in leaf size ("little leaf”)
- dwarfism and growth reduction (the most distinct symptom of Zn deficiency)

Management: Foliar application of Zn is better than soil application for correcting deficiency symptoms. In the case of Zinc deficient soils ZnSO4 @ 50 kg/ha as basal or ZnSO4 0.5% spray thrice at 45, 60 and 75 DAS.

Boron (B)

Boron is the most important among micronutrients in obtaining high quality crop. The major function of B in cotton is in the elongation of cotton fibre and prevents callusing of the fibre . It also plays an important role in the translocation of sugars.

Deficiency Symptoms : Boron is not readily translocated within the plant and symptoms are first visible at the growing point where the leaves give a wrinkled appearance. With progress in deficiency, the terminal growing point die.

Management: Boron deficiency known to occur, only exceptionally on vertisols. Deficiency is more common in the sandy soils as borate is very easily lost by leaching. Application of borax (10 kg/ha) is recommended or spraying of borax at 60 and 90 days after sowing @ 1 to 1.5 grms / lit water two times at 7 days interval.

Water Management :

Cotton is a drought tolerant crop due to its deep root system. Water requirement of the crop is 600 to 800 mm. Cotton cannot tolerate excess moisture in the soil and so frequent irrigation is not necessary. Interval between two irrigations depends on the soil type, rainfall and others related climatic factors. The crop must not be allowed to suffer from water stress during flowering and fruiting period, otherwise excessive shedding of flower buds and young bolls may occur resulting in loss of yield. The crop cannot tolerate water logging conditions at any stage of growth.

Critical Stages: Square formation stage, Flowering stage and Boll developing stage

Up to First flower – 3.5mm/day
Up to maximum flowering – 8.9mm /day
Up to last picking – 5.1mm/day

Bud and Boll shedding:

It is a natural phenomena in cotton. Heavy shedding of flower buds and young bolls occur which is aggrevated under adverse conditions of soil, climate and management under such situation it

may be as high as 60% . Under natural conditions 10 to 15% loss occurs. Various reasons for bud and boll shedding in Cotton is

1) Unfavaurable Weather conditions: - Reduced light conditions - Excess or lack of moistures in the soils - Cloudiness -High relative humidity

2) Imbalanced nutrient supply

3) Incidence of pest and disease

4) Weeds alter the microclimate

5) Physical injury - due to use of farm machinery This problem can be minimized by using certain hormones like NAA, since it increases the supply of auxin to bolls and buds, thus the senescence of them is reduced. Spraying of NAA – planofix @10 ppm at flower initiation (1 ml in 100 liter) 50 – 60 DAS & 15 days after 1st applicaton resulted in retention of more bolls.

Harvesting :

Harvesting usually commences in the month of Nov. and extends to March depending upon sowing time and duration. Harvesting is done usually by manual labour ie hand picking the cotton from the open matured bolls. Since cotton is indeterminate type, flowering occurs in no. of flushes hence all the bolls do not mature at a time and bolls come to maturing stage at intervals of 2-4 weeks period. Harvesting is done in 4 -5 pickings as and when bolls are fully matured. Precautions must be taken to maintain the quality of fibre at the time of picking.

1) Picking needs good experience, care is taken that all the cotton from all segments should be removed in one stroke. without leaving any fibre in the boll.

2) Produce from each picking should be dried separately and stored separately. Cotton from all pickings should not be mixed since they vary in their quality. Cotton should be dried on clean floor in shade.

3) Kapas should not be contaminated with foreign materials like leaf bits, trash, soil particles etc, at the time of picking and shading.

While picking weather conditions must be taken into account. Usually pickings are done in the early hours of the day, As the day advances the fruit wall becomes brittle due to sun and while picking they easily collapse and contaminate. Picking must commence after cessation of dew fall Cotton of early picking are of superior quality and later pickings produce inferior quality fibre due to inadequate nutrient supply at later stapes, high incidence of pest and inadequate moisture at later stages. Boll affected with insect is common feature which not only reduce yield but produce yellow stained cotton which is considered inferior fibre.

Cotton- Quality parameters:

1. **Length of fibre:** The length of fibre is mainly predetermined by heredity and is only slightly influenced by growing conditions. fibre length is the mean length of lint hair expressed in mm. longer the length superior will be the quality.

By using digital fibrograph where in sum amount of light is transmitted through the fibre beared after combing along the fibre length and calculated. On the basis of fibre length , cotton is classified into six groups. Groups Length (mm) Varieties

Short staple < 19.5

Medium staple 20.0 – 21.5

Medium long Staple 22.0 – 24.0

Long staple 24.5- 26.5

Superior long staple 27.0 – 29.5

Extra long staple 32 & above

2. **Fibre fineness:**

It denotes the diameter of the fibre hair or thickness . Lesser the diameter superior is the quality . Thickness of the fibre ranges from 15-20 microns. Fineness is measured by taking the weight per unit length of fibre which gives indirectly the finesses because measuring diameter of the fibre is very difficult as they are thin and minute. Fibre fineness is generally expressed as microgram/ inch of the fibre which is also called micronaire value.

3. **Fibre maturity** :

Fibre is matured when the cavity of the lint is completely filled with the cellulose . Extent of the filling indicate its maturity . According to cellulose content fibres are classifed into Mature fibres - Yellowish white fibre Half mature fibres - Bluish or bluish green Imature fibre - Deep blue or purple.

4. **Fibre strength:**

Fibre strength doesnot refer to a individual fibre but to a tuft of fibres of a given thickness. It is expressed as maximum load in terms of Kg that a fibre bundle can take when stretched in one direction before it breaks. Strength is determined by using STELOMETER . Generally the tuft of finer fibre will have greater strength . Fibre strength is measured in thousands of pounds /sq inch or kg/sq cm and grade is allotted, based on strength cotton is classified into Group Grade Very strong >95 Strong 86 – 95 Average 76 – 85 Fair 66 -75 Weak 66- below.

5.Spinng count:

Spinnabilty of the fibre depends on length and thickness of the fibre . It is expressed in counts or hanks. A count is the number of hanks that a pound of cotton gives. One count is equal to 840 yards .

Thus finer the thread the greater will be the count. Ordinarily Indian cottons have 22 counts . While the best quality cotton may have count ranging between 80 to 400 . On the basis of spinnability cottons are divided into five groups.

Group	Counts
Course Cotton	1 - 17
Medium coarse	17-26
Superior medium coarse	26 – 35
Fine	35 -48
Superior fine	40- 80

Cotton growing zones of A.P:

Cotton cultivation is spread over three distinguished areas i.e. Coastal, Rayalaseema and Telangana regions which vary widely in climate and soil types and also production levels. In A.P Cotton growing regions are divided into three regions.

I) Northern region:

It comprises of Adilabad, Warangal and Nizamabad districts. Two distinct cotton grown zones are there in this zone.

1) High plains locally ca lled as “Ghat areas of Adilabad : Soils are black cotton soils which are fairly deep and highly water retentive .Fairly assumed rainfall of 750mm from June to October. Most of the area cultivated during Kharif with American cotton.

2) Low altitude plains or Gaorani tract comprising parts of Adilabad, Nizamabad and Medak. Soils are black cotton soils and are less deeper, rain fall is 550mm and is often ill distributed under rainfedcondition desi cotton is grown and under irrigated condition of Sri Ram Sagar command area American cottons are grown.

II) Central region:

Traditional cotton growing area of Rayalseema. Desi cottons (G.arboreum and G. herbaceum) and American cotton (G.hirsutum) are grown purely under rainfed conditions distributed over three districts of Kurnool, Kadapa and Anantapur. Based on the agro climatic conditions and varieties grown, this region is sub divided into four tracts. 1.Mungari tract (early kharif planting): G.arboreum cottons are grown in light red and black loam soils of KNL, KDP and ATP Dts during early Kharif season. 2.White Northern tract: Desi cotton G.arboreum are grown as late Kharif (Hingari) season. The soils are very deep and highly moisture retentive. However, the mean annual rainfall of 650 mm which is most unpredictable both in intensity and distribution. 3.Rainfed American Cotton tract: American cottons are grown during late Kharif season as Hingari cotton. Dominant soils are black cotton soils.

Mean annual RF 650mm with normal distribution. Confined to rainfed conditions but in Tungabhadra command area grown as irrigated crop. 4.Western tract: Desi cottons(G.herbaceum) are grown during late Kharif (Hingari) season under rainfed conditions. Low rainfall region i.e 450-500mm annually.

III) Western region:

Based on climate and soil it is divided into two cotton growing areas.

1.Kharif cotton areas: It comprises of the Nagarjuna Sagar Project ayacut areas of Guntur, Prakasam, Krishna, Nalgonda and Khammam Dts. Two types of soils viz black and light red soils are available in 2:1 proportion. The annual rainfall in the region is 900-1100mm. The American cottons are grown under irrigated and rainfed conditions.

2.Rabi/Rice follows area: It comprises parts of Krishna and Nellore dt. And confined to rice fallows with supplemental irrigation. Both desi and American cottons are cultivated in this zone.

India ranks first in the world in respect of acarage with about 9.0 m ha under cotton and fourth in total seed cotton production (10-14 m bales). In India, cotton is cultivated on a large scale in Maharashtra, Gujarat, Andhra Pradesh Karnataka, Madhya Pradesh, Punjab, Rajasthan, Haryana, Tamilnadu and Uttar Pradesh. Gujarat is the largest producer of cotton in India followed by Maharashtra. Maharashtra is first in area with nearly 3.0 m ha.

Varieties:

Daesi:
Pandaripuram mungari, Saraswathi, Srisailam, Mahanandi, Aravinda, Raghavendra
American:
MCU 5, LRA 5166, LPS 141, L 389, NA 920, LAM 604, LAM 603, Krishna
Hybrids:

LAM hybrid 1, NSPHS 5, NSPSS 7

Bt Cotton

Cotton is a long duration crop and is attacked by large number of insect pests throughout its growth and development. The three bollworms, American bollworm Helicoverpa armigera, Pink bollworm Pectinophora gossypiella and the Spotted bollworms, Earias vittella and Earias nsulana are major pests and cause serious threat to cotton production resulting in significant yield losses. Bt cotton is genetically modified cotton crop that expresses an insecticidal protein whose gene has been derived from a soil bacterium called Bacillus thuringiensis, commonly referred as Bt. Many subspecies of B.thuringiensis are found in soils and are in general known to be toxic to various genera of insects but safe to other living organisms. Bt was first discovered by a Japanese scientist Ishiwata in the year 1901. Bt has been used as an insecticide for control of stored grain pests since 1938 in France and from 1961 as a registered pesticide in the USA and later in many other countries including India as sprays in

cotton IPM programs to control insects. The Bt gene cry1Ac was used to develop the first Bt-cotton variety. The gene was transferred into the genome of cotton explants (tissue pieces) using a bacterium called Agrobacterium tumefasciens. The transformed cells were developed into a full GM plant now called Bt-cotton. In general, Cry1Ac toxins are highly specific to insects at species level, and are not known to cause any harm to non-target species such as fish, birds, farm animals and human beings.

The first transgenic plant was developed in 1983 in tobacco (Fraley et.al.1983) in U.S.A. In cotton, the first transgenic plant was developed in 1987 in U.S.A. by Monsanto, Delta and Pine companies (Benedict and Altman, 2001).Later on, the research work on development of transgenic was intensified all over the globe and several transgenic plants were developed. In Inida first time Mansanto along with Mico company developed ECH-12 Bt, MECH 162 Bt and MECH 184 Bt verities and from 1999-2001 researches were conducted in different parts of India and in 2002 it was released in market. In our state Banni Bt and Raashi Bt are majorly cultivated.

How it works on cotton bollworms:

The B.thuringiensis strains produce three types of insecticidal toxins, crystal (Cry) toxins, cytolytic (Cyt) toxins and vegetatively expressed insecticidal proteins (vip). These toxins are highly specific to certain insect species. . In general, Cry1Ac toxins are highly specific to insects at species level . The active toxin traverses the peritrophic membrane to bind cadherin receptors present on the brush border membrane of the insect midgut their by makes the insect to die. Bt-cotton incorporated with Cry1Ac is highly toxic to the bollworms and other minor pests such as the cotton semilooper and hairy caterpillar, but not effective on the leaf eating tobacco caterpillar Spodoptera litura.

The major advantage of Bt cotton are summarized below:

1. The Bt cotton has inbuilt genetic resistance to bollworms and is very effective in controlling the yield losses caused by bollworms to a considerable extent. The resistance is governed by a single dominant gene.
2. Use of Bt cotton reuces use of pesticides resulting in reducing the cost of cultivation.
3. It results in improvement of yield levels and also improves margin of profit to the farmers.
4. It provides opportunities to grow cotton in areas of severe bollworm incidence.
5. It promotes ecofriendly cultivation of cotton and allows multiplication of beneficial insects i.e. parasites and predators of bollworms (Fitt et al. 1994, Luttrell and Nerzog, 1994).
6. It also reduces environmental pollution and risk of health hazards associated with use of insecticides because in Bt cotton the insecticides are rarely used. An average reduction of

3.6 sprays per crop season has been reported in Bt varieties as compared to non-Bt.

Constraints in Bt Cotton :

1. Bt cotton is ineffective against many cotton sucking pests such as plant bugs, stink bugs, and aphids.
2. In Bt cotton the gene will be active up to 100 -110 days only.
3. During the drought situation and in high rainfall situation the gene will not be in active stage to control bollworms.
4. The gene toxicity is mainly observed in cotton leaves rather than flowers, squares and bolls. There by the pests attack is common in to them.
5. BG 1 Bt cotton seeds cannot control the tobacco caterpillar in cotton.

In India, cotton is cultivated on a large scale in Maharashtra, Gujarat, Andhra Pradesh Karnataka, Madhya Pradesh, Punjab, Rajasthan, Haryana, Tamilnadu and Uttar Pradesh. Gujarat is the largest producer of cotton in India followed by Maharashtra. Maharashtra is first in area with nearly 3.0 m ha.

Classification: The predominant species cultivated

Gossypium hirsutum - >90% of the area
" arboretum - 5%
Gossypium herbaceum – 2%
Gossypium barbadense – negligible

Gossypium hirsutum:

(American Cotton) Species contain haploid number of chromosomes (26) plants are either annual shrubs or large perennial shrubs (1-1.5mt tall), Flowers are creamy white in colour when first open and turn pink or red later. The capsules are 3-5 locular with 5-11 seeds in each locule. Seed contain a thick coat of lint hair besides a thick coat of fuzz hair. Fibre is medium coarse and length varies from ¾ " to 1 1/4" (27-30mm).

Gossypium barbadense:

(Sea island / Egyptian Cotton): Species contain haploid number of chromosomes (26). Plants are either anuual shrubs or perennial shrubs. Petals are yellow with purple spot at the base. Capsules are 3.5 locular with 5-8 seeds, in each locule. Seeds bear a thick coat of lint and thick coat of fuzz and fuzz may be absent in some varieties. Fibre is fine and extra long ranging from 1/2" to 2'' length. Lint is readily detachable from the seed.

Gossypium arboreum:

Species contain haploid number of chromosomes (13). Plant may be annual sub shrub or

perennial. Capsules are tapering with prominent oil glands in the pits and are 3 or 4 locular with 6-17 seed in each locule . Seeds are usually covered with two coats of hair (lint +fuzz). Fibre is coarse and short and length varies from ½" to 7/8".

Gossypium herbaceum:

Haploid number of chromosomes (13). Plants are sub shrubs. Capsules are brown provided with beak, smooth surface or with shallow pits with oil glands. The capsules are 3-4 locular with 8-10 seeds in each locule. Seeds are covered with two coats of hair (lint+fuzz). Fibre is coarse and short with lint length varying from 1/2" to 7/8''.

Characteristics of varieties and hybrids released so far

Variety /Hybrid	Year of release	Yield (q/ha)	Duration (days)	Ginning (%)	2.5 span length(mm)	Counts	Remarks
Varieties							
LK-861	1993	25-26	170	34	29	50	Immune to whitefly
LPS-141	1987	24-25	170	34	26	40	Resistant to whitefly
L-603	1997	25-30	150-160	35	28	40	Tolerant jassids
L-604	1997	25-30	150-160	36	27	40	Tolerant jassids
Hybrids							
LAHH4	1997	35	160-170	35	27	40	Wider Adaptability
Lam Hybrid 5	2002	32-35	160-165	35	29	40	Resistant to BLB cercospora
Lam Hybrid 7	2006	34-35	160-170	36	32	40	Resistant to jassids

SUGARCANE (*Saccharum officinarum*)

Family: Graminae

It is an important crop in the Indian sub-continent. · Sugar industry is second largest agro-based industry next only to textiles · Sugarcane crop contributes more than 62% of world sugar production. · S-cane provides cheapest form of energy giving food [sucrose]. In addition to sugar, 38 value added products are obtained. · Juice is used for making of white sugar, brown sugar [khandasari] and jaggery · Is a source as bio-fuel, fibre, fertilizer etc. by products viz, bagasse [power of sugar mills} and molasses [main raw material for alcohol].

Area & Production

- Brazil has the largest sugarcane area
- Cuba, China, Pakistan, Mexico, S. Africa, Australia, Indonesia, are cane growing countries.
- Today, India ranks second in the world, after Brazil, in terms of area (4.1 m.ha) and Sugarcane production (355 million tonnes in the yea r 2007)

	A.P.	**India**	**World**
Area (m ha)	4.5 lakh acres	4	20.42 **(m ha)**
Production (m t)	136 lakh tons	167	1333 **(**m t)
Productivity(t / ha)	60-70	68	

· Among the states, Uttar Pradesh occupies half (2.25 m.ha) of the total area followed by Maharashtra (1.04 m.ha). Though UP dominates in production with 134 MT followed by Maharashtra with 79 MT, in terms of productivity, Tamil Nadu leads with 105 t/ha followed by Karnataka (88 t/ha) and Andhra Pradesh (82 t/ha).

· U.P has the highest area under s. cane followed by Maharashtra .

· Bihar, A.P, TN , K'taka, Gujarat and Punjab are the other cane growing states

· In A.P. crop is cultivated in 4.5 lakh acres with 136 lakh tones production.

· In Andhra Pradesh average yield per acre is 68 tones only.

Sugarcane in India is grown in two distinct agro-climatic regions-the **Tropical** (largely comprising Maharashtra, Karnataka, Gujarat and Tamil Nadu) and the **Sub-tropical** (Uttar Pradesh, Punjab, Haryana and Bihar).

Climate:

A growing season which is long and warm with adequate rainfall or irrigation, long hours of bright sunshine and higher relative humidity which permits rapid growth to build up adequate yield (more tonnage) and a ripening season of around 2-3 months duration having warm days, clear skies,

cool nights and relatively a dry weather without rainfall and higher difference in day (maximum) and night (minimum) temperatures for buildup of sugar are required.

Temperature : Optimum cane growth is achieved in temp. between 24 & 30C C

Rainfall : In India, grown in areas ranging from 600 to 3000 mm, rains at active growth period ,encourages rapid cane growth, cane elongation whereas rains at ripening period, leads to poor juice quality.

Humidity: High humidity coupled with warm weather at vegetative growth is essential, humidity of 45 to 65% + limited water supply is must at ripening phase

Sunshine : S'cane is sun loving plant. Higher sunshine hours, favours higher cane yield, sugar recovery Frost : In, N.India extreme cold conditions will arrests cane growth.

Suitable Varieties for different situations

Late maturing varieties (12 -13 months):

Co 7219, Co7706, Co8011, CoR8001.

Mid-late maturing varieties (11-12 months) :

CoA7602, CoT8201, Co7805, Co8021, 85R186, 86A146, 87A 397, 83V15, 83V288.

Early maturing varieties (9 -10 months) :

Co6907, Co7505, 90A 272, 81A99, 82A123, 83A145, 81V48, 85A261, 86V96, 84A125, 91V83, 93V297, 83R23, 87A298.

Soils

Crop can be grown on various types of soils varying from sandy to heavy clays. • Moderately heavy and medium deep loams, are better suited than heavier and shallow soils • Soil must be of good depth and drainage with no compactness.

Tillage ·

Field is ploughed 2-4 times with iron plough and pulverization to break the clods. · Surface soils are dug to a depth of 20 cm to facilitate drainage and deep root system. Tractor ploughing is a common practice.

Sugarcane Planting Methods

1. **Planting in flat beds ·**

It is very popular method on Northern India and in parts of Maharashtra. 115 · Shallow furrows of 8-10 cm deep are made. · Distance between two rows should be kept 75-90 cm. · Generally 3 budded setts are used to plant in the end to end planting system. · The furrow is covered by 5-7 cm of soil and field is leveled by planking

2. Ridge and Furrow Method: ·

The method is adopted in areas with moderate rainfall but have drainage problem. · Deep furrows are opened in 'v' shape,10-15 cm deep in N. India,20 cm in S.I. · It is also practiced in Eastern UP,& in Peninsular India particular in heavy soils.

3. Pit Planting ·

Method is very popular in Tillah soil in Assam and also in Kerala hilly tracts. · Pits are made at interspacing of 20-30cm in rows along the contours with row to row spacing of 75 cm, · Organic manure is placed at bottom of pits. · Cane setts are placed in the triangle in pits and covered with soil. · System can be used in rain fed agriculture.

Recommended planting method

- Ridge and furrow method is easy and mostly followed
- Areas subjected to water logging immediately after planting : Partha method
- Farm with Drip irrigation Facility- Paired row planting
- Saline soils - Modified trench method
- Ridges are made at a spacing of 60-75 cam with a depth of 25 cm and irrigation and drainage channels should be opened along the field borders at regular intervals.
- Phosphates are applied in the furrows, then treated setts are placed in end to end or in over lapping fashion.
- Setts are covered with soil and irrigated
- **Dry** planting followed in light soils
- In heavy soils furrows are irrigated soil is brought to more or less puddle condition and setts are pressed in the soil ,which is called as **"wet method"**
- At the time of planting buds should face upwards, buds facing downwards do not germinate or difficult to emerge facing upwards may be exposed in washing of soil while irrigating and thus may dry out.

- System facilitates easy irrigation, provides good soil aeration, solid support to the plant when earthed up.

MANURES & FERTILIZERS

Place	N	P	K	Time of application
Srikakulam, vizag, Medak	45	40	48	N application at 45, 90 DAS in two equal splits
East Godavari, West Godavari, Krishna, Guntur	67	40	48	N application at 45, 90 DAS In waterlogged areas N applied at 30,60 DAS
Karnool, Ananthapur, Chittoor	90	40	40	N application at 45, 90 DAS in two equal splits
Nizamabad-Eksali crop	100	40	48	Two equal splits at 60, 150 DAS

Time & Method of application.

- Nitrogen requirement is maximum at tillering, early grand growth period from 1-6 months. Late application of N beyond 120 days, reduces the juice quality, increases soluble N in juice, and formation of water shoots.
- First application should be given at 30 days of crop age, next at 60 and 90 DAP.
- Phosphorous applied basally in furrow bottom and mix slightly with soil before planting.
- Potassium application normally done along with N application because of better utilization of N, in the presence of K. therefore K is applied at 45, 90 DAS.
- Late application of K, at 6 months under drought situations improve sugar recovery
- Nitrogen and potassium fertilizers are given in split doses applied in bands on either side of row
- Foliar Nutrition of urea @1- 2.5% & potassium @2.5% under moisture stress is useful to improve yield and quality

WEED MANAGEMENT

Requires weed free for the first 90-100 days before and, most sensitive to weeds during tillering stage · Manual weeding at 30, 60 & 90 DAP is effective to control weeds, · Trash mulch at 45 DAP @ 7-10 t/ha, 10 cm thick is effective against many weeds. · Application of Atrazine @ 5kg/ha in 1125 litres of water to be sprayed on the third or fourth day after planting, depending on soil moisture · At 20 and 60 days of planting spraying of 2,4-D (41 /2 kg) + Gramoxone (2.5 lts) in 125 lts/ha is recommended · Initial ploughing, off baring, trash mulching, are the weed control methods in ratoon .

WATER MANAGEMENT

- Water requirement of cane is high and varies with region
- In Tropics, water requirement is 2000-3000 mm, in sub-tropics 1500-2000 mm
- Under severe stress the yield loss may go up to 60-70 per cent.
- For early planted cane , moisture stress coincides at grand growth phase ,affects stalk elongation ,in late planted cane, moisture stress affects the formative phase maturity and ripening phases.
- Limited stress during ripening helps improve percent sugar content in cane.
- Sugarcane grown in waterlogged areas ,damages crop and leads to 25 per cent reduction in, low sugar recovery
- Irrigate the crop depending upon the need during different phases of the crop.
- Number of irrigations required varies with varying rainfall patterns.
- Light & frequent irrigations gave higher yield, than heavy irrigations at longer intervals.
- In summer, irrigation interval depends up on soil type and season. Generally shorter interval in winter and in heavy soils whereas longer intervals in summer and in light soils.
- Trash mulching has to be done three days after planting @ 3 t /ha.
- Irrigation can be provided : 0.75, and 0.50 IW/CPE ratio at tillering, grand growth, maturity.

The irrigation intervals in each phase are given below.

Days of irrigation interval Stages :

	Sandy soil	Clay soil
Tillering phase (36 to 100 days)	8	10
Grand growth phase (101 - 270 days)	8	10
Maturity phase (271 - harvest)	10	14

Management practices for moisture stress situation

1. Choosing appropriate variety
2. Soaking the setts in saturated lime water
3. Choosing appropriate planting method
4. Close row spacing while planting
5. Basal manure application
6. Pre-stress manuring and irrigation
7. Trash mulching
8. Protective irrigation if available
9. Appropriate post-stress crop management
10. Foliar spray of urea , DAP, potash and trash mulching .
11 Inducing hardness.
12 Use of antitranspirants
13 Use of drought resistant varieties like Co -740, Co- 235, Co -997, Co -6304

Propping: · Propping is done by tying the cane together using dry leaves or green leaves, to prevent the crop lodging due to heavy winds and keep the field open for better aeration. Usually trash is twisted to form a rope and cane stalks are tied together – trash twist propping.

Check lodging of cane. Trash without removing from cane is twisted to form sort of rope and cane stalks are tied together. This is known as trash-twist propping. Propping can be done for each row or two rows can be brought together and tied.

Detrashing

Detrashing refers to removal of unwanted bottom dry and green leaves at 150 DAP. · Sugarcane stalk bears large number of leaves (30-35) · Maintaining clean field · Enhances air movement , an ideal micro-climate for unrestricted growth of cane · More food material is made available for stalk growth · Reduces the problem of infestation of insect- pests like scales, mealy bug, etc · Minimizes rodents, rats, squirrels in the field which cause damage to the crop · Detrashed trash can be used as a mulch for moisture conservation for composting

JAGGERY MAKING

Step 1. Cutting sugar cane from fields

Step 2. Feeding the grinder to extract juice Step

3. Boiling the juice

Step 4. Adding Ingredients

Step 5. Tray Feeding

Step 6. Jaggery output

Step1:

Fresh sugarcanes are cut from the fields, canes are cut in such a way that the head and tail are chopped off. They are carefully brought in a plastic sack, to the place where they are made juice.

Step2 :

To extract juice from the sugarcane, they use a power run machine, where at one side four or five canes are fed, and at the other end, extracted sugar cane juice is directly feed to the vessel.

Step3 :

Next step involved is boiling the extracted juice, juice is feed to a large big iron vessel, which is usually called as kadai as the below. heating unit of the vessel is set up in such a way that, at a single stretch two vessels are boiled, heating unit is nothing but a small pit above which this vessel is placed, there is a man who keeps on adding fuel to the heating unit from a small opening, the extract which is obtained after juice has been taken from the canes, these extract are dried in sunlight and used as a fuel for heating. The juice is boiled in the vessel for at least three hours, until the liquid juice becomes a semisolid paste.

Step4 :

When juice becomes a semisolid paste, small quantity of sodium carbonate is added as a reducing agent, which helps in making Jaggery balls.

Step5 :

After stirring well until the juice becomes a semisolid paste, the paste is fed to a iron tray. With the help of a long wood stick, at one end which contains a flat block they stir well again in the tray, until more thickening comes.

Step6 :

With help of a wet cloth, hot Jaggery paste are made as balls precautions are taken, to prepare the balls as fast as possible, as the paste gets to the solid state within a short span of time.

Ratoon Management

- The number of succeeding cane crops raised from single planting is “Ratoon”
- Ratoon occupies 50-55% of total cane area in India
- In India one or 2 ratoons are taken .
- The crop raised from planting cane setts is “Plant crop”
- Plant crop is harvested the under ground portion of stem stubble are left in the field.
- Harvesting close to the ground level is most important for good rationing
- If harvesting is done unevenly stubble shaving should be done.
- After harvesting of plant crop, trash left in the field, should be burnt, to clean the field and destruction of eggs and pupae of pests
- Soil compaction affects ratoon growth , to improve soil physical conditions,

  off barring and ridge flattening is necessary where ridges are broken by ridger

  - improves soil organic matter, through decay of old root mass and promote quick emergence of roots from stubble.
- Intensity of gaps in ratoon is 10-30 per cent
- Gap filling is done with young sprouts from stubbles or in poly bags or nursery with 30-35 day old.
- Trash mulching suppress weed growth and aids in moisture conservation

besides increasing fertilizer use effect.

- **Varieties** Early varieties are poor ratoons than mid late or late varieties
  Thin or mid thin varieties are better ratooners than thick varieties .
  Plant crop should be harvested in Feb – March to ensure
  favorable re-growth of ratoon sprout
- **Fertilizers :-** 200 N + 60 P_2O_5 + 60 K_2O are recommended for good ratoon crop
- Nitrogen should be applied in 2 splits at ratoon initiation and 60 days after root initiation.Entire dose of P & K should be applied at ratoon initiation
- **Irrigation :-** Ratoon crop require more frequent irrigations than plant crop, because of shallow root system. Irrigation at 40% DASM is ideal for ratoon crop
- Irrigation at 12-15 days interval in subtropical regions and 8-10 days in tropical ares.
- **Earthing up :** Is done to check excessive tillering to prevent crop lodging & destruction of weeds. Earthing up is down twice first before onset of monsoon and 2nd at start of monsoon
- **Propping** is done by tying the cane together using dry leaves or green leaves, to prevent the crop lodging due to heavy winds and keep the field open for better aeration. Usually trash is twisted to form a rope and cane stalks are tied together – trash twist propping.
- **Weeding :** Pre-emergence application of Atrazine [1.0-1.5] followed by one hoeing – 45 days after ratoon initiation is effective and economical for weed control. Manual weeding at 0, 45 & 90 days after ratoon initiation is more effective.
- Application of cycocel [CCC] or etherel to foliage before 30 days of cane harvest, can

promote bud

sprouting in ratoon crop.

- **Plant Protection :** Ratoon crop needs more plant protection care than plant crop. Grassy shoot disease, ratoon stunted disease and smut are major diseases associated with ratooning

- **Advantages:-**
- Operational cost on seed and preparatory tillage is reduced by 25-30% by ratooning
- Ratoons mature earlier than plant cane .
- Ratoons can be harvested easily, field will be available for next crop
- Ratoons give equal or more yield than plant crop
- Ratoons give better quality cane with improved sugar recovery
- Cost of production per ton of ratoon crop is less than plant crop.
- The deeper root system thus obtained facilitates optimum utilization of the nutrients and moisture available in the lower soil layers and provides good support for growth of the ratoon crop

Tobacco

Scientific Name: ***Nicotiana tabacum, N. rustica***

The information available on the origin and history of tobacco suffers generally from ambiguity and contradictions. According to one source, tobacco was in existence in Asia even during the 12th century, when it was not known elsewhere. It was not only used as an intoxicant but also as a cure for all kinds of ills and paying homage to deities. However, it was Christopher Columbus who discovered the narcotic qualities of tobacco accidentally in the course of his American voyage in 1492. On landing in the Islands of Tobag, Columbus and his men were taken by surprise to find the natives either sniffing a powdere d dry leaf with evident pleasure or smoking roughly made roll of dried-up leaves. On trying these themselves, Columbus and his men were satisfied with the intoxicating effect. They took along with them some quantity of dried leaves and seeds and that was how tobacco got introduced into Europe.

Tobacco is said to have been introduced into India in the beginning of 17th century. As elsewhere in the world, it has thrived in spite of considerable neglect and social disapproval.

Distribution:

Leading tobacco growing countries are China, India, Brazil, USA, Zimbabwe and Turkey

Types Of Tobacco

With its rich agro-climatic diversity, India has the unique position of growing different types of tobacco which are broadly classified as:

1.	FCV tobacco	Andhra Pradesh & Karnataka
2.	Bidi tobacco	Gujarat, Nipani area of Karnataka & Nandyal area of Andhra Pradesh
3.	Cigar & Cheroot tobacco	Tamil Nadu & West Bengal
4.	Hookah tobacco	Assam, West Bengal, Bihar, UP & Gujarat
5.	Chewing & Snuff tobacco	Tamil Nadu, West Bengal, Bihar, Assam & Uttar Pradesh
6.	Natu, Burley, Lanka & HDBRG tobacco	Andhra Pradesh & HDBRG
7.	Pikka tobacco	Orissa

Climate

Besides soil, the other important factor which affects tobacco growth is the climate. Rainfall, temperature, relative humidity, wind and sunlight have a profound influence on growth, flowering and metabolism of tobacco plant. To maintain turgidity and expansion of leaf area, tobacco plant needs considerable amount of water. On the other hand, tobacco plants are very sensitive to flooded/water-logged condition of soil because of deprivation of oxygen in soil essential for the development of a fibrous root system. Tobacco is tropical in origin, but it is grown successfully under tropical, sub-tropical and temperate climates. Normally it requires about 100 to 120 frost-free days with an average temperature of 80o F, to mature. Ideal conditions required for successful production of high quality leaf are 1) a liberal and well-distributed rainfall during active vegetative growth stage 2) long day lengths and 3) a high relative humidity of 70-80%. In India, tobacco is grown under a very wide range of conditions from the coast-line to an altitude of 3,000 feet. In the South, the crop is raised in winter from October to March when the temperatures are moderate. But in Punjab, it is grown as an early summer crop. In the eastern and western parts of the country, it is grown between September and January.

Soils:

Tobacco is very sensitive to the physical and chemical properties of the soil. Soils which are open, well drained and properly aerated are the best suited for tobacco cultivation. The plant is highly susceptible to injury from flooding or inundation of the soil. The desirable soil pH is 5.0 to 6.0. But, in many parts cultivation is successful where the pH is 8 or more.

The Traditional black soils are clay loams, silty clay loams and clays, highly clayey (50-80% clay) throughout the profile, slightly alkaline in reaction (pH 7.5 to 8.8), calcareous, low in organic carbon, rich in fertility, high in available soil moisture with very poor drainage. Tobacco is grown on conserved soil moisture as post monsoon crop during winter. Northern light soils (East Godavari, West Godavari and Khammam districts of A.P.) are sandy loams to loamy sands, slightly acidic, very low exchangeable cations, low water holding capacity, poor fertility status with very good drainage. Tobacco is grown in these soils under irrigated conditions during winter. Southern light soils

(Prakasam and Nellore districts of A.P.) are red loamy soils, neutral in reaction, low to medium fertility status, moderately well drained, moderately low permeability, with moderate water holding capacity and low to medium cation exchange capacity with more than 75% base saturation. Tobacco is grown during winter on conserved soil moisture from North East monsoon rains.

Tobacco Varieties Released In India

Variety **FCV tobacco**	**Year of release**	**Developed at**	**Cured leaf yield (kg/ha)**	Area of adoption and salient features
Chatam	1950	CTRI, Rajahmundry	1100	For TBS
Delcrest	1960	CTRI, Rajahmundry	1200	For TBS
Kanakaprabha	1971	CTRI, Rajahmundry	1500	For TBS
Dhanadayi	1972	CTRI, Rajahmundry	1520	For TBS
CTRI Special	1976	CTRI, Rajahmundry	1365	For TBS
16/103	1976	M/S ILTD Co., Rjy	1717	For NLS
Special FCV	1976	M/S ILTD Co., Rjy	1118	For TBS and KLS
Jayasri	1979	CTRI, Rajahmundry	1990	For TBS
CTRI Spl.(MR)	1980	CTRI, Rajahmundry	1200	For TBS and SLS; Resistant to TMV
Godavari	1982	CTRI,	1525	For TBS and SLS;
Spl. Swarna	1984	Rajahmundry CTRI Res. Stn., Hunsur	1450	Resistant to TMV For KLS; Resistant to powdery mildew
Mc Nair 12	1986	CTRI, Rajahmundry	1880	For NLS; Tolerant to black shank
Jayasri (MR)	1986	CTRI, Rajahmundry	1503	For TBS and SLS; Resistant to TMV
Hema	1987	CTRI Res. Stn., Guntur	1560	For TBS
Bhavya	1988	CTRI Res. Stn., Hunsur	2000	For endemic black shank areas of KLS; resistant to black shank and tolerant to root-knot nematode
Gauthami	1992	CTRI, Rajahmundry	2000	For TBS and SLS
CM 12(KA)	1993	CTRI, Rajahmundry	2000	For NLS; Tolerant to black shank
VT-1158	1993	CTRI, Rajahmundry	2000	For TBS; Resistant to TMV
K-326 (NLS-4)	1998	CTRI, Res. Stn., Jeelugumilli, CTRI Res. Stn., Hunsur	2000	For NLS and KLS; Tolerant to black shank and nematodes
Trupthi (KST-19)	1998	Reg. Res. Stn., Navile	1800	For KLS
Ratna	2000	CTRI Res. Stn, Hunsur	2000	For KLS
Kanti (CY-79)	2001	CTRI Res. Stn, Kandukur	1600-2000	For the SLS & SBS of Andhra Pradesh
Hemadri (II- 1624)	2002	CTRI Res. Sta., Guntur	2500	For Traditional black soils of AP.
Bidi tobacco				
Keliu 20	1956	BTRS, Anand	1550	For Gujarat

Anand 2	1969	BTRS, Anand	2555	For Gujarat, Karnataka, Maharashtra & Andhra Pradesh
Anand 3	1966	BTRS, Anand	2500	For Gujarat
Anand 23	1969	BTRS, Anand	2477	For Gujarat ; Tolerant to leaf-burn disease
Anand 119	1969	BTRS, Anand	2625	For Gujarat, Karnataka, Maharashtra & Andhra Pradesh
GT 4	1976	BTRS, Anand	2605*	For Gujarat
			2841@	Drought tolerant
NPN 190	1979	ARS, Nipani	1964	For Karnataka and Maharashtra
PL 5	1984	ARS, Nipani	2000	For Karnataka and Maharashtra
GT 5	1986	BTRS, Anand	3301	For Gujarat; Tolerant to root-knot and high nicotine
GT 7	1993	BTRS, Anand	2535	For rainfed areas in Gujarat; drought tolerant
GTH 1	1995	BTRS, Anand	3644	For Gujarat; Tolerant to root-knot and high nicotine
Bhavyasree (NPN-22)	2000	ARS, Nipani	1420	For Karnataka
Chewing tobacco				
Chama	1956	CTRI Res. Stn, Dinhata	1800	For North Bengal (clay soils)
Podali	1956	CTRI Res. Stn, Dinhata	1600	For North Bengal (sandy soils)
DP 401	1958	CTRI Res. Stn, Pusa	2000	For Bihar
Gandak Bahar	1976	CTRI Res. Stn, Pusa	2280	For Bihar
Sona	1977	CTRI Res. Stn, Pusa	3178	For Bihar
Vairam	1977	CTRI Res. Stn, Vedasandur	2800	For pit-cured tobacco growing areas of Tamilnadu
Thangam	1980	CTRI Res. Stn, Vedasandur	3226	For smoke -cured tobacco Growing areas of Tamilnadu
Bhagyalakshmi	1980	CTRI Res. Stn, Vedasandur	3532	For sun-cured tobacco growing areas of Tamilnadu
Maragadham	1981	CTRI Res. Stn, Vedasandur	3013	For smoke -cured tobacco growing areas of Tamilnadu
Prabha	1981	CTRI Res. Stn, Pusa	2200	For Bihar
GT 6	1986	BTRS, Anand	2712	For Lal and Kala Chopadiu tobacco
PT- 76	1990	CTRI Res. Stn, Pusa	2600	For Bihar
Meenakshi	1992	CTRI Res. Stn, Vedasandur	4000	For sun-cured areas of Tamilnadu
Vaishali Special	1993	CTRI Res. Pusa Stn,	2778	For Bihar
Abirami	2001	CTRI Res. Stn. Vedasandur	4000	For southern, central and western zones of Tamil Nadu except Coastal belt
Dharla	2001	CTRI Res. Stn.	2700	North Bengal zone

		Dinhata		
Lichchavi (PS-14)	2001	CTRI Res. Pusa Stn.	3000	North Bihar
Rustica tobacco				
DD 437	1977	CTRI Res. Stn, Dinhata	1865	For Motihari areas of West Bengal
Sonar Motihari	1977	CTRI Res. Stn, Dinhata	1690	For Motihari areas of West Bengal
GC 1	1981	BTRS, Anand	2693	For *rustica* areas of Gujarat
GCT 2	1994	BTRS, Anand	3512	For *rustica* areas of middle Gujarat
Natu Tobacco				
Prabhat	1977	CTRI Res. Stn, Guntur	1500	Natu areas of Andhra Pradesh; suitable for cigarette natu, resistant to TMV
Vishwanath	1986	CTRI Res. Stn, Guntur	2429	Suitable for cigarette natu areas of Andhra Pradesh
Natu Special	1992	CTRI Res. Stn, Guntur	1600	Suitable for cigarette natu areas of Andhra Pradesh
Pyruvithanam	2001	NRPT Centre, Berhampur	1250	Pikka tobacco growing areas of Orissa
Bhairavi (NG73)	2002	CTRI Res. Stn., Guntur	2600	Suitable for cigarette natu areas of Andhra Pradesh
Cheroot tobacco				
DR 1	1960	CTRI, Rajahmundry	2620	For river-side Island of East Godavari district of
Bhavani Special	1980	CTRI Res. Stn,, Vedasandur	2837	Andhra Pradesh; strong, pungent and aromatic For Bhavani area of Coimbatore district of Tamilnadu
Lanka Special	1981	CTRI, Rajahmundry	2780	For river side Island of East Godavari district of Andhra Pradesh; strong, pungent and aromatic
Sendarapatty Special	1986	CTRI Res. Stn,, Vedasandur	2100	For Salem area of Tamil Nadu
Cigar-wrapper tobacco				
Krishna Burley tobacco	1986	CTRI Res. Vedasandur Stn,,	2250	For cigar-filler area of Tamilnadu
Banket A1	1994	BTRC, Jeddangi CTRI,	1800	For light soil agency areas Of East Godavari, Visakapatnam, Vijayanagaram districts of A. P. Resistant to TMV
Sweta (BSRB 2)	2002	BTRC, Jeddangi CTRI,	2000	For light soil agency areas of East Godavari,Visakapatnam, Vijayanagaram districts of Andhra Pradesh. Resistant to TMV

TBS: Traditional black soils of Andhra Pradesh; NLS: Northern light soils of Andhra Pradesh; SLS:

Southern light soils of Andhra Pradesh; KLS: Karnataka light soils,
* Rainfed, @ normal conditions; BTRC, Burley Tobacco Research Centre.
CTRI RS: Central Tobacco Research Institute Research Station

NURSERY MANAGEMENT

Tobacco seeds are very small and egg-shaped with thick seed- coat. They are about 0.75 mm long, 0.53 mm broad and 0.47 mm thick. Depending on the variety and the conditions under which the seed is produced, the size and the weight of the seed vary considerably. In N. tabacum the average weight of the seed is 0.08 to 0.09 mg and there are 11,000 - 12,000 seeds per gram. In N. rustica, the seed is larger and about three times heavier. The emerging seedlings are tiny and delicate and therefore, the seeds are unsuitable for sowing directly in the field. Hence, they are sown in nurseries initially and tended carefully till the seedlings attain a particular size before transplanting in the main field. For successful raising of nurseries, proper location, good preparation and manuring, adequate facilities for watering and timely controlling of pests and diseases are essential. Site Selection: Generally tobacco nurseries are grown on sandy or sandy loam soils. The cigarette-tobacco growing areas of Andhra Pradesh are an exception in that the crop is grown on a heavy black soil and the nurseries are generally raised on sandy to gravely loams. Raising of nurseries on heavy black soils is hazardous due to poor internal drainage due to clay content, heavy rainfall, high temperatures and pre-disposing the crop for disease like damping off.

Sterilisation / Rabbing: The nursery site should have a good internal as well as surface drainage and should be situated at an elevated place. It is desirable to change the nursery site every year as it would minimise incidence of pests and diseases and also eliminate contamination by other varieties. If it is not possible to change the site, old site can be used after sterilizing by rabbing, i.e. by burning any of the slow burning waste materials like, tobacco stalks, paddy husk, sugarcane-trash, etc. For the best results this operation should be done at the right moisture content, after the final preparation of the seed bed and a few days before sowing.

Seed bed preparation: Systematic layout of nursery on raised beds with intervening channels helps in quick drainage of rain water. The beds of 1.0 m to 1.22 m width facilitate hand weeding and watering with rose cans. The beds can be of any convenient length along the slope but generally not more than 10 m. Channels should be 50 cm wide and 10 cm deep. Mixing of sand at 100 to 200 tonnes/ha in the preparation of the beds, helps in improving the drainage in heavy soils. Manures and fertilizers: Application of FYM or filter press cake @ 25 tonnes/ha by mixing well in the top layers atleast 20 days before sowing is beneficial in obtaining more number of transplantable seedlings. Growing of a green manure crop like dhaincha or sunnhemp for 6 to 7 weeks and ploughing it is also practiced in places like Dinhata (West Bengal). Basal application of 50 g of ammonium sulphate, 50 g of potassium sulphate and 300 g of super phosphate and 100 g of dolomite per 10 sq.m. bed is recommended. After germination of seed, top dressing of ammonium sulphate @ 25 g/10 sq.m. twice at 4 days interval and thereafter @ 50 g/10 sq.m. thrice at 4 days interval and potassium sulphate @ 25 g/10 sq.m. twice is recommended. After each pulling top dressing with ammonium sulphate @ 100 g/10 sq.m. is to be applied to boost the growth of remaining seedlings. 148 Seed rate: Seed rate is actually dictated by

climatic conditions and the optimum seed rate is 3-5 kg/ha (0.4 g/sq.m). A seed-rate of 3 kg/ha for N. tabacum and 6 kg/ha for N. rustica was found to be optimum under Dinhata (West Bengal) conditions.

Time of Sowing:

Sowing time	State	Type of Tobacco
Aug-Sep	A.P.	Cigarete, Cheerot and Bidi
April- May	Karnataka	FCV and Natu
May-June	Gujarat	Bidi
June -July	U.P	Cheewing
Aug-sep	Bihar	Hookah and Chewing
Dec.	UP	Chewing

Spacing:

Bidi Tobacco- 70cm X 50cm
Natu Tobacco- Irrigated- 90cm X90 cm Rainfed- 60cm X60 cm
Burley Tobacco- 80cm X40 cm
Lanka Tobacco- 60cm X60 cm

Fertilizer management:

Place	FYM (t/ha)	NPK(kg/ha)	Method of application
Northern light soils	10-12	115-60-120	Zolap
Southern light soils	5	60-60-60	PRPF
Black soils	7.5	45	PRPF
Burley tobacco	10	125-50-50	Zolap
Natu irrigated	10-15	300-50-100	Zolap
Natu rainfed	15	60-50-50	PRPF
Lanka tobacco	20	300-50-50	Zolap
Bidi tobacco	25	100-50-100	Zolap

Source of N is ammonium sulphate, calcium ammonium nitrate, urea
Source of P is DAP
Source of K is K_2SO_4

Inter cultivation and Weed management:

Inter cultivation is done with a three-tyned hoe two or three times at fortnightly intervals by working the hoe in cross directions. The first cultivation usually commences about 10 to 15 days after planting by which time the plants are well established. In vertisols, the final cultivation is done deep with country plough to prevent cracking of the soil. For each interculture, the soil around the plants is loosened with a hand-weeding tool. These operations help in eradication of weeds, mulching the surface soil and promoting rooting at deeper layers by driving out the

moisture at the top. In the case of irrigated crop, soil in the furrow which has the tendency to form a hard crust is broken by harrow and ridges are reformed to increase the height with each progressive irrigation.

These regular intercultural operations will keep the field weed free and conserve the moisture. Orabanche is found to be attached with the roots. For managing them,

- Summer ploughing
- Stop the cultivation of tobacco for 1 or 2 seasons where the intensity is more.
- Do not cultivate brinjal, tomato, bhendi.
- Growing trap crops like Jowar, Gingelly, Sesame, Blackgram etc. should be gropwn in Kharif, which will reduce the seed bank.
- coleection and destroying as soon as they are seen in the field.
- Use alyl alcohol
- Spraying of GR 7,24,28

TOPPING & DESUCKERING:

Toping is the process of removal of flower head alone or with few top leaves. Removal of the flower bud (topping) arrests the apical dominance and buds in the top 3 to 4 axils grow rapidly to replace the plants reproductive capabilities. The primary buds get stimulated initially and removal of these primary buds, in turn, stimulates secondary buds. Topping is associated with improvement of root system, leaf thickness and leaf weight. Topping increases the nicotine and nitrogen contents of the leaf. Topping and removal of subsequent suckers form a composite operation. If suckers are not removed there is no use of topping. The management aspects of topping and desuckering are spe cific to tobacco types. 154 Sucker control can be done either manually or by applying chemicals. Application of neem oil emulsion 15-20% in the top 5-6 axils controls the suckers considerably.

Irrigation:

Tobacco cannot tolerate wit h water logging under any circumstance. FCV tobacco grown in Blackcotton soils rarely requires irrigation. However, grown in light soils requires regular irrigations.Irrigation through all furrow system is a general practice, but it consumes more water and requires more labour; and leaching losses of nitrogen and potassium are also more. The alternate skip furrow method of irrigation is more economical and checks the wastage of irrigation water, electricity and time. It improves the leaf quality and gives 10-20% higher yield than all furrow irrigation.

Irrigation schedule for Northern light soils FCV Tobacco

At the time of planting in plough furrow	15 mm
1st irrigation 15-20th day after planting by surface irrigation, if needed	24 mm
2nd irrigation 30-35th day after planting as surface irrigation	24 mm
3rd irrigation 40-45th day after planting all furrow irrigation immediately after ridge formation	48 mm
4th irrigation 50-55th day after planting all furrow irrigation	48 mm
5th irrigation 65-70th day after planting by alternate skip furrow method	24 mm
6th irrigation 80-85th day after planting by alternate skip furrow method	24 mm
7th irrigation 95-100th day after planting by alternate skip furrow method	24 mm
8th irrigation 115-120th day after planting by alternate skip furrow method	24 mm

Critical stages:

Critical stages for irrigation is knee height to bloom. Schdulling at 50 % DASM is ideal for Tobacco. Quality of water for irrigation to tobacco in respect of chlorine content is paramount important. Limit of is up to 30 ppm and should not exceed 50ppm.

Harvesting

1. **Priming:**

Harvesting two to three well-matured and ripe leaves is is termed as Priming as followed in FCV tobacco. Ripe leaves have greenish-yellow colour, with a velvety feel, losing much of the stickiness. They have a tendency to lie horizontally or bend slightly down the plant and the leaf-tips are slightly dry. As a general rule, leaves are harvested from bottom lower leaves on slightly greener side, middle leaves when they are ripe and top leaves when they are fully ripe. Harvesting must be done on a clear weather day and on an average, not more than three leaves are harvested at a time. Immediately after rains or irrigation, harvest is to be delayed by 2 - 3 days.

2. **Stalk cut method:**

Cigar, cheerot, chewing and hookah types are harvested by stalk cut method. In this method plants are cut close to ground with the sickle and generally left in the field over night for wilting.

CURING:

Curing is essentially a drying process whereby most of the moisture in the green leaf is removed. However, this process of drying is conducted in such a way as to produce certain welldefined and desirable qualities in different types of tobacco. A bad leaf produced on field cannot be 155 improved by curing; but a good leaf can be spoiled by bad and defective curing. During the progress of curing, some important biochemical changes take place. Depending on the type of tobacco, four principal methods of curing can be distinguished, namely, i) flue -curing, ii) air-curing, iii) fire-curing and iv) sun-curing.

METHODS OF CURING

1. **Air curing**

The matured leaves are primed and kept around the plant. The primed leaves are tied in to bunches of 8 to 10 leaves and cured on bamboo splinters in curing sheds for 4 to 6 weeks. Various indigenous tobaccos are subjected to air-curing. Most prominent among them are; wrapper tobacco of West Bengal, lanka tobacco and Burley tobacco grown in Andhra Pradesh. The process is rather slow and takes 6-8 weeks. Generally air-cured tobacco is dark brown in colour with lower levels of sugars and rich in nitrogenous constituents.

2. **Pit Curing**

Bundles of shade-cured leaves are pit cured in the pits of 8 feet diameter and 3 feet depth by keeping them in circular layers up to half of the pit and then covered by palmyrah leaves and soil to make it air tight. After 24 hours, the leaf is transferred to another pit of the same dimensions, filled and covered in the same way as the first one and kept for 48 hours. Later, the leaf is transferred to the 1st pit in the same way and kept for 24 hours. This transferring process is done at nights to avoid loss of moisture. Eg. Lanka Tobacco in A.P. and Hookah Tobacco in Punjab.

3. **Sun-curing**

In India, a number of tobaccos are Sun-cured. In this method construction of costly structures are avoided. The process is relatively quick (2-3 weeks) and there is little interference from weather changes. After initial wilting in the field , Leaves are stung to bamboo poles and sun cured for 15 to 20 days. There are many modifications of Sun-curing. a. Curing whole plant on racks: Cigar and chewing tobaccos of Tamil Nadu. b. Curing leaves together with pieces of stalk on racks: Natu tobacco in Andhra Prades h. c. Curing whole plant on the ground: Bidi tobacco of Gujarat, Hookah and chewing tobacco in Bihar. d. Curing primed leaves on the ground: Chewing tobacco in Uttar Pradesh and Hookah tobacco in West Bengal.

4. **Fire -curing**:

Important type of tobacco that is fire-cured is Jaffna tobacco of Ceylon and Tamil Nadu used for chewing purpose. The leaf is harvested by either priming or stalk-cutting each leaf together with a portion of the stem. The leaves are wilted for four hours in the field, tied into bundles and hung of laths in smoke huts. They are then smoked for 12 hours by burning coconut husks, leaf stalks and palmyrah nuts, stacked for 3 days and again smoked. Alteration of firing and stacking at an interval of few days helps in making the colour of leaf uniform. During the smoke treatment, creosotic substances are deposited on leaf surface imparting a peculiar taste. After smoking, the leaves are bulked for 3-4 weeks and treated with salt water/jaggery prior to sale. 161

5. **Flue-curing of Virginia Tobacco**

Harvesting of two or three well-matured and ripe leaves is termed as priming which is essential for production of quality tobacco. Ripe leaves have greenish-yellow colour, with a velvety feel, losing much of the stickiness. They have a tendency to lie horizontally or bend slightly down the plant and the leaf-tips are slightly dry. As a general rule, leaves are harvested from bottom lower leaves on slightly greener side, middle leaves when they are ripe and top leaves when they are fully ripe.

Harvesting must be done on a clear weather day and on an average, not more than three leaves are harvested at a time. Immediately after rains or irrigation, harvest is to be delayed by 2 - 3 days. Under normal conditions, harvests are carried out at weekly intervals. Leaves should be plucked against the direction of the sun for better judgment of the colour of matured leaf. While picking, midribs should not be bent down, but they have to be bent side-ways. A well-matured leaf will snap crisply with a characteristic sound. The leaves are to be carried carefully without pressing to one end of the field and placed carefully in a wide basket with tips upward. The basket has to be taken to the tying shed as early as possible to minimize wilting in the field.

Green-leaf grading: In spite of utmost care, there is a chance that immature and over mature leaves are harvested. The over ripe (yellowish white) and under-ripe (dark green) leaves have to be sorted out and tied separately so that each stick contains leaves of uniform colour.

Tying the leaves: The leaves are to be tied to sticks by handling gently in a shaded place avoiding wilting and bruising. A bruised leaf (physically damaged) does not cure well in the barn. About three leaves are tied in a bunch, back-to-back, with a jute twine loop on a stick. About 90-100 such leaves are tied in separate bunches with a series of loops on a stick approximately 130 cm long. The leaves are distributed uniformly all over the length of the stick to avoid over crowding.

Loading the barn For a satisfactory curing, the whole barn should be loaded with the freshly harvested leaves from a single priming. The un-ripe leaves (green) are placed on the top tiers, the over-ripe leaves (yellowish-white) leaves on the bottom tier and well-matured leaves (greenish-yellow) in the bulk of the intermediate tiers. The sticks are placed on the tiers at a distance of 20-25 cm so that the leaves from the adjacent sticks slightly touch each other without pressing. A 5m x 5m x 5m barn is usually loaded with 750 sticks with the above spacing. The barn should not be over loaded while curing the bottom and middle leaves since slow rate of drying affects leaf quality. Top leaves may be crowded slightly by closer spacing without affecting grade outturn.

Curing practice Curing virginia tobacco according to fixed schedule is not possible always because of the variability in green leaf due to various factors like weather condition, plant position, leaf maturity, disease prevalence and in such cases, slight adjustments are necessary.

Curing schedule:

1.Yellowing:

Temperature: Dry bulb: 85-105oF, Wet bulb: 82-94°F.

Time: 36-48 hours.

Furnace is charged after loading the leaf and temperature is raised by 5 to 6°F above outside temperature. Top ventilator is left very slightly open, especially during the cooler hours of the night, bottom ventilators are left open with slight gaps so that upward movement of air continues in the barn. Temperature is raised by not more than 1 to 2°F per hour up to 105°F when the leaf becomes yellow and is ready for fixing. Top and bottom ventilators are gradually opened to 3” .

3. **Fixing colour**

Temperature: Dry bulb: 105-120°F Wet bulb: 94-98°F

Time: 5-10 hours Progressive total time: 39-47 hours.

Utmost care is required in raising the temperature during this stage. It is raised by not more than 1 to 2°F per hour. Bottom ventilators are opened to 3" to 5" at the base. Top ventilator is raised to a height of 3" to 5" from the roof. It is not necessary to raise the top ventilator completely.

4. **Leaf drying**

Temperature: Dry bulb: 120 to 145°F Wet bulb: 98 to 110°F

Time: 36-48 hours

After attaining 130 °F, the top ventilators are gradually closed and subsequently the bottom ventilators are closed. At 140°F all the ventilators are closed.

5. **Midrib drying**

Temperature: Dry bulb: 145 to 160°F Wet bulb: 110 to 114°F

Time: 24-36 hours Progressive total time: 88 to 101 hours.

Temperature is raised and maintained at a maximum of 160°F until the stem is dry. The ventilators which have been closed during the later part of the leaf-drying stage continue in the closed position.

Grading:

Grade specifications for the 10 farm grades for black soil tobacco

1	Farm-I	Bright lemon or orange	Thin to Medium	Soft	25%	1 to 4
2	Farm-II	Light Brownish yellow or Brownish lemon	Medium	Good	25% (White to yellow blemish allowed)	LBY 1
3	Farm-III	Light Brown	Good to Medium	Medium	50%	LBY 2
4	Farm-IV	Brown	Heavy Body	Medium to Coarse	50%(brown blemish allowed)	Brown

5	Farm-V	Dark Brown	Heavy Body	Medium to Coarse	50%	Dark Brown
6	Farm-VI	Light Greenish orange	Good	Soft to Medium	10%	LG
7	Farm-VII	Light Medium green	Heavy	Medium to Coarse	25%	LMG
8	Farm-VIII	Medium Green	Heavy	Medium to Coarse	35%	MG
9	Farm-IX	Dark Green	Coarse	Coarse		DG
10	Farm-X	Orange, yellow green and / or brown	Variable			Pl & Bits

Quality Characters:

The concept of quality in flue -cured tobacco has attained a new dimension in the present day context because of higher mobility in international market, ever - growing sophistication among smokers taste and increasing automation in cigarette industry. While overall monetary return is a good enough criterion of quality to a farmer, visible quality like colour, is very important for marketing purposes; but to an industrialist, those manufacturing qualities which maximise profit are most desirable features provided tobacco possesses satisfactory smoking quality which in turn depends upon chemical composition of the leaf material. Flue-cured tobacco quality thus is made up of many complex components, viz. physic al, chemical, organoleptic and also economic attributes. Smoking quality plus manufacturing capacity equals the suitability of tobacco. So the quality characters of FCV tobacco are divided into visual characters, manufacturing characters and chemical characters.

The visual characters are colour, body, texture, maturity/ ripeness, graininess, hygroscopicity, shatterability, blemish, elasticity, fluffiness, aroma, leaf size, vein colour etc. These characters are subjective based on which the tobacco leaf is graded and

purchased by the trader. Objective quality criteria have been developed for manufacturing characters and chemical characters. The manufacturing characters are filling value, equilibrium moisture content, pore volume, elasticity, shatterability, combustibility, lamina-midrib ratio (strip yield), number of leaves per kg, lamina weight per unit area etc. Though, tobacco leaf contains hundreds of chemical constituents, only few have a dominating influence on quality. Nitrogenous and carbohydrate fractions are the two groups of chemical constituents having profound effect on the smoking quality. Chloride in leaf is also very important as it influences the combustibility and keeping quality of leaf.

Physical Properties:

Tobacco buyers evaluate tobacco by its visual characteristics. Such a system of subjective quality evaluation varies with personal fancies and hence cannot be considered as precise. The necessity of objective laboratory tests to evaluate physical qualities has become essential.

Filling value

Filling value is the volume occupied by unit weight of cut tobacco at predetermined moisture level under a specific stress. Filling value may be taken to be a measure of the relative number of cigarettes of a given firmness that could be manufactured from a unit weight of tobacco.

Shatterability

Another important economic factor in tobacco quality is its resistance to breakage during handling. Tobacco is a fragile material that tends to shatter to a greater or lesser degree with handling. Breakage becom es accentuated under the stress of mechanical

processes in the factory. Tobaccos do differ in their relative brittleness due to various factors. Strength in tobacco leaf is dependent on calcium pectate, the cementing material in the cell wall.

Strip yield

Strip yield in flue-cured tobacco is important to manufacturers since it is the lamina portion of leaf that is normally used in cigarette making. Because of the low utility of midrib, a large bulk of exportable flue-cured leaf is despatched only in the form of strips. This makes strip yield an important criterion in developing varieties, as higher the strip yield, greater is the economic return. Strips constitute, on an average, about 75% of leaf by weight, ranging from 70-80%. Within this range, higher the strip yield, better is the usability of tobacco.

Elasticity

Elasticity is the ability of the leaf, when moist, to undergo stretching without breaking. Such tobaccos after being compressed, as practiced during cutting in the manufacture of cigarettes, will spring back immediately.

Texture or porosity

Leaf structure or texture is an important physical property of flue-cured tobacco. Texture and grain are synonymous for cigarette tobacco. Graininess in flue cured tobacco is a measure of porosity of leaf which regulates its capacity to absorb and retain additives in the intercellular air chamber.

Hygroscopicity

Hygroscopic properties of cured leaf as judged by equilibrium moisture content is an important technological criterion for judging quality. It is the moisture absorbing capacity of leaf which depends on the relative humidity of the surrounding environment. Cured leaf low in hygroscopicity is very difficult to get to `order' or `condition', with the result the leaf handling is difficult. High hygroscopicity on the other hand, entails operational difficulty in the cutting and making machines.

Combustibility

Combustibility or burning quality of tobacco involves several criteria like fire holding capacity, rate of burn, evenness or completeness of burn and character of residual ash. Leaf burn is very commonly used to determine the burning quality of cured leaf.

Chemical Characters:

Total nitrogen

It is generally considered that flavour and taste of smoke is correlated with nitrogenous constituents. Flue-cured tobacco containing 1.6 to 2.3% total nitrogen gives the most satisfying smoke. Higher nitrogen content of tobacco would result in, apart from curing difficulty, deep brown coloured trashy leaf which shatters readily and it has flat-insipid tasting smoke. Generally high level of nitrogen is associated with high level of nicotine. Lower nitrogen content would result in `washed out', pale coloured leaf, lacking in rich colour characteristic of good tobacco.

Nicotine

Nicotine content of tobacco is an important constituent because of its stimulatory effect on the smoker. In FCV tobacco, a nicotine level of 1.7 to 2.0% is desirable and nornicotine should not exceed 5% of total alkaloids. Higher proportion of nornicotine leads to abnormal and objectionable smoke due to pyrolysis of nornicotine into myosmine.

Nitrogen / nicotine ratio

The ratio of nitrogen to nicotine is assumed to give some chemical balance within the leaf. Tobacco with higher ratio is less desirable because it tends to be light bodied. A ratio of about 1.35 results in pale colour, slick texture, poor physical characters and deficiency in aroma. In fact, a value exceeding 1.0 has been ascribed as unbalanced. Low value (below 0.5) is considered undesirable because the tobacco is heavy bodied and associated with high nicotine content and low level of reducing sugars. Ratio in the range of 0.6 - 0.7 is adjudged as most desirable in medium to light bodied matured tobacco.

Reducing sugars

Higher content of reducing sugars in flue cured tobacco is undesirable as it imparts an acidic character to the smoke. Lower content imparts alkalinity to smoke due to high nitrogenous constituents. During smoking, sugars yield CO_2 and water as pyrolysis products, thus helping to neutralise free base and increase moisture content in smoke and serving as an emollient.

Reducing sugars / nicotine ratio

The ratio of sugar to nicotine would give a balance of opposing effects and thus serve as an index of smoking quality. Higher ratio indicates mildness and smoothness while a very low ratio reflects the harsh and irritating smoke. If cured leaf is low in nicotine and sugars, as generally is the case with Indian flue-cured tobaccos, the ratio appears to be acceptable. Higher sugar content consistent with nicotine level is the most desirable feature for smoking quality in flue-cured tobacco and the desirable ratio is 7-13.

Carbohydrate / protein ratio

The ratio of carbohydrates to proteins is known as Shmuk number and the ratio of carbohydrates to total nitrogen is known as Kovalenko coefficient. These ratios also give similar indications as in the case of reducing sugar to nicotine.

Chlorides

Higher level of chloride in leaf inhibits leaf burn or combustibility. The chloride content of leaf must be preferably less than 1. 5% but should never exceed 2%. Chloride content is positively correlated with deterioration of colour. High chloride content in leaf leads to dull muddy orange colour with sour or linoleum smell. Further, such leaf due to its moisture holding capacity bruises easily and tends to develop `off-colour'. These characteristics render this type of leaf to be of low value for cigarette manufacture. Chlorine acts as a negative combustion catalyst in tobacco.

Potassium

Potassium content in the cured leaf improves the burning quality of tobacco.

An adequate level of potassium in cured leaf tends to off-set the deleterious effect of chloride on burning quality.

Potassium acts as a mineral catalyst and oxygen carrier in promoting leaf burn. Cured leaf with low potassium content is trashy and dull which may not have any commercial value.

Acceptable limits for the important quality constituents and quality indices in flue -cured tobacco.

Constituent/Quality Index	**Acceptable Limits**
Total Nitrogen (%)	1.0 - 3.0
Nicotine (%)	0.7 - 3.0
Total Sugars (%)	10.0 - 26.0
Reducing Sugars (%)	8.0 - 24.0
pH	4.6 - 5.5
Reducing Sugars/ Total N	7 - 13
Reducing Sugars/Nicotine	7 - 13
Total N/ Nicotine	< 1.2
Chloride (%)	< 1.5
Filling value at 60% R.H. and 20 ^{0}C	3.3 - 3.8cc/g of shreds
Equilibrium moisture content at 60% R.H. and 20 ^{0}C	11 - 15%
Pore Volume	0.13 - 0.18 ml/g
Combustibility	2.5 - 3.5 mm/min
Leaf burn	3 - 6 sec.
Shatterability Index	> 3

Note: The individual chemical constituents alone should not be taken into consideration for quality evaluation. The ratios of the constituents are also very important and should be taken into consideration for quality appraisal of tobacco.

In the case of non-FCV tobaccos, all the visual characters mentioned in the case of FCV tobacco are also important. Nicotine content is considered to be an important chemical constituent determining quality. Nicotine contents of different tobaccos produced in India are presented below.

Tobacco Type	**Nicotine (%)**
Virginia tobacco	1.2 - 3.6
Bidi tobacco (Anand)	9.7
HDBRG (Guntur)	3.9
Natu tobacco (Black soils)	2.8
Natu tobacco (Light soils)	3.5
Burley tobacco	1.3
Chewing tobacco (Tamil Nadu)	2.9
Cigar tobacco (Tamil Nadu)	1.2
Chewing tobacco(Bihar)	3.7
Cigar filler (West Bengal)	2.0
Cigar wrapper (West Bengal)	1.4
Jati-Chama (West Bengal)	3.7
Jati-Podali (West Bengal)	4.0
Motihari-Hemti (West Bengal)	4.8
Motihari-Bitri (West Bengal)	6.6

Varieties:

Hema, Gowthami, Jayasri, Hemadri, Siri

CHILLI

Botanical name: *Capsicum annum*

Family : Solanaceae

Green chillies are rich in proteins 2.9 g per 100 g. Ca, Mg, P, K, Cu and S. vitamins like Thiamine, Riboflavin and Vitamin C. Chillies are the major ingredients in curry powder. In powdered from it is mixed in red or cayenne pepper. Chilli pulp is pickled in strong vinegar or brine. Extracts of chillies are used in the production of Ginger beer and other beverages. Cayenne pepper is incorporated in poultry feeds, green chillies are rich in Rutin which has pharmaceutical use. Pungency of chillies is due to capsaicin. The pigment (colour) in chillies is due to capsanthin also contains many other oleoresins.

Climate:

Chilli is grown in both tropical and sub-tropical areas. It can grow up to 1100 MSL altitude. For vegetative growth it requires warm humid climate. For fruit maturity it requires warm dry weather. It requires a well distributed annual rainfall of about 500 – 900 mm. Heavy rainfall

leads to poor fruit set and high humidity leads to fruit rot. Optimum temperature for root development is 18-38C. Average night temperature favours high capsaicin content.

Soil:

Chilli can be grown on a wide variety of soils provided. They are well drained, well aerated and rich in organic manure. Sandy loam soil with adequate irrigation and manuring can support better crop of chilli.

Seed rate:

650g seed is required to raise seedlings per acre.

Seed treatment

- Treat the seeds with *Trichoderma viride* @ 4 g / kg or *Pseudomonas fluorescens* @ 10 g/ kg and sow in lines spaced at 10 cm in raised nursery beds and cover with sand.
- Watering with rose can has to be done daily.
- Drench the nursery with Copper oxychloride @ 2.5 g/l of water at 15 days interval against damping off disease. Apply Carbofuran 3 G at 10 g/sq.m. at sowing.

Nursery management:

Generally nursery of chilli is prepared by following method. Selcted area is ploughed to a fine tilth. Nursery bed should be prepared to a size of 6 m length 1 m width with a 15 cm raised. Raised beds are preferred than flat beds because on flat beds root development is poor and incidence of damping off is more. Application of 80g fipronil granules along with seed is required to avoid the incidence of sucking pests. Apply 1kg NSKE to 40m2 area. Mix 1% Bordo mixture or 3g COC in 1 litre water and apply to nursery bed area by 9^{th} and 13^{th} day. Optimum age of transplanting is 6 weeks.

Field preparation

Thoroughly prepare the field with the addition of FYM @ 25 t/ ha and form ridges and furrows at a spacing of 60 cm. Apply 2 kg/ha of Azospirillum and 2 kg / ha of Phosphobacteria by mixing with 20 kg of FYM. Irrigate the furrows and transplant 40-45 days old seedlings, with the ball of earth on the ridges.

Spacing

Varieties : 60 x 45 cm

Hybrids : 75 x 60 cm

Transplanting time:

Kharif : July, August

Rabi : October, November

Weed management:

Chilli is a slow growing crop cannot compete with aggressive weeds hand weeding or hoeing or application of herbicides need to be done in order to ensure weed free conditions. Herbicides like fluchloralin 45% 1 lit/acre incorporate in soil. Or pendimethalin 30% 1.3-1.6 lit or oxyflorfen 23.5% 200ml In 200lit water applied 1, 2 days before sowing.

Manuring:

10 tonnes of well decomposed FYM need to be applied in the last ploughing. Besides that 60 kg N, 40 kg P, 50 kg K per ha is to be applied. Entire quantity of FYM, Phosphorus, potassium and half of nitrogen is to be applied at the time of field preparation. Remaining half nitrogen is to be given as top dressing in two equal splits at one month interval of transplanting.

Harvesting:

Kharif : 3-4 pickings

Rabi : 6-8 pickings.

Varieties:

G 3, 4, 5, Sindhur, Aparna, LCA 235, LCA 206, LCA 305, LCA 304, 324, 334, 357 and poprica.

TURMERIC

B.N: ***Curcuma longa***
Family: Zingiberaceae

Turmeric is an important spice grown in India since ancient times. It is referred as Indian saffron and commonly called as Haldi. India is the largest producer, consumer and

exporter of turmeric in the world. The global production of turmeric is around 11 lakh tonnes per annum. India dominates the world production scenario contributing 80% followed by China (8%), Myanmar (4%), Nigeria (3%) and Bangladesh (3%). Major turmeric importing countries from India are Bangladesh (15,888.88 tonnes), Iran (11,859.50 tonnes), Morocco (7,225.72 tonnes), USA (6,318.45 tonnes) and UAE (5,938.10 tonnes). Underground rhizome is used as condiment, dye stuff, drug and cosmetic. India is the largest producer of Turmeric.

In India during 2019-20, about 2.54 lakh ha (6 lakh acres) area was covered under turmeric. The important turmeric growing states in India are Telangana 55,443 ha (1,37,000 acres), Odisha 27,864 ha (68,852 acres), Tamil Nadu 18,296 ha (45,209 acres), West Bengal 17,711 ha (43,764 acres), Karnataka 17,598 ha (43,895 acres), Assam 16,550 ha (40,895 acres), Maharashtra 14,511 ha (35,857 acres) and Andhra Pradesh 13,223 ha (32,674 acres).

In Telangana during the year 2019-20, area covered under turmeric was 0.55 lakh hectares (1.37 lakh acres) as against 0.53 lakh hectares (1.31 lakh acres) in the corresponding period of last year. Major turmeric growing districts in Telangana are Jagtial 13,707 ha (33,870 acres), Nizamabad 13,549 ha (33,480 acres), Nirmal 8,005 ha (19,780 acres), Warangal (Rural) 4,612 ha (11,396 acres) and Mahabubabad 4,424 ha (10,932 acres). According to Telangana State Government 3rd advance estimates, turmeric production in 2019-20 is at 3.07 lakh tonnes with productivity of 5543 Kg/ha (2243 Kg/acre).

Climate:

Tropical herb. Grows well 1200-1400m above MSL. Requires warm and moist climate. Rainfall 600-700mm. Temperature range preferable is 25 to 30 C.

Soils:

Can be grown on various soils. Thrives best in well drained, friable, rich sandy or clay loam soils. Crop stands neither water logging nor alkalinity.

Preparation of land:

Give 4-6 deep ploughings to get fine tilth up to 20 -25 cm depth. Apply 10t FYM at the time of last ploughing.

Time of sowing:

Short duration varieties: second fortnight of may

Mid duration varieties: first fortnight of June

Long duration varieties: second fortnight of June to second fortnight of July.

Seed rate:

1000kg/acre.

Seed Treatment

- Seed rhizomes dipped in phosalone 35 EC 2ml/lit or monocrotophos 36 WSC 1.5 ml/lit. 0.3% Copper oxychloride for 30 min or
- Seed treatment with *P. fluorescens* 10 g/kg and *T. viride* as 4 g/ Kg.

Propagation

- Mother rhizome & finger rhizomes. Seed rate of finger rhizome - 2000kg/ha.

Main Field Preparation:

- Main field is ploughed four times with chisel and disc plough each one time and cultivator twice.

- Ridges and furrows are formed at spacing of 45 cm (or) raised beds of 120 cm width are formed at an interval of 30 cm and the laterals are placed at the centre of each bed.

- The beds are wetted for 8-12 hours through drip irrigation depending upon soil moisture level.

Spacing

- 45 x 15 cm. 25-30 g weight rhizomes are to be dibbled at a depth of 4 cm.

Manuring:

To get higher yields along with chemical fertilizers add 4t vermi compost per acre , it will improve soil physical condition and organic carbon which helps in rhizome development.

Time of application	Fertilizers	As pure crop	Maize as intercrop
Last ploughing	FYM	10t	10t
	Castor/neem cake	200kg	250kg
	SSP	150kg	300kg
	MOP	25kg	60kg
40DAT	Neem cake	200kg	250kg
	Urea	50kg	90kg
80DAT	Urea	50kg	90kg
	MOP	25kg	30kg
120DAT	Urea	50kg	90kg
	MOP	25kg	30kg

Irrigation:

A good soaking irrigation is given immediately after sowing.Thereafter, irrigate at weekly interval.

Mulching :

The crop is to be mulched immediately after planting with green leaves @ 12-15 t/ha. Mulching may be repeated @ 7.5 t/ha at 40 and 90 days after planting after weeding, application of fertilizers and earthing up.

Intercrops:

Maize or chillies are grown as inter crops.Turmeric can also be raised as an inter crop in coconut and arecanut plantations. Rotations: Turmeric is a heavy feeder. Hence depletes soil nutrients. Continuous cropping results in build up of diseases. It is rotated with rainfed paddy, sugarcane, banana, betelvine, vegetables.

Harvesting:

Depending upon the varieties, the crop comes to harvest in 7-9 months.

1. Main season of harvesting falls in February – April.

2. Maturity indication is complete yellowing and drying up of plants

3. Above ground parts are cut close to the ground level.

4. Field is irrigated 1-2 days in advance of harvesting the crop.

5. Crop is harvested by Ploughing or digging.

6. Rhizomes are gathered by hand picking and cleaned.

7. Rhizomes are washed.

8. Mother rhizomes are separated from the fingers before they are cured.

Processing:

Fresh rhizomes are not useful for marketing. Curing makes fresh rhizomes marketable. Curing involves boiling, drying and polishing.

A. Boiling: is done either by traditional or improved method.

I. Traditional method: Water is poured to cover rhizomes in the vessels of copper or galvanized iron or earthen material. Mother rhizomes and fingers should be boiled separately, since fingers take long time for boiling. Stop boiling when froth, fumes with typical odour comes. Rhizomes yield to finger pressure. Over cooking should be avoided as it spoils the colour, while under cooking renders the dried product brittle.

II. Improved method: 50 kg of cleaned rhizomes are taken in a perforated trough made of GI sheet. It is immersed in a pan. Alkaline solution 0.1% sodium carbonate/ sodium bicarbonate is poured in the trough. Boil till fingers become soft. Alkaline solution helps in imparting orange yellow colour to the core.

B. Drying: The boiled rhizomes are sun dried in 5.7 cm thick layers for 10 – 15 cm layers. Rack frequently for uniform drying. Dry until they become hard, brittle, break with a metallic sound. After drying they should possess only 8 – 10 % moisture.

C. Polishing: The dried rhizomes are smoothened by manual or mechanical rubbing. Manually they rubbed on hard surface or trampled under feet. Mechanically they are polished by mechanically operated polishing drums.

D. Colouring: They are coloured to improve the appearance. Rhizomes are artificially coloured in two ways. Dry and wet colouring. Half polished fingers are coloured. In dry process – turmeric powder is added in the last 10 min to polishing drum. In wet process – turmeric powder is suspended in water and mixed by sprinkling. For brighter colour – boiled, dried, half polished fingers are taken in baskets and shaken continuously with an emulsion of Coloured rhizomes are again sun dried before sending to market.

Varieties:

Long duration:

Mydukur, Tekuripeta, CLL 326, Armur, Duggirala erupu, Guntur telupu

Medium duration:

CLI 317, Amrutapani, Kottapets

Short duration:

Kasturi, Suguna, Sudarhana

CORIANDER

Botanical name: ***Coriandrum satuvum***
Family : Apiaceae.

Coriander is cultivated both for seed and leaves. It is a minor seed spice. It is grown for seed in Andhra Pradesh, Tamil Nadu, Karnataka, Madhya Pradesh, Orissa, Rajasthan for leaf throughout

the country. In Andhra Pradesh, Coriander is grown in Kurnool, Anantapur, Cuddapah, Guntur and Prakasam, Medak and Nizamabad

Varieties:

The improved varieties released from RARS, Lam.

Lam CS 2 – Sindhu: It is a medium tall variety – more branching – seeds are straw coloured. It withstands pests and diseases – It yields about 1300 to 1400 kg per ha. The duration of the crops is about 105-110 days.

Lam CS 4 – Sadhana: It is fairly tall – good branching – seeds are straw coloured. It withstands pests and diseases – it is a dual purpose – it yields about 1400 to 1500 kg per ha – the duration is about 115 – 120 days.

Lam CS 6 – Swathi: It is a medium tall variety. Much branching. Seeds are straw coloured. It is an early and short duration variety. It yields about 800 to 1200 kg per ha. It has a duration of about 80 -85 days. It escapes Powdery Mildew disease.

Lam CS 7: It was developed as a selection from North India – It is a dwarf plant with more leaves.

Climate:

It can be grown under tropical and subtropical conditions. It require cool climate in early stages and warm dry weather at maturity. It needs dry and cool weather free from rains at flowering and fruit setting stage. Heavy rains effect the crop.

Soil:

Well drained soils, moisture retentive, humus rich soils are essential. It can be grown in sandy loams to heavy black cotton soils. Heavy Black cotton soils of Deccan and South India are particularly suited.

Land preparation:

For rain fed crop plough 3-4 times. For irrigated crop plough twice or thrice. After ploughing is complete, the land is laid out into beds and channels.

Sowing time:

for rabi crop mid October to middle of the November. For Kharif crop June-July to August - September.

Seed rate:

it needs 12-15 kg per ha in A.P. Crush or trample the seeds gently to separate pericarps. Soak the seeds in water fro 12- 21 hours. Treat with Thiram @ 2 g per kg seed. Shade dry before sowing.

Method of sowing:

Broadcast sown for rainfed crop. A spacing of 3-40 cm x 15 cm is adopted for an irrigated crop. Germination starts within 10-15 days and will be over by 30 days.

Manuring:

10-15 tonnes FYM; 20-30 kg N; 40 kg P2O5; 20 kg K2O per ha is given as basal dose.20-30 kg Nitrogen is given at flowering under irrigated conditions.

Maturity indices:

Green colour turn to straw coloured. If harvesting is delayed – seeds shattered, fruits splitted. Plants are cut or pulled. Tied in bundles. Piled in shade for drying to avoid grain shattering and loss of essential oil. After 2-3 days of shade drying, the grain is threshed, winnowed and sundried. The moisture content is reduced from 2 to 6 per cent. The cleaned, dried produce is stored in gunny bags lined with white polythene.

Harvesting:

The crop will be ready for harvest in 80-120 days. Kharif crops comes to harvest earlier than Rabi.

Varieties:

Sindhu, Sadhana, Swathi, Sudha