

RICE (*Oryza sativa*)

Rice (*Oryza Sativa*) is associated with wet, humid climate, though it is not a tropical plant. It is probably a descendent of wild grass that was most likely cultivated in the foothills of the far Eastern Himalayas. Another school of thought believes that the rice plant might have originated in southern India, then spread to the north of the country and then onwards to China.

Climatic Requirements

In India, rice is grown under widely varying conditions of altitude and climate. Rice cultivation in India extends from 8 to 35°N latitude and from sea level to as high as 3000 meters. Rice crop needs a hot and humid climate. It is best suited to regions which have high humidity, prolonged sunshine and assured supply of water. The average temperature required throughout the life period of the crop ranges from 21 to 37° C. Maximum temp which the crop can tolerate is 40 °C to 42 °C.

Crop Production Practices

In India, Rice is mainly grown in two types of soils i.e., (i) uplands and (ii) low lands. The method of cultivation of rice in a particular region depends largely on factors such as situation of land, type of soils, irrigation facilities, availability of labourers intensity and distribution of rainfalls. The crop of rice is grown with the following methods :

- Dry or semi-dry upland cultivation
- Broadcasting the seed
- Sowing the seed behind the plough or drilling
- Wet or lowland cultivation
- Transplanting in puddled fields
- Broadcasting sprouted seeds in puddled fields.

Soils

Rice cultivation has been carried into all regions having the necessary warmth and abundant moisture favorable to its growth, mainly subtropical rather than hot or cold. Experts point out that, rice is grown in such varied soil conditions that it is difficult to point out the soil on which it cannot be grown. However, soils having good water retention capacity, good amount of clay and organic matter are considered ideal for rice cultivation. It grows well in soils having a pH range between 5.5 and 6.5. The classification of soils has been done depending upon the soil texture, colour of the soil etc.

VARIETY

Sl No	Name of the Zone	Land type	Suitable variety
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1.	North Western Plateau, Sundargarh	Up	Mandakini, Khandagiri, Heera, Ghanteswari, Kalinga-III, Annada, Jogesh, Sindhanta, Parijata, Jyotirmayee, Sahabhagi Dhan, CR Dhan-100, CR Dhan -101, CR Dhan-205, CR Dhan-207
		Medium	Lalat, Konark, Naveen, Surendra, Swarna, Pratikshya, Gajapati, MTU-1001, MTU-1010, Hiranmayee, Moudamani, CR Dhan-300, 303,304,305,310, Bina Dhan 11, Unnat Lalata, Pradeep, Prativa.
		Low	Savitri, Mahanadi, Prachi, Indravati, Jagabandhu, CR-1014 , CR Dhan-401, CR Dhan-500, CR Dhan-501, CR Dhan-503, CR Dhan-507, CR Dhan-1009 Sub-1, Asutosh, Kalachampa
2.	North Central Plateau, Keonjhar	Up	Khandagiri, Vandana, Kalinga-III, Ghanteswari, Jogesh, Sindhanta, Jaldi Dhan, Kamesh, Jyotirmayee, Sahabhagi Dhan, CR Dhan-100 CR Dhan-101, CR Dhan-205, CR Dhan-207
		Medium	Lalat, Surendra, Konark, Tapaswini, Swarna, MTU- 1001, Naveen, Hiranmayee, CR Dhan-300, 303,304,305,310, Unnat Lalata, Pradeep, Prativa. Aromatic rice: Kalajeera, Pimpudibasa, Geetanjali
		Low	Mahanadi, Prachi, Kanchan, Savitri, Moti, Padmini, Jagabandhu, Ketakijoha, Rani Dhan, CR-1014 CR Dhan-500, CR Dhan-501, CR Dhan-503, CR Dhan-507, Pooja, Kalachampa, Asutosh.
3.	Mid Central Table Land, Mahisapat	Up	Vandana, Kalinga-III, Khandagiri , Kamesh, Jyotirmayee, Sahabhagi Dhan, CR Dhan-100 CR Dhan-101, CR Dhan-205, CR Dhan-207
		Medium	Lalat, Surendra, Konark, Naveen, Tapaswini, Ranjit, Swarna, BPT-5204, Satabdi, Surendra, MTU-1010, Unnat Lalata, Pradeep, Prativa, Bina Dhan 11.
		Low	Savitri, Mahanadi, Indravati, Kanchan, Moti, Padmini, Upahar, Mrunalini, Hasant, Asutosh, Jagabandhu, Swarna Sub-1, Rani Dhan, CR-1014, CR Dhan-500, CR Dhan-501, CR Dhan-503, CR Dhan-507, Pooja, Kalachampa
4.	North Eastern Coastal Plain,	Up	Parijat, Khandagiri, Ghanteswari, Pathara, Badami, Annada, Lalitagiri, Kamesh,

	Ranital		Jyotirmayee, Sahabhagi Dhan, CR Dhan-100 CR Dhan-101, CR Dhan-205, CR Dhan-207
		Medium	Lalat, Surendra, Naveen, Konark, Gajapati, Swarna, Pratikshya, Tejaswini, Hiranmayee, Manaswini, Moudamani, Unnat Lalata, Pradeep, Prativa, Bina Dhan 11.
		Low	Mahanadi, Jagabandhu, Savitri, Pooja, Kanchan, Lunishree, SR 26 B, Utkal prava, Padmini, Manika, Upahar, Mrunalini, Hasant, Asutosh Prachi, Tulasi, Ramchandi, Varshadhan , CR Dhan-500, CR Dhan-501, CR Dhan-503, CR Dhan-507, Pooja, Kalachampa
5.	Western Undulating, Bhawanipatna	Up	Khandagiri, Vandana, ZHU XI-26, Parijata, Annada, Heera, Kamesh, Jyotirmayee, Sahabhagi Dhan, CR Dhan-100 CR Dhan-101, CR Dhan-205, CR Dhan-207.
		Medium	Lalat, Konark, Surendra, Naveen, Swarna, Kharavela, CR Dhan-300, 303,304,305,310, Unnat Lalata, Pradeep, Prativa. Pratikshya, MTU – 1001, Aromatic rice- Geetanjali
		Low	Mahanadi, Moti, Indravati Hasant, Asutosh, Reeta,Swarna Sub-1, Rani Dhan, CR- 1014, CR Dhan-500, CR Dhan-501, CR Dhan-503, CR Dhan-507, Pooja, Kalachampa. Aromatic rice: Dubraj, Ketakijoha
6.	South Eastern Ghat, Kalimela	Up	Khandagiri, Aditya, Parijat, Annada, Pathara, Vandana, Ghanteswari, Kalinga-III. Kamesh, Jyotirmayee, Sahabhagi Dhan, CR Dhan-100 CR Dhan-101, CR Dhan-205, CR Dhan-207.
		Medium	Lalat, Naveen, Kharavela, Gajapati, Surendra, Hiranmayee, Moudamani, Manaswini, Tejaswini, IR 64, Sebati, Gouri, Pusa-44, CR Dhan-300, 303,304,305,310, Unnat Lalata, Pradeep, Prativa. Swarna. Aromatic rice: Dubraj, Dahan Prasad, Karpur Kranti, Geetanjali
		Low	Jagabandhu, MTU 1001, Swarna, Utkal Prava, Gayatri, Savitri, Varshadhan , CR Dhan-500, CR Dhan-501, CR Dhan-503, CR Dhan-507, Pooja, Kalachampa. Aromatic rice: Ketakijoha

7.	Eastern Ghat High Land, Semiliguda	Up	Kalinga-III, Vandana, Heera, Khandagiri, Parijata, Jogesh, Sidhanta, Pathara, Kamesh, Jyotirmayee, Sahabhagi Dhan, CR Dhan-100 CR Dhan-101, CR Dhan-205, CR Dhan-207..
		Medium	Konark, Sarasa, Lalat, Naveen, Tapaswini, IR 64, Swarna, Pratikashya, Gajapati, CR Dhan-300, 303, 304, 305, 310, Unnat Lalata, Pradeep, Prativa. Aromatic rice: Geetanjali.
		Low	Indravati, Jagabandhu, Ramachandi, Utkal Prava, Varshadhan, Ranidhan, Hasant, Asutosh, Swarna Sub-1, CR Dhan-500, CR Dhan-501, CR Dhan-503, CR Dhan-507, Pooja, Kalachampa. Aromatic rice: Dubraj, Ketakijoha
8.	North Eastern Ghat, G.Udayagiri	Up	ZHU-XI-26, Vandana, RR 166-645, Khandagiri, Pathara, Heera, Kalinga-III, Kamesh, Jyotirmayee, Sahabhagi Dhan, CR Dhan-100 CR Dhan-101, CR Dhan-205, CR Dhan-207...
		Medium	Lalat, Konark, Naveen, Surendra, Jajati, Swarna, BPT-5204, Pusa-44, MTU-1001, CR Dhan-300, 303, 304, 305, 310, Unnat Lalata, Pradeep, Prativa.
		Low	Mahanadi, Prachi, Hasant, Swarna Sub-1, CR Dhan-500, CR Dhan-501, CR Dhan-503, CR Dhan-507, Pooja, Kalachampa.
9.	East & South Eastern Coastal Plain, Bhubaneswar	Up	Heera, Kalyani II, Kalinga-III, Parijat, Khandagiri, Pathara, Jogesh, Sidhanta, Anjali, Vandana, Kamesh, Jyotirmayee, Sahabhagi Dhan, CR Dhan-100 CR Dhan-101, CR Dhan-205, CR Dhan-207.
		Medium	Lalat, Konark, Naveen, Surendra, Birupa, MTU-1001, Gitanjali, Pratikshya, Moudamani, Manaswini, Tejaswini, IR 64, Sebati, Gouri, Pusa-44, CR Dhan-300, 303, 304, 305, 310, Unnat Lalata, Pradeep, Prativa. Aromatic rice: Geetanjali.
		Low	Swarna, Jajati, Kanchan, Jagabandhu, Padmini, CR- 1018, T- 141, Sarala, Pooja, Mahanadi, Indravati, Utkal Prava, Dharitri, Moti, CR-1014, Sonamani, Reeta, Mrunalini, Ramchandi, Upahar, Varshadhan, CR Dhan-500, CR Dhan-501, CR Dhan-503, CR Dhan-507, Pooja, Kalachampa, Hasant, Asutosh, Swarna Sub-1. Aromatic rice: Magura, Kalajira, Karpur Kranti, Kalakrushna, Ketakijoha.

10	West Central Table Land, Chiplima	Up land	Heera, Kalinga-III
		Rainfed (Unbunded)	
		Rainfed (Bunded)	Annapurna, Heera, Badami, Ghanteswari, Khandagiri, Keshari. Kalinga-III, Kamesh, Jyotirmayee, Sahabhagi Dhan, CR Dhan-100 CR Dhan-101, CR Dhan-205, CR Dhan-207.
		Irrigated (Bunded)	Parijat, Pathara, Ghanteswari, Annapurna
		Medium (Berna)	Ananga, IR 36, Lalat, Naveen, MTU- 1010, Swarna, Bhuvan, Jajati, Gouri, Pratikshya, Meher, Konark, Surendra, Moti, Bhanja, Samanta, Manaswini, Tejaswini, CR Dhan-300, 303,304,305,310, Unnat Lalata, Pradeep, Prativa. Aromatic rice: Pusa Basamati-1, Basmati-370, Kasturi, Geetanjali, Ketakijoha
		Low (Bahal)	Mahanadi, Prachi, Ramachandi, Indravati, Kanchan, Jagabandhu, Savitri, Gangotri, Utkal Prava, CR Dhan-500, CR Dhan-501, CR Dhan-503, CR Dhan-507, Pooja, Kalachampa, Hasant, Asutosh, Swarna Sub-1. Aromatic Rice- Dubraj, Ketakijoha

- The variety is the one that meets the best of the farmers needs. The choice is influenced by either from rain or irrigation, soil type, field elevation and whether rice will be sold or consumed at home.
- Select good quality and high density seed of a variety/hybrid suitable for the location/season
- Select varieties resistant to pests and diseases.
- In case of problem soils (Acidity/salinity) specific variety should be selected
- Varieties having good yield records in the grown area should be selected. In case of hybrid/new varieties are to be grown, enquire about the performances in FLD/OFT

UPLAND RICE

Field preparation

Cultivate the land after harvest of the previous crop preferably with a MB plough. Summer ploughing should be done after summer showers. Ploughing should be done 3 weeks before sowing seeds. The depth of ploughing should be

12-15 cms. It (i) reduces weed population, (ii) helps in fixation of atmospheric nitrogen, (iii) reduces pest and diseases, (iv) makes land preparation easier before sowing, and (v) makes soil nutrients available to the crop. Final land preparation may be done with pre-monsoon showers for sowing.

Stale seed bed (*Paga Bhangiba*) method may be followed by allowing 5-7 days time after a pre-monsoon shower to have the first batch of weeds come up and destroyed by the final ploughing. Apply adequate amount of compost or FYM @ 5t/ha for improving soil structure and water holding capacity of soil.

Sowing

Early sowing may be done in uplands soon after one or two good early monsoon showers in last week of May or first week of June, to take a second crop. In certain areas and years dry seeding should be adopted in anticipation of late onset of monsoon.

Test the germination percentage (more than 85%) before sowing. Sow the seeds in line preferably with seed drill or three tyne cultivator-cum-seed drill or by opening lines at 15 cm apart. It has the following advantages: (i) less seed is required (ii) the germination is synchronous with uniform crop stand and desired plant population (iii) weeding is easier by hoeing or using rake weeder and (iv) uniform growth of the crop. Seed should be placed at a depth of 4-6 cm. Use 60-80 kg/ha of good quality seeds depending on the test weight of the seed. Seeds should be bold, uniform in size. It should be soaked in salt water and remove immature and chaffy seeds. It should be treated with fungicides like carbendazim/Dethane M -45@ 2.5 gm /kg of seed or Cartap @ 2.5 gm/kg of seed.

Interculture

Timely weed control of the direct seeded crop is very important. Weeds compete with young rice plant for space, nutrient, water, light and serve as alternate host for pest. Weeding should be done at two weeks of germination. In line sown crop, it will be economical to work in the interspace with a rake weeder or any hoe. In broadcast crop, ploughing of the land on the third day of sowing (*mendha*) and working with a tooth harrow (*bida*) two weeks after germination in a sunny weather reduces weed population. When labour is scarce, adopt chemical weed control method with pre-emergence application of butachlor or pendimethalin @ 1.0 kg/ha, or arozin @ 0.3 kg/ha or oxyfluorfen @ 0.03 kg/ha the day following sowing or after first shower in case of dry sown crop followed by one hand weeding at 30 days after.

Manuring

Apply well decomposed FYM or compost @ 5 t /ha with chemical fertilizers. It is better to apply fertilizer on the basis of soil test recommendation. N:P:K @ 40:20:20, 30:20:20 and 60:30:30 kg/ha for improved, local and HYV, respectively depending on the initial fertility of the soil and the yield potential of the variety. Full P & K be applied as basal by broadcasting and mixing at final ploughing. Wherever possible, these should be preferably placed below the seed

with a seed-cum-fertilizer drill. In case of placement, 25% of N should be supplied as basal application to have early vigour of the seedlings where line sowing has been done. When no basal application is possible, 75% N be applied as first top dressing at the time of interculture (hoeing and weeding) in the third week from germination and the rest 25% at the panicle initiation (PI) stage (18-20 days before panicle emergence). In well drained sandy soil, apply full P as basal and N & K in split. In other soils, apply full P & K as basal and N in splits.

Water management

The crop is most sensitive to water stress in the reproductive stage. Wherever water is available, irrigate the crop at this stage if rain fails. Collect all rain water after 45 days by strengthening the bunds.

Harvesting

Harvest the crop when the grains in the panicle are grey in colour. Delayed harvesting causes considerable loss by shattering and due to damage by rats and birds. However, early varieties should be harvested 25 days after 50% flowering. Improved sickle should be used for harvesting the crop as it reduces drudgery of the worker and gives 20% more coverage than local sickle. The improved sickles are GAIC sickle (Gujarat Agro Industries Corporation, Ahmedabad) and Naveen sickle.

Post-harvest technology

The early crop is to be threshed within a day or two after harvest otherwise there would be fermentation and discolouration of grains. Reduce the moisture content of grains to 14% by drying. Pedal operated and power operated thresher should be used for threshing. Hand operated winnower should be used for cleaning the grains. Power operated thresher-cum-winnower should be used for simultaneous threshing and cleaning of the grains.

MEDIUM AND LOW LAND RICE

DIRECT SEEDING

Field preparation

Plough the field with a MB plough soon after the harvest of the *Rabi* crop when adequate moisture is available. Repeated summer ploughing or harrowing is needed to keep down weeds and maintain tilth and keep the soil exposed to sunlight and air.

Dry sowing should be done from second half of May to first half of June till the onset of monsoon. Sowing should be done preferably in lines 20 cm apart to ensure better plant population. Line sowing will eliminate 'Beusan' operation which reduces plant population. If sowing is delayed due to unavoidable circumstances, pregerminated seeds can be directly sown on the puddled field in lines after providing proper drainage. Wet seeding in line can give as much yield

as the transplanted crop. Use a seed rate of 60-80 kg/ha depending upon the test weight and tillering habit of the variety. Line sowing behind the plough or seed drill may be taken under suitable field condition. Three row pre-germinated seeder should be used to sow germinated seed. The field should be puddled, levelled and well drained at the time of using seeder. Seeds with 2 mm sprout are most suitable for the pre-germinated seeder.

Interculture

In the line sown crop the interspace can be worked out with a narrow plough or rotary weeder or rake weeder after 3 to 4 weeks of germination. In broadcast crop, *Beusan* is the common practice for killing weeds. This operation is followed by proper "*Khelua*" to maintain adequate plant population. Do not *Beusan* the crop, if it is delayed beyond 45-50 days after sowing due to want of standing water. Weed out the field and apply fertilizer. Control weeds with pre-emergence application of butachlor @ 1.25 kg/ha or pretilachlor @ 1.00 kg/ha or pendimethalin @ 1.00 kg/ha or arozin @ 0.4 kg/ha or oxyfluorfen @ 0.04 kg/ha. Herbicides should be sprayed in moist soil one day after sowing or after first shower in case of dry sown crop.

Manuring

Apply FYM @ 5 t/ha at the time of final ploughing for sowing. Besides, adequate amount of N:P:K in form of chemical fertilizer be applied in splits. Use fertilizer as per soil test report. Meet 50% N requirement of rice from organic sources and rest 50% N through inorganic fertilizer for sustenance of soil fertility.

In low land situation, where top dressing of N is not feasible apply moderate dose of NPK(40:20:20 kg/ha) all at sowing. Application of slow release nitrogenous fertilizer like urea super granule, large granule urea or coated urea would prove still better under this condition. However, in extra long duration varieties if the crop shows the sign of nitrogen deficiency at the PI stage one or two urea sprays may be given if possible at 25 days and 10 days before panicle initiation stage (3-4% urea spray to supply 15-20 kg N/ha). Use always ammonium containing or ammonium forming fertilizer (urea) at basal application.

Fertilization for beusan rice

Apply full P at the time of seeding. 50% N and full K at *Beusaning*, and 50% N in two equal splits i.e., at 3 weeks after first application and at PI stage. If application of P at sowing is not possible, it can be applied at *Beusaning*. If N is not given at *Beusaning* it can be applied at *Khelua*.

Water management

Wherever possible, maintain soil moisture at saturation for 20-25 days to induce tillering and about 3 cm standing water till primodia initiation. This will

prevent weed growth and will not interfere in tillering. Thereafter, maintain 5 cm depth of water in the field. Drain out water about a week before harvest. Where cutworms are likely to appear, water should not be drained out till harvest. There is no extra benefit if depth of water is maintained at more than 5 cm. Cyclic submergence (5 ± 2 cm) 3 days after disappearance of ponded water saves water without reduction in yield.

Harvesting and post-harvest technology

Dry the grains to reduce the moisture content to 14% for consumption and 12% for seed purpose.

TRANSPLANTED RICE

Field preparation

Maintain standing water and plough the field to incorporate the weeds and rice stubbles for proper decomposition. Level the field by repeated laddering. A well levelled field is beneficial for uniform fertilizer distribution, water management and weed control. Use MB plough, puddler and plank to achieve a good puddle. The power tiller operated rotavator, tractor with single cage wheel and cultivator or tractor with double cage wheel should be used to achieve a good puddle in all types of soils.

Nursery management

Utmost care should be taken while preparing the nursery as it is the place where rice seedlings grow and establish themselves. Nursery should be prepared nearer to the main field so as to minimize the shock during transplanting. Wet bed nursery is practised in areas of water abundance. Dry bed method is practised in areas of less water where soil is loamy or clayey. Appropriate seed rate (40-50kg/ha) should be used on the variety selected. For good nursery 3-4 time soil ploughing followed by leveling with irrigation and drainage channel should be made. Incorporate 1 t. FYM/1000 m² bed during last ploughing/puddling.

Broadcast sprouted seeds @ 5kg/100 sq m of soil. For 200 sq m nursery apply 2 kg N (1 kg N at sowing and another 1 kg N at 12-14 days), 1 kg P₂O₅ and 1 kg K₂O. In cold areas double the dose to be applied. Weeding should be done at 15-20 days. In Zinc deficiency area 2 kg ZnSO₄ dissolved in one litre. water may be applied. If Iron deficiency is noticed spray 20g/lit (2%) ferrous sulphate solution.

Protect the nursery from bird damage. Apply Carbofuran 3 G granules 10 DAB the seeds @160 g/40 sq m of nursery or monocrotophos 1.6 ml or chlorophyriphos @ 2.0 ml/l of water. Seedling should be uprooted with soil and transplanted immediately to minimize the shock to the seedlings.

Planting

Erect and shallow planting of 2 seedlings per hill with required spacing ensures adequate plant population. The following spacing and plant population should be maintained for varieties of different duration.

Variety	Spacing	No. of hills/ha (in lakh)
Early and early medium	15 cm x 10 cm	6.7
Medium and late	20 cm x 10 cm	5.0
Late (if planted in July)	20 cm x 15 cm or	3.4
	15 cm x 15 cm	4.5

Erect planting helps in quick establishment. Conventional planting requires more time and energy to strengthen and establish the seedlings. Use of transplanting guide reduces the labour requirement for line transplanting by 30% as compared to existing rope and guide method of line transplanting. Shallow planting helps in quick tillering. If the basal node is planted deep in the mud, tillering is delayed. Use rice transplanter and mat seedlings to reduce the cost of transplanting and ensure timely planting.

Interculture

Weeding of the crop should be done within 3 weeks of transplanting, Weed can be controlled with herbicides recommended for direct sown medium land rice applied 3 days after transplanting. Herbicides can be applied mixed with clean and dry sand @ 50 kg/ha.

Fertiliser use

Apply full P, K and 25% of N at planting, 50% of N at tillering (3 weeks after transplanting) and rest 25% of N at PI stage. Forms of fertiliser and methods of application are same as that of direct seeded crop. Apply urea at 5 cm depth preferably by an urea applicator to increase its efficiency. In case of randomly planted crop, fertilizer broadcaster should be used for uniform application.

Water management

Water should not be allowed to stand in the field for 5-7 days after transplanting. Maintain saturation to 3 cm standing water till 25-30 days after transplanting and low depth of 3-5 cm of water till 15 days after flowering. Drain out water at yellow ripe stage (10-15 days before harvesting) for uniform maturity and efficient use of paddy reaper.

Summer Rice

Field preparation

After harvest of kharif rice, it is desirable to plough the field in dry condition to incorporate the stubble and expose the soil to the sun. Summer rice should be transplanted or pre-germinated seed can be sown in lines on well puddled and levelled field. The land should be flooded 10 to 12 days before

transplanting and ploughed and harrowed at intervals impounding water in the field. The stubble of the previous crop most desirably be made to decompose and organic manure should be thoroughly incorporated in the soil at puddling. A well levelled field is important for uniform fertilizer distribution, water control and weed control. To achieve a good puddle and levelled field mould board plough, puddler and plank/ladder should be used. For the light soils of coastal districts **bose/rocket plough and zig-zag puddler** should be used, where as **implement factory mould board plough and rotary blade puddler** should be used for the soils of Mayurbhanj, Gajapati and Ganjam districts. For the heavy soil of the inland districts **implement factory heavy soil mould board plough and rotary puddler** should be used. The power tiller operated rotavator, tractor with single cage wheel and cultivator and tractor with double cage wheels should be used to achieve a very good puddled condition in all types of soils.

Nursery Management

- Utmost care should be taken while preparing the nursery as it is the place where rice seedlings grow and establish themselves
- Nursery should be prepared nearer to the mainfield so as to minimize the shock during transplanting. Wet bed method is practiced in areas of water abundance and Dry bed method is practiced in areas of less water and where the soil is loamy or clayey. Appropriate seed rate (40-50 kg/ha) should be used based on the variety/hybrid selected. For good nursery 3 to 4 times soil ploughing followed by leveling with irrigation and drainage channel should be made.
- Incorporate one tone FYM per 1000 m² bed during last ploughing/puddling.
- Broadcast the sprouted seed 5 kg/100 sq.mt of soil. For 200 sq.mt of nursery bed apply 2 kg. Nitrogen (1 kg N at sowing and another 1 kg at 12-14 days), 1 kg P₂O₅ and 1 kg K₂O). In cold areas double dose should be applied.
- Weeding should be done once in 15-20 days as it helps seedlings grow effectively without competition for nutrients, water etc.
- If zinc deficiency is noticed spray 2 g ZnSO₄ dissolved in 1 liter of water. In case of dry nursery if Iron deficiency is noticed spray 20 g/l (2%) ferrous sulphate solution.
- Protect the nursery against bird damage of seed by netting or taking colour ribbons.
- Apply Carbofuran 3 G granules 10 days after broadcasting/the seeds @ 160 g/ 40 sq.mt of nursery or Monocrotophos 1.6 ml or Chlopyrifos @ 2.0 ml. per liter of water. Seedlings should be uprooted with soil and transplanted immediately to minimize the shock to the seedlings.

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Erect and shallow planting of 2 seedlings per hill with required spacing ensures adequate plant population. The following spacing and plant population should be maintained for varieties of different duration.

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Interculture

Weeding of the crop should be done within 3 weeks of transplanting, Weed can be controlled with herbicides recommended for direct sown medium land rice applied 3 days after transplanting. Herbicides can be applied mixed with clean and dry sand @ 50 kg/ha.

Fertilizer Use:

Apply fertilizer on soil test recommendations. If soil testing has not been done apply fertilizer as recommended below.

Duration	Without BGA (kg/ha)			With BGA (kg/ha)		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
Low fertility						
Medium duration	80	40	40	60	40	40
Short duration	60	30	30	45	30	30
Average fertility						
Medium duration	60	30	30	45	30	30
Short duration	40	20	20	30	20	20

Apply 25% nitrogen and all phosphatic and potassic fertilizer at final puddling and incorporate the fertilizer thoroughly in the soil. Apply 50% nitrogen 15 to 20 days after transplanting, the rest 25% at 18 to 20 days before heading (panicle initiation stage). Late top dressing will encourage non-bearing tillers. In

light textured soils, apply potassium in two equal splits at final puddling and panicle initiation stage. With BGA application distribute the total N at three equal splits i.e. at transplanting, 18 days after transplanting and 18 days before panicle initiation. Apply 15 kg BGA/ha, 7 days after transplanting.

Weeding

Timely control of weeds is very important. Weeds compete with young rice plants for nutrient, light and water. Weeding should be done three weeks after transplanting. For the direct seeded crop, weeding at 4-5 week stage (when plants attain 15-20 cm height) by using a weeder between lines is required. Wheel finger weeder or paddy weeder should be used as the cost of mechanical weeding is much less than the conventional weeding practices.

Recommended herbicide for rice

SRI Rice			
Chemical Name	Dosage (g a.i./ha)	Time of application	Effective on
Pre-planting herbicides			
Glyphosate 41 SL	750-1500	15 DBT	All vegetation
Transplanted rice			
Pre/Post emergence herbicides			
2,4 D Na 80 WP	800	20-25 DAT	BLW
Butachlor 50 EC	1500	5-7 DAT	Annual grasses and some sedges
Butachlor + 2,4-DEC 50 EC + 36 EC	1000+400	5-7 DAT	Grasses and BLW
Pretilachlor 30 EC	500-750	3-7 DAT	<i>Ischaemum</i> , annual grasses & some BLW
Anilophos 30 EC	300-400	5-7 DAT	Annual grasses & some BLW
Anilophos+Triclopyr-BGE 30 + 30 EC	1250	3-5DAT	Grasses & BLW
Anilophos +Ethoxysulfuron 21 + 1 SC	375+15	10 DAT	Grasses & BLW
Acetochlor 90 EC	75	3-5 DAT	Grasses
Cinmethalin 10 EC	50-75	7 DAT	Grasses
Cinemethalin + 2,4-DEC(50 EC)	375-500	7 DAT	Grasses & BLW
Oxyfluorfen 25 WP	100	5-7 DAT	Annual grasses & some BLW
Oxadiargyl 6 EC/80 WP	150	5-7 DAT	Annual grasses some Sedges
Pyrazosulfuron-ethyl 5 WP/ 10WP	5-20	5-7 DAT	<i>Echinochloa</i> sp.

Penoxulam 24 SC W/V	20	8-12 DAT	Annual grasses, some BLW
Bensulfuron-methyl 60 DF	60	20-25 DAT	BLW
Bensulfuron-methyl 60 DF + Pretilachlor 50 EC (6.6 G)	60+600	0-5 DAT	Grasses & BLW
Fenoxaprop-p-ethyl 7.5 EC	56	15-20 DAT	Annual grasses
Fentrazamide 50 WP	120-150	4-7 DAT	Grasses
Flufanacet 60 WP	120	3-5 DAT	Grasses
Chlorimuron + Metsulfuron-methyl 20 WP (Almix)	4	20-25 DAT	Grasses & Annual BLW
Bispyribacsodium 10% 100/LSC	20-35	15 DAT	Grasses & Annual BLW
Almix + Butachlor 20 WP + 50 EC	4+938	3-5 DAT	Grasses & BLW
Penoxsulam 24 SC	25	7-10 DAT	Grasses, aquatic weeds
Triasulfuron 20 WP	6.9	7-12 DAT	BLW
Triasulphuron + Pretiachlor 20 wG + 50 EC	6+500	5-7 DAT	Grasses & BLW
Copper sulphate	15000-20000	As and when appear	Algae & scum
Direct sown rice under puddle condition			
Butachlor +Safener 50 EC	1500	0-3 DAS	Annual grasses, some BLW
Pretilachlor +Safener 50 EC	600	0-3 DAS	Annual grasses, some BLW
Ethoxysulphrun 15 WSG	15	15 DAS	BLW
Anilophos +Ethoxysulfuron 21 + 1 SC	375+15	5-7 DAS	Grasses & BLW
Cyhalofop-butyl 10 EC	60	10 DAS	Grasses
Almix 20 WP + Surfactant (0.2%)	4	20-25 DAS	BLW
Bispyribacsodium 10% 100/LSC	20-30	10-15 DAS	Grasses & Annual BLW
Direct sown rice under upland conditions			
Pendimethalin 30 EC	1500	3-5 DAS	Grasses & some BLW

Water management

Allow only a thin film of standing water in the field for about a week after transplanting. Thereafter follow cyclic submergence of water to a depth of 5±2 cm one day after disappearance of ponded water till panicle initiation (PI) stage. Maintain about 5 to 7 cm standing water in the field from PI to dough stage. Drain out water at the dough stage i.e., 10 to 12 days before harvesting for uniform maturity and use of reaper.

DIRECT SEEDING IN PUDDLE SOIL

Sprouted seeds are usually sown as a contingency measure in post flood situation. In rabi season sprouted seeds are sown when transplanting was delayed due to late release of canal water, labour scarcity for raising seedlings and transplanting. The method is :

- Puddle and level the land properly.
- Apply full dose of P and K as basal.
- Incorporate the fertilizer into the soil by light laddering.
- Allow the soil particles to settle before sowing if the soil is muddy.
- Soak the seeds for 24 hours and incubate for 48 hours for sprouting of seeds.
- Sow the sprouted seeds in line by 8 rows drum seeder or by broadcasting @ 75-80 kg/ha.
- Use bird scarer to prevent from bird damage.
- Apply pretilachlor + safener @ 0.45 kg/ha as pre-emergence spray 5 DAS or butachlor 0.5 kg/ha 5 DAS to control weeds.
- Maintain a thin film of water till development of green leaves. Never allow the puddle to dry up. Subsequently irrigate the field one day after disappearance of ponded water.
- Complete weeding before top dressing of nitrogen.
- Top dress 50% N 20-25 days after sowing (DAS) and the rest at panicle initiation. In light textured soil and relatively longer duration variety nitrogen can be applied in three splits i.e. 50% 20 DAS, 25% at late tillering and 25% at panicle initiation.
- For top dressing, N can be incubated with FYM in 1:10 ratio for 48 hours to reduce volatilization loss.

SYSTEM OF RICE INTENSIFICATION(SRI)

What is SRI?

SRI is an acronym for system of rice intensification. It is a suite of management practices that raises factor productivity of land, labour and capital. SRI is a model of sustainable agriculture that reduces inputs, conserves water, improves soil structure and increases yield. It mainly emphasizes on careful transplanting of younger seedlings at a wider spacing, which ensures more root growth and profuse tillering. This was originated in Madagascar and was first synthesized in 1983 by Fr. Henri de Laulanie, a french Jesuit Priest.

Attributes of Higher Productivity

- ❖ Less seed rate-5kg/ha
- ❖ Transplanting young seedlings-10-12 days old

- ❖ Transplanting single seedlings-one seedling instead of 2 -3
- ❖ Wider spacing-25cm*25 cm
- ❖ Maintaining field saturation
- ❖ Incorporation of weeds through operation of weeder-use of cono weeder
- ❖ Use of preferably organic manures as source of nutrition

Benefits Associated with SRI

- ❖ Water savings upto 25-50%
- ❖ Saving in cost of seed
- ❖ Stronger tillers, large root system and less lodging
- ❖ Reduced pest and disease attack
- ❖ Low cost of production
- ❖ Increased factor of productivity
- ❖ Environmental benefits

AROMATIC RICE

varieties	Duration(days)	Average yield(t/ha)
Basmati-370	130	3.0
Taraori basmati	140	3.0
Type-3	130	2.0
Pusa basmati-1	125	4.0
Kasturi	125	3.6
HKR-228	135	3.5
Vasumati	125	4.0
Geetanjali	135	4.5
Ketakijoha	150	4.0

Besides , the local scented rice varieties grown in different pockets of Odisha are Kalajeera, Basubhoga,Sitabhog, Gopalbhog,Pimpudibasa and Dubraj.

Seed rate -30kg seeds/ha

Spacing-20cm*15 cm

Fertilizer-60-30-30 kg/ha for improved tall variety, 80-30-30 kg/ha for semidwarf and 40-20-20 N-P₂O₅-K₂O Kg/ha for local varieties.Apply full P,K and 25% N as basal.Top dress 50 %N at 15 days after planting and rest 25 % N at PI Stage.

HYBRID RICE

Hybrid	Duration(days)	Yield(tons/ha)
KRH 2	125	7.0
PA 6201	125-135	8.0
PHB 71	125-135	8.0
Rajalaxmi	135	7.0
Ajaya	135	7.5

- ❖ Seed rate-15kg/ha
- ❖ Seedling density in nursery-10-20 g/m²
- ❖ Time of planting-mid-july
- ❖ Spacing-20cm*15cm
- ❖ Seedlings per hill-1 or 2
- ❖ Fertilizer dose-120-60-60 kg of N-P₂O₅-K₂O/ha
- ❖ Full P,K and half N as basal , 25% N at tillering and rest 25% N at PI stage .
- ❖ Water management -cyclic submergence(5+2 cm) 3 days after disappearance of ponded water.

MAIZE (*Zea mays*)

Maize or corn is a cereal crop that is grown widely throughout the world in a range of agro-ecological environments. About 50 species exist and consist of different colors, textures and grain shapes and sizes. White, yellow and red are the most common types. The white and yellow varieties are preferred by most people depending on the region.

The crop is grown in climates ranging from temperate to tropic during the period when mean daily temperatures are above 15°C and frost-free. Adaptability of varieties in different climates varies widely. Successful cultivation markedly depends on the right choice of varieties so that the length of growing period of the crop matches the length of the growing season and the purpose for which the crop is to be grown. In respect of day length, maize is considered to be either a day-neutral or a short-day plant. The growth of maize is very responsive to radiation. However, five or six leaves near and above the cob are the source of assimilation for grain filling and light must penetrate to these leaves. The plant does well on most soils but less so on very heavy dense clay and very sandy soils. The soil should preferably be well-aerated and well-drained as the crop is susceptible to water logging.

Varieties

Maize can be cultivated in our state during kharif, rabi and summer seasons with provision of irrigation. Rabi and summer maize give more yield than kharif maize. The varieties recommended for cultivation in Odisha during rabi and summer are as follows :

Composites/ hybrids	Variety	Duration (days)	Average grain yield (q/ha)
Composites	Dhawal	100-110	60.0
	Navjot	90-100	55.0
Hybrids	Deccan 103	100-110	65.0
	Ganga II	100-110	60.0
	Deccan 105	100-110	60.0
	Trishulata	100-110	60.0
	PAC 705	100-110	65.0
	PRO 345	100-110	60.0
	Bisco-2418 (Super Kohinoor)	90-100	55.0

Field preparation

Select well drained land for maize. Prepare land well before sowing. Incorporate FYM or compost @ 5 t/ha at final land preparation. In termite infested areas apply chlorpyrifos 1.0% dust @ 25 kg/ha during land preparation. For a good seed bed, use implements like borse plough, rocket plough, implement factory MB plough, power tiller operated rotavator and tractor operated cultivator.

Seed treatment

Treat the seeds with fungicides like vitavax power @ 1.5 g or (carbendazim 1.0 g + thiram 1.5 g)/kg of seed. Seed treatment protects the crop from seed borne diseases viz; leaf blight in maize. Seeds can be treated uniformly by the seed treating drum.

Sowing

Kharif sowing should be done during month of June. Rabi sowing should be done between October-November. The second fortnight of January is the best period of sowing for the summer crop. Bright sunshine, high temperature and low humidity affect grain formation and therefore summer maize should not be sown

beyond the first week of February. Seed should be sown at a depth of about 5 cm. Deeper sowings will delay germination. To place the correct amount of seeds at desired spacing, maize dibbler or a planter should be used.

Plant population

Maintenance of adequate plant population is very important to obtain good yields. Over population should be avoided. Maize should be sown in lines to facilitate inter-cultivation within rows. An optimum plant population of 60,000 to 65,000/ha should be maintained. Seed should be sown at a spacing of 25 -30 cm from plant to plant and 60 cm from row to row. Seed rate of 15 to 17.5 kg/ha will be adequate to maintain optimum population as indicated above.

Fertilizer

Apply 5 t FYM or compost /ha at the time of sowing. Fertilizer requirement of maize crop is high. Apply 80 kg N, 40 kg P_2O_5 and 40 kg K_2O /ha for composite varieties. For hybrids, apply 120 kg N, 60 kg P_2O_5 and 60 kg K_2O /ha. Apply all the P and K as basal. Nitrogen should be applied in 3 splits, 25% as basal, 50% at 3 weeks and 25% at 6-7 weeks stage. In acid soil apply 1-2 tonnes lime/ha at the time of 1st land preparation (15 days before sowing). Water soluble phosphate should be applied to the limed soil. Top dressing of fertilizer should coincide with hoeing/ interculture and earthing up operation so that the fertilizer can be incorporated into the soil. Placement of manures and fertilizers in the furrows before sowing and ensuring that the seeds do not come in contact with fertilizers give better results. For top dressing, place fertilizers on the side along the rows after hoeing or interculture and then earth up. These practices increase fertilizer efficiency. Trench hoe or wheel hoe should be used for hoeing and earthing up.

Interculture

Maintain only one plant/hill within 15 days after germination by removing the excess plants. Early interculture of maize within 2 to 3 weeks of germination destroys weeds. A second hoeing and earthing up at 6-7 weeks stage is very useful for the crop. The hoeing or interculture should be shallow to avoid root injury. Earthing helps to provide better anchorage to the crop and prevents lodging from strong winds in rabi and summer season. Rotary peg weeder/wheel finger weeder should be used for interculture operation and weeding. Weeds can also be controlled by pre-emergence spray of atrazine or simazine @ 1.0 kg /ha on medium to heavy textured soils within 2 days of sowing.

Water management

Maize is highly sensitive to water-logging. Water should not be allowed to stand in the field at any stage of the growth of the plant. Earthing up of the crop not only prevents lodging but also facilitates drainage of excess water. Irrigate at 10 days interval for first one and half months and 15 days interval subsequently till ripening in sandy loam soils.

Harvesting

Harvesting is done by detaching the cobs from the plants. Shelling of maize should be done by hand operated or power operated maize sheller. Winnowing can be done by a manually operated winnower.

Yield 50 to 60 quintal/ha.

Speciality and Other Corn:-

1) Quality Protein Maize-Normal maize grain is very low in two essential amino acids like lysine and tryptophan and very high amount of undesirable amino acids like leucine and isoleucine. Quality protein maize (QPM) has balanced amount of amino acids with high content of lysine and tryptophan and low content of leucine and isoleucine. So in the QPM there is a balanced proportion of amino acids which results its higher biological value of human food and poultry/animal feed and thereby has a great role for ensuring food and nutritional security. The QPM hybrids recommended for Odisha are HQPM 1(89 days), HQPM 4(95 days) and HQPM 5(98 days).

2) Sweet corn- Sweet corn is consumed at green stage as raw or after roasting. It is also used in preparation of soup, salads and other recipes. It is becoming very popular in urban areas of country. Therefore, its cultivation is remunerative for peri-urban farmers.

Variety : Hybrids-Hy-brix 53(ADVSW-2), Hi-brix-39(ADVSW-1)

Composite- Priya, Madhuri

Duration-70-75 days

Seed rate-8.0kg/ha

Spacing-60 cm *25 cm

Fertilizer-120/60/60 kg N-P₂O₅-K₂O/ha

Harvesting –At green cob stage(after 18-20 days of pollination.)

Average yield-8.0-10.0t/ha green cob in hybrids and 1.5t/ha in composites.

3) Baby Corn-Baby corn is consumed as raw in salads and used for culinary purposes for making curry, pakodas, pickles, halwa and other food items. Baby corn is a young finger-like unfertilized cob which is harvested within 1-3 days of sil emergence depending upon the growing season. The desirable size of baby corn is 6-11 cm length and 1-1.5 cm diameter.

Variety-Hybrid-HM 4

Composites-VL Baby Corn-1, COBC-1

Seed rate-20-25 kg/ha

Spacing-60 cm *20 cm(rainfed), 60 cm*15 cm(irrigated)

Fertilizer dose-120/60/60 kg N-P₂O₅-K₂O/ha

Harvesting- Immediately after silk is visible

Yield-1.0 t/ha for composites and 4.0-5.0 t/ha for hybrids.SS

JOWAR(*Sorghum vulgare*)

It is grown in southern and western districts of the state.

Varieties

A number of composites and hybrids can be grown in the state. Choose the right variety suitable for your area or in the neighbouring area. The particulars of the variety of jowar which are recommended for cultivation are given below.

Variety	Maturity (days)	Poten- tial yield (q/ha)	Special features
Swarna (CSV 1)	115	30- 35	Erect leaves, medium dwarf in height (120-150 cm) thick population possible for its erectophile habit
CSH-1 (hybrid)	95-100	30- 35	Dwarf in height, grains are white pearly in colour
CSH-2 (hybrid)	115-120	30- 35	Medium late, 150 to 200 cm in height
CSH-9 (hybrid)	105-115	35- 40	140-150 cm in height, white pearly grain
CSV-15	110	35- 38	Dual purpose, tall (220-230 cm)
CSV 216	110	35- 40	Medium duration
CSH 17 (Hybrid)	105	35- 45	Early, white grain, tanin free, tolerant to moisture stress and green molds, resistance to leaf diseases
ASH 1 (Hybrid)	110	30- 40	Medium duration
SPH837 (Hybrid)	110	30- 40	Medium Duration

Field preparation

Select well drained soil. Prepare the land well before sowing and incorporate FYM or compost @ 5 t/ha at final land preparation. In termite infested areas, treat the soil with Chloropyriphos @25kg/ha. For a good seed bed, rocket plough, borse plough, Implement Factory. MB plough, power tiller operated rotavator or tractor operated cultivator can be suitably used.

Early sowing

Early sowing 10-15 days before onset of monsoon increases yield by about 15% and eliminates shoot fly attack .

Plant population

Maintenance of adequate plant population is very important to obtain good yield. Over population should be avoided. Jowar should be planted in lines to facilitate intercultivation between rows.. It should be planted in rows 45 cm apart and thinned to maintain a spacing of 12 to 15 cm between plants which will give about 1,80,000 plants per ha. A seed rate of 10-12 kg/ha is adequate to maintain optimum population.

Interculture

Thinning jowar at 10 days stage, early interculture of jowar within 2 to 3 weeks after germination to destroy weeds, a second hoeing and earthing up at 6 to 7 weeks stage are desirable. The hoeing or interculture should be shallow to avoid root injury. Earthing up helps to provide better anchorage to the crop in the rainy season and prevents lodging. Rotary peg weeder/wheel finger weeder should be used for interculture operation and weeding. However, pre-emergence application of atrazine or simazine or butachlor @ 1.0 kg/ha on the day following sowing in moist soil effectively controls weeds.

Fertilizer

Supplement organic manures with chemical fertilisers. Jowar responds favourably to fertiliser application. Apply the following doses of fertilizer.: 80-40-40 kg N-P₂O₅ -K₂O/ha

Apply full P and K as basal. Nitrogen should be applied in 3 splits, 25% as basal, 50% at 3 weeks stage at first hoeing and earthing up and 25% at 6-7 weeks stage at second hoeing and earthing up. Top dressing of fertilizers should coincide with hoeing/interculture and earthing operations to incorporate fertilizer into the soil. Placement of manures and fertilisers in the furrows before sowing and thorough mixing with soil gives better result. Point placement of 10 kg N/ha at silking stage increases yield by 10-12%.

Water management

Jowar is highly sensitive to waterlogging and moisture stress. Water should not be allowed to stand in the field at any stage of the crop. Earthing up not only prevents lodging of the crop but also facilitates drainage. Ensure irrigation at cob development stage if rain is inadequate.

Harvesting

For manual harvesting use improved sickle like GAIC and Naveen (CIAE, Bhopal) sickle.

RAGI (*Elusine coracana*)

It is mostly grown in Ganjam, Gajapati, Rayagada and Koraput districts.

Ragi is an important food crop next to rice, wheat and maize. Ragi is valued as staple food & predominately grown as a dry land crop. The nutritional value of ragi in terms of amino acid, protein, lipid, carbohydrate, vitamin & minerals is more than rice, wheat and maize. Ragi is suited for cultivation in areas with annual rainfall of 700-1200 mm.

Nutritional value of ragi flour

Nutrient	Amount (Typical)(%age)	Amount (Range)
Carbohydrate	72.6	71.3 – 89.5
Protein	7.7	5.8 – 12.8
Fibre	3.6	3.5 – 3.9
Fat	1.3	1.3 – 2.7

Soil: Ragi is cultivated on a variety of soils ranging from rich loam to poor shallow upland soils. It prefers porous and well drained loam to light red loam and sandy loam soils of good fertility but reasonable water holding capacity. It can tolerate some water logging. Black soils with sufficient drainage capacity also support to cultivate Ragi crop. In southern India, it predominates on marginal soil conditions, provided by lateritic and red sandy loams. It withstands and thrives well on slightly alkaline soils too. It seems to have ability to utilize rock phosphate than other cereals do. The soil should be rich in organic matter. Deep vertisols and rocky soils are not suitable for this crop owing to poor drainage and low fertility. It can be grown in soils with pH of 4.5-7.5. Heavy clay soil with poor drainage is less suitable.

Land Preparation- The land is prepared separately for irrigated and rainfed conditions. In areas with a rainfall of 60 to 75 cm, ragi is cultivated as a rainfed crop. So the field should be deeply ploughed for moisture conservation. But in irrigated crop, plough the field immediately at the arrival of monsoon until gets fine tilth. One deep ploughing with mould board plough followed by ploughing with wooden plough twice is necessary. Apply 5 t/ha of FYM, Azospirillum (2 kg/ha) and Phospho-bacteria (2 kg/ha) with compost

Sowing time- For Kharif- June, Rabi- October

Seed rate- A plant population of 4 to 5 lakhs per ha is optimum for getting higher yields. There are various methods practiced for ragi cultivation. For Broadcasting, seed rate is 15 kg/ha; for line sowing, seed rate is 10 kg/ha and for transplanting, seed rate is 7-8 kg/ha.

Seed treatment- Seeds are treated with Thiram @ 3 gram/kg or Carbandazim @ 2 gram/kg of seed.

Spacing: Direct sowing is the practice of sowing seeds directly in the main field, eliminating the process of seedling raising and transplanting. The seeds are sown in the prepared land before or with the onset of monsoon. A spacing of 20-25 cm x 10 cm is to be maintained.

Variety

Variety name	Duration (days)	Average yield (q/ha)
Dibya sinha	85-90	17.0
Champabati	90-95	24.0
VL149	90-95	22.0
Godavari	115-120	28.0
Nilachala	100-110	25.1
Bhairabhi	105	27.0
Chilika(OEB10)	110-115	26.0
Subhra(OUAT-2)	100-105	22.0
Arjuna(OEB526)	105-110	25-27.0
Kalua(OEB532)	110-115	20-25.0

Fertilizer- Apply fertilizer as per soil test based recommendation. In absence of soil test results, apply 40:30:20 kg N:P₂O₅:K₂O per ha in direct sown early variety. For transplanted crop apply 50-40-25 kg N:P₂O₅:K₂O per ha. Entire P₂O₅ and K₂O are to be applied at sowing. About 25 per cent of recommended nitrogen is to be applied at sowing and the remaining 50% at 25days after sowing and rest 25 percent N at 35-40 days after sowing.

Weed management

Early weeding of the direct seeded crop is essential for getting good yields. First hoeing and weeding should be done within 2 to 3 weeks of sowing and the second a fortnight after. Thin out the plants 12 to 15 days after sowing to maintain proper plant population. One weeding of the transplanted crop, between 2 to 3 weeks after transplanting is adequate. A second weeding may be done 15 to 20 days after, if necessary. Apply isoproturon @ 0.5 kg/ha as pre-emergence and 2,4-D sodium salt @ 0.75 kg/ha as post-emergence spray 20-25 days after sowing for effective weed control.

Yield- 20-25 q/ha

BAJRA (*Pennisetum typhoideum*)

Bajra is popularly known as pearl millet. Pearl millet is a warm season annual grass crop. It is mainly grown in Gajapati, Ganjam, Koraput, Rayagada, Kandhamal districts of the state.

Health benefits of pearl millet

- Millets are a great source of starch, making it a high-energy food. It is also an excellent source of protein and fiber. It is said that the amino acids in the pearl millet are more easily digestible than the ones found in wheat.
- Due to essential nutrients such as methionine (an amino acid), B complex vitamins (niacin, thiamin and riboflavin), folic acid, lecithin, potassium, magnesium, manganese and zinc, millets are very effective in several roles. Niacin reduces cholesterol while magnesium is essential for maintaining good heart health, as it lowers blood pressure and reduces the risk of heart attacks.
- Pearl millet is a rich source of phosphorus, which plays an important part in the structure of body cells. Phosphorus, found in pearl millets, is a significant component of several necessary compounds including adenosine triphosphate (ATP). This element is also a crucial component of nucleic acids, which are the building blocks of the genetic code. Phosphorus is a constituent of lipid-containing structures such as cell membranes and nervous system structures.
- Recent studies have proven that regular consumption of pearl millets help in preventing gallstones in women. They contain insoluble fibers which not only speed up intestinal transit time but also reduce the secretion of bile acids. Pearl millets are known to increase insulin sensitivity and lower the level of triglycerides.
- Regular intake of millets provides protection against breast cancer in pre-menopausal women. Apart from that, it has also shown a considerable reduction in the occurrence of wheezing and asthma in children.
- Millets contain an essential phytonutrient, lignin; which is very beneficial for the human body.
- Consumption of pearl millets helps in minimizing the risk of type 2 diabetes. Being a good source of magnesium, millets act as a cofactor in a number of enzymatic reactions.

Climate- The crop has a wide adaptability as it may grow under different day lengths, temperature and moisture stress. It requires low annual rainfall ranging between 40-50 cm and dry weather.

Soil- Light soils of low inherent fertility good drainage, mild salinity are best type for this crop.

Preparatory tillage: 2-3 harrowings and a ploughing is followed so that a fine tilth may be obtained to facilitate the sowing and proper distribution of seed at appropriate depth.

Manures and Fertilizers: Generally the crop requires low quantity of nutrients. But All India Co-ordinated millet Improvement Project has proved that new plant types of bajra especially hybrids respond to very high doses of fertilizers. Under rainfed areas application of organic manures such as FYM or compost @ 2 t/ha helps in increasing the crop yield. About 80 kg N:40 kg P₂O₅:40 kg K₂O is recommended.

Fertilizers are applied in split doses, half of nitrogen, full phosphorus and potash should be basal placed at the time of sowing. The organic manures may be applied 20 days before the sowing of the seeds for full decomposition. One fourth doses of nitrogen should be applied about 30 days and 60 days after sowing.

Sowing time:- Most appropriate time of sowing is middle or last week of June.

Varieties

Varieties	Duration (days)	Yield (q/ha)
ABH-251 (Dev giri)	78-83	25-30
AIMP-92901	78-83	26-28

Seed rate and Spacing:

10 kg/ha

Spacing 40 –45 cm between rows, 10 –15 cm within rows.

Seed treatment- Seeds are to be treated with thiram @ 3g/kg or carbendazim @ 1.5 g/kg of seed to control seed borne diseases.

Interculture - Thinning or gap filling is followed, weeding is done or application of Atrazine @ 1 kg /ha is recommended to control weeds.

Harvesting and Threshing

The crop is harvested when grains become hard enough and contain moisture. Two methods are adopted for harvesting the crop a) Cutting ear head first from standing crop followed by cutting of remaining plants later b) Cutting of entire plants by sticks and staking the plants for five days in sun for obtaining grains. Grains are separated either by beating the ear heads with sticks or by trampling the ear heads under bullock feet. For storage moisture level should be 12-14%.

Yield: - Irrigated crop yields 30-35 quintals/ha, while unirrigated crop yield is 12-15 quintals/ha.

ARHAR (Cajanus cajan)

The place of origin is very controversial as some people believe is to originate in India while others say that red gram was found in the wild estate in Africa in regions of upper Nile and the coastal districts of Angola. From Africa it spread to other parts of the world and to India. Australian people grow it for fodder and vegetable purposes. Now it is being grown in Africa, America, Australia, Hawaii, Ceylon, Netherlands, Malaya, East and West Indies, India, Indo-China, Pakistan, etc.

In India, arhar is mostly grown in the states of U.P, M.P, Maharashtra, Bihar and Andhra Pradesh, Punjab, Haryana, West Bengal, Assam, Odisha, Rajasthan, H.P., Gujarat, Jammu and Kashmir, Karnataka, Tamil Nadu, Kerala, etc. However, the major area is restricted to north Indian states.

Arhar is grown as annual but tur varieties grow like perennial plants. The plants are bushy, densely branched having a height of about 150 cm to 300 cm depending upon type and management practices. It bears tap root with well developed lateral or secondary roots that consist nodules on them like any other leguminous plants. The stem is strong, woody, round but slightly ridged during active growth period having numerous branches. The leaves are pinnately compound and trifoliate with oblong, lanceolate leaflets. They open in the evening and remain open whole night and up to noon time of the next day.

The *Cajanus cajan* differs in plant character, pod character and maturity duration, etc. but most of the cultivated types belong to two categories.

- i. **Cajanus cajan var.bicolor:** They are late maturing, plants grow very tall or probably they are tallest of both the types which are freely branched and bear flowers at the end of the branches. The pods are relatively longer and use to contain 4 to 5 seeds in them.
- ii. **Cajanus cajan var.flavus:** They have shorter duration and accordingly they fall in early maturing category of plants. Plants are shorter, bushy having flowers at several points along the branches. The pods are also shorter which bear two to three seeds in them.

Climatic and Soil requirements

Arhar needs moist and warm weather during germination (30-35°C), slightly lower temperature during active vegetative growth (20-25 °C) but about 15-18 °C during flowering and pod setting, however, at maturity it needs higher temperature of around 35-40 °C. Water logging, heavy rains, frost are very harmful for the crop. Hailstorm or rain at maturity damages the entire crop.

The crop may be grown on any type of soil but sandy loam to clayey loam soils are supposed to be best. Soil must be very deep, well drained and free from soluble salts in them.

Land preparation

Arhar grows well in well drained sandy loam, loamy sand and loamy soil. It cannot withstand waterlogging. Sloppy uplands and high lands are ideal for arhar cultivation in the rainy season. Improved ploughs (bose/rocket/MB plough) should be used for field preparation. The field should be ploughed to obtain a fine tilth to sow the crop in line. It helps quick establishment of the crop. Addition of compost or FYM 2 t/ha at land preparation helps to conserve moisture and boost the yield. Application of paper mill sludge @ 1.0 t/ha at the time of first land preparation neutralizes soil acidity and improves yield.

Varieties

Variety	Duration	Yield (q/ha)	Characteristics
ICPL-51(Jagriti)	115-120	20-25	Very early, white grains medium size
IPCL-87119 (Asha)	170-200	15-16	Grains red and bold
Maruti (ICP - 8863)	170-180	15-16	Resistant to wilt, suitable for intercropping
ICPL-87 (Pragati)	120-125	15-16	Very early, suitable for ratooning, grains red, medium size
ICPL-84031(Durga)	130		Determinate
ICPL-85063(Laxmi)	175		Semispreading
CORG 9701	135-140		indeterminate
Parbati	170-175		Indeterminate, resistant to wilt and sterility mosaic
BRG-2	165-170		Semi-spreading ,indeterminate
BRG-4	170-175		Semi-spreading type ,indeterminate, white-seeded
BRG-5	160-165		Indeterminate, spreading, suitable for late sowing

Sowing

Early and dry sowing of pulse crops with pre-monsoon showers or before the onset of monsoon helps better establishment, growth and production. Line sowing facilitates interculture and early weeding. Early control of weeds prevents competition for nutrients and water. Sowing may be done during June.

Line sowing by seed drill at a depth of about 7-10 cm using a row to row spacing of 45-60 cm and plant to plant 20 cm is always better than broadcasting. About 15-20 kg high quality seed would be sufficient for one hectare area but it depends on variety and sowing time.

Manures and Fertilizers

As a practice, the arhar crop is grown on marginal and sub-marginal lands of poor soil fertility status due to which the yield is found to be so poor that it does not give much profit. The crop is heavy feeder but due to symbiotic bacteria present in the root nodules, most of the required nitrogen is fixed from atmosphere, however, it needs heavy doses of phosphate. The crop grown from

inoculated seeds needs lesser quantity of nitrogen as the plants emerged from treated seeds are well nodulated hence they have high nitrogen fixing capacity than the plants grown from untreated seeds.

Apply 20 kg N, 40 kg P₂O₅ and 20 kg K₂O/ha at sowing. Basal application of 250 kg gypsum/ha is beneficial where SSP has not been used to meet the requirement of phosphorus.

Interculture

The crop plants grow very slowly during their early growth period of 45-50 days and the crop suffers from severe weed infestation which causes a drastic reduction in grain yield. Therefore, it is advisable to keep the field free from weeds. Weed is the major problem of the kharif pulses. Control of weeds within 15 to 20 days after sowing is necessary. Line sowing facilitates early weeding which should be popularized. Pre-emergence application of alachlor/ butachlor/ benthocarb/ pendimethalin/ metolachlor @ 1 kg/ha or oxadiazon @ 0.75 kg/ha with 500 litres of water the day following sowing followed by a hand weeding at 50 days after sowing (DAS) in arhar and 35 days after sowing for other pulses controls most of the weeds. Post emergence spray of quizalofop ethyl 5 EC 10-30 days after sowing @ 2ml/litre controls the grasses effectively. For arhar, which stands in the field for much longer period, a second weeding 4 weeks after the first one is necessary. Rotary peg /wheel finger weeder should be used for weeding and interculture.

Irrigation

The crop is mostly grown rainfed but one light irrigation between flowering and pod filling stage increases the seed yield. In the event of drought or under aberrant weather condition the crop needs life saving or protective irrigation which is in addition to those mentioned earlier.

Harvesting and yield-Arhar is harvested by cutting the matured fruiting branches. A good crop of one hectare gives about 25-30 quintals of grains and about 50 to 60 quintals of sticks and 10 quintals of dried leaves in the form of bhusa.

GREENGRAM (*Vigna radiata* L.)

Greengram is the major pulse crop cultivated in Odisha . The reason of low yield is due to use of local variety and poor crop management practices . The productivity of greengram in the state could be increased by cultivating quality seeds with advance production technology.

Land preparation:

Greengram requires a well pulverized seed bed. 3-4 ploughing by tractor or M.B plough , 2-3 harrowings followed by leveling. The bed must be free from stubbles and weeds completely.

Improved Varieties:

A number of varieties have been recommended as follows :

Variety	Duration (days)	Season	Remarks
Durga (OBGG-52)	65	kharif, pre-rabi, rabi,summer	Long Pods; Resistance to YMV diseases
Kamdev (OUM 11-5)	60-65	kharif, pre-rabi	Long pods; bold seeded; Resistance to YMV diseases
TARM 1	60-70	rabi, pre-rabi	small seeded; Resistance to powdery mildew & YMV diseases
Sujata	65-70	kharif, pre-rabi, rabi,summer	Resistance to YMV diseases
Dhauli	65-70	for kharif, pre-rabi	Long pods; bold seeded; Resistance to powdery mildew diseases
LGG 460	75-80	Pre-rabi	Long pods; bold seeded; Resistance to powdery mildew diseases
SML668	65-75	for summer	Long pods; bold seeded; Resistance to YMV, powdery mildew diseases
IPM 02-3	65-70	Kharif and pre-Rabi	Resistant to YMV
IPM 02-14	70-75	Kharif and pre-Rabi	Resistant to YMV
Pant mung 8	75-85	Kharif and pre-Rabi	Resistant to YMV and powdery mildew

Seed rate:

25 kg seeds for sowing one hectare land.

Seed treatment:

Seed treatment with 1.5 g Carbendazim or 3 g Thiram or 5 g *Trichoderma viride* for one kg seed 7 days before sowing.

Seed treatment:

Seed inoculation with 20g Rhizobium culture and 25g Phopoculture per one kg of seed

Time of sowing:

Kharif: June to July ; *Pre-rabi*: September-October; *Rabi* : November-December; *Summer*: February 3rd week to March 1st week

Method of sowing:

Sowing the seed at 2.5 cm depth with spacing 30X 10 cm during *kharif* and 25X10 cm during *rabi* . Gap filling at 4-5 DAS and thinning at 7-10 DAS.

Integrated Nutrient Management:

Application of 5t FYM/Compost incubated with 5 kg PSB / Azotobacter during final land preparation. Recommended Fertiliser dose for greengram is 20:40:20 kg N:P:K /ha for *kharif* and 10:30:20 kg N:P:K /ha for *rabi* . Apply $\frac{1}{2}$ N + Full P+ Full K as basal before sowing and rest $\frac{1}{2}$ N top dressed at 21 DAS during 1st intercultural operation. Application @ 5q/ha PMS before 1 month for acid soil. Soil application of 15 kg ZnSo₄ during final land preparation. Foliar spraying of DAP 0.02% during flowering and pod formation stage.

Integrated Weed Management:

In greengram crop, yield loss upto 15-40 % due to severe weed infestation. So crop should be kept weed free during primary stage upto 1 month. Two hand weeding at 20 & 40 DAS is beneficial. Application of Trifluralin 48 % EC (Clear) 2 litre/ha 1 day before sowing as pre plant incorporation . Pre-emergence application of Pendimethalin 30% EC (Stomp, Dhanutop, Pendiherb) 3.3 litre/ha or Butachlor 50% EC(Machete, Delchlor) 2 litre/ha or Oxyflourfen 23.5% EC (Zargon, Oxygold, Goll) 200 ml/ha at 2 DAS. Post-emergence application of Quizalofop ethyl 5% EC (Targa super) or Emazethapyr 7% EC (Persuit) 1 litre/ha at 15-20 DAS.

Mechanical weeding by wheel finger weeder or cyclic weeder in case of line sowing is beneficial.

Water Management:

The critical stages for irrigation are flowering and pod formation stage. Life saving irrigation at pod initiation stage as when required in *kharif* crop. One pre sowing irrigation preferred during *rabi*. Water logging causes premature death of plant. First irrigation at 25 DAS and subsequent irrigation at 7-10 days interval during summer.

Cropping system:

Greengram being a short duration crop, fits well into a number of sequence and intercropping system in mid central table land zone. Greengram+ Arhar(3:2), Greengram+Groundnut(2:6) is remunerative intercropping. Crop sequences like Greengram-vegetable, Greengram-sesamum, Paddy-greengram is beneficial in the existing agro-climatic zone.

Harvest and Post harvest operation:

Greengram is usually ready for harvest in 60-65 DAS depending on the variety. Harvest at physiological maturity when 80-90 % green pods turn to brown. Delayed harvesting results in breakage and causes seed weathering in field which deteriorates the quality of seed. Harvested plants should be left in the field for two days for drying. Threshing of dried plant should be done either by beating the plants by sticks or trading under light weight tractor without grip tyres. Cleaned seeds are dried before they are packed. The seed should be packed in air moisture proof bags at moisture level 6-10% in godowns. The seeds can be treated with 3 ml mustard oil or 2 g turmeric per kg of seeds.

Yield:

8q /ha during *kharif* and 10 q/ha during *rabi* and summer season

BLACK GRAM (*Vigna mungo*)

Blackgram is the second important pulse crop next to Greengram in Odisha. Major blackgram districts are Cuttack, Kendrapara, Bolangir, Ganjam, Kalahandi, Puri etc.

Table: Varieties , Duration and characteristics

Variety	Duration(days)				Remark
	<i>Kharif</i>	<i>Pre-rabi</i>	<i>Rabi*</i> (Nov-Dec)	<i>Summer</i> (Mid Feb to 1st week of March)	
Sarala (B 12-4)	75	85	70-80	65-70	Resistant to YMV and PM
T 9	75	80	70-80	-	Susceptible to YMV
Pant U30	65-70	65-75	70-80	-	Resistant to YMV, PM, leaf spot
Pant U 19	65-70	70-75	70-80	65-70	Suitable for paira, resistant to YMV, leaf spot
Pant U 35	65-70	65-75	70-80	65-70	Resistant to YMV, leaf spot
KU 300	65-70	65-75	-	-	Resistant to YMV, leaf spot
KU 301	65-70	65-75	70-80	-	Resistant to YMV, leaf spot
TU 94-2	-	-	70-80	-	Tolerant to YMV, Suitable for rice fallows
WBG 26	-	-	70-80	-	Resistant to PM
LBG 685	-	-	70-80	-	Suitable for Paira
PDU 1	-		70-80	-	
ADT 4	-	-	70-80	-	Suitable for paira
B3-8-8 (Prasad)	-	70	70-75	-	Tolerant to leaf crinkle & leaf curl
OBG-17 (Ujala)	70	75	70-80		Resistant to YMV, leaf spot
OBG-31 (Mahuri)	70	75			Resistant to YMV, leaf spot
OBG-33 (Sashi)	70	75			Resistant to YMV, leaf spot

Land preparation

It can be grown in kharif , Pre-rabi, Rabi and Summer seasons on a variety of soil provided drainage is satisfactory. The fields should be ploughed immediately after the harvest of the previous crop and as far as possible good tilth is obtained for efficient sowing in lines.

Seed rate :25 kg/ha

Spacing :25cm×10cm

Seed treatment :Suspend 200g of Rhizobium culture and 250 g phosphate solubilizing bacteria (PSB) in 600 ml of water and mix thoroughly. Now pour the slurry on 10 kg of seed drop by drop and mix with the hands till the uniform coating of culture is obtained on all seeds.

For obtaining better result and keeping the crop free from seed borne diseases, like damping off of seedling and seedling blight, seeds should be treated with seed dressing fungicides like (Carboxyn 37.5% + Thiram 37.5%) @ 2 gm per kg of seed.

Nutrient management:

Black gram responds admirably to liberal doses of phosphate application. A starter dose of

20 kg N/ha helps in quick establishment of the crop and root nodule development. Application of 40 kg P₂O₅, 20 kg of K₂O and 20 kg S/ha greatly increases yield of black gram and also benefit the succeeding crop. Mix the fertilizer with the soil thoroughly at final land reparation before sowing. The fertilizer can also be applied in the furrows with greater advantage. However, for local varieties apply 15 kg N and 30 kg P₂O₅/ha. Phosphorus can be applied as 50:50 mixture of super phosphate and rock phosphate. Apply full P, K and 50% N as basal in seed furrows at a depth of 8-10 cm. Top dress the rest 50% N within 3 weeks after sowing in bands followed by a light earthing up and irrigation.

Weed management

Weeds should be controlled within 2-3 week stage to conserve nutrients and moisture for the crop. For management of annual grasses & BLW application of pendimethalin @ 0.50 kg a.i/ha is effective..

Irrigation management:

Mostly grown on residual soil moisture without irrigation during PreRabi and Rabi seasons. However, during summer it is grown under assured irrigation conditions. Flowering and pod development stages are critical for irrigation.

Harvesting

Harvest the crop when the crop is fully mature.

BENGAL GRAM (*Cicer arietinum*)

Major bengalgram growing district in Odisha are Kalahandi, Mayurbhanj, Nuapara, Keonjhar, Angul and Sundargarh and is a rabi season crop.

Varieties	Duration (days)	Remarks
Desi or Small Seeded Varieties		
Radhey	150	Yield potential 25-30 q/ha
ICCV-10	95-100	Yield potential 17.8 q/ha
Pusa-372	120-140	Yield potential 18-22 q/ha
H-208	110-115	Small and wrinkled - brownish yellow, yield potential-18-20q/ha
Kabuli Gram Varieties		
L-550	160	yield potential 18-22 q/ha
Pusa-1003	130-135	Yield potential 28 q/ha
ICCV-2 (Swetha)	85-90	100 seed wt. 25g
PG-9531(Vihar)	110-120	100 seed weight 35 g

Field preparation

Chick pea is highly sensitive to soil aeration. This imposes a restriction for its cultivation on heavy soils and calls for special care in seedbed preparation. A rough seedbed is required for chick pea. In case the chick pea crop is taken after a kharif fallow, it would be desirable to go for a deep ploughing during the monsoon as the same would help in larger conservation of rain water in the soil profile for subsequent use by this crop. Very fine and compact seedbed is not good for chick pea. It requires a loose and well aerated seedbed.

Seed and sowing

Date of sowing has been recognized as single non-monetary input affecting most the yield of chick pea in all chick pea growing areas. Experiments conducted under the second fortnight of October is the optimum time for sowing chick pea in most of the chick pea growing areas of northern India. For peninsular India, first fortnight of October is the best time for chick pea sowing. First fortnight of November is most suitable. Early sowing of chick pea results in excessive vegetative growth and poor setting of pods. The early sown crop suffers more from wilt owing to high temperature at that time.

The crop may be sown by seed drill or local plough at a row spacing of 30-40 centimeters. A seed rate of 75-100 kg per hectare depending upon seed size may

be sufficient for one hectare. The seed should be placed 8-10 centimeters deep because the shallow be treated with 0.25 per cent.

Seed Treatment

Thiram or Carbendazim (Bavistin) 2-3g/kg of seed before sowing.

Manures and fertilizers

Chick pea being a leguminous crop fulfills the major part of its nitrogen requirement (about 75%) through the process of symbiotic nitrogen fixation which works effectively from three to four weeks after sowing. However, soils with low organic matter and poor nitrogen supply may require 20-25 kg/ha of nitrogen as starter dose which can meet plant requirement before the formation of nodules. Fertilizer dose is 20:40:40::N:P₂O₅:K₂O /ha. Besides nitrogen, Black gram respond very favourably to phosphorous application if the soils are deficient in phosphorous supply. If both nitrogen and phosphorous are required to be supplied then diammonium phosphate (18-46-0) at the rate of 100 to 150 kg per hectare should be applied uniformly before the last discing ploughing. It is better if all the fertilizers are drilled in furrows at a depth of 7-10 centimeters.

Water management

Chick pea is mostly sown as a rainfed crop. However, where irrigation facilities are available, give a pre-sowing irrigation. It will ensure proper germination and smooth crop growth. If winter rains fail, give one irrigation at pre-flowering stage and one at pod development stage. In no case first irrigation should be given at flowering time of gram crop. A light irrigation should be given because heavy irrigation is always harmful to gram crop. Excess of irrigation enhances vegetative growth and depresses chick pea yield.

Weed control

Chick pea being a stature crop suffers severely by infestation of weeds. One hand weeding or inter culture with hand hoe or wheel hoe after 25-30 days and second if needed after 60 days of sowing may take care of weeds. Fluchloralin (Basalin) 1 kg per hectare in 800-1000 liters of water as pre-planting spray may be used as an effective herbicide. It should be well incorporated in the soil before sowing. In case Basalin is not available use Metribuzin or Prometrynen at the rate of 1.0-1.5 kg active ingredient in 800-1000 liters of water per hectare as pre-emergence spray. Hand weeding or inter culture with the help of hoe is always better than herbicides because inter culture operations improve aeration in the soil.

Yield

A well managed crop yields about 20-25 quintals of grain per hectare.

SESAME (*Sesamum indicum* L.)

Sesame which is commonly known as Til is cultivated in Kharif, Rabi and summer season in Odisha. Major sesame growing districts are Angul, Ganjam, Rayagada, Deogarh, Sambalpur, Gajapati, Dhenkanal etc. in the state.

Improved Varieties:

Variety	Duration (days)	Oil content (%)	Seed colour	Seed yield (q/ha)	Remarks
Uma	70 -75	53	Pale white	10	Capsules compactly arranged, escape shattering
Usha	80-85	49	Bright biscuit	10	Resistant to diseases and pests
Nirmala	75-80	50	White	11	Resistant to bacterial diseases
Prachi	80-85	48	Black	12	Resistant to major diseases & pest
Vinayak	85-90	48	Reddish	6	Glabrous, resistant to stem rot
Kanaka	80 -85	47	Biscuit	8	Pods pubescent
Kalika	80 -85	49	Brown	8	Resistant to leaf spot
Amrit	75-80	49	white	11	Resistant to various diseases and pests
Smarak	75-80	44-49%	Golden yellow	8-10	Moderately resistant to phyllody, leaf curl and leaf roller
Subhra	75-90	46-52%	Bright white	9-10	Moderately resistant to phyllody, leaf curl and leaf roller

Soil suitability: Sandy loam soil, PH = 5.5 to 8.0

Seed rate:

5 kg seeds for line sowing and 7.5kg seeds for broadcasting are required for sowing one hectare land.

Seed treatment:

Seed treatment with 2 g Bavistin / 3 g Thiram / 5 g *Trichoderma viride* for one kg seed 2 days before sowing.

Land preparation:

Sesamum requires a well pulverized seed bed. 3-4 ploughing by tractor or M.B plough, 2-3 harrowings followed by leveling.

Time of sowing:

For *Kharif*: June ; *Pre-rabi*: September; Summer : February

Method of sowing:

Sowing the seed at 2 cm depth with spacing 30X 10 cm during *kharif* and 25X10 cm during *rabi* . Gap filling at 4-5 DAS and thinning at 7-10 DAS.

Integrated Nutrient Management:

Application of 5t FYM/Compost incubated with 5 kg PSB / Azotobacter during final land preparation. Recommended Fertiliser dose for sesamum is 30: 15:15 kg N:P₂O₅:K₂O /ha. Apply ½ N + Full P+ Full K as basal before sowing and rest ½ N top dressed at 15 DAS during 1st intercultural operation. Application of Gypsum 100 kg /ha with basal dose for increasing oil content and 5q PMS before 1 month for acid soil. Foliar application of 0.02 % ZnSO₄ during growth stage. It can be grown after harvest of potato successfully without application of fertilizers.

Integrated Weed Management:

In sesamum crop yield loss upto 20-40 % due to severe weed infestation. So crop should be kept weed free during primary stage upto 1 month. Two hand weeding at 20 & 40 DAS is beneficial. Application of Trifluralin 48 % EC (Clear) 2 litre/ha 1 day before sowing as pre plant inoculation. Pre-emergence application of Butachlor 50% EC (Machete, Delchlor) 2 litre/ha or Oxyflourfen 23.5% EC (Zargon, Oxygold, Goll) at 2 DAS. Post-emergence application of Quizalofop ethyl 5% EC (Targa super) or Emazethapyr 7% EC (Persuit) 1 litre/ha at 15-20 DAS.

Mechanical weeding by wheel finger weeder in case of line sowing is beneficial.

Water Management:

The critical stages for irrigation are 4-5 leaf stage, flowering and pod formation stage. *Kharif* crop rarely receives irrigation but protective irrigation will benefit when prolong dry spells occur. One pre sowing irrigation preferred during *rabi*. Water logging causes premature death of plant.

Cropping system:

Sesame being a short duration crop, fits well into a number of sequence and intercropping system in mid central table land zone. Sesamum+ Arhar(4:2), Sesamum+Groundnut(1:4) and Sesamum+ Sugarcane(1:1) is remunerative intercropping. Crop sequences like Sesamum-Horsegram-Fallow, Greengram-sesamum, Paddy-vegetable-sesamum is beneficial

Harvest and Post harvest operation:

Sesamum is usually ready for harvest in 70-80 DAS depending open the variety. Harvest when the leaves turn yellow and start dropping, while capsules are still greenish. Delay in harvest causes bursting and shattering of capsules. Stake the harvested plants for a week and dry the plants keeping the tips towards the sun till complete drying of capsules. Threshing should be done 2-3 days after

drying. Seeds can be stored after cleaning the seeds and bringing down the seed moisture content to 5% % by drying.

.Yield: 5q /ha during *kharif* and 8-10 q/ha during *rabi* season

GROUNDNUT (*Arachis hypogaea* L)

Groundnut is the leading oilseed crop of Odisha which occupies nearly 33% of total oil seed area and 55% of the total oil seed production. The crop is grown throughout the year in three crop seasons, i.e. Kharif, Rabi and Rabi-Summer season . This groundnut crop is predominantly grown in Jajpur, Bargarh, Ganjam, Malkangiri, Kalahandi, Balasore and Puri. Groundnut is grown in Kharif , Rabi and summer season in Odisha. The Kharif groundnut is basically grown in inland districts during June-November where the crop is sown in June-July depending upon the monsoon rains. But the Rabi groundnut is cultivated during October to March in coastal belts in rice fallow where the sowing stretches from mid October to mid December depending upon the residual moisture condition. Rabi-Summer groundnut is however grown during December to May as irrigated crop depending on the availability of irrigation water. Rabi groundnut is quite remunerative due to its high productivity and low cost of cultivation.

Suitable groundnut varieties for Odisha

A large number of groundnut varietal trials have been conducted to identify suitable varieties for the state of Odisha for both kharif and rabi-summer situations. Some of the varieties recommended for commercial cultivation are presented below.

Table – 1: Suitable groundnut varieties for Odisha

Variety	Duration (days)		Type	Shelling %	Oil Content	Other Characterizes
	Kharif	Rabi				
AK 12-24	95	105	Erect	70	48	Tolerant to tikka and rust
Kissan	100	110	Erect	71	50	Possesses dormancy of 15 days
Jawan	95	105	Erect	70	47	Tolerant to tikka
Smruti	100	110	Erect	71	51	Tolerant to collar rot and stem rot
JL 24	105	115	Erect	75	51	Tolerant to drought

ICGS 44	105	125	Erect	70	51	Tolerant to peanut, bud necrosis
TAG 24	100	110	Semi erect	70	49	Tolerant to PBNB and tikka
TG 3	100	110	Spreading	75	49	Tolerant to drought
Devi	95	130	Erect	70	49	Tolerant of mid season and end off season drought
Kadiri-6	100	105	bunchy	72	49	Tolerant to leaf spot
Kadiri-9	105	110	bunchy	70	50	Tolerant to early and end season drought
Dharani(TCGS 1043)	100	105	bunchy	75	49	Drought tolerant

Soil type and land preparation

Well drained light textured sandy loam and loamy soils with pH 6.5-7.5 ideal for groundnut crop. The pegs can penetrate the soil easily and pods can be harvested from such soils with minimum losses .Clay and heavy textured soils are not suitable as for the crop as they interfere with penetration and development of pegs and create difficulty in harvesting. In acid soils application of lime @ 5 q/ha is required prior to one month before sowing.

Good land preparation provides suitable soil conditions for rapid and uniform germination, good root penetration and growth, and steady pod development. Land should be well prepared with 4-5 numbers of ploughings and adding 12-15 CL of FYM before last ploughing. All previous crop residues and weeds should be completely removed or buried, and seed beds should be smooth and well pulverised to provide good soil- to seed contact after sowing.

Yield of any cultivar is a product of its genetic potentiality and environment. Full or maximum achievable yields of any cultivar can be obtained through adoption of suitable agro techniques. The agro techniques developed for optimizing groundnut productivity in Odisha have been summarized below.

Agro techniques

Seed rate and spacing

- For realization of higher pod yield, sowing of groundnut crop on 15 June with a spacing of 30 cm x 10 cm in kharif season and between December

and first fortnight of January with a spacing of 25 cm. x 10 cm in rabi is recommended. Seeds should be sown at a depth of 3-5 cm.

- Generally a seed rate of 100 kg kernel/ha in kharif and 125 kg kernel/ha in rabi season is required for a desirable plant stand.
- Bold seed size is recommended for sowing a regards to realization of higher pod yield from groundnut.
- Prior to sowing seeds may be treated with 20 g of Rhizobium culture per kg of seed. About 200g culture is thoroughly mixed with 400 ml of water to prepare slurry. The slurry is sprinkled over 10 kg of seed and mixed by hand to form a coat by the suspension. Then after drying in shade, seeds are sown immediately preferably during afternoon hours. Addition of ammonium molybdate @ 3 g/ 10 kg seeds at the time of Rhizobium inoculation enhances nodulation.

Nutrient management practices

Basal application of N:P₂O₅:K₂O @ 20:40:40 kg/ha is a general recommendation for groundnut crop. However, soil test based fertilizer recommendation is much preferred. As calcium and sulphur play an important role in pod development and oil content gypsum @250 kg/ha at the time of hoeing should be applied. Application of Borax @10 kg/ha in boron deficient soils increases pod yield. Some experimental findings on nutrient management increasing pod yield are presented below ;

- Spraying of urea @ 4% on groundnut crop after initiation of flowering helps in increased pod yield and higher shelling percentage.
- Phosphorous supplied through single super phosphate (SSP) increased the pod yield of groundnut by 15% over diammonium phosphate (DAP).
- Application of phosphorus @ 40 kg./ha in 1:2 ratio of SSP and rock phosphate helped to realize 9 and 13.4% higher pod yield respectively over application of phosphorus through SSP alone in acid soil.
- Application of gypsum @ 250 kg/ha. along with recommended dose of 20:40:40 kg N:P₂O₅:K₂O/ha increased the pod yield of groundnut by 14%.
- Soil application of 20 kg N/ha coupled with gypsum @ 250 kg/ ha. At flower initiation stage increased the pod yield by 37% over no nitrogen.
- Higher dose of N @ 30 kg/ha over 20 kg/ha had no positive effect on yield.
- Application of 40 and 60 kg P₂O₅/ha enhanced pod yield by 21 and 33% respectively over 20 kg P₂O₅/ha.
- Application of Ca @ 100 kg./ha as gypsum + Mg @ 10 kg/ha as MgSO₄ along with recommended fertilizer of 20:40:40 kg N: P₂O₅ :K₂O/ha increased pod yield by 12%. Further application of micro nutrients (Zn + Cu + B + Mo) at recommended dose increased pod yield by 18.7%.
- Spraying of malic hydrazide @ 250 ppm at 42 days after sowing increased pod yield by 13.9%.

Integrated Weed Management

Weeding in groundnut should be completed by 25-30 days. The soil should not be disturbed after flowering of the crop. Some herbicidal measures for weed control are given below.

- Pre emergence spraying of Alachlor or Metolachlor @ 0.75 kg /ha or Oxyflurofen @0.02 kg ai/ha controls groundnut weed effectively.
- Pre-emergence spraying of pendimethalin @ 0.75 kg /ha coupled with post emergence spraying of Butachlor @ 0.5 kg ha at 30 DAS effectively controlled monocot and dicot weeds in groundnut and recorded .Post emergence spray of quizalfop-ethyl @ 0.05 kg /ha at 20-30 days after sowing controls the grasses.

Water Management

- Flowering, pegging and pod development are the critical stages of groundnut and soil moisture should not be deficient during these periods.
- Under assured irrigation condition, 6 cm irrigation at an interval of 7-10 days throughout the crop growth period produced maximum pod yield of groundnut in sandy loam to sandy clay loam soil. Under limited water supply, the crop can be irrigated at an interval of 12-14 days up to 60 DAS and thereafter at an interval of 7-10 days till maturity.
- The interval of irrigation, determined in summer groundnut is 14-16 days during January, 12-14 days during February and 8-10 days during March onwards. Under situation of shallow water table i.e. below 100 cm from the soil surface, irrigation interval should be increased.

Mechanization in Groundnut Production:

Tractor Operated groundnut planter

The performance evaluation of the tractor operated multi crop planter has been found satisfactory in coastal and western Orissa. This machine has got provision for planting seeds in desired spacing and applying fertilizer in desired rate simultaneously in nine rows and takes around 4 to 5 hours per ha as compared to 10 bullock pair days and 20 man days per ha. The cost of operation by this machine is around Rs. 1300/- per ha against Rs. 3800/- per ha in conventional method.

Weeding in groundnut crop

The manually operated wheel finger weeder (Push-Pull type) is used for weeding which take about 15 man days/ha as compared to 50 man days/ha in conventional method of manual hand weeding using hand tools (khurpi, trench hoe, etc), saving 35 man days/ha.

The Power weeder of TNAU design has been modified to make it applicable for weeding in groundnut crop with row to row spacing of 30 cm and the output has been found out to be 10-15 hrs/ha. The additional modification cost of Rs. 5000/- over existing price of the power weeder Rs. 60,500/- could save around 13 man days/ha over weeding by wheel finger weeder. Besides, the drudgery could be avoided apart from saving time, labour and cost.

Harvesting

Harvest the crop by uprooting when the plants turn yellow and leaves start drying, shedding of lower leaves, shell becomes hard and blackish streaks develop inside the shell and original seed colour develop on the kernel. If the soil is dry, harvest the crop after light irrigation. Dry the uprooted plants making upside down for 5-6 days under shade. For seed purpose store the pods in poly-lined bags with 250g calcium chloride for each 30 kg bag.

NIGER(*Guizotia abyssinica*)

Variety

1. GA-10 (Deomali) 110-120days Purple stem, longer yellow rayflorets, black shiny seeds
- 2.. IGP-76(Sahayadri) 100-105days Greenish purple stem, smaller yellow ray florets, black seeds
3. Utkal Niger-150 duration 125-130 days, medium stem, black shiny seeds

Seed rate -10(kg/ha)

Seed treatment with Thiram 3 g/ kg or Captan 3g or Carbendazim 2 g/kg of seeds, Treat the seeds 24 hours prior to sowing.

Sowing/planting time Aug-Oct

Spacing -30cm x 10 cm

Nutrient management

Compost/FYM 5 t/ha

Chemical fertilizer (kg/ha) 40:20:20::N: P₂O₅: K₂O. N 40kg nitrogen is to be applied in two or three split doses depending upon moisture availability. In areas of good rainfall and moisture availability, 50% of recommended nitrogen is to be applied at sowing and the remaining 50% in two equal splits at 25-30 and 40-45 days after sowing. In areas of uncertain rainfall, 50% at sowing and the remaining 50% around 35 days after sowing is recommended. P₂O₅ 20kg as basal K₂O 20kg as basal

Interculture (nos) Hoe and hand weed on the 20th-25th day of planting and subsequently on 40th-50th days, respectively

Irrigation (nos) 2nos (Flowering, pod development)

Yield - 5-7.5 q/ha

RAPSEED-MUSTARD (*Brassica* spp)

In Odisha, both toria and mustard varieties are cultivated. The toria varieties are more promising than mustard ones because of short and mild winter and low irrigation facilities.

Table: Varieties , Duration, Yield & Oil content

Variety	Duratio n(days)	Yield (q/ha)	Oil content (%)	Remarks
Toria				
Parbati	75	15	41.0	Suitable for rainfed & early sowing
Anuradha	75	14	44.0	Suitable for irrigated and late sown condition
PT 303	85	12	40.0	Suitable for irrigated condition
TS 29	80	9	39.0	Suitable for rainfed condition
M-27	75	7	40.0	Suitable for rainfed condition
Sushree	75	9-14	42.2	Suitable for both rainfed and agrigated condition
Mustard				
Varuna	110-115	18	37.0	Suitable for irrigated and rainfed condition
Kranti	115-130	20	38.0	Suitable for irrigated condition
Pusa Bold	110-115	15	40.0	Suitable for irrigated condition
Pusa Bahar	105-120	22	40.0	Suitable for irrigated condition
Pusa Jaikisan (BIO 902)	90-95	15	40.0	Suitable for irrigated condition
NRCHB-101	100-110	12-18	39.2	Suitable for both rainfed, agrigated and late sown condition
Rajendra Suphalam	100-110	11-15	40	Suitable for both rainfed, agrigated and late sown condition
NDRE-7	100-110	11-15	38.7	Suitable for both rainfed, agrigated and late sown condition

It is often confused when we describe rapeseed, toria and mustard in the field. It may be mentioned here that rapeseed-mustard comprises a group of oilseed crops belonging to genera Brassica, Eruca and Synapsis. The different ecotypes of Brassica campestris are yellow sarson, brown sarson and toria, collectively called rapeseed. Brassica juncea is a distinct species which is called indian mustard or rai or raya. The genera Eruca (taramira) and Synapsis are not cultivated in our state. In trade, yellow sarson, brown sarson, toria and taramira are known as rapeseed and rai as mustard.

Land preparation

Rapeseed-mustard require a fine seed bed. In rainfed crop, plough the land once or twice with country plough or cultivator each followed by planking to conserve soil moisture. In irrigated crop, give a first ploughing by MB plough followed by 2-3 ploughings with country plough to obtain a good tilth. Make the seed bed free from weeds and stubble of previous crop. Apply FYM or compost

@ 7.5 t/ha during final land preparation and incorporate it in the soil. Divide the land length and breadth wise into sub-plots of convenient sizes by drawing furrows at a distance of 3 to 4 m apart for irrigation and drainage.

Seed rate

Line sowing : 7.5 kg/ha Broadcasting : 10.0 kg/ha

Seed treatment Treat the seeds with vitavax power 1.5 g or (carbendazim 1.0 g + thiram 1.5 g) per kg seed prior to sowing. Sowing Optimum sowing time : Toria: Last week of September to mid-October Mustard: Mid October to end of October Spacing : 30 cm x 10 cm Sowing depth : 3-4 cm

Nutrient Management

fertilizer application :

The fertilizer dose recommended for toria and mustard are as follows.

Crop	Fertilizer dose(kg/ha)		
	N	P ₂ O ₅	K ₂ O
Toria(rainfed)	40	20	20
Toria (irrigated)	50	25	25
Mustard(rainfed)	40	20	20
Mustard(irrigated)	80	40	40

Apply the entire fertilizer dose as basal 5.0-7.5 cm below the seed furrows in rainfed crop. In irrigated crop apply 50% N and entire dose of P₂O₅ and K₂O as basal and rest 50% N at 3 weeks stage. The nitrogen should be applied preferably as ammonium sulphate and phosphorus as single super phosphate otherwise apply gypsum @ 250 kg/ha as basal to meet the sulphur need of the crop as the crop responds to sulphur. In zinc and boron deficient soils, apply ZnSO₄ @ 25 kg/ha and borax @ 12.5 kg/ha, respectively to increase the seed yield and oil content.

Interculture : Thin out the excess plants within the rows to maintain plant to plant distance at 10 cm at 2 weeks stage. Perform hoeing, weeding and thinning (wherever necessary) at 3 weeks stage. Weeds can also be controlled by using fluchloralin @ 0.5 kg/ha as pre-plant incorporation one day before sowing.

Irrigation : The crop responds well to irrigation. Besides a pre-sowing/post sowing irrigation to facilitate uniform germination, the crop requires irrigation at an interval of 12-15 days depending on soil and weather conditions. Under limited supply of irrigation, if one irrigation is available apply it at 3 weeks stage and with two irrigation apply one at 3 weeks stage and second at seed filling stage.

Irrigation : the crop responds well to irrigation. Besides a pre-sowing /post sowing irrigations facilitate uniform germination, the crop requires irrigation at an interval of 12-15 days depending on soil and weather conditions. Under limited supply of irrigation, if one irrigation is available apply it at 3 weeks stage and with two irrigation apply one at 3 weeks stage and second at seed filing stage.

Harvesting and threshing : Harvest the crop when the pods turn yellowish. Delay in harvesting causes shattering problems. Stack the harvested bundles in the threshing floor for 4-5 days for ripening of the upper siliqua. Dry the bundles

for 2-3 days and thresh with sticks or bullocks/tractor in a sunny day. Clean the seeds and dry in the sun 4-5 days or till the moisture content comes down to 8.0 percent for safe storage.

SUNFLOWER (*Helianthus annuus*)

Sunflower is the fourth important oilseed crop in the world next to Soyabean, groundnut and rapeseed. In Odisha, it is an ideal oilseed crop for rabi season and is grown as an irrigated crop. Its oil has high oleic acid content which reduces blood cholesterol level. The crop is performing well in land districts and has been successfully introduced in coastal districts of the state. In some parts of the state it is also grown as Kharif crop.

Table: Varieties, Duration, Yield & Oil content

Variety/hybrid	Duration (days)	Average Yield (q/ha)	Oil content (%)
Variety			
Morden	90	10.0	35.0
Hybrid			
DRSH-1	100	16.0	42.0
KBSH 44	100	16.0	40.0
MSFH 17	110	15.0	43.0
Jwalamukhi	110	18.0	42.0
KBSH 78	90	20.0	40.0
KBSH 53	100	22.0	42.0

Land preparation Plough the land once or twice to a depth of 15-20 cm with a MB plough at optimum soil moisture followed by planking or harrowing for obtaining a fine seed bed. **Sowing** It is a photoinensitive crop. Therefore, it has remarkable adaptability to be grown as a winter crop (mid October-Mid November sowing) or as a early summer crop (1st fortnight of January sowing). Care should be exercised in planting time to avoid flowering period coinciding with temperature above 38-40°C as this would cause desiccation of pollens, resulting in poor seed set and yields.

Seed rate Variety : 10 kg/ha Hybrid : 5 kg/ha (hand dibbling in open furrows)

Spacing : Variety : 45 cm x 30 cm Hybrid : 60 cm x 30 cm **Sowing depth** : 5 to 7 cm (Firm seed-soil contact in the moist soil is essential for good stand establishment)

Seed treatment Treat the seeds with (carbendazim 1.0 g + thiram 1.5 g) or vitavax power @ 1.5 g/kg of seed just before sowing.

Fertilizer application

A fertilizer dose of 60-80-60 and 30-40-30 kg of N-P₂O₅-K₂O/ha along with FYM @ 5 t/ha are recommended for hybrids and varieties, respectively. Apply full dose of P and K along with 50% N as basal in the seed rows at a depth of 7.5-10.0 cm and cover it with the FYM before sowing and the rest 25% N at button stage and 25% N at flowering stage. Sunflower responds to Ca, S and B. Calcium helps in seed filling and improves seed weight. Sulphur is required for oil synthesis and S application helps in increasing seed and oil yield. Boron increases the pollen viability, stigmatic receptivity and seed set. To meet these elements apply gypsum @ 250 kg/ha and Borax @ 10 kg/ha as basal in seed furrows. If borax is not given as basal, it may be applied at a concentration of 0.2% as directed spray to capitulum or 2.0 kg borax as dusting to capitulum at ray floret stage.

Interculture Thin out the excess plants at 2 weeks stage. Follow hoeing, weeding, top dressing and earthing up at 3-4 weeks and 6-7 weeks stage followed by irrigation. Pre-emergence application of alachlor or pendimethalin @ 1.0 kg/ha on the day following sowing effectively controls weeds. For effective seed setting, adopt hand pollination or apiary or use niger as inter crop (3:1).

Irrigation Besides a pre-sowing/post sowing irrigation, subsequent critical stages of irrigation are bud initiation, flowering and seed development stages.

Harvesting Harvest the crop when the back of the head turn from green to lemon yellow colour. The heads are dried in sun in the threshing floor for 4-5 days and threshed by beating with stick or by sunflower thresher. Dry the seeds to reduce the moisture content to 9% for safe storage.

Castor (*Ricinus communis* L.)

Introduction :

Castor (*Ricinus communis* L.) is one of the important non-edible oilseed crops of the world. It is non-edible due to the presence of toxic protein 'ricin' in seed. The oil content in castor ranges from 48 – 52%. Castor oil is used for deriving a number of industrial products, viz. dye, detergents, plastics, printing ink, ointment, polishes, surface paints, adhesives, lubricants and hydraulic fluids etc. It is used as an illuminant giving bright and steady flame and burning much longer than any other vegetable oil. After oil extraction ricin rich Castor cake is

considered to be excellent organic manure which contains about 6% N, 2.5% P₂O₅ and 1.5% K₂O. It has also anti-termite and nematicidal properties. Castor oil extracted through traditional method has got diverse medicinal uses. Green castor leaves are traditionally fed to eri-silk worms. Castor seeds are not affected by any stored grain pests due to presence of hard seed coat and ricin toxin. Seeds have long period of viability and can be stored for long periods (4-5 years) under normal room temperature and moisture free conditions. Apart from these, it is grown as a shade crop in turmeric plantations, as a wind break/border plant in sugarcane and as a trap crop in tobacco. This is a high foreign exchange earner crop.

It is an important drought tolerant crop which comes up well in rainfed uplands. The leading districts are Kalahandi, Nuapara, Nabarangpur, Ganjam and Koraput. The productivity is low due to use of local varieties which are having low yield potential, use of marginal and sub-marginal lands for castor production, non use/low use of organic and inorganic fertilizer, poor weed, pest and disease control measures.

In this context it is highly essential to adopt improved package of practices to increase the productivity of castor to a significant level.

Characteristics of Castor varieties/hybrids performing well in Odisha

Varieties/Hybrids	Days to maturity of primary raceme/spike	Seed yield upto 180 Days after sowing (q/ha)	Oil Content(%)
48-1 (Jwala)	110-120	12.0	48

Other Varieties/Hybrids recommended for Odisha

Sl. No.	Genotypes	Days to maturity (days)	Average yield (q/ha)	Oil content (%)
	Varieties			
1	Jyothi (DCS 9)	. 90*-150**	11.0	49
2	Kranti(PCS 4)	90*-150**	. 14.0	48
3	Aruna	120*-150**	10.0	50
4	Bhagya	120*-150**	10.0	51
5	Harita	90*-150**	15.0	50
	Hybrids			
1	PCH-111	90*-180**	15.0	52
2	DCH 177	90*-180**	15.0	51
3	GCH-7	90*-180**	14.0	50

* 1st picking ** Last picking

Climate :

Castor is tolerant to drought and grows well in relatively dry and warm regions having well distributed rainfall. Castor requires a moderately high temperature (20⁰ to 26⁰ C) with low humidity throughout the growing season to produce maximum yield. At flowering stage, the crop is highly sensitive to high temperature (40⁰C), low temperature (10⁰C), high humidity, heavy rains, and frost.

Soil :

It requires well-drained soils. It grows in a wide range of soils which should be free from water-logging.

Land Preparation :

Summer ploughing should be done for better tilth, reduce weed problem, increase water holding capacity of soil and for sowing the crop in time. The land should be prepared well with 3-4 ploughings after receipt of rain.

Seeding Time :

During *kharif* season sowing of castor should be done during second fortnight of June to first fortnight of July to ensure good germination and better crop growth.

Manures and Fertilizers :

FYM @ 5t/ha should be applied at the time of final land preparation for better incorporation in soil and for maintaining soil health. A fertilizer dose of 60-40-40kg N-P₂O₅-K₂O/ha is applied to the crop. For this, a basal fertilizer dose @ 20-40-20kg N-P₂O₅-K₂O/ha should be applied in lines and mixed well

with soil before sowing of seeds. Topdressing of 20kg N/ha is done after 1st hoeing and weeding operation. Rest 20kg N/ha is applied as basal application for enhancing production and increasing oil content in seed. Sulphur @ 20kg/ha through can be used as basal application for further enhancing production and increasing oil content in seed.

Seed Treatment :

Seed treatment should be done with Carbendazim @ 1.5 g/kg of seeds before sowing.

Seeding Method :

Castor is generally sown behind the country plough. It can also be sown in slightly raised pits during kharif season. A spacing of 90 cm between lines and 60cm between plants should be maintained. 10 kg seeds are required for one hectare of land. Sowing of 1-2 seeds/hill is done to ensure full plant stand. Drainage channels should be kept in regular intervals for drainage of excess water during heavy rainfall.

Weeding and Interculture :

Pre-emergence application of Pendimethalin @ 1.0kg/per hectare will effectively control weeds during initial growth stage of the crop. Keep only one healthy seedling /hill and uproot extra seedlings within a week after germination. During 3rd to 4th week after germination, first hoeing and weeding should be done. Earthing up should be done after topdressing @ 20kg N/ha . As castor is a long duration crop weeding should be done 2 to 3 times during its growth period as per the need.

Irrigation :

Castor crop generally does not require irrigation during *kharif* season. However during prolonged dry spells protective irrigation can be given for getting better yield.

Harvesting and Threshing :

Flower racemes starts appearing in 50-60 days after sowing. It appears in different phases in about one month interval in HYVs/hybrids of castor. Thus spikes of castor mature in 4-5 phases over a span of 6-7 months. The main spike becomes ready for harvest in 90-120 days after sowing. The subsequent pickings can be taken up in one month interval. Harvesting should be done when some of the capsules in a spike turn brown in colour. The matured spikes are cut and dried in sun for few days for easy threshing. Threshing is usually done by beating the capsules with sticks. Large scale threshing can be

done by castor thresher. Dry the seeds in partial shade and store it in moisture proof condition.

Yield:

By adopting improved package of practices seed yield of 12-15q/ha can be achieved in *kharif* castor

JUTE (*Corchorus* spp.)

Jute is the 2nd important fibre crop in Odisha next to cotton. It is mostly grown in Balasore, Bhadrak, Cuttack, Jajpur, Kendrapara and Keonjhar districts of Odisha.

Classification of jute- Jute varieties are classified into 2 types:-

A)Peeta Jute-*Corchorous capsularis*-suitable for medium and low land.

B)Meetha Jute-*Corchorous olitorius*-suitable for up and medium land.

Varieties

Varieties	Duration (days)	Yield (q/ha)
Olitorius :		
JRO-524(Nabin)	120-130	30-40
JRO-8432(Shakti)	120-130	30-40
KOM-62 (Rebati)	130-135	30-35
S-19(Subala)	125-135	35-40
JRO-8432 (Shakti tossa)	135-140	35-40
TJ-40 (Mahadev)	135-142	40.0
JRO-632(Baisakhi tossa)	120-130	30-32
JRO-878(Chaitaii tossa)	120-130	30-32
JRO-66(Goldenjubilee tossa)	135	35-40
CO-58 (Saurav)	110	30-34
JRO-204(Suren)	120-125	30-35
JRO-128	120-125	32-35
S-19	130-135	30-35
Capsularis		
KC 1(Jayadev)	125	30-38
JRC-4444 (Baladev)	135	24-30
JRC 212 (Sabuja Sona)	135	24-30
KJC-7(Srestha)	120	25-28
JRC-80 (Mitali white)	130	30-35
JRC-698 (Shrabanti)	125	30-35

Field preparation

Prepare the land to a fine tilth & apply well decomposed compost or FYM @ 5 t/ha before sowing.

Seed treatment

Seed treatment should be done with plant protection chemicals like thiram, carboxin 37.5% + thiram 37.5% @ 0.2% or Vitavax power @ 2.5g/kg of seed.

Sowing Time & Seed Rate

Sow the seeds in April for higher yield.

Capsularis - 6 kg seed/ha (Line sowing)

8 kg/ha (Broadcasting.)

Olitorius- 5 kg/ha (Line Sowing)

7 kg/ha (Broadcasting)

Planting geometry:

Capsularis: 30 cm apart in rows, 5-7cm (plant to plant)-

Olitorius: 25 cm apart in rows 5-7cm (plant to plant)-

Sowing depth - 3 cm.

Interculture

- First weeding, hoeing and partial thinning - 21 days of germination.
- Second intercultural operation- 5 weeks after germination.
- Thinning to maintain a spacing of 5-7 cm between plants in the line and in broadcast crop thin out the plants 15-20 days after sowing.
- Apply Basalin@2l/ha as pre-emergence herbicide 1-2 days before sowing and Quizalofop-ethyl 5 EC (Targa super)@ 500ml/ha at 15-20 days after sowing to control the grasses effectively.

Nutrient Management:

Apply Compost/FYM @ FYM @ 5 t/ha during last ploughing

Capsularis: apply 80kg N, 40kg P₂O₅ and 40kg K₂O

Olitorius: 60 kg N, 30 kg P₂O₅ and 30 kg K₂O

Apply full dose of Phosphorus and potash as basal . Apply 50% N between 20-25 days after sowing and rest 50% 15 days thereafter. Spray Urea (2%) as foliar spray along with insecticide twice at 50 and 60 days after sowing in rainfed condition.

Irrigation management

Jute requires 50hacm in its lifetime which can be provided through 4-6 flood irrigations

Harvesting

Harvest the crop at small pod stage i.e. 130-135 days. Thick and thin plants should be bundled separately for uniform retting. Leave the bundles in the field 3-5 days for shedding of leaves then retting of plants should be done.

Retting & Extraction of Fibres

Before retting add 2-3 Dhanicha plants to each bundle for quick retting. Retting should be done in flowing clear water. Submerge the bundles in horizontal position. Keep the bundles 30 cm below the surface water and it should not touch the bottom of the tank. Stone or logs should be used to press down the bundles in the water. CRIJAF bacteria culture can be applied for quick retting. Extract the fibres when it comes out easily. The optimum temperature for retting is around 34 degree celsius. Then it should be thoroughly cleaned with water to remove dirt and other matters. Then dry the fibres, grade it and make separate bundles for selling the fibres. The CRIJAF scientists have developed a new type of retting using pepticolytic bacteria by which the duration of retting is reduced and good quality of jute can be obtained. This is recognized as CRIJAF *Sona*.

Grading of JUTE-

There are 8 grades of jute:-

1. Capsularis type-W1,W2,W3,W4,W5,W6,W7,W8
2. Olitorius type-TD1,TD2,TD3,TD4,TD5,TD6,TD7,TD8

The W1 and TD1 categories are very good types of jute whereas W8 and TD8 categories are weak types of jute.

COTTON(*Gossypium* spp)

Cotton is the most important fibre crop of Odisha. It is widely grown in Kalahandi, Bolangir and Rayagada and Nuapada districts. It is also grown to some extent in districts of Ganjam, Sonepur, Gajapati, Boudh, Bargarh and Koraput districts.

I. Major cropping system in the region

Intercropping:

- i. Cotton + Green gram / Black gram (1:2 row proportions)
- ii. Cotton + pigeon Pea (8:2 row proportions)

II. Crop season:

Kharif (June to February)

Varieties of Cotton

Sl.No.	Variety /hybrids	Duration (days)	Seed cotton yield (q/ha)	Fibre length (mm)
1.	MCU-5	175-180	14	36.4
2.	Suraj	165-170	21	33.3
3.	Surabhi	160-165	22	31.7

4.	Bunny	160-165	19	32.4
5.	Savitha	165-170	17	30.5
6.	TCHH-4	160-165	23	32.3
7.	Takkat	155-162	23	33.2
8.	Shalimar	155-162	21	32.4
9.	Bhakti	162-167	22	32.2
10.	Mallika	157-162	22	32.3
11.	Chandramukhi	162-167	22	32.6

III. Land preparation:

- Moderately heavy to heavy well drained soil is suitable for cotton.
- Plough the soils having hard pan formation at shallow depths with MB plough at 0.5 M interval, first in one direction and then in the direction perpendicular to the previous one, once in three years.
- Spread 5.0 t of FYM or compost or 2.5 t of vermicompost per ha if available, uniformly on the unploughed soil.

IV. Seed treatment:

- Seeds should be treated with imidachloprid 70 WG @ 7 g/kg of seed for protection against sucking pests

V. Seed rate and sowing:

- Early sowing is conducive to get higher yield. Complete sowing latest by end of June. Use a seed rate of 3.75 kg/ha both for variety and hybrids
- Dibble two seeds per pit at a depth of 4-5 cm and cover the seeds with soils.

VI. Spacing and plant population:

- Dibble the crop in lines. Closer spacing of 90 cm X 60 cm can be adopted for increasing plant population to 18,500 / ha for normal planting and 60cm X 10cm for high density planting(1,66,600 plants/ha).

VII .Thinning:

- Thin weaker plants in the cotton field at 10-12 days after germination. Gap filling is done with planting of seedlings raised in leaf bags.

VIII. Application of biofertilizer

Seed treatment with azotobactor @ 25 gm/kg seed and PSB @ 20 gm/kg seed. In addition apply Azospirillum (2 Kg/ha) and PSB (2 Kg/ha) mixed with 25 kg FYM and 25 kg of soil on the seed line. This saves 25% nitrogen besides increasing yield. .

IX. Application of inorganic fertilizers

- Fertiliser application should be made on the basis of soil test recommendation.
- Fertiliser dose of 120:60:60 kg NPK/ha for hybrids and 90:45:45 Kg NPK/ha for varieties gives higher yield. At sowing 25% N, 100% P and 50 % K should be applied. At 25-30 DAS (Square formation stage) apply

50% N and remaining 50% K . Rest 25% N should be applied at 55-60 DAS depending upon the availability of rainfall.

- Spraying of 1.5% DAP at 75 and 90 DAS and 0.75% DAP+ 0.75% MOP at 105 DAS help in better boll retention.
- Delay in application of basal dose of fertilizers reduces the yield of seed cotton to the tune of 10 to 40% within late duration period of 10 to 30 DAS

X. Management of Leaf reddening

- Spraying of 2% urea at flowering stage and 1% urea with 1% Magnesium sulphate at boll development stage reduces reddening of leaves and increases seed cotton yield.

XI. Green manuring with sunhemp:

Growing Sunhemp @ 20-25 kg/ha as a green manure and weed smothering crop in cotton and subsequent incorporation in soil at 21-25 DAS reduce weed growth, minimizes weeding cost and improves soil health considerably by adding 8-10 ton of green manure/ha supplying 30-40 kg Nitrogen to the soil.

XII. Weed management:

- Keep the field weed free up to 60 days after sowing (9 weeks)
- Insufficient soil moisture is not available for applying herbicides hand weeding may be given at 10 – 20 days after crop emergence.
- Hand weeding at 20 DAS + Post-emergence directed spray of Glyphosate @ 1.0 kg/ha
- It is advisable to use separate sprayer for herbicide spray or the same sprayers should be washed thoroughly with water before using for spraying pesticides.

Harvesting:

Fifty percent bursting of bolls start from 105 to 111 days and 4 to 5 pickings are taken within 50 days. Picking should be done only when the bolls are fully burst open and in the cool hours of the morning. The mixture of dry leaves should be avoided to maintain quality.

Yield:

Under rainfed condition with good management varieties give seed cotton yield of 20-22 q/ha and the hybrids give 20-25 q/ha.

SUGARCANE (*Saccharum officinarum*)

The cultivation of sugarcane dates back to the Vedic period. The most ancient reference to sugarcane is in Athervaveda which is 4,000 years old. At present, while the raw sugar prices are progressively escalating, sugarcane cultivation and sugar industry are being pushed into fresh new crises. In countries

like India, more particularly in Odisha it is the small landholding farmers who cultivate crops predominantly and the costs of cane cultivation have risen alarmingly for seed/planting material, manures and fertilizers, irrigation, cultural practices and harvesting. Scientific management of the crop can help the farmers to harness maximum benefit out of sugarcane and help in area expansion along with enhancement in production and productivity.

Promising Sugarcane Varieties Suitable For Odisha

Variety	Yield (t/ha)	Sucrose %	Special characters
Early duration (10 months)			
Co 6907	103	16.3	Red rot and grassy shoot disease resistant, drought tolerant, high ratooning ability
Co 87002	95	17.7	Red rot resistant
Co 87263 (Saraju)	110	17.8	Red rot and smut resistant, drought tolerant
Co A 89085	95	18.2	Red rot resistant, long internodes ,thick cane
CoC 92061	100	17.7	Red rot resistant
87 A 298 (Biswamitra)	125	19.0	Red rot resistant, suitable for ratoon
83 R 23 (Basudha)	115	18.2	Red rot resistant, medium tolerance to smut, suitable for ratoon
Co Or 03151(Sabita)	105	16.5	Red rot resistant, drought and water stagnation tolerant
Co Or 03152 (Neelamadhab)	104	16.5	Red rot resistant
Co Or05346 (Neelachakra)	108	16.7	Red rot resistant and drought tolerant
Medium duration (12 months)			
Co 7219	100	19.0	Red rot and wilt resistant, tolerant to salinity
Co 86032 (Nayana)	105	20.0	Red rot susceptible, long internodes, suitable only for upland well drained condition, preferred due to higher sucrose %
Co 87044(Uttara)	105	18.5	Red rot and smut resistant, produces high quality jaggery
Co 86249 (Bhabani)	110	18.0	Red rot, leaf spot and smut resistant, resistant to most of the insect pests
Co 8371 (Bhima)	113	18.7	Suitable for irrigated condition, thick canes with long internode
Co 91010 (Dhanush)	127	19.0	Red rot and smut resistant, suitable for jaggery production
Co 62175	105	18.0	Red rot resistant,suitable for jaggery production, good ratooner

Co Or 04152 (Raghunath)	102	17.5	Red rot resistant, long internodes ,thick cane and can tolerate knee deep water stagnation for one month
CoOr10346(Charchika)	100	18.0	Suitable for irrigated ecosystem,red rot resistant and high sucrose content

Field preparation

Sugarcane being a long duration and deep rooted crop requires good soil tilth to give the crop an early vigorous start. It grows well in soils with neutral pH. However, the crop can tolerate moderate acidity. The field should be ploughed deep during the summer season and levelled properly. This practice destroys the insect pests and weeds and conserves moisture which helps to grow a healthy crop. Two to three days prior to planting the field should be given one light irrigation and furrows of 15 cm depth and 30 cm width are opened 75 – 90 cm apart using bullock drawn plough or tractor mounted furrow openers/ridgers. November to February is the most suitable period for sugarcane planting in our state. However, in some pockets where water scarcity is severe sugarcane can be planted after onset of monsoon rains. In such cases the crop can be harvested after six to seven months and can effectively be utilized for seed cane purpose.

Seed selection and sett treatment

Six to seven months old, healthy canes can be used for seed purpose. Care should be taken to avoid diseased and pest infested canes while selecting the seed material. If the crop is more than seven months old then use only upper two third portion as seed as lower one third portion has low glucose concentration and very often rooting initiates from the lower buds at the time of harvest for which the germination percentage is low. For one acre land 48000 three budded setts are required for planting, which amounts to around 10 t/ha. The setts are planted @ 4 sett s per meter i.e. 12 buds/meter with buds placed at the side of the furrows. The setts should be treated prior to planting to avoid disease infestation and enhance germination. For seed treatment add 150g Carbendazim, 200 ml Chlorpyriphos and 1 kg calcium carbonate (lime) to 100 litre water. Dip the setts in this solution for 15-20 minutes. Then remove the treated setts and shade dry them before planting. This controls red rot disease to a great extent. Avoid collection of seed materials from red rot infested fields. Sett treatment with 54 ° C hot steam for 2 hours controls black smut, red strip and grassy stunt disease.

Fertilizer management

The crop is mainly grown in rain-fed conditions. Most soils in Odisha are low in organic carbon content, available N and K content. Because of its large biomass yield and long growth period, sugarcane requires a considerable amount of plant nutrients for its vegetative growth and development. Because of significant depletion of soil nutrients, sugarcane soils become less fertile and fail to produce higher yield. Henceforth, nutrient replenishment through the addition of manures and fertilizer in the soil is indispensable for achieving sustainable

cane production. Continuous application of FYM along with NPK fertilizer improves physicochemical properties of soil, cane yield, and juice quality. Furthermore, successive applications of green manures help to increase the total carbon, total nitrogen, exchangeable K contents, and the porosity of the soil and decrease its bulk density. For sustainability in sugarcane and sugar production, neither chemical fertilizers nor organic manures alone but their integrated use has been observed to be highly beneficial.

Nutrient management in sugarcane cultivation is very essential for profitable crop growth. It is always better to know the required quantity of nutrients through soil testing and enrich the soil accordingly. In general FYM or Press mud @ 10t/ha is applied during final land preparation. Press mud is a rich source of organic carbon (35 – 37%) and supplies 1.0 – 1.5% N, 1.09 – 1.53% P, and 0.25 – 0.66% K. Besides, it is a good source of micronutrient and qualities to amend the soil nature. Recommended dose of fertilizer for sugarcane in Odisha is 250-100-60 kg N P₂O₅ and K₂O/ha for plant crop. Total amount of phosphorous along with 50% K is applied as basal. Nitrogenous fertilizer is applied in two or three splits i.e. at 30, 60 and 90 DAP or at 45 and 90 DAP depending on water and labour availability. In no case nitrogenous fertilizer should be applied beyond 120 DAP. Rest 50 % potassic fertilizer is applied along with last dose of nitrogenous fertilizer. For ratoon crop: 25% extra N is recommended i. e. 300 -100-60 kg N P₂O₅ and K₂O/ha. Full P + 33% N+ 50% K is applied after 15 days of harvesting (DAH). At 45 DAH 33% , N is applied and at 90 DAH rest 33% N along with remaining 50% K is applied. Biofertilizer @ 8 kg *Azotobacter* + 2 kg *Azospirillum* + 5 kg PSM mixed with 250 kg FYM/ha is applied in 2 splits at 30 & 60 DAP for upland. For medium and low land 2 kg *Azotobacter* + 8 kg *Azospirillum* + 5 kg PSM in 250 kg FYM/ha is applied in 2 splits at 30 and 60 DAP. The same mixture can be used in ratoon crop at 30 & 45 DAH of plant crop.

Sustainable Sugarcane Initiative (SSI)

In traditional methods - the seed rate is 2.5 to 4 tonnes/acre. Despite high seed rate, close planting can only support a population of 25,000 canes per acre due to high mortality while competing for sunlight and nutrients with lesser number of tillers (4-6 per plant) and few millable canes (1-2 per clump). The average weight of canes is 0.75 kilogram, which under good circumstances ends up yielding about 25 to 30 tonnes/acre. Depleting water tables and absence of proper water management practices, shortage of labour as the traditional practices have high labour requirement poses great difficulty for sugarcane growers of our state.

A package of simple agricultural innovation applied for sugarcane farming using less seed and water – inspired by SRI experience called Sustainable Sugarcane Initiative (SSI) is known as ‘More with Less’ approach. SSI has helped

a lot of farmers so far in India to improve their water productivity by 40 percent, their profits by 30 percent, while reducing their ecological impact. SSI leads to healthier soil and plants supported by greater root growth and the nurturing of soil microbial abundance and diversity. In addition, it has been found in farmers' experience that using drip irrigation leads to a great saving of water, by as much as 80 percent. As such, SSI is becoming a focus for the industry, governments, as well as financial institutions for its scaling up. The principles that govern SSI are:

- Raising a nursery using single-budded chips from canes.
- Transplanting young seedlings (25-35 days old).
- Maintaining wide spacing (5 to 9 X 2 ft) in the main field.
- Providing sufficient moisture and avoiding flooding of fields.
- Encouraging organic methods of providing nutrients, plant protection and other intercultural practices.
- Practicing intercropping for effective utilization of land and maintaining ground cover.

Single-budded chips, carefully removed from healthy canes, are used for raising the nursery. Only 50-75 kg of bud chips are used for a hectare of crop and the remaining canes could be sent for crushing.

To raise the seedlings, the selected buds are placed individually in the cones of plastic or biodegradable germination trays along with the coco-pith (coconut coir waste). Through this method, a high percentage of germination can be achieved within a week, based on the agro-climatic conditions. Treatment solution for bud chips for 1 acre (5500 buds) Malathion – 40 ml + Carbendazim – 10 g/ *Trichoderma* / *Pseudomonas* 1 kg + Cow urine – 3 to 4 litres in 20 litres of water Put the bud chips in a porous plastic/gunny bag or bamboo basket and immerse the bag/basket in the prepared solution for 20 minutes

The following steps are to be taken for this:

- Fill half of each cone in the tray with well-decomposed coco-pith.
- Place the buds in a slightly slanting position in half-filled cavities of trays.
- Do not press or push them hard. Ensure that the bud side faces up.
- Then cover the bud chips in the trays completely with coco-pith.
- After filling the trays, place them one above the other and finally, place an empty tray upside down on the top of the stack. This way, about 100 trays arranged in 4 sets (each set consisting of 25 trays) are to be placed together and wrapped tightly with polythene sheets. Keep them closed for 5 to 8 days in the same position. to create high temperature and good humidity.
- White roots (primodia) will come out within 3-5 days and shoots will also appear in the next 2 to 3 days.

- All the trays with sprouted buds are to be removed from the polythene sheet on or between 5th and 8th day and are then kept side by side on the polythene sheets spread on the ground to facilitate watering and other nursery management practices.

The SSI method encourages application of organic manure as much as possible as this enhances the macro and micronutrient availability in the soil in an eco-friendly way. It helps in appropriate utilization of some of the chemical fertilizers and protects the soil from degradation and other hazardous effects. Apply organic manure like FYM/compost/well decomposed press mud (about 8-10 tonnes/acre). Quantity of organic manure could be adjusted in such a way to supply 112 kg N/acre through one or more sources depending on their N content. *Trichoderma*, PSB, *Azotobacter*, *Pseudomonas* and decomposing cultures (4-5 kg in 500 kg of FYM/acre) can be mixed with the organic manures and applied in furrows. This will control soil pathogens and improve the soil fertility to realize higher yields.

Water management in Sugarcane

Irrigation is normally applied once in 10 days during the tillering period (36-100 days), once in 7 days during the grand growth period (101-270 days) and once in 15 days during the maturity period (from 271 days till harvest). Furrow irrigation helps in proper application and saving of water. Alternate furrow irrigation i.e. irrigating the furrows with odd numbers initially, followed by irrigating the furrows with even numbers after 7 to 15 days, as per the moisture content of the soil and the age of the crop. This will ensure saving of water up to 50 percent. Drip irrigation can be practiced more effectively in SSI due to wider spacing.

Weed management in Sugarcane

Pre emergence application of Atrazine @ 4 kg (50% WP) or Metribuzine @1.4 kg (70%WP)/ ha in 1000 litre water can keep the field weed free upto 45 days after planting. Other wise, hand weeding or mechanical weeding at 60, 90 and 130 days after planting are better for long term benefits. Trash mulching is important in sugarcane cultivation as it helps in checking the weeds and providing needed moisture. Sugarcane trash can be applied in 2.5 to 3.5 cm thick layer within 3 days of planting checks weed growth, conserves moisture and controls early shoot borer in sugarcane. Similarly, after detrashing the removed leaves can be applied in the inter spaces as mulch. Partial earthing up is done on the 75th day after planting, essentially to disturb the roots a bit and hence to trigger more tillers in the initial stage of the crop. Full earthing up is done on the 120th day

after planting. This heavy earthing up helps in controlling further production of tillers and provides sufficient anchorage to the crop against lodging.

Propping can be done in the 7th month, either by tying the canes in each row or by bringing the canes of two rows together and tying them. While harvesting, care should be taken to cut the canes from the base, preferably 5 cm below the ground using axe or similar kind of implements to facilitate a healthy ratoon crop.

POTATO (*Solanum tuberosum* L.)

Potato has very high yield potential and it produces the highest biomass per unit area per unit time.

Varieties

Characteristics of the varieties recommended for Odisha

Early (70-80 days)

Characteristic	Kufri Chandra mukhi	Kufri Ashoka	Kufri Jawahar	Kufri Bahar
Tuber size	Large	Large	Medium	Large
Tuber shape	Large	Large	Medium	Medium
Tuber shape	Oval	Oval	Round	Oval
Skin colour	White	White	White	White

Eyes	Fleet	Fleet	Fleet	Deep
Plant height	Medium	Medium to tall	Medium to tall	erect
Stems	Spreading	Erect	Short erect	Erect
Av. yield (q/ha)	210	250	240	280
Reaction to disease				
Early blight	Susceptible	Susceptible	Mod. resistant	-
Late blight	Susceptible	Susceptible	Mod. resistant	-

Medium (80-100 days)

Characteristic	Kufri Jyoti	Kufri Sutlej	Kufri Pukharaj	Kufri Badshah	Kufri Lalima	Kufri Aruna	Kufri Surya
Tuber size	Large	Large	Medium	Large	Medium	Medium	Large
Tuber shape	Oval	Oval	Oval	Oval	Round	Long	Long
Skin colour	White	White	White	White	Red	Red	White
Eyes	Fleet	Fleet	Fleet	Fleet	Shallow	Medium deep	-
Plant height	Tall, erect, compact	Tall, erect, compact	Tall, semierect	Tall, erect	Tall, erect, compact	-	-
Stems	Vigorous	Medium compact	Medium, compact	Vigorous	Erect	-	-
Av. yield (q/ha)	200	280	320	300	280	300	300
Reaction to disease							
Early blight	Mod. resistant	-	-	Mod. resistant	Mod. resistant	-	-
Late blight	Mod. resistant	Mod. resistant	Mod. resistant	--	-	Resistant	-

Soil

The soil should be friable, porous and well drained. The optimum soil pH range is 4.8 to 5.4. It prefers a cool weather. Potato is mostly grown as a rainfed crop in regions receiving a rainfall of 1200 – 2000 mm per annum.

Season

Planting is done during October – November in plains.

Seed rate

About 3000 – 3500 kg/ha of seeds is required.

Breeding of Dormancy in Potato

Sprouted tubers establish better and gap filling can be avoided. Treat tubers with carbon disulphide (20 cc/100 kg of seed) 90% of tubers sprout in a period of 40 days.

Seed treatment

Use Carbon disulphide 30 g/100 kg of seeds for breaking the dormancy and inducing sprouting of tubers.

True potato seed

The cost of seed tubers and spread of virus disease can be greatly minimized by using 'true potato seeds'. The hybrids developed by Central Potato Research Institute viz., HPS 1/13, HPS 11/13 and HPS 24/111 are suitable for true potato seed production. The seeds are raised in nursery beds like other vegetables and seedlings are transplanted 30 days after sowing. For raising one hectare of crop, a quantity of 100 g seed is required.

Preparation of field

Prepare the land to fine tilth. In hills provide an inward slope in the terraces. Provide drainage channel along the inner edge of the terrace. Form ridges and furrows with a spacing of 45 cm between ridges either by hand hoe or ridger.

Seeds and Sowing

Select Disease free tubers (obtain from reliable source) of about 35-40 g in weight and with 2-3 eyes which have already sprouted. If the tubers are big in size, they may be cut into 2-3 bits having 2-3 eyes i.e. sprout. About 1.5 to 2 tons of the cut seeds are required per hectare and tubers should be kept for 2-3 days under shade so as to form callus on the cut end. Whole or cut tubers before planting should be allowed to sprout then dipped in Vitavax power 0.2% + Streptocyclin @ 0.01% or Plantomycin 0.1% for 15 minutes followed by shade drying to check fungal and bacterial infection.

The tubers are to be treated with Agallol 25 to 50 g/10 lit of water for 2-5 minutes to check seed borne fungal disease. The planting is to be done on one side of ridge with sprouts upwards. A spacing of 20 cm x 50 cm should be adopted. The land should be irrigated immediately after planting. In Drip irrigation system the spacing will be 20cm between PXP and 45cm between RXR on bed having width 3feet and as much long possible.

Interculture : After 75% of the tubers come to sprouting, first earthing should be done by taking the earth from the spaces in between the lines. After 15 days, the second earthing is done, taking care that the tubers already formed are not disturbed. Before earthing, the field should be lightly hoed for weeding and at the time of earthing the remaining weeds are removed. For effective weed control apply Alachlor @ 1.0 kg/ha or Metribuzin 0.7 kg/ha as pre-emergence spray within 3-4 days of planting. Chemical weed control is advisable since frequent entry into the field helps in the spread of contact virus like potato virus X and potato virus S.

Manures and Fertilizers

Manure and fertilizer:

Apply 15 t/ha of FYM and 2 kg each of *Azospirillum* and *Phosphobacterium* as basal. Potato is a fertilizer intensive crop. It responds to higher fertilizer levels. It is better to apply fertilizer as per soil test recommendation. If the soil test is not done, the fertilizer may be applied @ 150 kg N, 80 kg P₂O₅ and 100 kg K₂O/ha. Apply 1/3 of nitrogen, full dose of phosphorus and half of potash as basal dressing in furrows and mix well with compost and then tubers should be planted. Rest of nitrogen may be applied in 2 splits at first and second earthing up when the plant will be about 30 days and 45 days of sowing, respectively. The remaining quantity of potash should be given along with second split of nitrogen at the time of second earthing up. Avoid application of urea at sowing. In case of early variety, splits should be reduced to two, i.e. basal and first earthing up. Apply Magnesium sulphate at 60 kg/ha as basal dose. Apply mix micronutrient 10 Kg. per hectare for better growth of tuber.

Irrigation

Irrigate the crop 10 days after planting. Subsequent irrigation should be given once in a week.

Weed control

The critical period of weed-competition is upto 60 days and it is essential to keep the field weed-free during that period. Take up the first hoeing on 45th day without disturbing stolons. Second hoeing and earthing can be taken up at 60th day.

Yield

15 – 20 t/ha of tubers can be obtained.

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