

# Agronomy of Oilseed, Fibre and Sugar Crops

Course Code: Agron 507

Credit Hours: 2+1



**Centurion**  
**UNIVERSITY**

*Shaping Lives...*  
*Empowering Communities...*

**Department of Agronomy**  
**MS SWAMINATHAN SCHOOL OF AGRICULTURE**  
**CENTURION UNIVERSITY OF TECHNOLOGY & MANAGEMENT**  
**Paralakhemundi, Odisha-761211,**  
**INDIA**

***Theory Class course outlines***

<b>Sl. No.</b>	<b>Lecture No.</b>	<b>Topic</b>
<b>1.</b>	<b>1-4</b>	<b>Rapeseed and mustard</b>
<b>2.</b>	<b>5</b>	<b>Linseed</b>
<b>3.</b>	<b>6</b>	<b>Niger</b>
<b>4.</b>	<b>7-9</b>	<b>Groundnut</b>
<b>5.</b>	<b>10</b>	<b>Sesame</b>
<b>6.</b>	<b>11</b>	<b>Castor</b>
<b>7.</b>	<b>12</b>	<b>Sunflower</b>
<b>8.</b>	<b>13-14</b>	<b>Soybean</b>
<b>9.</b>	<b>15</b>	<b>Safflower</b>
<b>10.</b>	<b>16-20</b>	<b>Cotton</b>
<b>11.</b>	<b>21-23</b>	<b>Jute</b>
<b>12.</b>	<b>24</b>	<b>Mesta</b>
<b>13.</b>	<b>25</b>	<b>Sugar-beet</b>
<b>14.</b>	<b>26-32</b>	<b>Sugarcane</b>

## Index

<b>Sl. No.</b>	<b>Topic</b>	<b>Page No.</b>
<b>1.</b>	<b>Rapeseed and mustard</b>	<b>4-12</b>
<b>2.</b>	<b>Linseed</b>	<b>13-19</b>
<b>3.</b>	<b>Niger</b>	<b>20-24</b>
<b>4.</b>	<b>Groundnut</b>	<b>25-31</b>
<b>5.</b>	<b>Sesame</b>	<b>32-37</b>
<b>6.</b>	<b>Castor</b>	<b>38-41</b>
<b>7.</b>	<b>Sunflower</b>	<b>42-47</b>
<b>8.</b>	<b>Soybean</b>	<b>48-53</b>
<b>9.</b>	<b>Safflower</b>	<b>54-58</b>
<b>10.</b>	<b>Cotton</b>	<b>59-67</b>
<b>11.</b>	<b>Jute</b>	<b>68-72</b>
<b>12.</b>	<b>Mesta</b>	<b>73</b>
<b>13.</b>	<b>Sugar-beet</b>	<b>74-76</b>
<b>14.</b>	<b>Sugarcane</b>	<b>77-88</b>

## Oil seeds and their importance

What is fat penalty?

- Oil seeds are energy rich crop
- 1g of photosynthate is converted as:
  - 0.70 g of cereal
  - 0.64g of pulses
  - 0.42g of oil / fat
- Energy content MJ/kg
  - Oil - 39.8
  - Protein - 23.9
  - CHO - 16.8

**Table 2: Estimated domestic production, import and total availability of edible oils during last 3 years (November to October) (Quantity in lakh tonnes)**

Vegetable oils	2014-15		2015-16		2016-17	
	Oils	Oilseeds	Oils	Oilseeds	Oils	Oilseeds
<b>Primary source (A)</b>						
R-M	19.47	62.82	21.08	67.97	24.74	79.77
Soybean	16.6	103.74	13.73	85.70	22.10	137.94
Ground nut	17.02	74.02	15.27	67.33	17.16	75.65
Sunflower	1.43	4.34	0.98	2.96	0.80	2.41
Sesame	2.57	8.68	2.65	8.50	2.45	7.84
Niger seed	0.23	0.76	0.21	0.74	0.24	0.83
Safflower	0.27	0.90	0.15	0.53	0.22	0.78
Castor	7.48	18.70	6.16	17.52	4.99	14.21
Linseed	0.47	1.55	0.32	1.25	0.39	1.54
<b>Sub-total (A)</b>	<b>65.54</b>	<b>275.51</b>	<b>60.55</b>	<b>252.50</b>	<b>73.09</b>	<b>320.97</b>
<b>Secondary source (B)</b>						
Coconut	4.80		4.32		5.32	
Palm oil	1.71		1.98		2.30	
Cotton seed	12.15		10.05		12.24	
Rice bran	9.20		9.90		10.31	
SEO	3.00		3.50		2.85	
Tree & Forest origin	1.60		1.50		1.50	
<b>Sub Total</b>	<b>32.46</b>		<b>31.25</b>		<b>34.40</b>	
<b>Total (A+B)</b>						
Less exports & Industrial use	<b>5.94</b>		<b>5.50</b>		<b>6.50</b>	
<b>NDA of edible oils</b>	<b>92.06</b>		<b>86.30</b>		<b>100.99</b>	
<b>Import of edible oils</b>	<b>138.53</b>		<b>148.50</b>		<b>153.17</b>	
<b>Total consumption of edible oils</b>	<b>230.59</b>		<b>234.80</b>		<b>254.16</b>	

*Source: DGCIS, Department of commerce*

**Table 3: India's Imports of oilseed and vegetable oil Products**

(Quantity: '000 tonnes), (Value Rs. Crore)

Commodity	2015-16 (P)	
	Quantity	Value
Sesame seeds	23.60	179.66
Niger seeds	5.78	44.14
Groundnut	0.11	0.31
Other oil seeds	62.51	218.62
Vegetable oils	15642.33	68676.62
Oil meals	148.30	210.38
Castor oil	0.14	2.23
<b>Total</b>	<b>15882.77</b>	<b>69331.96</b>

Source: DES, DAC&amp;FW

**Table 4: India's Exports of Oilseed and Vegetable oil Products**

(Quantity: '000 tonnes), (Value Rs. Crore)

Commodity	2015-16 (P)	
	Quantity	Value
Sesame seeds	328.46	3012.31
Niger seeds	14.12	123.27
Groundnut	542.73	4075.63
Other oil seeds	204.62	964.47
Vegetable oils	30.60	522.94
Oil meals	6578.17	16519.53
Castor oil	565.99	4309.82
<b>Total</b>	<b>8264.69</b>	<b>29527.97</b>

## Share of vegetable oil consumption in India

- 70's
  - Peanut – 53%
  - Rapeseed – 25%
  - Cotton seed oil – 9%
  - Palm, soybean, & sunflower – 4%
- 1999-2000
  - Palm – 38%
  - Soybean – 21%

## Historical oil seeds in India

- Coconut, sesame, mustard, cotton seed, linseed, castor, Niger, safflower

## Newly introduced oil seeds

- Groundnut, soybean, sunflower, oil palm

## Byproducts of cultivated crops

- Rice bran, tapioca seed, maize germ, tobacco seeds, rubber seeds, tung(*Aleurites fordii*), jute seeds, spent coffee grounds, tea seeds
- Plus many more

## Importance of oilseeds in Indian agriculture

- The crops that are cultivated for the production of oils are known as oilseed crops.
- Oilseeds are the raw materials for vegetable oils and they are energy rich crops.
- Oilseed crops are the most important commercial crops in India.
- The Rapeseed and Mustard, Sesamum, Sunflower, Safflower, Linseed, Soybean, Niger, Groundnut and Castor are the most important oil seed crops of India.

### Classification

- The oilseed crops are classified according to the nature of oil produced
- **Edible oilseed crops**
  - The most important source of supply of edible oils are the seeds known as edible oil.
  - E.g., Rapeseed & mustard, sesamum, groundnut, Niger, sunflower, safflower, soybean etc.
- **Non-edible oil seed crops**
  - The most important source of supply of non-edible oils are the seeds known as non-edible
  - E.g., Castor, Linseed etc.
- **Nutritional value of oilseeds**
  - The bio-chemical composition and quality of the oilseeds and their products are important for the food and feed purposes.
  - Edible oils are the concentrated sources of energy. The energy content of oil is much higher (39.80 MJ/kg) than protein (23.88 MJ/kg) or carbohydrate (16.76 MJ/kg).
  - They contain useful carbohydrates, essential fatty acids and vitamins A, D, E and K and provide essential fatty acids.
  - Oil cakes/ oil meals are rich sources of protein (40-60%) to human and animals. They can also be used as organic manures.
  - Oil quality for food purpose can be described in terms of Saturated Fatty Acid (SFA), Monounsaturated Fatty Acid (MUFA) and Poly Unsaturated Fatty Acid (PUFA).
  - Saturated Fatty Acid (SFA) - Palmitic and Stearic acid. They have direct relation with blood cholesterol and coronary heart diseases as it increases low density lipoprotein that is harmful.
  - Unsaturated Fatty Acid (SFA) - Oleic, Linoleic, Linolenic and Erucic acids.
  - Linoleic & Linolenic acids (Poly Unsaturated Fatty Acids – PUFA) are Essential fatty acids (not synthesized by human body and are to supplied from outside).
  - Groundnut, coconut, sesame and sunflower oils have moderate amounts of saturated

fatty acid but lack in one essential fatty acid i.e. linolenic acid.

- Soybean, safflower and mustard oils have both essential fatty acids as Linoleic and Linolenic acids.

➤ **Importance of oil seed in Indian economy**

- In terms of vegetable oils, India is the fourth largest oil economy in the World after USA, China and Brazil.
- The oil seeds contain 20 – 60 % oil, which is chiefly consumed as food and energy source.
- They are energy rich and cash value crops.
- Oil seed crops can serve as pasture, cover and green manure crops. They are also used as fodder and for silage.
- Vegetable oils have medicinal and therapeutic value and also used as laxatives. E.g., Castor, Safflower & Sunflower oil.
- Safflower tea – prevents cardiovascular diseases and gynecological disorders. If consumed daily, it reduces blood pressure.
- Certain oil seed cakes have vermifugal action & it is used for pest control purposes. E.g., Mustard, Castor.
- Vegetable oils and its derivatives are biodegradable and eco-friendly thus they can be used as diesel substitutes.
- The edible oils are used as cooking oil, vanaspati and proteins.

## Rapeseed-Mustard

*Brassicas sp.*

Brassicas are grown next to peanut in India. Rapeseed-mustard is a common name to three Genera :

- *Brassica*
- *Eruca*
- *Sinapsis*

- o Brassica is more important

### Importance of Brassicas in India

- o It is main Rabi season crop in India
- o Green tender plant is used as vegetable
- o Whole seed is for preparing pickles and flavoring vegetables and curries
- o Oil for cooking, frying and pickles
- o Oil is also used for vegetable ghee, hair oil, soap, lubricating oil, and tanning industries
- o Seed & oil have peculiar pungency
  - o Due to presence of glucose sinigrin
- o Oil cake is a cattle feed to be fed at smaller quantity

### Canola

- o It is a trade name to rapeseed oils which possess
  - o <2% erusic acid
  - o Solid components should contain
    - <30 micromoles /g of glucosinolates
- o May be Canadian oil like “Mazola” (maize oil – Corn oil), “Sanola” sunflower oil( again brand name for PUFA content)
- o Of late refers to ‘generic’ but
  - o Those rapeseed varieties metingabove the specification (Erusic acid causes heart lesions and Glucosinolates cause thyroid enlargement)

### Brassicas grown in India

Taxonomic name	Common name	Hindi	Oil Content
<i>B. Campestris</i>	Turnip rape	Brown sarson	Kali sarson
<i>Var. brown sarson</i>	Brown sarson	Kali sarson	43%
<i>Var. yellow sarson</i>	Yellow sarson	Peeli sarson	45%
<i>Var. toria</i>	Indian rape	Toria	35%
<i>B. napus</i>	Swede, summer, winter rape	Gobhi sarson	Oilseed
<i>B. Juncea</i>	Indian mustard Mustard	Rai, Raya Laha	35%
<i>B. toumefortii</i>	Wild mustard	Jungli rai	18%



<i>B. carinata</i>	Ethiopian mustard	Karan rai	Oilseed
<i>B. nigra</i>	Black mustard	Banarsi rai	29% Condiment
<i>B. Oleracea</i>			Vegetables
<i>Eruca sativa</i>	Rocket	Taramira	28%

#### Rapeseed vs. Mustard

Character	Rapeseed (Sarson/Toria/Lahi)	Mustard (Rai, Raya, Laha)
Plant height (cm)	45 – 150	90-200
Leaves	Sessile, leaf lamina clasps the stalk	Leaves stalked but do not clasp
Siliquae (pod)	Short or thicker	Long & slender
Pollination	Cross pollinated	Self pollinated
Seed coat	Smooth	Rough

#### Brown sarson vs. Yellow sarson

Character	Brown sarson	Yellow sarson
Leaves	Pale, thin	Dark green and fleshy
Branching	Erect, spreading	Erect
Siliquae (pod)	Thin, narrow	Thick and broad
Seed coat	Dark brown to reddish brown & mucilaginous	Yellow & non mucilaginous

#### Origin

- Rai – China
- Toria – East Afghanistan
- Brown sarson – E. Afghanistan & adjoining Indian sub-continent
- Yellow sarson – N.E. India

#### Rapeseed-Mustard: Area cultivated in the world (1997) – (Million ha & million t)

Country	Area	Production	Productivity
India	6.81	6.96	1.02
China	6.79	9.54	1.41
Canada	4.84	6.19	1.29
France	0.99	3.49	3.53
Germany	0.92	2.84	3.10
<b>World</b>	<b>24.2</b>	<b>35.15</b>	<b>1.45</b>

Rapeseed-Mustard : Area in India (1997) (Million ha & million t)

State	Area	Production	Productivity
Rajasthan	2.96	2.65	0.99
UP	1.43	1.47	1.03
Gujarat	0.34	0.47	1.37
Haryana	0.61	0.89	1.46
MP	0.82	0.75	0.91
WB	0.32	0.28	0.89
Assam	0.28	0.14	0.51
Punjab	0.09	0.11	1.27
<b>India</b>	<b>6.81</b>	<b>6.96</b>	<b>1.02</b>

**Brassicas Area in India**

- Till independence area remained constant (2.0million ha)
- From 50's area rose steadily
  - Due to increase in irrigated area
  - Increased productivity, varieties and agronomic practices
  - Maximum area was in 6.87 million ha -96-97
- Major states growing are
  - Rajasthan, UP, Gujarat, Haryana, MP, WB, Assam & Punjab

**Climate**

- A crop of temperate
- Can be in higher elevation of tropics
- Rabi season crop in India,
  - Sep-Oct to Mar-Apr
- Temperature range 3 to 40°C
- Optimum 18-25°C with cool, dry clear weather
- High RF, high humidity, cloudy atmosphere at flowering undesirable
- Most susceptible to frost

**Season**

- Sowing starts from August ends in November
- Sowing of rapeseed is ahead of mustard
- Taramira is sown from mid-Sep to Oct end
- Region wise season varies

**Varieties**

- Mustrad
  - Varuna (T 59), TM 2, TM 4, Seetha
- Brown sarson
  - KNS 3, KOS 1
- Yellow sarson
  - PUSA GOLD, YS 93
- Toria
  - Jawahar Toria, Panchali, TS 29
- Taramira
  - RTM 13, TMC 1

## **Soil**

- Varying soil from sandy loam to clay
- Thrives well in light soil
- Mustard on any soil but rapeseed in light
- Well drained soil is more suitable
- Waterlogging should not be
- Saline alkaline soils are unsuitable
- pH 6.5 to 7.5, neutral soil is ideal

## **Land preparation**

- Fine seed bed since seeds are small
- Flat bed to perform ferti cum seed drill

## **Seed rate & spacing**

- 4-6 kg depending upon seed weight
  - 3-5 g/1000 depending upon crop and variety
- 30 x 10 to 30 x 15cm
  - 22.2 to 33.3 plants m<sup>-2</sup>

## **Sowing**

- Treat the seeds with fungicides well before sowing
- May be behind the country plough
- Ferti cum seed drill
- Depth of sowing 3-4cm
- Avoid shallow sowing
- Cover the seeds after sowing
- Sowing may be on conserved soil moisture

## **Manuring**

- Oil seed crops removes huge nutrients
- S is removed in large and needs return
- General recommendation varies to States
- 60-40-40 for irrigated
  - Half N 30 DAS
  - If SSP is applied S is taken care, if not
  - 20-40kg elemental sulphur, if soil analyzed with <10ppm
- 30-20-20 for rainfed (half of irrigated)
  - All basal
- Nutrient requirement may be calculated by critical concentration
  - 6.07 – 6.62% N in top 2-3rd leaf at 60 DAS
  - 0.408 – 0.412% S in 4-5th leaf from top
- Integration with biofertilizer 'Azotobactor' is desirable

## **Irrigation**

- Total water requirement - 400mm
- Moisture at pre-flowering and pod filling stage is critical
  - Two irrigations for mustard
    - One at rosette stage (20-30DAS)
    - Another at siliqua atage (50-60DAS)

- In light soils three irrigations, the third at 90DAS
- IW/CPE ratio of 0.6 is optimum

### Weed management

- Dominant weeds
  - *Chenopodium album*
  - *C. murale*
  - *Convolvulus arvensis*
  - *Melilotus alba*
- Intercultural operation 5-10days after 1st irrigation
  - Hand hoeing is desirable, it aerates the soil
  - Soil aeration is to conserve soil moisture
- Herbicides can also be used
  - Pendimethalin pre-emergence 0.5-1.5 kg/ha based on soil
  - Fluchloralin 1.25kg pre-plant incorporation
  - Post emergence Isoproturan 0.75 kg /ha for
    - Wheat+mustard mixed systems

### Harvesting maturity

- Color of leaves, stem and silique turn green to pale yellow
- Lower silique looks – dried appearance
- Upper may be green
- Seeds in the silique makes rattling sound
  - Silique with 2 carpels and a false septum
  - During over maturity the two carpels split and seeds shed
  - Premature harvest leads to shriveled grains

### Threshing

- After sun drying for few hours
- Beating pods along with the plants
  - Either manually
  - Machine
  - Walking bullocks, or running tractor
- Cleaning and drying to 8-10% moisture for storage
- Average yield
 

▪ Irrigated rapeseed	1.5 to 2.0 t
▪ Rainfed rapeseed	1.0 to 1.5t
▪ Irrigated mustard	2.0 to 2.5 t
▪ Rainfed mustard	1.5 to 2.0t

### Cropping systems

- Fallow / millets / pulses – mustard
- Rice – rapeseed
- Intercroppings
  - Mustard + chickpea
  - Mustard + sugarcane
  - Mustard + barley / wheat / chickpea
  - Potato + mustard

**Linseed**  
*Linum usitatissimum*

---

**Linseed**

- It is dual purpose crop like soybean and cotton. It is called 'Old world fibre'. Of late in India it is used primarily for oilseed.
- Linseed fibre or FLAX first of the vegetable fibres spun to cloth
- Oil in seed was used only later
- When grown for fibre called as Fibre flax
- When identified for oil then
  - Oil flax or
  - Seed flax or
  - Linseed
- Linola – (Edible linseed)

**Importance of Linseed**

- It is primarily considered for fibre - FLAX
- In India primarily for oil seed
- Entire plant has usage
- Oil
  - 80% for industrial purpose
  - Very small scale for direct consumption
  - Rich in Linolenic acid (66%)
    - Perfect drying oil, used in paint & varnish industry
  - Used for manufacture of lithographic inks and soaps and coating of high ways
  - After hydrogenation, substitute for tallow (hard fat from animals)
- Oil cake good for milch animal & as manure
- Stem yield good quality fibre (linen) having strength and durability
- Fibres are lustrous and blend well with wool, silk, cotton
- Strong canvas, suiting, shirting and various indispensable products for defense purposes
- Woody matter for high quality paper
- Demand is increasing, as a result import is going on

**Problems and prospects for linseed in India**

- As fibre there is scope, even today, but farmers' preference is for oilseed.
- As oil seed also its importance for industry is declining due to:
  - Paint industries are relying on synthetic and petroleum based alternatives
- Expansion of area is limited to cooler regions only

### World Scenario – Linseed - 1999-2000 (million ha & million t)

Country	Area	Production	Productivity
India	0.80	0.28	0.34
Canada	0.79	1.05	1.32
China	0.57	0.20	1.30
Ukraine	0.21	0.30	1.41
UK	0.21	0.30	1.41
Germany	0.20	0.34	1.69
USA	0.16	0.20	0.39
Russia	0.11	0.03	0.25
Argentina	0.10	0.09	0.84
<b>World</b>	<b>3.48</b>	<b>2.98</b>	<b>0.86</b>

### Indian Scenario – Linseed – 1999 -200 (Million ha & million t)

State	Area	Production	Productivity
MP	0.40	0.13	0.34
UP	0.13	0.06	0.47
Maharastra	0.13	0.04	0.30
Bihar	0.06	0.03	0.57
<b>India</b>	<b>0.80</b>	<b>0.28</b>	<b>0.34</b>

Linseed is also cultivated in Assam, HP, J&K, Karnataka, AO, Nagaland, Orissa, Rajasthan, WB, and Punjab in India.

#### Origin

- No clear centre
- May be from Ethiopia
- Persian gulf
  - The Caspian sea and Black sea
- Possibilities of introduction to India
  - By Aryans from Central Asia
  - From Europe sources
  - Aryan materials crossed with other species
  - Independent origin of Peninsular linseed in the South and Gangetic linseed in the North

#### The plant

- Annual herb
- Tap root system
  - Gangetic group – shallow with secondary roots
  - Peninsular – deep tap root – drought tolerant
- Stem either erect or procumbent
  - Fibre varieties are thin, tall growing, less tillering
  - Oil seed are dwarf, highly tillering and branched
- Leaves
  - Attractive

- Linear to lanceolate
- Smooth, margin entire, tapering to blunt apex
- Green to bluish green with variable size & thickness
- Inflorescence
  - Carymbose, with single flower
  - Petals 5, varying colors
  - Ovary is 5 celled, each locule divided into two by false septum thus making 10 roomed capsule with each with one ovule
  - The fruit is capsule of 5-10mm diameter
  - Mature capsule is dehiscent
- Seeds
  - Oval, smooth, shiny and pointed
  - Seed color varies from pure yellow, yellowish with brownish tinge, light brown, to deep brown
- Pale yellow – edible
  - Linola, Linoleic is higher
- Brown – industrial purpose

### **Climate**

- Requires moderate to cool temp during vegetative
- Dry weather during maturity
- Crop for oil seed
  - Moderate cool climate
- Crop for fibre
  - Cool and moist climate
- Susceptible to frost
- Fairly resistant to drought
- Well distributed rainfall, but not heavy rains
- Also grown as irrigated in dry regions

### **Soils**

- Variety of soils except sandy and poorly drained soils
- Well drained fertile, medium heavy soils, silty loam, clay loam and silty clay are best
- Soil pH 5.0 to 7.0
- Acid range 6.0 is more suitable
- Oil content decreases but iodine increases under saline

### **Management**

- Field preparation
  - Beds and channel
  - For rice fallow in standing crop
- Varieties
  - For 'Rice fallow' – R 552
  - For 'Rainfed' – Kiran, Sheetal
  - For Irrigated – Jawahar 23
  - For both rainfed & irrigated situation of Assam, Bihar, WB & Punjab:

- Shubra, Himalini
- Season
  - Oct – Nov 15th
  - Middle of October is best suitable
- Seed rate
  - 25-50 kg varies due to
    - States
    - Varieties
    - Methods
  - Bold seeded 50 kg
  - Rice fallows
    - 35kg cuscuta free seeds
- Spacing
  - Drill seeding
    - 20-30cm row
    - Plant to plant 7-10cm
  - Rice fallow
    - Broadcast seeding
- Depth of sowing
  - 2-3cm, shallow seeding is good
- Seed treatment
  - With fungicides before sowing

### **Nutrient Management**

- Irrigated crop
  - Seed purpose: 90:30:30
  - Double purpose: 120:40:40
  - Apply N in 2 splits
    - Basal
    - At first irrigation – 25-30DAS
- Rainfed
  - 40:20:20 all basal
- Rice fallow / Utera / Piara
  - Management starts with previous rice
  - Nutrients applied to rice
  - Leveling, weed management and water management all like rice fallow pulse of Tamil Nadu

### **Water Management**

- Responds well to irrigation
- >90% is rainfed even then one or two irrigations will enhance the yield
  - Two irrigations at 35 & 75 DAS
  - In light soils 3-4 irrigations
  - Drought during after flowering reduces the seed yield
  - Moisture stress at stem elongation benefits seed yield
  - With more (>4) number of irrigations



- WUE decreases
- Oil content decreases

### **Weed Management**

- Crop-weed competition is – 20-45 DAS
- Hoeing and aerating 15 and DAS
- Herbicides:
  - PPI – Fluchloralin @ 1.0 kg
  - PE – Methabenzthiozuran @ 1kg
  - Post Emergence – Dichlofop-methyl @ 0.7 kg at 30 DAS
- Cuscuta is menace with linseed
  - Crop rotation with non-host cereals
  - Herbicides:
    - Pronomide @ 1.5kg as post-emergence at 2-3 weeks stage
    - PPI of Fluchloralin itself is sufficient to reduce infestation

### **Maturity**

- When the stem become
  - Woody
    - Capsules turn hard
    - Leaves dry
    - the capsules turn brown and
    - the seeds become shiny

### **Harvest**

- Sickle the entire plant

### **Threshing & Post harvest processing**

- Cut crop is field dried for 3-4 days
- Plants with secondary and tertiary branches to be separated with capsules for seed
- After threshing for seeds stalk are processed for fibre

### **Retting**

- It is a process of fibre extraction
- Kinds of retting
  - Hot water, cold water, snow, dew retting
  - Temp decides duration of retting and quality
  - Standing warm water is more suitable than running cold water
  - Double retting is in practice in cold countries
  - Retting period is 4-6 days
- After retting cleaned in running water, dried and ready for scutching
  - To separate the valuable fibers of (flax, for example) from the woody parts by beating
- Rainfed areas in India water availability is problem hence they are not opting to fibre flax

### **Oil quality**

- Depends up on hull thickness
- Yellow seeds possess thin hull and more oil
- Refining the pigments are necessary to improve the quality

### **Fibre**

- Great strength, fineness & durability

- Less stretchy, more durable and better resistant to environmental fluctuations than cotton and jute

### **Double Purpose Linseed**

- Looking for fibre and oil is advantageous
- Varieties needed for this purpose
- Double purpose varieties may show differential response
  - In temperate region with long growing period, controlled supply of N can do the need
  - Extraction of fibre requires cooler climate for retting
  - This is a major limitation in our country
  - Of late invention on development of dry scutching machine may be a boon to produce fibre from oil seed stems too

### **Cropping systems**

- As pure crop
  - Cultivation is restricted to areas where no other crop is possible
  - Productivity under the situation is very low & subject to pests and disease outbreak
- As sequential crop
  - Hybrid maize – linseed + wheat
  - Groundnut – linseed + wheat
  - Rice (early) – linseed
- An intercrop
  - Linseed + chickpea / wheat / potato / safflower

### **Linola**

- A new crop developed
- Low linolenic acid mutants
- Have elevated levels of linoleic acid, 65 - 76%.
- Reduction in linolenic acid greatly increases the oxidative stability of the oil
- It becomes an edible PUFA oil equal to sunflower in fatty acid
- The colour of the seed is also changed, with edible linseed being a pale yellow colour enabling it to be distinguished from non-edible linseed, which is brown

### **Development of edible linseed is a joint venture between**

- CSIRO (Commonwealth Scientific and Industrial Research Organisation, Australia) and United Grain Growers Ltd of Winnipeg, Canada (UGG Ltd)
- This crop has been named Linola.
- Linola is a registered trademark of CSIRO
  - Specialty of Linola – it's oil quality
  - Mostly cultivated in Australia & Canada
  - 60-130 thousand ha = (0.06 to 0.13 m ha)

**Fatty acid composition of Linola with 5 major vegetable oils (%)**

Crop	Saturated	Mono unsaturated	PUFA		P/S
		Oleic	Linoleic	Linolenic	
Linola	10	17	71	2	7.3
Safflower	10	14	76	Trace	7.6
Sunflower	12	16	71	Trace	6.0
Maize	13	29	57	1	4.5
Soybean	15	23	54	8	4.1
Canola	7	61	21	11	4.6

**Fatty acid composition of Linola with 5 major vegetable oils (%)**

Crop	Saturated	Mono unsaturated	PUFA		P/S
		Oleic	Linoleic	Linolenic	
Linola	10	17	71	2	7.3
Safflower	10	14	76	Trace	7.6
Sunflower	12	16	71	Trace	6.0
Maize	13	29	57	1	4.5
Soybean	15	23	54	8	4.1
Canola	7	61	21	11	4.6

**Niger**  
*Guizotia abyssinica*

---

**Niger**

- An oil seed for poor soils and coarse texture
- It is the crop suits in soils wherein all other crops are not possible
  - Like Horsegram in the tropics
- It is a minor oil seed cultivated in smaller area of the world

**Importance of Niger**

- Primarily (75%) for oil extraction
- Also used as food including confectionaries (18%) in India
- It is feed to birds in western countries
  - Export value for India
- Plant is feed to sheep but only silage to cattle
- Cake is valuable cattle feed
- Seed contains 35-40% oil
- Oil is pale yellow with nutty taste and a pleasant odour
- Keeping quality is poor due to oxidative rancidity
  - Oleic acid 38%, Linoleic acid 52%
- Oil is used for
  - Culinary purpose
  - For anointing the body
  - Manufacture of paints and soft soaps
  - Lighting and lubrication
- Niger oil is a good absorbent of fragrance
  - Used in perfume industries
- Oil a substitute for sesame oil in pharmaceutical purpose
- Niger based agar medium
  - to distinguish *cryptococcus neoformans*, a fungus that causes a serious brainailment

**Distribution and area of Niger in the world**

*Major countries:*

- World area is around 1.0 million ha
- India & Ethiopia posses the major area
  - In Ethiopia it is cultivated in water logged soils where most othercrops fail to grow

*Other Countries:*

- Sudan, Uganda, Zaire, Tanzania, Malawi, Zimbabwe, Pak, West Indies, Nepal, Bhutan & Bangladesh

## Niger area in India (million ha & million t)

States	Area	Production	Productivity
MP	0.20	0.043	0.215
Orissa	0.15	0.047	0.309
Maharastra	0.06	0.019	0.280
Karnataka	0.04	0.008	0.182
All India	0.52	0.150	0.286

Other states which also cultivate niger are Bihar, AP, Assam & WB

### Origin

- From the highlands of Ethiopia
- From Ethiopia migrated to East Africa
- During the beginning of 2nd millennium BC to India

### The Plant

- Annual dicotyledonous herb
- Seedlings
  - Pale green to brownish hypocotyls and cotyledons
  - The cotyledons remain on the plant for long time
- First leaf is paired and small
- Successive leaves are larger and opposite
- Leaves are sessile, lanceolate
- Softly hairy on both surfaces
- Dark green is usual color
- But lower leaves pale yellow
  - The stem is usually round, smooth to slightly rough
- Approximately 1-2 cm diameter
- Can grow up to 1.5 m
- Stem are hallow and break easily
- Color is green to reddish green
- Moderately branched
  - The capitula are surrounded by leafy involucre bracts
- Outer bracts being leaf like
- Inner smaller and finally merges with flattened paleas
  - The fruit is achene, typical of the composite, small.
  - Seed is 3-5mm length and 1.5mm width, lanceolate in shape
  - The testa is hard, glossy, and usually black
  - Normally 1000 seeds weighs 3-5g
  - There are 15-30 seeds/head
    - Sometimes more with immature seeds

### The Climate

- It is temperate region crop
- Adapted to semi-tropical
- Performance is better between 500 -1000m elevation though suits up to 2500m

- Moderate Temp during growth
  - 18-23°C
  - >30°C growth adversely affected
  - Indian strains are less affected by temp compared to Ethiopian
- Frost will kill the young plant
- 1000-1300 mm RF can be tolerated but not >2000mm
- Peak flowering should not coincide with heavy rain
  - High wind – seed shattering
- Tolerates excess moisture and drought

#### **The soils**

- On wide range of soils
- Light textured soil but well drained heavy soil is also suitable
- pH 5.2 – 7.3
- Can tolerate water logging
  - Under waterlogged soil it develops aerenchyma cells
- It can grow in saline but increased salinity
  - Flowering gets delayed
- It can under dry soil
  - but not a dry land crop

#### **Management**

- Field
  - It is small seed hence requires fine seed bed
- Season
  - Aug-Sep
  - After a Kharif crop or early Rabi
- Varieties
  - No 71
  - IGP 76
- Spacing & Seed rate
  - 5 to 8 kg
  - Row width varies from
    - 20 to 30cm
  - Between plants
    - 10 or 15 cm
- Method of sowing
  - Most common is broadcasting
  - Drilling by seed drill is advanced and more useful
  - Depth of sowing 1-3cm
- Seed treatment
  - With fungicides
  - Void mixing with fertliers

#### **Nutrient management**

- Cultivated in poor soils with less input due to
  - Poor economy of the farmer

- Poor economic return of the crop
- Response to fertilizers in rainfed is poor
- A schedule of
  - 20:20:0 is recommended
    - N in two splits, at sowing and 30 DAS
    - K is recommended in Karnataka @ 10kg
  - 40:40:0 is recommended in Orissa

#### **Weed management**

- Niger grows rapidly and covers quickly the surface
- One or two weedings – sufficient
- Dodder (*Cuscuta*) infested areas are there (Orissa)
  - *Cuscuta* free seeds
  - Herbicide Chlorpropham G at dodder germination @ 4kg /ha
  - Pronomide @ 2kg/ha as pre-emergence soil treatment or as foliar spray 20 DAS

#### **Water management**

- Very rarely grown as irrigated in India
- Crop is sensitive to moisture stress at early stage
- Schedule according to soil and climate
- Further research needed in this area
- Check basin or border strip is ideal methods

#### **Maturity & harvest**

- Duration varies 80-145 days
- Delayed harvest leads to shattering
- Seeds are loose in head, hence over maturity leads to grain shattering (25%)
  - When the leaves dry up, harvest it
- Harvesting like gingelly,
  - When the bud moisture is 45-50%
- Stacking in the floor for a week and drying and cleaning, as usual

#### **Yield potential**

- Normally 300-500kg but up to 1000kg/ha
- When intercropped
  - 400 kg with sunflower
  - 100 kg with sorghum

#### **Cropping systems**

- Sequential cropping
  - Little millet or finger millet – Niger
- Intercropping
  - Niger + sunflower (4:2)
  - Niger + soybean (2:1)
  - Niger + peanut (2:2)
  - Niger + blackgram (3:3)
  - Niger + castor

#### **Cropping systems**

- Preceding pulse is more remunerative than sole crops

### Some more edible oil seeds

#### **Oil Palm**

##### ***Elaeis guineensis***

- Originated in West Africa
  - But has planted successfully in tropical regions within 20 degrees of the equator
- An oil produced to 21.5 million t in 2000
- Area grows annually by 2%
- World's largest producer and exporter - Malaysia - 47%
- Indonesia is the second largest world producer - 36%
- Both are expanding their palm oil production
- Both pulp and seed contains oil
  - Pulp contains 20%
  - Seed 1.6%

#### **Simarouba**

##### ***Simarouba glauca***

- Paradise tree
- Edible oil 42% by seed and 65% kernel
- Introduced into India

#### **Olive (*Elaeagnus angustifolia* L.)**

- Olive oil is an oil derived from the fruit of the olive tree, which originated in the Mediterranean area.
- It has a very high content of monounsaturated fats.
- Nowadays, olives are ground to tiny bits, obtaining a paste that is mixed with water and processed by centrifugation, separating the oil from the pomace (the other remaining substances).
- Edible commercial olive oil can be divided into several categories according to its chemical characteristics and the production method:
  - Extra Virgin Olive Oil,
  - Virgin Olive Oil, and
  - Olive Oil.
- The first two, virgin olive oils, are obtained only by physical extraction from the fruits.
- Non virgin olive oil is obtained by the chemical refining of a low-quality non-edible grade of virgin olive oil called "lampante" olive oil

#### **The list enlarges this way:**

- Corn oil
- Soybean oil
- Rice bran oil
- Coconut oil



## **Groundnut**

*Arachis hypogaea*

---

### **Origin**

- South America
- Brazil is considered as centre for many wild spp
- Native of new world crop
- Cultivated extensively in Meso-America & South America
- Remnant pericarp tissue from Peru dates 3900-3750 years before

The word *Arachis hypogaea* (groundnut) has been derived from two Greek words, *Arachis* meaning a legume and *hypogaea* meaning below ground (referring to the formation of pods in the soil). Groundnut has never been found in the wild state anywhere and its origin has, therefore, been a matter of considerable speculations and even controversy. There are two schools of thoughts about its origin—one supporting the view that groundnut had originated in Africa and the other tracing its origin to Brazil in South America. According to some literatures it is clear that from the beginning of the sixteenth century the west coast of Africa and naturally they introduced it from Brazil into Africa. De Gandolle (1825) stated its origin to be in Brazil (South America). Its introduction in India is considered to be through Jesuit Fathers (Missionaries) who followed Vasco De Gama shortly after his first landing in India i.e. in the first half of the 16th century.

### **Distribution**

- Throughout the tropics and subtropical zones
- India, China, Sudan, Nigeria, Senegal, Zaire, USA
- In India
  - Gujarat
  - AP
  - TN
  - Karnataka
  - Maharashtra

### **Spread in India**

- Commercial cultivation from early 19th century
- Largest area in South Arcot in 1840 of Tamil Nadu
- Possible way of entry from New World, South America via Philippines or China or Java
- Ground nut oil production was from 1840 only

- Today it is cultivated and consumed as largest crop

**World - Area, production and productivity (million hectares and million tonnes)**

Country	Area	Production	Productivity
India	8.50	8.40	0.99
China	3.62	9.72	2.69
Nigeria	1.48	1.20	1.15
Sudan	1.09	0.81	0.74
Senegal	0.89	0.68	0.76
Ziare	0.66	0.55	0.83
USA	0.65	1.94	3.00
<b>World</b>	<b>22.89</b>	<b>31.59</b>	<b>1.38</b>

**Oilseed scenario of the world**

- Until mid 80's
  - Soybean > Cotton seed oil > groundnut
- Today
  - Soybean > Cotton seed oil > rapeseed oil > peanut > sunflower

**Ground nut area, production and productivity in India (Million ha & Million t)**

State	Area	Production	Productivity
Gujarat	1.99	2.38	1.20
AP	2.17	1.77	0.82
TN	1.15	1.84	1.60
Karnataka	1.21	0.95	0.79
Maharastra	0.60	0.63	1.04
<b>All India</b>	<b>8.50</b>	<b>8.40</b>	<b>0.99</b>

**Classification**

- Bunch
- Semi spreading and
- Spreading
- Also Virginia, Spanish and Valencia
- All are compatible for crossing purpose

**Climate**

- Adapted to wide range of climate
- However plant gets affected when
  - Low light intensity during early growth & flowering
  - Cloudy weather at flowering
- A temp range of 25-30°C
  - < 20°C and > 35°C growth gets retarded
- Once established
  - It can tolerate drought
  - Also flood for a week if drained properly

- A rainfall of 500-1000mm is fair but can produce a good crop with 300-400mm well distribution

### Soil

- Well drained soil is so ideal
- Light colored loose, friable, sandy loam
- Soil with well supplied calcium and moderate amount of organic matter
- Sandy loam is more suited than clay
  - Since penetration of peg is easy and viable
- A soil pH of 6.0 to 6.5 (ranges 5 to 7)
- Saline soils are less suitable
  - since has low salt tolerance

### Growth stages

Vegetative

VE – Emergence of cotyledons near the soil

V0 – Cotyledons are flat and open

V1 - First tetra foliate leaf one

Reproductive

R1 – Bloom one

R2 – Peg one

R3 – Pod one

R4 - Full pod one

R5 – Beginning seed one

R6 – Full seed one

R7 – Beginning maturity one

R8 – Harvest maturity

R9 – Over matured pod

### Growing seasons

In India grown in four seasons

Kharif

85%

Rainfed

Second fortnight of June

Rabi

where winter is very mild – usually in rice fallows Sep-Dec

Summer

II FN Dec- I Week Feb

Spring

I FN Feb – I Week Mar

In Tamil Nadu

Rainfed

Apr-May - (Pollachi, Theni, Tenkasi) Jun-Jul - (NEZ)

Jul-Aug – Most dts

Oct – NEZ & Kanyakumari Irrigated

Summer – All districts

Dec-Jan – All dts

Feb-Mar - New delta

### **Varieties in Tamil Nadu**

- TMV 2 – cosmopolitan – bunch (360g)
- TMV 7 – Bunch (360g)
- TMV 10 –semi spreading (540g)
- JL 24 – Bunch - rainfed / irrigated (460g)
- VRI 2 – Spanish bunch (500g)
- VRI 3 – Bunch (350g)
- VRI 4 – Bunch (408g)
- CO 1, 2, BSR 1 – Bunch

### **Seeds and seed treatments**

#### **Dormancy**

- Varieties differ for seed dormancy
- It is common in Virginia types
- Dormancy may go if harvest delayed
- Normally it may go off during storage

#### **Selection of kernel is important**

- Sound matured bold seeds
- Discard shriveled, broken, disease affected
- Hand decorticated is preferable

#### **Treat with bio-fertilizers – Rhizobial cultures**

- Before sowing *Trichoderma viride* @ 4g /kg

#### **Seed management**

- Selected seeds are soaked for 6 hrs with 0.5% CaCl<sub>2</sub> solution in 50% by volume
- Spread the seeds in moist gunny bag and cover with moist gunny bag for 20-24hrs
- Seeds with viable expression of radicle is alone selected and shade dried to sowing moisture
- Unviable seeds are discarded
- Germination is ensured by 95%

#### **Seed rate**

- 140 kg for rainfed
- 125 kg for irrigated
- Increase by 10% if bold seeded (like JL 24, CO 2 & TMV 10)

#### **Spacing**

- 30 cm x 10 cm
- 15 cm x 15 cm wherever ring mosaic is prevalent

#### **Field preparation**

- Fine tilth to be obtained
- Chiseling for soil with hard pan
- Amendments for soil surface crusting
  - Lime 2t /ha along with FYM / compost
- Farm beds and channels

- o 10 to 20 m<sup>-2</sup>

### **Sowing**

- o Rainfed
  - o Use seed drill or gorru
  - o Can also be sown behind country plough
  - o Pre-monsoon sowing is also a way
- o Irrigated
  - o Dibbling at 4cm depth with adequate soil moisture
  - o Can also be sown behind country plough
  - o Irrigation may be after sowing if sown in dry soil

### **Nutrient management**

- o Rainfed
  - o 10 : 10: 45 kg N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O / ha
- o Irrigated
  - o 17 : 34 : 54 kg N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O /ha
  - o Sulphur sludge 60 kg /ha
- o Gypsum to groundnut
  - o 400 kg for all non calcareous soils at 40-45 DAS
  - o Apply by the side and irrigate

### **Irrigation management**

- o Irrigation at 25% depletion of ASM
- o IW/CPE ratio
  - o 0.5 up to 40 DAS
  - o 0.75 later
- o Total water requirement 400-600mm
- o Sowing or pre-sowing irrigation
- o 20 days after sowing
- o At flowering 2 irrigations
- o At pegging one or two
- o In pod development 2-3

### **Weed management**

- o Stirring the soil to remove weeds also aerates
  - o Aeration is more essential for peg formation
- o Fluchloralin 2 lit
  - o pre-sowing incorporation or
  - o Pre emergence application as spray
- o Metalachlor 1 kg
  - o Pre-emergence and hand weeding
- o If no herbicide applied two hand weeding on 20 & 40 DAS

### **Peg formation**

- o No of pegs developed are higher in bunch
- o Daily min temp is positively correlated
  - o But maximum temp negative
- o High light intensity affects pegging
- o Soil moisture if goes to wilting

- Process of peg formation stops
- Formed pegs may dry
- Early formed flowers may inhibit the later to form peg
- Auxin and GA produced by pro-embryo promotes growth
- Length of peg is generic
- Strength of peg is a concern for management

#### **Harvesting & Processing**

- Maturity
  - Yellowing of foliage
  - Spotting of leaves
  - Dropping of leaves
  - Hardening and toughness of pods
  - Dark tannin discoloration inside the pods
  - Unwrinkled kernels and coloration of testa

#### **Harvesting & Processing**

- Delay in harvest causes 5-15% reduction
- Bunch type usually matures in about 100-105 days
- Spreading 130-150 days
- Uprooting is the way in bunch
  - Blade harrows, tractor drawn diggers
- In spreading types by digging
- Storage:
  - Plant with pods dried for two days
  - Pods separated and dried in open sun for 2-3 days
  - Proper drying of the pods may be judged by
    - Pods should give rattling sound when shaken
    - When the kernel is pressed between thumb and index finger it should split into 2 cotyledons
    - When the surface of the kernel is roughed hard a portion of the testa should come off.

#### **Cropping systems**

- Row Intercropping
  - Peanut + sorghum / ragi / redgram / chilli / cotton, sunflower / castor etc indifferent proportions
- Mostly mixed crop with pulses
  - Groundnut – wheat
  - Rice - groundnut
  - Rice – rice - groundnut

#### **Economic uses**

- Edible oil (50% oil)
- Haulms are palatable fodder to cattle
  - May be as hay or silage
- Groundnut kernels have high protein
  - 1.3% times higher than meat
  - 2.5 times higher than egg

- 8 times than fruits
- Numerous industrial uses
  - Preparation veg oil (vanaspati)
  - Low quality oils for soap
  - For beauty aids, shaving cream, cols cream
  - For medical aids – plasters, ointments
  - Cake powder for laundry starch and manufacture of paper, gummed tapes and plastics
  - Activated carbon
- Oil cake - Good organic manure and cattle feed
- Cake flour is easily blends with wheat and others to bakers, confectioners, candymakers and ice cream manufactures

**Sesame**  
*Sesamum indicum*

---

**Importance**

- It is 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
- Very ancient

**cropEconomic Importance**

- 38-54% high quality oil
  - Containing 1-15% protein
- 75% sesame is used for oil
- 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

**feedDistribution**

- A crop of tropics and sub-tropics
- But it is grown up to 40°N in China
- India is the major producer

**Sesame - World - Area, production and productivity  
(Million hectares and million tonnes)**

Country	Area	Production	Productivity
India	2.13	0.50	0.24
Sudan	1.05	0.25	0.25
China	1.00	0.56	0.62
Burma	0.87	0.21	0.25
Nigeria	0.25	0.08	0.30
<b>World</b>	<b>6.57</b>	<b>2.27</b>	<b>0.35</b>

**Sesame – Indian scenario ( Million ha & million t)**

State	Area	Production	kg/ha
Gujarat	0.30	0.09	0.29
Rajasthan	0.21	0.02	0.07
Tamil Nadu	0.17	0.09	0.54
MP	0.17	0.04	0.21



UP	0.16	0.03	0.19
Maharashtra	0.13	0.04	0.30
WB	0.01	0.09	0.85
India	2.13	0.50	0.24

### The plant

- It is erect, branched annual
- Multi flowered, fruit is capsule with small oleaginous seeds
- Leaves are most variable in shape and size
- Lower leaves tend to be broad
- Upper leaves are more narrow and lanceolate
- Flowers arise in the axils of leaves & on the upper portion of the stem

### Seed

- Small, ovate 3g/1000
- Testa color varies black, white, yellow, dark grey
- Dry matter content in the seed increases rapidly between 12-24 days in parallel with oil content
- A capsule may contain 50-100 seeds

### Climate

- Requires fairly high temp
- 2700 heat units are normally required
- 27-33°C is found to be optimum
- < 10°C growth process stops
- > 40°C can affect fertilization
- A rainfall of 500-650mm
- Heavy rain at flowering affects yield
- Extremely susceptible to water logging
- It is drought resistant, can withstand drought
  - Except establishment period
  - A crop for SAT regions
- Susceptible to wind damage & hail
- Heavy storms can virtually strip off leaves

### Soils

- From sandy to clay soils
- Thrives well under well drained moderately fertile soils of medium texture
- Soils with impervious sub-soil are not suitable
- Soils with neutral pH
- Sesame grows with a range of 5.5 to 8.0 soil pH
- Many soils where sesame cultivated are saline

### Land preparation

- Fine tilth by deep ploughing
- Land should be leveled properly
- Beds and channels is more suitable
- In heavy rainfall areas broad bed furrows

- Ridges may be to drain the excess rainfall

**Improved varieties**

- CO 1
- TMV 3, TMV 4, TMV 5, TMV 6
- Paiyur 1
- SVPR 1 (white)
- VRI 1

**Duration**

- 80-85 days

**Oil content**

- 44-56% mostly 50%

- Season
  - North
    - Kharif - according to monsoon set
- In
  - Bihar, WB & Orissa:
    - Irrigated - March
  - Tamil Nadu
    - Seed rate & spacing
      - Seed rate - 5 kg /ha
      - Spacing
        - 30cm x 30cm (11 plants m-2)
        - Broadcasting and thinning to - 11
      - Spacing adapted in other states
        - 30x15 (AP, Assam, Karnataka, Orissa, WB)
        - 45 x 10 in Kharif and 45x15 in Rabi in Gujarat
    - Seed treatment & sowing
      - Treat the seeds with Trichoderma @ 4g/kg
      - 3 pockets of Azospirillum /ha
    - N
      - Mix the seeds with four times its volume of dry sand and mix
      - Drop / broadcast uniformly
      - Depth of sowing 3cm
    - Transplanting of gingelly
      - Transplanting is possible
        - In light textured soil
        - Nursery
          - Raised bed, 300 m-2
          - Seed rate : 1.0 to 2.0g seeds m-2
        - Seedlings of 15-20days old
        - Irrigate and transplant
        - Transplant at late afternoon
      - Optimum population with equidistance gives yield advantage
    - Manures & Fertilizers
      - FYM/composted coir pith 12.5t/ha
      - Blanket - N:P<sub>2</sub>O<sub>5</sub> :K<sub>2</sub>O kg /ha
        - Tamil Nadu
          - Rainfed - 23:13:13
          - Irrigated – 35:23:23
          - If Azospirillum applied, N may be reduced by 5-10 kg
        - Other states with higher recommendation
          - Gujarat – Irrigated: 50:25:25
          - WB – Irrigated: 50:25:25
      - Apply all basal
      - 5kg MnSO<sub>4</sub> in Mn deficient soils
      - 5kg ZnSO<sub>4</sub> for Zn deficient soils
        - Micronutrients should be broadcast with sand after sowing
    - Water management
      - Irrigate at sowing

- L at short interval is better than heavy
- i ○ Heavy irrigations reduce seed weight and oil content
- f     ▪ Irrigation at flowering critical
- e     ▪ Soil moisture should be low at maturity
- Irrigation at 25% ASM
- i ○ IW/CPE ratio of 0.4
- r ○ Total water requirement- 250-350mm

#### **Weed management**

- i ○ Thinning, hoeing and weeding are important cultural practices
- g ○ Hoeing & weeding twice at 15 & 30 DAS
- a ○ Herbicides
- t     ▪ Pre-emergence application of Alachlor @ 1.25 kg/ha
- i     ▪ Or Fluchloralin 1kg/ha
- o     ▪ Herbicide application to be followed with hand weeding on 30th
- n     day

#### **Maturity**

- 25% of bottom leaves dropped
- d ○ Top leaves loose their green color – turn to pale yellow
- a ○ The colour of the stem turns yellow
- y ○ Capsules up to middle of the stem turn yellow
- s ○ Examine the 10th capsule for seed color
  - If the color is black then ready for harvest

#### **Harvest**

- a ○ May be cut to ground or uproot
  - Preferably in the morning
- e ○ Stack in the open one over other in circular heap
- r ○ Keep the top inside and roots out
- L ○ Cover top of the heap with straw and tie or add weight
  - Humidity and temp increases

#### **g Yield**

##### **Heap for 3-5 days**

- Open the heap and keep the stacks drying
  - i • Dry it for 2 or 3 days
  - r • Shake the plants after drying to separate the seeds
  - r • Dry the plant again and separate the seeds
  - i
- g Vary very widely
  - a ○ Few 100 to 3000kg
- t Rainfed in India
  - i ○ 375-500 kg
- o Irrigated (rabi)
  - n ○ 500-575kg
- Transplanted gingelly may give higher yield of 2.0 tonnes

### **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

### **Storage**

- Clean and dry
- 5% moisture for storage
- Containers should be tight tipped

**Castor**  
*Ricinus communis*

**Importance**

- It was poor man's crop
- Globalization changed the scenario
- Now it is one of the most commercial non-edible oil seed
- Its stem, leaves, seeds, oil and cake are useful
- Oil - variety of uses
  - Industrial
  - Lubrication- including 'aero-engines'
  - Medicine- both human and veterinary
- Oil cake - manure
- Stalk - fuel or thatching
- Leaves - used for rearing silk worms
- Castor oil
  - Purgative as medicinally as cathartic & obstetrics
  - Skin ointment
  - Soothing agent to eye applied after removal of foreign bodies
  - As resins
    - Surface coating to household articles, furniture, refrigerators
    - Base materials for several paints, enamels & varnishes of superquality
  - Manufacture of leathers, adhesives, synthetic perfumes & flavors
  - Variety of rubber goods, hair oils
  - Clear bright colors in dyeing fabrics
  - For soaking raw skins in fur trade

**Origin**

- Indigenous to Eastern Africa
  - Most probably in Ethiopia
  - There are four large centres based on wild varieties
    - Irano-Afghanistan-USSR region
    - Palestine-SW Asia
    - India China
    - Arabian peninsular

**World scenario of castor – (million ha & million T)**

Country	Area	Production	Productivity
India	1.05	1.00	0.95
China	0.24	0.28	1.17
Brazil	0.12	0.05	0.37
Thailand	0.02	0.02	0.79
<b>World</b>	<b>1.58</b>	<b>1.42</b>	<b>0.90</b>

## Indian scenario of castor – (million ha & million T)

State	Area	Production	Productivity
Gujarat	0.37	0.74	1.99
AP	0.24	0.06	0.25
TN	0.04	0.01	0.32
Orissa	0.02	0.01	0.31
Rajasthan	0.04	0.05	1.36
Karnataka	0.02	0.02	1.00
<b>India</b>	<b>1.58</b>	<b>1.42</b>	<b>0.90</b>

### The Plant

- Can be divided into 2 groups
  - Tall – Giant - like tree, tap roots
  - Short - Dwarf – tap root less apparent
- Stem
  - Round glabrous & covered with waxy bloom
- Leaves
  - Dark glossy green
  - Palmate with 5 -11 lobes
- Inflorescence
  - The capsule contains three seeds
  - Seeds may vary greatly in size
  - 1000 seed may vary from 100 to 1000 g but most dwarf weighs around 300g
  - Inflorescence
    - Pyramidal raceme – ‘spike’ or candle
    - Male flowers in lower raceme
      - Number influenced by climate
      - High temp causes maleness
    - Female flowers in upper
    - May reach 100cm
    - Flowering may continue
    - Fruit is globular capsule, spiny to some degree, becomes hard & brittle when ripe
    - Shattering at maturity in giants but not in dwarf

### Climate

- Hardy perennial
- Adapted to tropics to sub-tropics
- Now grows under warm temperate
- Temp ranging from 20-26°C with low humidity, long, clear, summer days throughout the growth favors high yield
- Frost free for dwarf is must
- It is long day crop
  - Short day (<9hrs /day) increases male flowers ratio
- Drought tolerant since deep rooted crop

## **Soil**

- All soils
  - except clay and poorly drained
- Grows well in light sandy soils
- Deep moderately fertile with acidic (pH 5.0 to 6.5) are more ideal
- It can tolerate up to pH 8.0
- Soil with high fertility un desirable
  - since excessive vegetative growth & poor yield
- It can be in soils where other commercial crops are not possible

## **Filed preparation**

- Deep ploughing is beneficial for rainfed crop for moisture conservation
- Chiseling in sandy soils
- Beds and channels in rainfed crops
- May be ridges and furrows in irrigated

## **Season**

- Onset on SW monsoon
- Depends upon the date of receipt in different states
- During winter when the soil temp is
  - <10-12°C

## **Method of sowing**

- Sowing behind the furrows –in AP
- Dibbling in lines
  - May be placed between 5-6cm
  - Germination is epigeal, can break surface crust also

## **Varieties**

- During 70's
  - SA 2, V 19 & RC 6
- Hybrids
  - GCH 3, GAUCH 1, GCH 2
- In TN
  - SA1, 2, TMV 4, 5, 6, TMVCH 1, CO 1

## **Spacing (cm)**

- 90 x 90
- 90 x 60
- 60 x 45
- 60 x 30

## **Seed rate**

- 10kg
  - depending upon seed weight and spacing

## **Manuring**

- In TN
  - 30:15:15 kg NPK
- In Gujarat
  - For rainfed - 40:40:0
    - N in two equal splits
    - Basal + 30-35 DAS



- Irrigated - 40:40:40 as basal
  - + 10 kg N after each picking
    - from 90DAS at 30 days interval
- There is N usage up to 150 kg in Gujarat

### **Irrigation**

- Mostly as rainfed
- During prolonged drought
  - 2-3 supplemental irrigations
- Rabi & Summer crops require
  - 6-8 irrigations
  - Less number of irrigations in heavy soils
  - High moisture during maturity leads to
    - New leaves and delaying maturity

### **Weed management**

- Weed free situation is 45-50days
- Early suppression by weeds
  - Intercropping is a solution
  - Summer ploughing, deep ploughing are to reduce the weed
- Herbicides
  - Fluchloralin 1.0 kg PPI
  - Pendimethalin – 1.5 kg PE (1-2 DAS)

### **Maturity and harvest**

- Harvesting in stages
  - 2-6 stages depending upon duration and spike opening
  - Capsules are picked when the spike turn yellow to black
- Drying
  - Sun drying the capsules and threshing

### **Yield**

- Yield
  - 0.8 to 1.0 t in rainfed and
  - 1.5 to 2.0 t in irrigated
- Oil yield 50%
  - Oil extraction
    - Kernel pressing followed by solvent extraction

### **Cropping systems**

- Crop rotation is very useful to control wilt
- Castor after pulse
- Castor followed by winter wheat
- Intercrops
  - Castor + peanut 1:3
  - Castor: blackgram 1:3
  - Castor : Pigeonpea 1:1

## Sunflower

*Helianthus annuus*

---

### About sunflower

It was an ornamental before 1969 in

India it is popular oil seed crop today

Its name is with reasoning

Annual but there are

perennials

Competing with 4 major oil seeds of the world after mid 19th

century Soybean, rapeseed, cotton seed, peanut

Soybean and cotton seed has other values as protein meal and fibre

### Specialty of sunflower oil

Among the vegetable oils most suitable to coronary

system High level of linoleic acid and absence of linolenic

acid

PUFA (Polyunsaturated fatty acid) – Linoleic content is more (67%) and about 90%

unsaturated (+monounsaturated 21%)

Major ingredient in margarine and shortening products

### Origin & spread

Probably from South - West America

Sunflower was introduced into Europe in 16th

century Reached Europe from Mexico via Spain

It was ornamental

Reached Russia via Holland in 18th century

First commercial production for oil -1830-40

After second world war introduction of Russian varieties such as Peredoviv,

Mennonite & Sunrise led to the development of this crop in Europe & America

In India it was only ornamental till 1969

Introduction of Peredoviv, Armveski varieties from Russia in 1969 led for the spread

### Sunflower world scenario in 1999 (Million ha & million t)

Country	Area	Production	Productivity
Russia	3.98	4.20	1.05
Argentina	3.79	6.50	1.72
Ukraine	2.78	2.75	0.99
India	2.25	1.25	0.56
USA	1.39	1.99	1.41
Romania	1.04	1.21	1.17
Spain	0.87	0.56	0.64
China	0.86	1.55	1.80
South Africa	0.82	1.21	1.46
France	0.80	1.87	2.34

Turkey	0.55	0.86	1.58
<b>World</b>	<b>22.84</b>	<b>1.25</b>	<b>28.48</b>

#### Indian Scenario of sunflower in 1999 (million ha & million t)

State	Area	Production	Productivity
Karnataka	0.88	0.36	0.41
Maharashtra	0.52	0.32	0.62
AP	0.29	0.22	0.75
Punjab	0.10	0.16	1.54
Haryana	0.06	0.11	1.76
UP	0.03	0.04	1.46
TN	0.02	0.02	1.17
<b>India</b>	<b>2.25</b>	<b>1.25</b>	<b>0.56</b>

#### Favourable features for growth of sunflower in India

- Wide adaptability
- Photoperiod insensitiveness
- Shorter duration (60-100 days)
- High quality edible oil (PUFA)
- High seed multiplication ratio (>1: 80)
- Easier & cheaper cultivation
- Remunerative market price
- Suitable for mechanization

#### The plant

- Erect, tall usually un-branched
- Plant height, head size, days to flowering & maturity are all vary due to environment
- Root – tap root - but thick root mat with short tap root is common
  - May be problem in light soil to heavy mass - lodging
  - Limitations in the exploitation of soil moisture & nutrients
  - Earthing-up interferes with roots
  - Irrigation frequency should be short to meet the demand
  - Waterlogging adversely affects the crop due to weakening of anchorage and proliferation of fungal diseases
- The stem
  - Mostly unbranched
  - Branching is not desirable
    - Basal branching may be useful
    - Leaf axil branching problem
    - N triggers branching

- Green stem contributes for photosynthesis
- Ht varies
  - 80-120 short can accomodate more plants
  - 120-150 medium
  - 150-180 tall
- The leaf
  - Varies with plant type and environment
  - Limited to number of nodes
  - 8 to as many as 70
  - Arranged alternate at right angle
- The inflorescence
  - Capitulum borne terminally
  - Surrounded by one or more whorls of bracts called involucre(modified leaves)
  - Head diameter is yield deciding factor
- Anthesis and fertilization
  - Flowering from periphery
  - Outermost opens first
  - Daily 1-5 rows continues up to 5-10 days
- The seed
  - Seed is called 'achene'
  - Seed size 7-25mm long, 4-13m long,3 -7.5mm thick
  - Dormancy normally 10-45 days
  - Oil content 36-37%
  - 1000 seed weight 43-45g

### **The climate**

Temp range 8-34°C

Optimum 20 & 25°C

Requires cooler (15-20°C) growing period and warmer maturing period (20-25°C)

Base minimum is 10°C

High temp (>38°C) in post-anthesis inhibit quantity and quality of oil

Rainfall of 500mm, with 300 mm it can yield

Avoid flowering coincide continuous drizzle

### **Soil**

- Can be in wide range of soils
- Any soil with good drainage is more important
- Neutral to moderately alkaline soils
- pH ranges 6.5 to 8.0
- Complete failure in sandy soil with pH 4.6

## Varieties

CO1, CO2, CO 3, CO 4  
Modern, K2, K1, BSH 1  
EC 68415

## Hybrids have advantage than varieties

- High yield potential
- Uniform crop stand
- More self-fertile, less problem of seed set
  - MSFH 1, BSH 1

## Seasons

### Rainfed

June-July, Kharif in North  
Oct-Nov

### Irrigated

- Dec - Jan
- April – May

## Field preparation

- Fine tilth
- Apply FYM / Compost incorporate
- Ridges and furrows

## Spacing

- 30 to 60cm according to variety
- 10 to 15 cm for short & medium stature
- 15 to 30 cm for tall (>120cm)

## Seed rate

- @ 2 seeds per hole
- Seed weight of
  - 45g/1000o 30 x 10  
30 kg
  - 30 x 15 20kg
  - 30 x 30 10kg
  - 60 x 30 5kg

## Seed treatment

- Trichoderma 4 g /kg
- Azospirillum 600 g to one ha
- Soaking the seeds
  - 2% ZnSO4 for 12hrs and
  - Shade drying for rainfed sowing is desirable

## Sowing

- Well prepared deep, friable seedbed is more preferable
- Depth of sowing 3-5cm

### **Plant population**

- 55,000 to 98,000 /ha almost same yield
- If the head diameter is <10cm more population
- If >20cm less population

### **Thinning**

- Highly sensitive to intra-specific competition

### **Nutrient management**

- Fast growing high oil yielding thus requires more nutrients
- Low yield in India is attributed to poor fertile soil, cultivated in rainfed conditions
- A crop yielding 2 t seed, 3.2 t stover and 0.8 t root uptakes 82 kg N, 13 kg P, 60 kg K, 9.4 kg S, 37 kg Ca and 21 kg Mg.

### **State wise nutrient recommendation**

- TN 40-20-20
- UP 80-60-40
- AP - Rainfed 60-30-0  
- Irrigated Hybrids 60-90-30 ; Variety 30-60-30

### **Weed management**

- Fluchloralin / Pendimethalin
  - 2.0kg as pre-mergence
  - High volume spray
- Hoeing and weeding on 15th day & 30th day
- Within three days irrigate the field

### **Water management**

- Immediately after sowing
- 4-5 days later once
- Interval of 7-8 days
- Seeding, flowering and seed development stages are critical

### **Seed setting and filling**

- Problem is seen with poor seed setting
- This problem is more in warmer regions
- In India seed filling under good management is only 75%
- It will be as low as 10-20%
- Reasons
  - Genetic
  - Environmental
  - Physiological
  - Availability of pollinators

### **Maturity**

Physiological maturity (30-40% seed moisture)

When the back of the head turns green to lemon yellow There will be 5-6 green leaves at this stage

Harvest maturity (10-12%)

Delay beyond harvest maturity severe yield loss

### **Cropping systems**

#### Sequential cropping

- Southern India
  - Rainfed - Sunflower – millets/pulses
  - Irrigated- Rice – sunflower
- North
  - Rainfed - SF – wheat / chickpea

#### ○ Row intercrop

- Groundnut + SF
- Pigeonpea + SF
- Castor + SF

## **Soybean** *Glycine max*

---

### **Importance**

- Owing the nutritional and health benefits of soybean, it is popular in the world as “WONDER CROP” of the 20th century.
- Soybean contains about 20% oil and 40% high quality protein.
- Soybean protein is rich in amino acid lysine (5%) in which most of the cereals are deficient.
- It is self pollinated crop.
- Soybeans are processed for their oil (see uses below) and meal (for the animal feed industry).
- A smaller percentage is processed for human consumption and made into products including soy milk, soy flour, soy protein, tofu and many retail food products.
- Soybeans are also used in many non-food (industrial) products.
- Soybean oil is used in cooking and frying foods. Margarine is a product made from soybean oil. Salad dressings and mayonnaises are made with soybean oil.
- Some foods are packed in soybean oil (tuna, sardines, etc.) Baked breads, crackers, cakes, cookies and pies usually have soybean oil in them.
- Biodiesel — biodiesel fuel for diesel engines can be produced from soybean oil by a simple process called transesterification. This process removes the glycerine from the oil, leaving soy biodiesel. Soy biodiesel is cleaner burning than petroleum-based diesel oil. Its use reduces particulate emissions, and it is non-toxic, renewable and environmentally friendly.
- Soy oil produces an environmentally friendly solvent that safely and rapidly removes oil from creeks, streams and shorelines without harming people, animals and the environment. Soy is an ingredient in many industrial lubricants, solvents, cleaners and paints.
- Candles made with soybean oil burn longer but with less smoke and soot.
- SoyInk is superior to petroleum-based inks because soy ink is not toxic, renewable and environmentally friendly, and it cleans up easily.
- Soy-based lubricants are as good as petroleum-based lubricants, but can withstand higher heat. More importantly, they are non-toxic, renewable and environmentally friendly.
- Capable of transforming nearly 60-100 kg atmospheric nitrogen into 30-40 kg nitrogen in the soil.



## **ORIGIN and DISTRIBUTION**

- Soybeans are reported to have originated in eastern Asia or China.
- Domestication of soybean has been traced to the eastern half of North China in the eleventh century B.C. or perhaps a bit earlier soybean production was localized in China until after the Chinese-Japanese war of 1894-95.
- Brazil, USA, Argentina, China, India, Paraguay are the major soybean growing countries.
- The USA alone has about 50% of the world acreage and accounts for about 66% of the world production.
- In India, the major soybean growing states are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, and Telangana.
- India is having soybean production of 13.5 m t from 11.4 m ha area with a productivity of 1185 kg/ha (April 2019 Report of ICAR – Indian Institute of Soybean Research, Indore).

## **SOIL and CLIMATE**

- Soybean has been adopted under wide range of climate and soil with better performance under Vertisols with good organic content. Well drained and fertile loam soils with a pH between 6.0 and 7.5 are most suitable for the cultivation of soybean.
- Sodic and saline soils inhibit germination of seeds.
- Soybean is a short-day plant and is highly sensitive to photoperiod.
- Soybean grows well in warm and moist climate.
- The optimum temperature for soybean is 20-30 °C, with temperatures of 35 °C and above considered inhibitory to production.
- Temperatures below 21°C and above 32°C can reduce flowering and pod set. Extreme temperatures above 40°C are harmful for seed production.
- Soybeans can be grown throughout the year in the tropics and subtropics, if water is available.
- Soybean requires 400 to 500 mm of water in a season for a good crop.
- High moisture requirement is critical at the time of germination, flowering and pod forming stage. However dry weather is necessary for ripening.
- Soybeans can tolerate brief water logging but weathering of seed is a serious problem in the rainy season.

## **LAND PREPARATION**

- One deep summer ploughing is required.
- Farmers are advised to incorporate organic manure (well decomposed FYM @ 5-10 t/ha or Poultry Manure @ 2.5 t/ha) at the time of land preparation.
- Soon after arrival of monsoon, the land may be prepared by harrowing followed by planking to level the field.

## VARIETIES

Zone	Recommended varieties
Northern hill zone (HP and Uttarakhand)	Bragg, Lee, Shilajeet, Soya-2, Pusa-16 & 20
Northern plain zone (Punjab, Haryana, UP, Delhi)	Bragg, Ankur
North-eastern zone (Assam, West Bengal, Bihar, Meghalaya)	Bragg, Birsa soy – 1, Pusa-16, Pusa-22 and Pusa-24
Central Zone (MP, Rajasthan, Gujarat, Odisha)	Bragg, Durga, Gaurav
Southern Zone (AP, Kerala and some parts of Maharashtra)	CO-1 & 2, Pooja, Monetta, improved Pelicon

## SEED and SOWING

- Two cropping seasons of soybean *kharif* and spring.
- In case of **kharif** season most common time of sowing is onset of monsoon or last week of June to first week of July while **spring** sowing is done between 15th of February and 15th of March.
- To reduce the fungal attack the seed should be treated prior to sowing with fungicides like Thiram @ 4.5 gm per kg of seed.
- For efficient nitrogen fixation it is essential that soybean seeds should be inoculated with suitable strain with *Rhizobium japonicum*.
- 70-80 kg seed per hectare is required for soybean crop but for late planting the seed rate should be 100-120 kg per hectare.
- Sowing should be done in lines 45-60 cm apart with the help of seed drill or behind the plough. Broad Bed Furrow planting and Ridges & Furrows planting methods are best.
- Plant to plant distance should be 4-5 cm with sowing depth 3-4 cm.

### Zone-wise optimum sowing time, seed rate and row spacing for soybean

Zone	Sowing Time	Seed rate (kg/ha)	Spacing (cm)
<b>North Eastern Hill</b>	15th June - 30th June	55	45
<b>North Plain</b>	20th June - 5th July	65	45
<b>Eastern</b>	15th June - 30th June	55	45
<b>Central</b>	20th June-5th July	65	45
<b>Southern</b>	15th June-30th June	65	30

Note: The fertilizer dose may be supplemented through addition of recommended quantity of organic manures.

### Nutrient Management

- 14-20 tones of FYM or compost per hectare may be added 15-20 days before sowing.
- Application of 20-30 kg N per hectare as starter dose is given to meet the nitrogen requirement of the crop in the initial stage.
- Soybean requires relatively large amount of phosphorus than other crops.
- 70-80 kg P<sub>2</sub>O<sub>5</sub> and 50-60 kg K<sub>2</sub>O per hectare is given to meet the requirement of the crop

Zone	Recommended N:P <sub>2</sub> O <sub>5</sub> :K <sub>2</sub> O:S (kg/ha)	Fertilizer Sources
<b>North Eastern Hill</b>	25:100:50:50	56 kg Urea+625 kg SSP+ 84 kg MoP
<b>North Plain</b>	25:75:25:37.5	56 kg Urea+470 kg SSP+ 42 kg MoP
<b>Eastern</b>	25:100:50:50	56 kg Urea+625 kg SSP+ 84 kg MoP
<b>Central</b>	25:60:40:20	56 kg Urea+375 kg SSP+ 67 kg MoP
<b>Southern</b>	25:80:20:30	56 kg Urea+500 kg SSP+ 34 kg MoP

Note: The fertilizer dose may be supplemented through addition of recommended quantity of organic manures.

### WATER MANAGEMENT

- Soybean is not a regularly irrigated crop, as it can be successfully grown in rainfed condition.
- Water requirement is 35 to 40 cm.
- When irrigation is provided to soybean (in summer), it is necessary to irrigate the crop at IW/CPE ratio of 0.6 or at every 10-12 days duration during summer (in sandy loam soil).

- Critical stages are Flowering and pod filling.

### **WEED MANAGEMENT**

- Weeds cause soybean yield losses of 25-85% if not controlled.
- It is a slow growing crop at initial stage, hence the critical period for weed control in soybean is 45-60 days.
- Control of weeds by intercultivation @ 20 DAS and 40 DAS is more cost effective, provided the ideal soil moisture permits such operation.
- Herbicides like Alachlor (1-2 l/ha), Metribuzin (1-1.5 kg/ha) or Trifluralin (1.5-2 kg/ha) may be applied as pre-emergence herbicides.
- Post-emergence herbicides are Imazethapyr 70 WG+ Surfactant (100 g/ha), Propaquizafop 10 EC (0.5-0.75 l/ha) at 15-20 DAS.

### **HARVESTING and THRESHING**

- Optimum time of harvesting is very important for soybean as it causes yield loss due to shattering and seed viability loss due to field weathering.
- The maturity period ranges from 90-140 days depending on the varieties.
- Initiation of change of pod color (physiological maturity) of soybean is the right indication to go for harvesting. At this time, the moisture percentage of soybean seed is around 14-16%. Hence, the farmers are advised not to wait till the foliage/plant turns yellow. Harvesting can be done when 95% pod changes color from green.
- The harvested soybean crop, after sun drying for 2-3 days is ready for threshing.
- The threshed soybean should again be allowed to sun drying for 3-4 days in order to bring down the moisture up to 10% which is essential to avoid fungal infection during storage.
- 30-35 quintals of grains per hectare of improved varieties of soybean can be obtained.

### **Constraints to Soybean Production**

Despite having made rapid stride for both coverage and total production, soybean still suffers on productivity front. There are a number of constraints, pertaining to climate, edaphic, production, and technology aspects as mentioned below that hinder higher productivity.

- Most of the area under soybean cultivation is a rainfed.
- Erratic behavior of monsoon affecting planting.
- Large spatial and temporal variability in rainfall.
- Soil moisture stress at critical growth stages, especially Seed-filling stage.
- High-temperature stress at critical growth stages.
- Biotic interferences to crop growth.
- Limited mechanization.
- Poor adoption of improved production technology
- Low risk covering ability.

- Mono cropping and poor varietal diversification increasing risk chances.
- Timely availability of quality inputs.
- Poor/inadequate technological information.
- Poor utilization in food chain owing to characteristics beanie flavor of soybean.
- Road blocks in utilization as pulses because of hard-to cook characteristics of soybean.
- Psychological stigmas and conventional food habits.
- Lack of awareness about health/nutritional benefits.
- Presence of anti-nutritional factors in soybean.

**Safflower**  
*Carthamus tinctorious*

**Economic Importance**

- Rich in PUFA (78%) – to reduce blood cholesterol
- Used for preparation of:
  - Margarine, and salad dressing
  - Varnishes, paints and surface coating materials
- Oil (28-32%) is also used in:
  - Infant food and liquid nutrition formulations
  - Effective non-allergenic dispersant for injectable medicines
  - Charred oil is used to heal sores and rheumatism
- Flowers
  - For dye extraction –red dye
  - Cosmetics preparations
  - Petals reported to have effects on circulatory systems
- Cake (30%)
  - Un decorticated cake as manure
  - Decorticated fed to ruminants and mono-gastric animals
  - Can be as human food, if bitter principles and phenolics are removed
- Hulls (40%) can be used for manufacture of
  - cellulose, insulations, abrasions, hard boards and as fuel
- Thinned young plants are used as vegetables
  - since contains carotene, riboflavin and vitamins
- It is crop as border against animals

**Origin and distributions**

- *Vavilow(1926)*: India, Afghanistan or Ethiopia
- *De Candole (1886)*: Arabia
- Modern assessment:
  - Area encompassing S. USSR, W. Iran, Iraq, Syria, S. Turkey, Jordan and Israel
- Distributed now:
  - Between 14° & 45° N and 15° & 35° S

**World scenario –safflower (million ah & million t)**

Country	Area	Production	Productivity
India	0.704	0.43	0.67
Canada	0.097	0.16	1.69
USA	0.095	0.20	2.05
Ethiopia	0.069	0.04	0.51
China	0.011	0.02	1.91
Australia	0.034	0.02	0.59
<b>World</b>	<b>1.039</b>	<b>0.93</b>	<b>0.90</b>

### India Scenario – safflower (million ah & million t)

State	Area	Production	Productivity
Maharastra	0.49	0.23	0.48
Karnataka	0.19	0.08	0.42
AP	0.02	0.01	0.38
Gujarat	0.01	0.01	0.60
MP	0.01	0.01	0.58
<b>India</b>	<b>0.70</b>	<b>0.43</b>	<b>0.67</b>

#### Climate

- A day neutral plant
- But short day can prolong rosette stage
- Temp is more important than day length
  - Thermo-sensitive
    - Extremes of cold and heat not suitable
  - Tolerance to low temp at vegetative
  - But susceptible to high temp during flowering
  - For germination 15°C
  - Vegetative : 20-21°C
  - Flowering: 24 to 32°C
- Rainfall at flowering affects pollination
- Excessive humidity at any stage affects
- More suitable for rabi season in India

#### The Plant

- Highly branched, herbaceous
- Annual height varying from 30-150cm
- Well defined fleshy tap root system
- Stem is stiff cylindrical fairly thick at base and thin at top
- Central stem branches at 15-20cm to secondary
- Each branch terminates in a flower head
- The angle of branching is varietals but can be by environment also
- The leaf deeply serrated on lower stem, short, stiff, ovate at the inflorescence
- The inflorescence – numerous florets
- Flower color may vary from whitish yellow to red-orange
- The capitula, head size may vary from 1.25 to 4.0 cm
- The fruit achene, resembles small slightly rectangular sunflower seeds
- Seed weighs 250 – 800mg/grain

#### Soils

- Fertile, fairly deep and well-drained
- pH range of 5-8
- Shallow soils irrespective of fertility seldom produces high yield
- In traditional belts it is black cotton soil
- On heavy soils
  - This crop follows early Kharif crops

- Or may often single crop in Rabi
- It is considered as salt tolerant next to cotton
- Tolerant to Na salts but < to Ca & Mg
- Salinity reduces seed size and oil content

### **Seeds and sowing**

#### **Varieties**

- K1 120 days, CO 1 125 days
- Bhima (33% oil) - Maharastra
- JSF 1 (30%) – Rajasthan & MP
- Manjira - AP
- Nira – (30%) Maharastra & TN
- HUS 305 (35%) for Peninsular India

#### **Seed rate**

- 7-20 kg depending upon spacing and variety

#### **Spacing**

- 45 x 15 cm in TN
- 45 x 20 cm
- 60 x 30 cm etc

#### **Seed treatment**

- Pre-sowing seed hardening
- Use fresh seeds every year

#### **Sowing**

- From last week of Sep to end of Oct
- Early sowing has advantage
- Line sowing using improved seed drill
- Ferti cum seed drill is more desirable
- Seeds can be sown behind the plough also
- Small furrow may be opened and seeds dropped and half covered
- Depth of sowing may be 5-7.5cm
- Light planking for the soils which loses moisture

### **Nutrient management**

#### **Rainfed crops**

- N ranges from 25 kg N to 50 kg
- P<sub>2</sub>O<sub>5</sub> – 20 to 50 kg
- K<sub>2</sub>O – Mostly not recommended
- General: 40:20:0

#### **Irrigated**

- 60:30:20 (Chatisgarh) to
- 75:75: 35 (Karnataka)

#### **Time of fertilizer application**

- Rainfed – basal – deep placed by ferti-cum seed drill
- Irrigated 50% N+ full P & K as basal



- Remaining half N at 5th week during 1st irrigation

### **Water management**

- It is deep rooted xerophytic plant, can thrive under scarce soil moisture
- One or two irrigations (25 & 75 DAS) is optimum
- Sensitive to excess moisture at any stage
- If the soil profile contains 250mm ASM
  - ET of the season is 250-300mm- no response to irrigation
- Under irrigated condition the crop may be sown under Broad beds of 1.35 to 1.8m and furrow
  - To drain the excess water
- Points to remember:
  - If one irrigation is possible , provide it at critical period
  - Avoid contact of above ground parts with irrigation water

### **Weed management**

- Being wider spaced
  - critical periods for weed management extends up to end of rosette (25-50DAS)
- Hand weeding and hoeing
  - at 20 and 35 DAS is good
- Herbicides
  - PPI – Fluchloralin 0.75 to 1.0 kg
  - PE – Oxadiazon – 0.75 -1.0 kg or
  - PE – Pentimethalin – 0.75 kg

### **Important intercultural operations**

- Thinning to single plant and filling the gap at the early stage (before 15DAS)
- Nipping of central shoot to induce branching
- Bird damage:
  - By parrots at Isolated pockets
  - Cultivate in contiguous block
  - Bird scaring - morning and evening during
    - Seed filling to physiological maturity

### **Harvesting**

- Duration of the crop varies due to regions
  - 115-140 days
  - 120-125 days in TN
  - Gujarat & Orissa – 140-150days
  - In cooler regions 150-180days
- Maturity
  - When the lower leaves and most of the bracteoles dry and brown
  - Harvest in the early hours
    - Shattering minimum
    - Spines relatively soft
  - Combine harvester is becoming popular now since
    - Manual harvesting, bundling, threshing are all becoming problematic

- Duration of the crop varies due to regions
  - 115-140 days
  - 120-125 days in TN
  - Gujarat & Orissa – 140-150days
  - In cooler regions 150-180days
- Maturity
  - When the lower leaves and most of the bracteoles dry and brown
  - Harvest in the early hours
    - Shattering minimum
    - Spines relatively soft
  - Combine harvester is becoming popular now since
    - Manual harvesting, bundling, threshing are all becoming problematic
- Yield
  - In improved agro-techniques are used
    - Under scanty moisture – 800-1200kg/ha
    - Under favourable 1500-2000 kg
    - Under irrigated – 1800-2800kg/ha
- Storage
  - 5% moisture, clean and dry

#### **Cropping system**

- It is potential crop to replace dry rabi crops
  - Wheat, coriander, linseed, chickpea, pulses
- In traditional areas it is raised as intercrops
  - Sorghum, wheat, linseed, chickpea, coriander etc.
- Sequence cropping
  - Farmers rarely raise more than one crop due to non availability of moisture
  - There is scope for double cropping either preceding with Kharif crop or after rabi by irrigation

## FIBRE CROPS

---

### What is a fiber?

- Sometimes, just a single cell (sclerenchyma) that is long and dead at maturity.
- Gives structural support to plant stems.
- Ones used for cloth are usually derived from herbaceous plants (but see barkcloth, below)
- Fibers often are associated with the vascular bundle of a stem.
- Sometimes the entire vascular bundle, that includes fibers as well as xylem and phloem is considered the "fibre" for spinning, such as in linen

### Plant vs. animal

- Animal fibers such as wool and silk are composed mainly of protein (keratin and fibroin)
- Plant fibers are composed chiefly of cellulose
- But also may have lignin, tannins, gums, pectins and other polysaccharides
- Cellulose is very strong - tensile strength rivals

### VEGETAL FIBRES

- FAO includes 12 primary crops and
- Five derived agricultural

### FIBRES OF ANIMAL ORIGIN

- Same uses as vegetal fibres,
- But are of much higher value

### Vegetable fibres

- COTTON
- FLAX - *Linum usitatissimum*
  - Flax is cultivated for seed as well as for fibre
  - The fibre is obtained from the stem of the plant
- HEMP - *Cannabis sativa*
  - Synonyms
  - *hemp, marijuana, bhang, ganja, hashish*
  - This plant is cultivated for seed & fibre
  - The fibre is obtained from the stem
- KAPOK - *Ceiba pentandra*
- JUTE
  - White jute (*Corchorus capsularis*)
  - Red jute, tossa (*C. olitorius*)
- JUTE-LIKE FIBRES
  - China jute (*Abutilon avicennae*)
  - Congo jute, malva, paka (*Urena lobata; U. sinuata*)
  - Indian flax (*Abroma augusta*)
  - Kenaf, Mesta (*Hibiscus cannabinus*)
  - Rosella hemp (*H. sabdariffa*)
  - Sunn hemp (*Crotalaria juncea*)
- RAMIE

- China grass, white ramie (*Boehmeria nivea*)
- Rhea, Green ramie (*B. tenacissima*)
- **SISAL** *Agave sisalana*
  - Sisal fibre is obtained from the leaves of the plant
- **AGAVE FIBRES**
  - Haiti hemp (*Agave foetida*)
  - Henequen (*A. fourcroydes*)
  - Ixtle, Tampico (*A. lecheguilla*)
  - Maguey (*A. cantala*)
  - Pita (*A. americana*)
  - Salvador hemp (*A. letonae*)
- **MANILA HEMP** *Musa textilis*
  - The fibre is obtained from stalks of certain banana trees
- **COIR** *Cocos nucifera*
  - Coir fibre is obtained from the fibrous covering of the mesocarp

#### **Animals Fibres**

- **WOOL**
  - A natural fibre taken from sheep or lambs
- **GOAT HAIR**
  - Hair from cashmere, angora (mohair) and similar goats
- **HAIR OF HORSES**
- **SILK WORM**

**COTTON**  
*Gossipium sp*

---

**Cotton**

- It is white gold
- Backbone of textile industry
- Contributes 7% of GDP
- Providing employment to 60 million people in India
- 45% world's fibre need is met from
- 10% of world's edible oil

**Importance of cotton**

- It is cultivated primarily for lint
- Raw cotton is also used for medical and surgical purpose
- Linters are used cushions, pillows etc
- Also used for high grade paper, rayon, films, explosives
- Stalk is a fuel
- Seed crushed for edible oil
- Cakes and meals are excellent cattle

**World production Scenario (1996-**

Country	Area -M ha	Lint -M tonnes	kg lint /ha
India	9.2	3.0	327
USA	5.2	4.1	792
China	4.7	4.2	890
Pak	3.2	1.6	497
Uzbekistan	1.5	1.0	689
World	33.8	19.4	574

+ Argentine, Turkey, Brazil, Turkmenistan, Greece, Australia, Egypt

**Cotton – Indian Scenario (1996-97)**

State	Area -M ha	Lint -M tonnes	kg lint /ha
Maharastra	3.10	Lint is 30% of Kapas0.56	182
Gujarat	1.52	0.43	282
AP	1.01	0.48	477
Punjab	0.74	0.27	367
Karnataka	0.67	0.15	229
Haryana	0.65	0.23	354
Rajasthan	0.65	0.24	364
MP	0.53	0.32	605
TN	0.26	0.09	360
India	9.17	2.97	327

Note: Lint is around 30% of kapas

- Cotton is cultivated in 9 states in India
- Area is classified as:
  - Northern – Punjab, Haryana, NW Rajasthan & W. UP (hirsutum-arboreum)
  - Central – Maharashtra, MP, Gujarat & S. Rajasthan (herbaceum – arboreum-hirsutum)
  - Southern – Karnataka, AP & TN – (hirsutum- arboreum- herbaceum)

Origin

- Old world cotton with 'A' genome may be from Southern Ethiopia
- *G. arboreum* and *G. herbaceum*
- Called as 'desi' cotton
- New world cotton 'D' genome
- *G. barbadense*, (Egyptian) *G. hirsutum* (American) are New world cotton

Cultivars and hybrids

- Lot of work on varietal improvement as early as 1900
- Hybrids are available at plenty
  - Hirsutum varieties are famous
    - MCU series
      - MCU 5, 7, 9, 10, 11, 12
    - LRA 5166
  - Arboreum
    - K 9, 10, 11
  - Barbedense
    - Suvin (Anjali), Surabi
  - Hybrids
    - Jayalakshmi, TCHB 213, HB 224,

The plant

- Root
  - Tap root system
  - Grows more than 1.6 m
- Shoot and branches
  - Monopodium and sympodia
  - It is similar in all except arboreum
    - In arboreum growth continues in monopodium
- Leaf
  - Spirally arranged on the main stem
- Fruiting structure
  - Begins as flower bud or square
  - After flowering it becomes a fruit called

bollGrowth stages

- Germination phase -4-7 days
- Early vegetative phase
- Squaring- it may be from 35-70DAS depending upon
  - The variety
  - Location and
  - Management

- Flowering
  - 20-35 days after first square formation
  - It continues for 60-80 days
  - However peak flowering is 70-100 DAS
- Boll development
  - Within 15-18 days boll attains 90% size
  - Mature size is attained within 25 days
  - Cotton fibre develops from the outermost cells of the seed-coat
  - Fibre elongation is complete by day 21-24
  - Secondary wall thickening strengthens the fibre and continues up to 30-40 days after anthesis

#### Climate

- A mean average temp of <15°C for crop growth
- Optimum temp for vegetative growth is 21°C
- For fruiting a day temp of 27-30°C with large diurnal variation
- Frostless period of 180-200 days
- Well distributed seasonal rainfall
- Open sunny

#### weatherSoils

- A soil to a depth of not less than 60cm
- Sandy, sandy loam, black soils
  - When the rainfall is heavy - a coarse textured soil
  - When moisture is problem then clay soil

#### Season

- North Zone
  - 1st week of May
  - For the new varieties 3rd week to 1st week of June
- Central zone
  - 3rd week of June to 1st week of July
  - Irrigated may start from March
- Southern zone
  - June in Karnataka
  - Jun / July in red soil of AP
  - August in TN

#### Field preparation

- Fine tilth is not a pre-requisite
- Application of FYM / compost
- Chiseling may be to break hard pan
- Forming ridges and furrows is ideal

- Spacing and seed rate

Variety / Hybrid	Spacing	Seed - Fuzz	Seed-Delinted	Seed Naked
MCU5, 9, 11, SVPR 2, LRA 5166	75 x 30	15	7.5	-
KC 2	45 x 15	20	15	-
SUVIN	90 x 45	-	-	6
Jayalakshmi, HB 224, TCHB 213	120 x 60	3.75	2.5	-
MUC 7, SVPR 1, ADT 1	60 x 30	15	7.5	-

#### Sowing

- Dibble the seeds at 3cm depth
- No of seeds
  - Fuzzy seeds
    - Hybrids - 2
    - Varieties -3
  - Delinted seeds
    - Hybrids – 1
  - Varieties - 2

#### In organic fertilizer – kg /ha

Variety / Hybrid	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
MCU5, 9, 11, SVPR 2, LRA 5166	80	40	40
MUC 7, SVPR 1, ADT 1	60	30	30
SUVIN, Jayalakshmi, HB 224, TCHB 213	120	60	60

- P & K as per soil test
- Time of application for Group I & II
  - ½ N + P+K basal
  - ½ at 40-45 DAS
- For Group III
  - N as three equal splits as basal, 40-45 and 60-65 DAS
- If the previous crop if heavily fertilized ( for crop like ragi) reduce N level by 25%
- If basal not applied fertilizer may be applied at 25th DAS
- Application of 'azospirillum' saves 25% N requirement

#### Weed management

- Herbicide application
  - Pre-emergence application of
    - Fluchloralin 1.0 kg
    - Pendimethalin 1.0 kg
  - Hand weeding at 30-45 DAS

#### Irrigation

- Cotton can be irrigated at
  - 75% depletion available soil moisture in clay
  - 50% ASM at sandy loam soils
- Early irrigation is important to have proper plant growth
- An mild stress before flowering is advantageous



- After flowering very crucial
  - Deficit results in fruit abscission
  - Excess leads to excess vegetative growth
- Methods of irrigation
  - Flooding through furrows
  - Surge may be followed
  - Drip fertigation is also possible

After cultivation

Thinning and gap filling

- Gap filling on 10th day
- Seedlings raised from by polyethylene bag may be useful
- Thin the seedlings to single plant on 15th

day Earthing up

- Digging and earthing up is essential for soil aeration

Nipping

- If monopodia continues more than 15 nodes

Harvesting

- Hand picking is usual practice
  - Strippers – spindle or brush type is used in developed countries
    - Periodical
    - Early morning
    - Without bracts or with minimum
  - May be machinery
    - Method of sowing needs change
    - Varietals preference
    - One time harvest
    - Weather at maturity (RF) plays vital role
  - Seed cotton should be collected from fully opened bolls
  - After harvesting should be dried in clean threshing floor
  - Should not be mixed with other varieties
  - Hand picking and cleaving the pest infected kapas will enhance the quality
- Quality parameters
- Ginning percentage
  - Color
  - Trash
  - Fibre quality
  - Fibre length
  - Fibre fineness
  - Fibre strength
  - Spinning performance
  - Oil content (14-26%) of the seed etc.
    - Absence of gossypol, gossy purprin, gossy pulvin

#### Very Important management

- Pests and disease

#### controlCropping system

- Rainfed areas
  - Mono cropped
  - Mono with mixed crops
    - Pulses, millets, groundnut
- Irrigated
  - Cotton – wheat
  - Cotton – pulse – millets
  - Rice - cotton

#### Rice fallow cotton

- It is cotton cultivated in rice fields immediately after the harvest of rice when the field is in waxy condition when the season is optimum.
- No field preparation is needed to sow the crop.
- It may also be called minimum tillage crop.
- Management of previous rice crop including land leveling, P & K management, weed management, water management, and height of harvest of rice stubbles etc. decides the efficiency and growth characters of cotton crop.
- Season

- Jan 15th –Feb 15th
- Field
  - Immediately after the harvest of rice
  - Sowing at waxy soil condition
- Season
  - Jan 15th –Feb 15th
- Field
  - Immediately after the harvest of rice
  - Sowing at waxy soil condition
- Varieties
  - MCU 7, SVPR 1, ADT 1 LRA 5166
- Spacing
  - 60 x 30 and (75 X 30 for LRA)
- Fertilizers
  - 60:30:30
- Gap filling and thinning
  - Gap filling from 7th day onwards
  - Thinning on 15th day
  - Hand weeding around the plant
    - From 15th day
- Digging the rows and earthing up
  - From 21st day
- Irrigation
  - After drying of the soil dug between the rows
- Fertilizer application
  - Around 35th day
  - Followed by 1st irrigation
- Earthing up
  - Around 40th day after the moisture dried and soil loosened for secondtime
- 2nd irrigation may be around 50-60 DAS
- Plant protection
  - As per the need

**JUTE**  
*Corchorus capsularis*  
*C. olitorius*

---

**Importance**

- Raw jute in the trade & industry refers both jute and meta
- It is one of the best fibres in India
- Plays vital role in Economy
- Employment, industry, foreign exchange are three spheres
- States like WB, Bihar, Orissa & E. UP
  - 4 million small and marginal farmers are engaged
  - Labour intensive during processing
- It was tried an alternate to hemp
- Next to cotton
- Fibre for manufacture of packaging materials
  - Package materials to food grains, sugar, cement, fertilizers, cotton, salt, vegetables etc
- It is gaining importance again since there is awareness in eco-friendly
  - Meaning discouraging synthetic materials

Area, Production, Productivity of allied fibres of Jute – World (Million ha, tonne & t/ha)

Country	Area	Production	Productivity
India	0.96	1.66	1.73
Bangladesh	0.52	0.83	1.60
China	0.23	0.44	1.94
Thailand	0.09	0.13	1.45
Indonesia	0.01	0.01	1.00
World	1.93	3.27	1.69

Area, Production, Productivity of allied fibres of Jute – India (Million ha, tonne & t/ha)

State	Area	Production	Productivity
WB	0.57	1.192	2.10
Bihar	0.14	0.214	1.57
Assam	0.90	0.150	1.68
Orissa	0.01	0.002	1.58
India	0.96	1.660	1.73

**Origin**

- *C. olitorius*
  - Primary origin – Africa
  - Secondary origin – India
- *C. capsularis*
  - Indo-Burma

### Capsularis vs Olitorius

Characters	Capsularis	Olitorius
Height	5-12 feet tall	5-15feet
Waterlogging	Can withstand	Normally Cannot
Duration	3-5 months	4-5 months
Stem	Cylindrical	Cylindrical
Branches	Branched or unbranched	Branched but less vigorous
Capsule	Rounded, 5 locular, seeds 7-10in two rows in each locules, without transverse partitions,35-40 in each fruit	Elongated, 5-6 locules, seeds 25-40 in single row in locule, with transverse partitions, 125-200seeds/pod
Seed wt	300 seeds/g	500seeds /g

#### Climate

- Hot and humid climate
  - Temp 27 – 40°C
  - Humidity 65-90%
- Short day and low temp leads to
  - premature flowering in olitorius
- Jute growing areas are divided into zones
  - 9 Zones according to climate

#### Soils

- Well drained fertile light textured soil
  - for olitorius
- Heavy soils and wetland soils
  - for capsularis
  - Alluvial is more suitable for capsularis
- All soils except sandy and heavy clay

#### Season

- Best season for higher fibre yield is:
  - when the day is longer
  - In Northern hemisphere Mar- Sep
- Winter season is less favourable for fibre
- Jute seeds are sown anytime between March - May
- The crop prefers a hot & humid climate and low laying

#### Field preparation

- Deep ploughing
- Dry seed

#### Methods of sowing

- Broadcasting
- Line sowing by seed drill

- Seed rate, Spacing, Plants

Jute type	Line sowing (kg)	Broadcasting (kg)	Spacing (cm)	Plants/m <sup>2</sup> (No)
Olitorius	5	7	25 x 5	80
Capsularis	7	10	30 x 5	67

Varieties

Olitorius

- o JRC 212, JRC 321, JRC 7447

Capsularis

- o JRO 524, JRO 878, JRO 7835

### Intercultural operations

- Raking
  - Or harrowing twice for broadcast crop
    - 5-6cm height and a week later
  - Raking improves tilth, reduces weed and thin the stand
- Hoeing
  - May be wheel hoeing for row cropping
- Weeding
  - 3-4 weeks after sowing, depending upon the intensity
  - Fluchloralin 1.5kg/ha sprayed 3 DAS

### Manures and fertilization

- 5 t compost / FYM
- 20:20:20 N, P<sub>2</sub>O<sub>5</sub> & K<sub>2</sub>O kg /ha
- For traditional area
  - N may be 40 kg in two splits
  - Basal plus top at 3-4 weeks after germination

### Irrigation

- Generally rainfed
- Irrigation is needed if sown in March
  - One pre-sowing irrigation
  - Followed by 2-3 irrigations

### Harvesting

- Any time between 100-150 days
- Better quality when harvested early
- Higher quantity if harvested later
- Ideal harvest when the crop is in small pod stage (120-135 days)
- The plants are cut close to ground with sickle
- Plants are cut from the bottom
- Leaves are stripped off from the top
- Accumulated in

### bundlesRetting

- Retting is the process of extraction of the fibre
- Bundles are then submerged in water for 7 to 10 days
- Retting takes place due to joint action of water, aquatic and plant surfaceorganisms, mostly bacteria
- The cambium and the cortex gets

### decomposedStripping

- The labourer holds the stem in one bunch and taps the root end lightly with a mallet.
- This frees the fibre at the foot of the stalk.
- The fibre is then grasped & by lashing & jerking the stem in the water the rest of the fibre loosens and comes off

### Drying

- Jute fibres are kept hanging on makeshift hangers for drying
- This process takes about 2 to 3 days

- Now the fibre is ready to be marketed. Here Grading becomes imperative depending on the fineness, color, density, clearness etc, they are all score. Higher the score the better the price.

#### Grading

- Jute is then brought to JCI godowns
- The bundles are scanned and jute fibres are categorized as per grades (TD1 to TD7)
- Grade wise these are stocked at separate

#### locations Pressing

- Grade wise bundles are subjected to machine press to convert them in Bales
- Even the ropes used to tie the bales are prepared from the jute wastes
- The bales are finally stored in the warehouse as per their grades for

#### sale Cropping Systems

- Followed with rabi season winter crops
- Wheat, rice, millets, chickpea etc



**MESTA**  
*Hibiscus cannabinus*  
*H. sabdariffa var. altissima*

---

***H. cannabinus* (HC)-**

- Also called Kenaf

***H. Sabdariffa* (HS)**

- Roselle, Roselle hemp, Java jute, Thailand mesta
- In India both are called as Mesta
- Both are long vegetable fibre
- Closely allied to jute fibre
- HC Mesta
  - Yields better quality fibre
  - Sown in May
- HS Mesta
  - Rainfed sown in June to July middle
  - Sown in AP, Maharastra,, Karnataka & TN

**Crop Management**

- Almost same as that of jute
- Seed rate 18-20kg
- Spacing 30 cm between rows
- Broadcast application and laddering after sowing
- Thinning and removing the weeds by intercultural operations
- Can tolerate drought but not flood
- N may be up to 40 kg in 2 splits
- Harvest at 50% flowering for quality
- 1.5 to 2.2 t / ha of fibre yields

**AGVAVE**

- Sisal is an aloe-like plant from the Agaves family
- The plant grows semi-arid regions
- provides a substantial source of income to the local communities
- The fibre is strong, rough, yet smooth
  - weave directly into baskets,
  - hat, sisal mat, sisal wall-hanging, sisal lampshade
- Sisal is an aloe-like plant from the Agaves family
- The plant grows semi-arid regions
- provides a substantial source of income to the local communities
- The fibre is strong, rough, yet smooth
  - weave directly into baskets,
  - hat, sisal mat, sisal wall-hanging, sisal lampshade

## SUGARBEET

*Beta vulgaris* spp. *Vulgaris* var *altissima* Doll

---

### Importance of sugarbeet

- Tropical sugarbeet is a biennial sugar producing tuber crop, grown in temperate countries
- This crop constitutes 30% of total world production and distributed in 45
  - countries.
- Now tropical sugarbeet hybrids are gaining momentum in tropical and sub tropical countries including Tamil Nadu as a promising energy crop and alternative raw materials for the production of ethanol.
- Apart from sugar production, the value added products like ethanol can also be extracted from sugarbeet.
- The ethanol can be blended with petrol or diesel to the extent of 10% and used as bio-fuel.
- The sugarbeet waste material viz., beet top used as green fodder, beet pulp used as cattle feed and filter cake from industry used as organic manure.

Tropical sugarbeet now emerged as commercial field crop because of the favourable characters like

- tropical sugarbeet hybrids suitable for Tamil Nadu
- Shorter duration of 5 to 6 months
- needs moderate water requirement of 60-80 cm.(iv) higher sugar content of 12 – 15% (v) improve soil conditions because of tuber crop and
- grow well in saline and alkali soil.
- The harvesting period of sugarbeet coincides with March – June, the human resource of sugar factory in the off season may efficiently utilized for processing of sugarbeet in the sugar mills, which helps in continuous functioning of sugar mills.

### Hybrids and duration

The tropical sugarbeet hybrids suitable for cultivation in Tamil Nadu are

- Cauvery,
- Indus and
- Shubhra.
- The duration of these tropical hybrids will be 5 to 6 months depending on climatic conditions prevailing during crop growth period.

### Climate and season

- Tropical sugarbeet require good sunshine during its growth period.
- The crop does not prefer high rainfall as high soil moisture or continuous heavy rain may affect development of tuber and sugar synthesis.
- Tropical sugarbeet can be sown in September– November coincide with North East monsoon with a rainfall of 300 – 350 mm well distributed across the growing period which favours vegetative growth and base for root enlargement.
- The optimum temperature for germination is 20 – 25°C,
- for growth and development 30 - 35°C and
- for sugar accumulation in 25– 35°C. Season

- September to November and harvested during March and May. Field preparation
- Well drained sandy loam and clayey loam soils having medium depth (45" cm) with fairly good organic status are suitable.
- Tropical sugarbeet require deep ploughing (45 cm) and followed by 2 – 3 ploughing to obtain a good soil tilth condition for favorable seed germination.
- Ridges and furrows are formed at 50 cm apart. Manures and Fertilizers

Manures and Fertilizers	Basal Application	Top dressing
Manures	12.5 tonnes /ha	-
Biofertilizers		
Azospirillum	2 kg /acre (10 pockets)	-
Phosphobacteria	2 kg /acre (10 pockets)	
Fertilizers		
Nitrogen	75kg /ha	37.5 kg / ha each at 25 & 50
Phosphorus	75kg /ha	DAS
Potassium	75kg /ha	--

#### Seeds and sowing

- Optimum population is 1,00,000-1,20,000 /ha.
- Use only pelleted seeds 1,20,000 Nos /ha which require 6 pockets (3.6kg / ha.- One pocket contains 20000 seeds (600 g)]
- The recommended spacing is 50 x 20 cm.
- The pelleted seed is dibbled at 2 cm depth in the sides of ridges at 20 cm apart Weeding and Earthing up
- The crops should be maintained weed free situation up to 75 days.
- Pretilachlor 50 EC @ 0.5 kg /ha or Pendimethalin @3.75lit /ha can be dissolved in 300 litres of water and sprayed with hand operated sprayer on 0-2 day after sowing,
- Followed by hand weeding on 25th day and 50th day after sowing.
- The earthing up operations coincides with top dressing of N fertilizer. Irrigation
- Tropical sugarbeet is very sensitive to water stagnation in soil at all stages of crop growth
- Irrigation should be based on soil type and climatic condition.
- Pre-sowing irrigation is essential since at the time of sowing, sufficient soil moisture is must for proper irrigation.
- First irrigation is crucial for the early establishment of the crop.
- For loose textured sandy loam soil irrigation once in 5 to 7 days and for heavy textured clay loam soil once in 8 – 10 days is recommended.
- The irrigation has to be stopped atleast 2 to 3 weeks before harvest.
- At the time of harvest if the soil is too dry and hard it is necessary to give pre harvest irrigation for easy harvest. Light and frequent irrigation is recommended for maintaining optimum soil moisture

#### Pest and diseases

- Pests - Aphids, Tobacco caterpillar and Flea beetles Diseases
- Root and crown rot, *Cercospora* leaf spot and Root knot nematode

#### Integrated pest and disease management

- Seed treatment with *Pseudomonas fluorescens* @ 10 g/kg of seed

- Summer ploughing and exposing the field to sunlight
- Crop rotation for 3 years with Marigold or gingelly or sunnhemp for root rot and nematode
- Soil application of *Trichoderma viride* or *Pseudomonas fluorescens* @ 2.5 kg/ha mixed with 50 kg of FYM before planting
- Sow castor as trap crop around and within fields to attract adult *Spodoptera* moth for egg laying
- Set up light traps (1 mercury / 5 ha) for monitoring *Spodoptera litura*
- Setting up pheromone -Pherodin SL @ 12/ha for *Spodoptera litura*
- Removal and destruction of *Spodoptera* egg masses, early stage larvae formed in clusters
- Hand picking and destruction of grown up *Spodoptera* caterpillar based on need
- Spraying *Spodoptera* nuclear polyhedrosis virus at 1.5 x 10<sup>12</sup> POB/ha
- Spray NSKE 5% for aphids, flea beetles and for early instar caterpillars
- Use of poison bait pellets prepared with rice bran 12.5 kg, jaggery 1.25 kg, carbaryl 50% WP - 1.25 kg in 7.5 lit water for *Spodoptera litura*
- Spray any one of the following insecticides using a high volume sprayer covering the foliage and soil surface
  - Chlorpyrifos 20 EC - 2 ml / lit, Dichlorvos 76 WSC - 1 ml/lit, Fenitrothion 50 EC - 1 ml/lit, Spray malathion 50 EC (2 ml/lit) for flea beetle and leaf webber, Spray Imidacloprid 200 SL (0.2 ml/lit) or methyl demeton 25 EC (2 ml/lit) or dimethoate 30 EC (2 ml/lit) for aphids
- Applying neem cake @ 150 kg/ha for root rot
- Foliar spray of Mancozeb 2.5 g / lit or Chlorothalonil 2 g / litre of water for *Cercospora* leaf spot
- Neem cake @ 1 t/ha or carbofuran @ 33 kg/ha as spot application on 30 days after sowing for nematode management

#### Harvest and yield

- The Tropical sugarbeet crop matures in about 5 to 6 months. The yellowing of lower leaf whorls of matured plant, Nitrogen deficiency and root brix reading of 15 to 18% indicate the maturity of beet root for harvest.
- The average root yield of tropical sugarbeet is 80 – 100 tonnes / ha.
- Harvesting should be timed so as the roots reach the factory within 48 hours for processing.
- Till such time the roots should not be harvested.

## SUGARCANE

---

### Importance

- 62% world's sugar is met from cane
- Sugar requirement is projected at 150 million tonnes for the world
- India alone requires 16-20 million t
- Sugar industry is the largest agro-based industry next only to textiles in India
- At present there are 450 sugar factories
- Average productivity is 14.2 million t (1998)
- Average sugar recovery of 11% By products in sugarcane industry
- There are many end uses - probably more than 150
- But many of them are of negligible economic interest
- 38 end-products are potentially important
- But four main byproducts of the sugarcane are:
  - Cane tops
  - Bagasse
  - Filter mud / press mud and Spent Wash
  - Molasses
- Cane tops
  - Cane tops have no real market value
  - They can be compared to fair quality fodder with an average feed value, when fresh, of about 2.8 MJ of metabolizable energy per kilo of drymatter.
  - However cane tops should be collected and transported from the canefields to the feedlot
- Bagasse
  - It is the fibrous residue of the cane stalk left after crushing and extraction of the juice
    - It consists of fibres, water and relatively small quantities of soluble solids - mostly sugar
  - Utilizations are:
    - Electricity
    - Particle board
    - Paper
    - Furfural
      - It is a colorless, inflammable, volatile, aromatic liquid
      - 25 tonnes of bagasse to produce 1 tonne of furfural
      - Furfural has many industrial uses:
        - Selective solvent for the refining of lubricating oils
        - As an intermediate in the production of nylon and resins
    - Methane

- Filter mud / pressmud
  - The precipitated impurities contained in the cane juice, after removal by filtration, form a cake of varying moisture content called filter mud
  - This cake contains much of the colloidal organic matter anions that precipitate during clarification, as well as certain non-sugars occluded in these precipitates
- Filter mud / pressmud...
  - The use of filter mud
    - As animal feed has not proved economically rewarding, the main constraints being the magnitude of the drying process involved and the low digestibility of the dried scums
    - As soil nutrient there are limitations
      - Higher values of C.O.D. and B.O.D .
      - Wax percentage in substantial quantity which prevents microbial action
      - High concentration of various chemicals which are detrimental to survival of beneficial microflora
      - Bio-degradation being an exothermic reaction survival of microbes except thermophiles is difficult
      - Due to above mentioned difficulties, bio-degradation of pressmud and spent wash is a difficult process
- Molasses
  - Molasses is the final effluent obtained in the preparation of sugar by repeated crystallization
  - It is the residual syrup from which no crystalline sucrose can be obtained by simple means
  - The yield of molasses is approximately 3.0 percent per tonne of cane
    - but it is influenced by a number of factors (2.2 to 3.7 percent)
    - The specific gravity varies between 1.39 and 1.49, with 1.43 as indicative average
  - The composition of molasses varies but, on average, would be as follows:
 

▪ Water	20%
▪ Other carbohydrates	4%
▪ Sucrose	35%
▪ Nitrogenous compounds	4.5%
▪ Fructose	9%
▪ Non-nitrogenous acids	5%
▪ Glucose	7%
▪ Ash	12%
▪ Other reducing sugars	3%
  - For distillery industry
  - Alcohol and related products
  - Export to some developed countries as raw materials
  - It is an ingredient to animal feed

## Origin

- India is considered as native to thin cane
- Tropical thick canes from larger islands of Oceania with New Guinea as possible nucleus
  - Brandes (1956) – three different movements
    - Introduction to Solomon islands - 8000 BC
    - Westerly direction to Indonesia and Philippines – 6000 BC
    - Fiji, Tonga, Samoa, the Cook islands & Hawaii – 600-1100 AD

## World Scenario (Area, production, productivity, in million ha, tonne and t/ha)

Country	Area	Production	Productivity
Brazil	4.92	338.7	68.7
India	3.96	265.0	66.9
China	1.21	85.7	71.3
Pak	1.14	53.0	46.7
Asia	8.67	536.7	61.9
S. America	6.05	419.6	69.4
N. C. America	3.21	166.7	52.0
Africa	1.43	85.7	57.9
World	19.90	1254.9	63.1

## Indian Scenario (Area, production, productivity, in million ha, tonne and t/ha)

State	Area	Production	Productivity
UP	2.10	124.8	59.4
Maharashtra	0.52	41.8	81.0
TN	0.27	26.9	99.3
Karnataka	0.25	21.9	85.9
AP	0.20	14.9	75.1
Punjab	0.17	11.0	63.8
Gujarat	0.16	11.4	68.8
Haryana	0.16	9.0	55.0
Bihar	0.14	6.3	45.2
MP	0.06	2.2	38.1
India	3.96	265.0	66.9

## Species of sugarcane

- Cultivated
  - *Saccharum officinarum*
  - *S. barberi*
  - *S. sinense*
- Wild species
  - *S. spontaneum*
  - *S. robustum*

## The plant

- Grass family with tillering capacity

- Above ground parts are
  - Stem of stalk with nodes and internodes
  - Leaves
  - Inflorescence
- Roots
  - Sett roots developed from root primordial
  - Shoot root , thicker branched
  - Buttress roots, fibrous branched

#### Varieties

- After the introduction of hybridization programme in early 20th century many improved varieties are available
- Varieties for region and season are available in plenty
- SBI, Coimbatore in collaboration with NARS has set up breeding programme
- Breeders of NARS will visit and at a specified period and carry materials

#### Seasons

- There are four main seasons in TN
  - Early – Dec-Jan
  - Mid-season – Feb-Mar
  - Late – Apr – may
  - Special season – June-July
- All India
  - Spring – Feb-Mar
    - *Suru* in Maharastra, *Eksali* in Gujarat & AP
  - Autumn – Sep-Oct-
    - 13-15 months, supplies sugar for early crushing
  - Adsali – July Aug
    - 16-18 months
    - Increase in yield & sugar recovery
    - Though advantageous area is declining due to water problem
  - Late planting – beyond March, reduction in duration and yield

#### Soils

- Cultivated in wide range of soils
- Moderately heavy medium deep (1-2m) loams are better than
  - Heavier and shallow soils
- The soil must be of good depth and drainage
- No salt and compaction

#### Seed bed

- **Preparation of good seed bed is essential**
  - Since the same field is retained for 2-3 years
  - Deep ploughing / sub-soiling is needed
- **Field Layout**
  - In India - by adopting two systems viz.,
    - Ridge and furrows system
    - Flat system.
  - There are some special systems
    - Trench system



- Deep Trench system
- Paired - row system
- Ring or pit system etc.

### **Planting materials**

#### **▪ Vegetative propagation**

- Known as seed pieces or setts
- Buds on sugarcane germinate and give plants
- Planting materials may be
  - Single bud sett or Chip bud
  - Two budded setts
  - Three budded
  - Seedlings raised from nursery
  - Seedlings raised by poly bags or
  - Tissue cultured seedlings
- For sett planting
  - Sugarcane setts are prepared from nursery cane
  - Nursery cane is younger than (6-8 months) juice cane

### **Ideal cane sett**

- Ultimate plant stand and yield depends on the type of seed material used.  
The characteristics of good seed cane material are
  - Free from disease and pest infestation
  - Age of seed crop is around eight months
  - Setts should have healthy buds without any damage in handling and transport
  - Buds with higher moisture content, adequate nutrients, higher amount of reducing sugars
  - Cane should be free from aerial roots and splits
  - Pure in quality

### **Preparation of setts**

- Use of sharp knife to cut setts
- Treat the setts immediately with fungicide solution
- Machine cutting and mechanical planting is also followed in developed countries
- **Seed rates & spacing**
- Depends up on the spacing
- Spacing varies due to
  - Climate
  - Method of establishment
- In TN
  - 50,000 three budded setts
  - 75,000 two budded setts
  - 187,500 single budded setts
- Row spacing may vary
  - 0.9m to 1.5m and 2.4m

### **Method of planting**

#### **Flat Planting**

- In this method, shallow (8-10 cm deep) furrows are opened with a local plough

- orcultivator at a distance of 75 to 90 cm
- There should be adequate moisture in the field at the time of planting
- The setts are planted in them end to end
- Furrows are covered with 5-7 cm soil
- In most parts of northern India and some tracts of Maharashtra, cane is planted by this method

#### **Furrow Planting**

- In this method furrows are made with a sugarcane ridger about 10-15 cm deep in northern India and about 20 cm in south India
- Setts are planted end to end
- The furrows are covered with 5-6 cm soil, leaving upper portion of furrows unfilled
- Immediately after covering the setts water is let into furrows
- This method is practiced in parts of eastern UP and in Peninsular India, particularly in heavy soils

#### **Trench Method**

- In some coastal areas as well as in other areas where the crop grows very tall and the strong winds during rainy season cause lodging of cane, trench method is adopted to save the crop from lodging
- Trenches at a distance of 75-90 cm are dug with the help of ridger or by manual labour
- Trenches should be about 20-25 cm deep
- Fertilizers (NPK) are spread uniformly in the trenches and mixed thoroughly in the soil
- The setts are planted end to end in trenches
- The tractor-drawn sugarcane planter is a very suitable device for planting cane in trenches

#### **Modified trench system**

- Ridges and furrows are opened at 120 cm using a tractor drawn ridger
- The furrow bottom is widened
- As the crop grows while each manuring, only slight earthing up is done so that a trough is maintained through the crop growth
  - Here irrigation is given in the cane row itself
- The system has been found highly useful under :
  - Saline water irrigated and saline soil conditions
  - The salts are leached down from the root zone
  - Higher cane yield compared to conventional ridges and furrows
  - FYM or pressmud application and trash mulching in this system can further improve cane yield

#### **Special methods of establishment**

##### Single bud direct planting

- In this system single bud setts are planted directly in the field in the furrows at 30-45 cm spacing
- This method is highly economical and sowing of seed material.

- The buds should be healthy

#### **Transplanting technique (STP technique)**

- Seedlings are raised in a nursery bed using single bud setts.
- About 6 weeks old seedlings are transplanted
- Advantages by adopting this system are
  - Saving in the seed cost
    - Only about 2-3 t/ha against the normal 8-10 tonnes/ha.
  - Synchronous tillering leading to uniform maturity
  - Sufficient time availability to prepare the main field
  - Saving of 2-3 irrigations
  - Possibility of increased cane yield
  - Better weed management
  - Efficient fertilizer management

#### **Partha" method**

- A technique developed by Mr. S.V. Parthasaradhy an eminent sugarcane scientist.
- Suggested for water logged or excess soil moisture conditions (coastal Andhra Pradesh and Tamil Nadu during N-E monsoon period)
- In this method
  - three eye budded setts are planted in a slanting position, 60° to the vertical, in the wet furrow or half-way on the ridges
  - Usually one eye bud is thrust into the soil and the remaining two will be above, which will sprout
  - Once the monsoon recedes, the *in situ* sprouted setts are pressed down into the soil and made to lie horizontally
  - Soil is put to the base
  - At this stage, the crop is manured

#### **Measures to obtain higher germination**

- Using disease free healthy setts
- Careful preparation of setts without damaging the buds or setts
- Planting freshly prepared and treated
- Trash mulching under
  - moisture stress and hot weather and late planted conditions
- Seed treatment using a

#### **fungicide Manures for Sugarcane**

- Apply FYM / Compost during field preparation
- Inorganic fertilizers:
  - For Coastal and flow irrigated areas
    - 270 : 112.5: 60 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg /ha
      - N & K applied in three equal quantities at
      - 30, 60 and 90 DAG
      - N may be coated with neem cake @20%
  - For Lift irrigated areas
    - 225 : 112.5: 60 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg /ha
  - For Jaggery producing areas
    - 175 : 112.5: 60 N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O kg /ha
- For those soils deficient in ...

- In iron : 100 kg ferrous sulphate /ha
- In Zinc : 37.5 kg Zinc sulphate
- Foliar application and drip fertigation can
  - Reduce N dose
  - Increase cane yield
  - Save ground water pollution by fertilizers
- Azospirillum application can enhance the growth
- Band placement of fertilizer is another method by which losses can be minimized

#### **Irrigation**

- To support and sustain a vigorous nursery crop, irrigating at optimum levels inimportant
- Any shortage in the irrigation would lead to reduced sett yield
- Moisture stress would pre-dispose the crop to the attack of some pests anddiseases
- Irrigation at IW/CPE ratio of 1.0 is ideal
  - According to moisture depletion irrigating at 25% depletion of availablesoil moisture (ASM) may be ideal
  - This in practical terms means:
    - Once in 6-7days in a loamy soil and
    - At around 10-12 days in heavy day soil

#### **Weed control**

- A weed-free environment is absolutely essential
- Deep ploughing and removal of perennial weeds
- Pre-emergence application of
  - Atrazine 1.75kg or Oxyflurofen 0.75 lit/ha on 3-4 days of planting using knapsack sprayer
- Post-emergence application of
  - Gramaxone 2.5 lit + 2-4,D Sodium salt 2.5 lit/ha as directed spray on 21 DAP
- Hand weeding before each manuring
- Other cultural operations and precautions

#### **Cultural operations**

- Important cultural operations in sugarcane in addition to weeding, manuring andirrigation are
  - Earthing up
  - Detrashing
  - Propping and
  - Flowering control

#### **Earthing-Up**

- This practice is followed where furrows are practiced
- Earthing up are 2-3times during crop period.
  - The first earthing-up is known as "partial earthing-up and
    - To cover the fertilizers
    - To provide anchorage to root system
  - The second operation is "full earthing-up".

- Full earthing-up is done after final manuring (90-120 days coinciding with peak tillering)
- The soil from the ridge is thrown on both sides towards cane rows and the furrows will become as ridges and ridges as furrows
- The furrows so formed are used for irrigation

#### Wet earthing up

- Done around 6 months age of the crop
- The furrows are irrigated and the wet soil from furrows is taken and plastered on the ridges
  - It checks late tillering and watery shoots
- Heavy earthing up is useful during floods
  - When the flood water recedes, the excess water from earthed-up soil drains out quickly thus providing aeration

#### Hoeing

- This operation is done where soil crust formation is very common
- In sub-tropics hoeing is done after germination is over using a bullock drawn or tractor-drawn harrows

#### Hoeing

- While carrying out this operation some of the germinated setts may be uprooted and they are pressed down manually

#### Detrashing

- On an average a stalk may produce 30-35 leaves
- All are not useful for effective photosynthesis
  - Only the top 8-10 leaves are sufficient
  - Most of the bottom leaves are dried and will not participate in photosynthesis
  - At the same time they drain out the food materials which otherwise could be used for stalk growth
- Therefore it is important to remove the dry and lower leaves
- This operation is known as detrashing
- Detrashing helps in clean cultivation
- Easy movement of air within the crop canopy
- Reduce certain pests like scales, mealy bugs, white fly etc.,
- Easy entry into the field
- Avoids bud germination due to accumulation of water in the leaf sheath
- Easy to take up cultural operations including sprayings
- Easy to harvest, obtaining clean canes for milling
- Detrashed leaves can be used for
  - Mulching in the furrows or
  - Used for composting
  - Infested leaves with pest or disease may be burnt out

#### Propping

- Tying the canes by using the lower bottom leaves to check lodging of cane
- Propping can be either done for each row or two rows can be brought together and tied
- It is for:

- Prevention the lodging
- Extensively followed in coastal belt where cyclone effect is very severe
- Lodging also very common in
  - Tall varieties
  - Top growth is heavy and where the growth habit is not erect, and
  - The varieties with less fibre content

#### **Lodging leads to several problems**

- Cane breakage and thus loss of stalk number at harvest loss
- Lodged canes are easily infested by certain pests and diseases
- Damage by rats and rodents
- Bud sprouting leads to reduced cane quality
- Aerial root formation affects cane quality
- difficult to irrigate and harvest the cup

#### **To prevent lodging**

- Heavy earthing up
- Propping
- Paired row planting with earthing up
- Deep trench planting
- Selection of varieties resist lodging
- Raising wind breaks along the field borders
- Application of potassium

#### **Removal of water shoots**

- Water shoots are late formed tillers or side shoots which are robust and fastgrowing.
- They originate mainly due to excess water supply, heavy and late manuring, inadequate earthing up
- These water shoots contain lot of water, low sucrose and more of reducing sugars
- Water shoots affect the growth of adjacent stalks
- They harbor insect pests and when they are milled sugar recoveries are low because of reduced juice quality
  - Therefore removal of water shoots whenever they appear
  - Water shoots can be used as cattle feed

#### **Control of flowering**

- In commercial sugarcane cultivation, flowering is not desirable
- Once the plant flowered the cane growth stops and starts ripening
- If not harvested immediately reversion of sugars, increase in fibre, pith formation, cane breakage etc.
- The deterioration is much faster if it is summer
- Solution
  - Non-flowering or shy flowering varieties can be used where flowering is a severe problem
  - Controlled irrigation
  - Change of planting period
  - Use of growth regulating substances
    - Spraying of ethrel at 500ppm, twice or 1000ppm once at floral initiation

## Ratoon Management

- The crop raised from planting cane sett is called plant crop
- After the harvest of plant crop stubble sprouts and gives rise to succeeding crop called as ratoon crop
- The practice of taking up ratoon crop is called

### 'ratooning'

Ratooning ability

- Is generic, based upon ability ratoon varieties are classified as:
  - Good or poor ratooner
  - Co 1148, Co 419, Co 740 are some examples for good ratooners
- Ratooning has following advantages:
  - Reduction in the cost of field preparation, planting material, operation cost
  - Saving in field duration – ratoon matures earlier than plant crop
  - Ratoon may give equal yield that of plant

### Ratooning is common practice

- Number ratoon varies
  - In Cuba 10-11 crops
  - South Africa & USA 4-6 crops
  - Hawaii, Brazil and Australia 2-3
  - In India ratoon yield is generally poor since
    - Very little attention to manure ratoon
    - 30-40% area is under ratoon in India
    - The average productivity is low

### Ratoon management

- Select variety suitable during plant crop
- Plant crop should be harvested at right maturity
  - Delayed harvest to be avoided
- Harvesting close to the ground with sharp cutting
  - Stubble shaving to 4-6cm is recommended if no uniform cut at harvest
- Remove the trash but do not burn it
- Irrigated the field properly
- Shoulder breaking or off-barring to remove decayed stubbles
- Gap filling with sprouted setts or seedlings
- Ratoon is less efficient in N utilization hence 25% additional N from 5-7 days after ratooning is desirable
- P & K should be judiciously
- Spraying of FeSO<sub>4</sub> @ 2.5kg/ha in 150 litres on 15th day if chlorotic symptom is noticed
  - If persists repeat twice at 15 days interval
  - In the last spray add 12.5kg urea
- After cultivation practices to be done more effectively
- Ratoon requires more plant protection
  - Grassy shoot disease, ratoon

### stunting

Maturity and harvest

- Ripening of sugarcane refers to rapid synthesis and storage of sucrose in the stalk
- Accumulation of sugar in the stalk starts soon after completion of

elongation phase

- Glucose produced during photosynthesis is not utilized for conversion but stored as sucrose
- When the concentration exceeds 16% in the juice and 85% purity the cane is said to be matured
- As the crop advances in maturity:
  - Water content decreases
  - Sucrose content increases
  - Reducing sugars decreases
    - Both organic and inorganic non-sugars also decrease
  - At peak maturity sucrose content is at maximum and non-sugars at minimum
- Assessing maturity
  - Use of hand refractometer - Brix reading
  - Assess the maturity by HR meter survey – 18-25% indicates optimum maturity
  - When the reading between top and bottom is 1:1 – is right time to harvest
    - If delayed
      - Sucrose content decreases
      - Non-sugars increase
      - Fibre content increases
- Ripening is influenced by number of factors
  - Climate
  - Nutrition
  - Variety
- Cool dry weather is the key factor
  - Bright sunshine
  - Day temp 28-30C
  - Night temp 12-14C
    - RTD (Relative temp disparity) decides
- Ripeners
  - Spray Sodium metasilicate 4kg in 750 litres /ha 6 months after planting
  - Repeat at 8th & 10th months
    - and not at declining phase
  - Polaris and Ethrel are most extensively used in Hawaii
    - Polaris @ 5 kg in 600 l /ha

Cropping systems

- Intercropping
  - Since a slow grower during initial 2-3 months may be an intercrop raised
  - The crop should not affect cane yield
  - Marketability, ability and feasibility decides the short crops
  - Pulses, potato, onion etc are some
- Sequential cropping - Rotations
  - After sugarcane 1 or 2 or 3 crops
    - Rice based cropping system for one year
    - Wheat based