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PACKAGE OF PRACTICES OF CROPS

SUMMER RICE

Varieties

A number of high yielding varieties of different maturity groups are available. Choose the proper variety depending on the type of land and period of water availability. Choose relatively shorter duration varieties (**Annexure-I**).

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

Early raising of nursery between 10^{th} to 25^{th} December is highly desirable so that transplanting is over before the end of January. Early planting reduces stem borer attack and the crop is harvested early which leave enough time for land preparation of kharif crops and also timely sowing of jute in the coastal areas. Transplanting should be done between 10^{th} to 25^{th} January.

Treat seeds with (carboxin + thiram) i.e., vitavax power @ 1.5 g or (carbendazim 1.0 g + thiram 1.5 g)/kg seed as a protection against seed borne diseases namely blast, bacterial leaf blight and helminthosporium leaf spot. Seed treatment drum should be used to treat the seeds uniformly. If seedlings are stunted and yellowish with galls present in root, apply carbofuran @ 1 kg a.i/ha in nursery one week before uprooting and follow up with light irrigation against root knot and rice root nematodes. Seeds required per hectare is 50-70 kg depending on the grain weight of the variety. Soak seeds for 24 hours in water and incubate for 48 hours for sprouting. Always sow pre-germinated seeds on a well puddled nursery bed, after the puddle settle. Cover the sprouted seeds with a thin layer of FYM. Provide bird

scarer in the nursery to keep away the birds. Provide intermittent light irrigation to maintain field saturation to prevent yellowing of seedlings.

The seedlings should always be raised on well puddled beds. Draw furrows at 1.5m interval the puddle field and sow sprouted seeds on these stips. A total nursery area of about 1000 sq m will be required for transplanting one hectare of land.

To hasten early growth in cold weather apply 2 baskets of FYM per 40 sq m of nursery area along with application of N, P_2O_5, K_2O @ 10:15:20 g/m^2. Thoroughly mix the manure and fertilizer in the soil before drawing the furrows and sowing the seed. Apply granular insecticides in the nursery at 3 weeks after sowing.

Transplanting

Early transplanting in January is very helpful in getting good yield. Transplant two seedlings per hill at a spacing of 15 cm x 10 cm. Erect and shallow transplanting helps quick establishment of roots in the soil and better tillering. If the basal node is planted deep in the mud, tillering is delayed as tiller will start only after leaves originate at higher nodes. Transplant seedlings closer to secure about 70 hills/sq m (15 cm x 10 cm spacing). Maintain only a thin film of water at the time of transplanting. To complete seeding in time sprouted seeds can be sown in puddled field without sacrificing the yield. In such cases adopt a seed rate of 75 to 80 kg/ha depending on the grain weight of the varieties. It is advisable to sow pre-germinated seeds in lines 15 cm apart using a seed drill. In BPH endemic areas an alley of 30 cm may be left at the end of every 1.5 m to facilitate spraying against the pest even though it may result in slight reduction of yield or else wider spacing of 20 cm x 10 cm is recommended to give 50-55 hills/ sq.m. instead of 70 hills/sq m. In case of Jajati, transplanting should not be delayed after 20th January. Use of rice transplanter also reduces labour cost for transplanting.

For sowing pre-germinated paddy seeds in lines, three row pre-germinated paddy seeder should be used. The field should be puddled, levelled and well drained at the time of using the seeder. The seeds having 2 mm length sprouts are most suitable for the pre-germinated seeder.

Fertilizer

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_2O_5	K_2O	N	P_2O_5	K_2O
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 at 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. (for herbicide refer integrated weed management chapter).

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$\pm$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.

Plant protection

Prophylactic measures like clean cultivation, early planting, seed and nursery treatment are cheap and are widely advocated. Field control of insect pests and diseases should be done in time as per schedule given in the **Annexure- II, III and IV**. To apply the pesticide and insecticide effectively, hand compression sprayer or low volume sprayer (LV) should be used. Low volume sprayer required only 12 litres of water to spray one hectare of land.

Harvesting

Harvest the crop close to the ground when about 90% of the grains in the panicles are grey in colour (straw colour). Delayed harvesting may cause shedding of grains resulting in considerable loss in yield and increased percentage of broken rice during hulling. Harvesting of paddy is a tedious job. To reduce the drudgery, harvesting of paddy may be done by improved sickles designed by Gujurat Agro Industries Corporation (GAIC) or Naveen (CIAE, Bhopal) or Dev sickle (Dev Industries, Bangalore). For hard soil and non-lodged crop of rice, power tiller or tractor operated vertical conveyor reaper (VCR) should be used.

Threshing and winnowing

Threshing of paddy should be done by pedal operated paddy thresher or power operated paddy thresher. Cleaning of paddy is a major problem as it depends on velocity of wind. Hand operated mechanical winnower should be used for winnowing purpose.

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.

HYBRID RICE

Important rice hybrids recommended for the state are KRH 2, PA-6201, PHB 71, Rajalaxmi and Ajaya.

Sl. No.	Hybrid	Duration (days)	Yield (t/ha)
1	KRH 2	130	7.0
2	PA 6201	135	8.0
3	PHB 71	135	8.0
4	Rajalaxmi (CRHR-5)	135	7.0
5.	Ajaya (CRHR-7)	135	7.5

Seed rate : 15 kg/ha
Seeding density in nursery : 10-20 g/m^2
Time of planting : Mid January
Spacing : 20 cm x 15 cm
Seedlings/hill : One or two
Fertilizer dose : 120-60-60 kg of N-P_2O_5 -K_2O/ha
Full P, K and half N as basal, 25% N at tillering and 25% N at panicle initiation stage.
Water management: Cyclic submergence (5$\pm$2 cm) of water one day after disappearance of ponded water.

Follow other package of practices as under transplanted rice.

IMPACT POINTS

1. Choose short duration high yielding varieties.
2. Raise early nursery in December and complete transplanting within January.
3. Practise shallow, erect and close transplanting.
4. Complete timely weeding and follow proper water management schedule to check weed growth.
5. Use recommended dose of fertilizer and correct method and time of application.
   a. Incorporate full P and K and a part of N into the soil at seeding or transplanting.
   b. Use amide/ammoniacal form of N at seeding or transplanting.

SYSTEM OF RICE INTENSIFICATION (SRI)
METHOD OF CULTIVATION

About the system :

System of Rice Intensification (SRI) was first developed in Madagascar during the 1980's . It was not known outside Madagascar till about 1997. The potential benefits of SRI are being tested now in predominantly rice growing countries like China, Indonesia, Cambodia, Thailand, India, Cuba, Bangladesh & Sri Lanka.

SRI Technology uses less inputs. It uses less seed, water, chemical fertilizers and pestisides but uses more organic manures. Rice grown with SRI Technology has large root volume, profuse and strong tillers with big panicles, more and well – filled spikelets with higher grain weight.

Is rice an aquatic plant ?

Scientists say rice is not an aquatic plant. It can only survive in water but does not thrive well under hypoxic conditions. Under continuous inundation, rice plant spends lot of energy to develop air pockets (aerenchyma tissue) as survival mechanism. Under SRI, paddy fields are not flooded but only kept moist by alternate wetting and drying.

How to grow Nursery ?

Prepare the land thoroughly when dry. Apply FYM and puddle well. Then, make beds of 1 metre width with convenient length. Remove the soil from either side of the bed and put it on the bed. The bed automatically gets raised in height. Place wooden planks of bamboo slits all around the bed for support so that the soil will not loosen and get carried away with rain. The seedbed should be prepared as closely as possible to the main field so as to minimize transport time between removal of seedlings from the bed and transplanting in the field.

Soak the seed in water for 12 hours. Put the seed in a wet gunny bag and leave it for 24 hours for incubation. Level the seed bed. Spread a thin layer of well decomposed FYM on the bed. On this layer, broadcast the seed sparsely. See that 2 kg. seed is sown on 40 Sq. m area. Apply another layer of FYM to cover the seeds. Then mulch the bed neatly with paddy straw to prevent the seed to come in direct contact with sun, rain, birds etc. Irrigate carefully with rose can every morning & evening. Do not apply any agro chemicals to the nursery bed. In 8 to 12 days, vigorous & healthy nursery is ready for transplanting.

The six basic Principles of SRI are –

1. Use of young seedlings for transplanting
2. Careful transplanting
3. Planting at wider spacing
4. Weed control
5. Water Management
6. Organic manures

Early Transplanting :

Eight to 12 days old seedlings with just two leaves have to be transplanted. This ensures more tillers and more root growth. While 30 tillers per plant are fairly easy to achieve, 50 tillers per plant are quite attainable.

Taking out Seedlings from the nursery :

Take an Iron sheet of sufficient thickness measuring 18" by 15". Push through this sheet into the nursery bed beneath the plants about 3 inches down from the surface. Then lift the sheet gently. Now the plants alongwith the mud have come on to the metal sheet. Carry seedlings with the soil to the main field. With your right thumb and forefinger, take plant by plant alongwith soil and place the plant alongwith mud and roots gently at the intersection of grid lines made for the purpose to plant at wider spacing in a square pattern.

Preparing the main field for transplanting :

The land preparation does not require special tips. Plough the land thoroughly. Puddle it as is done with the conventional method. At every two-meter interval make 30 cm wide channels. To make channels, place sticks at appropriate intervals (i.e. 2 m, 30 cm) along the edge of the field and stretch tine rope between them. Hold two ropes, at 30 cm apart. Remove the soil within the two ropes and spread it on the adjacent beds thereby a channel is made. Level the field thoroughly.

Then take a "rake" that has teeth at 25cm apart which can be constructed simply from wood. It is pulled across the surface of the prepared muddy field, marking lines on the surface at 25 cm intervals. Drawing the rake across the first set of lines perpendicularly (at a right angle) to them creates the desired square pattern on which seedlings are planted at the intersections of lines. In traditional method, a thin film of water is maintained at transplanting. But in SRI, there should not be standing water at the time of transplanting. Sixteen plants are transplanted per Sq.m in this method as against 33 hills per sq. m conventional method.

Careful Transplanting :

It is important to avoid 'shock' or 'trauma' while transplanting the seedlings. Remove seedlings from nursery with seed, soil and roots intact carefully and plant it in the field without plunging too deep into the soil. The seed should be attached to the seedlings and transplanted as soon as possible after being removed from the nursery – within half an hour and preferably within 15 minutes to avoid desiccation and traumatization of the plant.

Care is to be taken to ensure that when the seedlings are transplanted that their root tips are not inverted as usually happened during the hurried, rough transplanting done in the conventional method. If the root tip was turned upward – shaped like a J, rather than an L it could take a week or more for the tip to reorient itself downward and resume growth. Hence, do not thrust seedlings downward into the soil. Rather, each seedling is slipped into the soil very 'gently' and close to the surface, so that its root lies horizontally in the moist soil. This makes the shape of the transplanted seedling more like 'L' than like 'J' and facilitates root

growing quickly downward. Only single seedling is to be planted at the intersection rather than in clumps of 2 or 3 or more.

Wider Spacing :

Rice plants can better realize their potential for tiller and root growth and for subsequent grain filling, if spaced widely rather than densely. Seedling are to be planted a square pattern at 25 x 25 cm wide. Leaving wide space between each plant ensures that roots have adequate room to grow and the plants will be exposed to more sunlight, air and nutrients. The result is more root growth and more tillering . The square pattern also facilitates weeding in both directions. This means that individual plants have more room to spread.

Weeding and Aeration :

As there is no standing water in rice fields under SRI method, weed growth is very high. Use simple mechanical rotary weeder to churn the soil for weed control. Rotate the weeder at least 2 to 4 times. This incorporate the weeds into the soil. The first weeding should be done at 10-12 days after transplanting to eliminate weeds when these were just germinating rather than wait for them to grow. Subsequent weedings are done at 10 days interval. Working with rotary weeders helps in greater aeration which results in more root growth, reduced weed competition, more oxygen and nitrogen to roots. Weeds incorporated into the soil with each weeding can add-up to 1 ton green manure per hectare per weeding and also helps build up large and diverse microbial population in the soil.

Can herbicides be used ?

No. Herbicides are not recommended under SRI method. Instead, weeds have to be incorporated into the soil.

Water Management :

Rice has traditionally been grown under standing water continuously. Clearly, rice is able to tolerate standing water. However, standing water creates hypoxic soil conditions. Under such conditions three-fourths of their root system gets degenerated by the time of flowering. SRI practices, by contrast, nurture sustain large and intact root system throughout the growth and reproductive stages of rice plant.

Water should not be allowed to stagnate under SRI method. Give regular irrigations to keep the soil moist. Alternate ‘wetting and drying’ should be done which give aerobic and anaerobic soil conditions for better nutrient mobilization by soil biota. This avoids root degeneration, which usually happens under continuous flooding. Unflooded conditions, combined with mechanical weeding, result in more air in the soil and greater root growth. Higher root growth provides access to more nutrients. Irrigate the field on the previous evening before the periodic weedings. Drain out water in the morning to facilitate rotary weeder operation.

Compost :

Instead of chemical fertilizers, FYM or compost is applied @ 10t/ha which is quite sufficient as a source of nutrients. As a result, more plant growth is achieved because of better soil health and more balanced nutrient supply. Apply diverse organic manures. Organic manures act as food for microorganisms.

Pest and Disease control :

Pest and disease problems appear to be less with SRI method, perhaps healthier and vigorous plants have more capacity to resist pest and disease attacks. It was observed that, sheath blight and BPH incidence is low under SRI method.

Comparison of SRI with Conventional method :

Conventional Method	**SRI Method.**
1) 20-25 kg seed is used per acre	1) 2 kg seed is sufficient for one acre
2) 25 to 30 day old seedlings are transplanted.	2) Only 8-12 day old seedlings are transplanted.
3) Seedlings are pulled with force, roots washed, bundled,stacked thrown thereby causing lot of trauma and shock to the plants.	3) Seedlings are treated very gently by scooping. No pulling, no washing, no bundling and no stacking.
4) Planted at random	4) Planted in square pattern
5) 33 hills are planted per Sq.m	5) 16 hills are planted per Sq.m or less
6) 3 or more plants are planted in clumps	6) Only one plant is planted per hill.
7) Application of NPK, fertilizers as recommended.	7) Application of organic manures only basal dose of fertilizers at present. No top dressing.
8) Continuous flooding	8) Moist condition.

Is it labour intensive?

Some farmers are hesitant at first to use SRI methods because they require more labour and skill and appear risky. At first, SRI may take 50 to 100% more labour. Planting and weeding are initially the most labour intensive part of SRI. Since yields can be double or even trippled than with current practices, it justifies mobilization of labour for profit. But over time. This amount is reduced. It requires even less labour once tools designed and techniques are mastered and confidence gained.

Benefits of SRI

* Higher grain and straw yields

* Reduction in duration by 10 days.

* Lesser chemical inputs

* Less water requirement (About half that of conventional method)

* Less chaffy grain

* Grain weight increased without change in grain size

* Higher head rice recovery

* Withstood cyclonic gales.

* Soil health improves through biological activity

* Cold tolerance

WHEAT

Scope

Wheat is as remunerative as rice and gives 3-4 tonnes of grains with good management practices. The crop requires less water than rice and about 3 hectares of wheat can be grown with the amount of water required for one hectare of paddy. The command areas of dugwells, lift irrigation points, tanks, MI projects, water harvesting structures and tail end areas of canals offer scope for wheat cultivation. Moreover, a third crop of pulses, ragi or sesame can be taken with light irrigation in summer after harvest of wheat.

Varieties

The varieties recommended for different sowing dates are as follows:

Sowing time	Suitable varieties
Timely sown (November 15 – 30)	HD 2824, HD 2733, PBW 343, PBW 443, HUW 468, K 9107, HP 1761, HP 1731, Sonalika
Late sown (December 1 – 25)	HW 2045, DBW 14, NW 2036, HD 2643, NW 1014, HP 1744, HP 1633 (Sonali), Sonalika
Very Late (Dec. 26 to January 7)	Raj 3765, PBW 373

All these varieties mature in 95 to 100 days. As wheat is a thermo-sensitive crop, it matures earlier in coastal than inland districts of the state.

Field preparation

Apply all the farm yard manure (5t/ha) at final land preparation. The field should be properly prepared to obtain a clean, friable and levelled seed bed to facilitate line sowing. Divide the field into small basins of convenient size (5 x 3 meter) for controlled irrigation. Field channels may be laid in alternate plots so that each channel can irrigate the plots on either side of it. Excess irrigation is harmful for wheat. Therefore, controlled irrigation by dividing the field into subplots is essential for getting high yield.

For the light soils of coastal districts bose plough should be used, whereas for the heavy soil, implement factory heavy soil mould board plough should be used. Power tiller with rotavator and tractor with cultivator are most suitable for land preparation in all types of soil.

Seed treatment and sowing

Seed treatment protects the crop from seed borne diseases like loose smut, helminthosporium leaf spot and alternaria blight. For loose smut, soak seeds in water for 5 to 6 hours and dry in hot sun for 4 to 5 hours in a very thin layer. Treat each kg of seeds with 1.5 g of vitavax power thoroughly. Only quality seeds with more than 80% germination be used for sowing. Seed treatment drum should be used for treating the seeds before sowing.

The second fortnight of November is the optimum period for sowing wheat. Tiller initiation takes place at about 18 days after germination. Low temperature of 21^{o}C or less favours tillering. The coldest period falls between 15th December to 15th January and this period prolongs in the inland districts upto 20th January. Wheat should, therefore, be sown by the end of November at the latest. In the interior districts and hilly areas, where the winter is more prolonged and severe, sowings may continue till the end of December. Early sowing before 1st week of November results in early emergence of earheads and very low yields. Wheat may be sown when coconut oil solidifies with the onset of winter.

Seed rate and spacing

Use 125 kg seed/ha for normal sowing and 150 kg/ha if sown late in December. Sow the seeds in lines 20 cm apart for inland districts and at 15 cm apart for coastal districts and late sowing under both the situations. Line sowing facilitates weeding, maintain adequate plant population and gives higher yield. Sow the seeds at a depth not exceeding 5 cm in moist soil by seed drill or behind the plough and compact soil by laddering.

Fertilizer use

Apply fertilizer on the basis of soil test recommendation. Where soil test is not possible, apply 80-50-40 kg N-P_2O_5-K_2O/ha for inland districts and 60-40-30 kg N-P_2O_5-K_2O/ha for coastal districts. Increase the fertilizer dose to 120-60-40 kg N-P_2O_5-K_2O/ha for Hirakud command and 100-50-50 kg N-P_2O_5-K_2O/ha for Koraput dsitrict. It is best to apply half of nitrogen and all the P and K 3 to 4 cm below the seed at sowing. The remaining half of Nitrogen should be applied at 18 to 21 days stage just before hoeing and weeding so as to incorporate the fertilizer into the soil. In light soil, nitrogen may be applied in 3 splits i.e. 25% basal, 50% at 18 to 21 DAS and 25% at 35 DAS. In acid soil liming @ 1-2 t/ha 15 days before sowing depending on pH of soils will help in increasing the yield. Phosphorus can be applied as 50:50 mixture of rock phosphate and superphosphate to economize cost of fertilizer and to increase yield. Under limed situation rock phosphate to be substituted by SSP.

Interculture

The crown roots appear in the third week after germination. Weeding, manuring and irrigation at this stage help root growth and development and also better tillering. In heavily weed infested field weeding earlier at about 15 days stage is necessary. Nitrogen top dressing can be done between the lines before hoeing and weeding so that the fertilizer gets incorporated into the soil there by reducing losses and increasing fertilizer use efficacy. For weeding wheel hoe and wheel finger weeder can be used. For effective control of weeds, apply pendimethalin @ 1 kg/ha as spray in 500 litres of water one day after sowing. At 30 days after sowing again apply, 2,4-D (80%) @ 0.75 kg/ha or methabenzthiazuron (70%) @ 1.2 kg/ha.

Irrigation

The critical stages of water requirement are crown root initiation, tillering, jointing, flowering and grain filling. Excess irrigation and standing water in the field is harmful as the plants become yellow and yield decreases. At sowing the top 5 cm of soil should be moist to facilitate quick germination. In loamy sand soils, sow the seeds and irrigate. In loam and clay loam soils give a soaking irrigation, prepare the land and sow the seeds. Otherwise, the field has to be given light irrigation. The first irrigation should be given at crown root initiation stage 18-20 days after sowing, soon after top dressing, hoeing and weeding which helps root growth and tillering. In very light soils, it may be necessary to irrigate the crop at 10 to 12 days after sowing. Thereafter irrigate at an interval of 12 to 15 days depending on the texture of the soil. The last irrigation may be given when the plants start yellowing and grains are at the hard dough stage. Each time irrigate 6 cm of water.

Plant protection

Follow the plant protection schedule in **Annexure-II and III**.

Hand compression sprayer or low volume sprayer can be used for applying pesticide and insecticide.

Harvesting

Flowering takes place between 45-65 days. Thereafter it takes another 45 days for wheat to mature and be ready for harvesting. When the plants are completely yellow and the grains dry up and become hard, wheat will be ready for harvest. One test is to bend the neck of the earhead and if snaps, then wheat is ready for harvesting. Another test is to take a grain and bite it and if it breaks with a cracking sound then the crop is ready for harvest.

Improved sickle can be used for harvesting wheat. Vertical conveyor reaper (power tiller or tractor operated) is recommended for harvesting if available with the farmer.

Threshing and winnowing

Wheat thresher should be used for threshing and cleaning of wheat which reduces the cost of threshing and increases the quality of bhusa.

IMPACT POINTS

1. Division of the field into small size plots
2. Line sowing and timely weeding at 18-21 days stage.
3. Top dressing, hoeing, weeding and irrigation at crown root initiation stage.

MAIZE

Varieties

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

Composites/ hybrids	Variety	Duration (days)	Average grain yield (q/ha)	Special features
Composites	Dhawal	100-110	60.0	White grain
	Novjot	90-100	55.0	Yellow grain
Hybrids	Deccan 103	100-110	65.0	Yellow grain
	Ganga II	100-110	60.0	Yellow grain
	Deccan 105	100-110	60.0	Yellow grain
	Trishulata	100-110	60.0	Yellow grain
	PAC 705	100-110	65.0	Yellow grain
	Cargil 900M	125	70.0	Yellow grain
	Cargil 633	120	65.0	-
	PRO 345	100-110	60.0	Yellow, Semi dent
	Bisco-2418 (Super Kohinoor)	90-100	55.0	Yellow, semi flint

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 chlorpyriphos 1.0% dust @ 25 kg/ha during land preparation. For a good seed bed, use implements like bose 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. Seed can be treated uniformly by the seed treating drum.

Sowing

Rabi sowing should be done between October-November. Germination and early growth of the crop will be delayed if sowing is done in December when the temperature is very low. 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 5cm. 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

Maize is a non-tillering crop and each plant counts. Therefore, 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 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. Sow two bold seeds per hill, maintain only one healthy plant/hill.

Fertilizer

Fertilizer requirement of maize crop is high. Apply 80 kg N, 40 kg P_2O_5 and 40 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 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. The dose of herbicides should be reduced by 40% in light soils. Alternatively, alachlor 50 EC @ 1.5 kg/ha as pre-emergence spray effectively controls the weeds.

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.

Plant protection

Termites, cut-worm, aphids, stem borers and leaf blight are common pests and diseases. Follow the plant protection schedule given in **Annexure-II and III**.

Hand compression sprayer or rocking sprayer or foot sprayer should be used for applying pesticide and insecticide.

Harvesting

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

Shelling and winnowing

Shelling of maize should be done by hand operated or power operated maize sheller. Winnowing can be done by a manually operated winnower.

SWEET CORN

Sweet corn is consumed at green stage after roasting. The dry seeds are shrivelled and irregular in shape.

Variety	: Madhuri, Priya, Sweet pearl (hyb)
Duration	: 65-70 days
Seed rate	: 5.0 kg/ha
Spacing	: 60 cm x 25 cm
Fertilizer	: 80-40-40 kg N-P_2O_5 -K_2O/ha (Nitrogen to be applied in 3 splits as in maize)
Harvesting	: At green cob stage
Yield	: 1.5 t/ha

BABY CORN

Baby corn is used for culinary purposes for making curry, pakoda and other food items. It can be cultivated in winter season. It is not suitable for summer season as the silk dries out due to high temperature.

Variety	: Him 129, VL 42, VL 16, VL 78, Prakash, Pusa Early Hybrid-1, 2 and 3
Seed rate	: 15.0 kg/ha
Spacing	: 40 cm x 20 cm
Fertilizer	: 120-60-60 kg N-P_2O_5 -K_2O/ha (Nitrogen to be applied in 2 equal splits as basal and at 3 week stage)
Harvesting	: Immediately after the silk is visible.
Yield	: 1.0 t/ha

IMPACT POINTS

1. Use high yielding composite/hybrid varieties.
2. Sowing in line and early weeding
3. Maintenance of adequate plant population
4. Use moderate dose of fertilizer
5. Apply P and K as basal
6. Top dress N strictly as per schedule.

RAGI

Ragi can be grown throughout the year as a kharif crop, pre-rabi crop, rabi crop with light irrigation and as a summer crop with moderate irrigation. Flowering will be delayed if it coincides with cold weather (below 20^{o}C). A mean temperature of 26 to 29^{o}C is ideal for growth and good crop yield. It is moderately tolerant to salinity and highly tolerant to alkalinity with pH as high as 11.0. The crop possesses good drought recovery characteristics. Nutritionally the grains are rich in phosphorus, potassium and amino acids and the richest source of calcium (410 mg/100 g grain). The grain provides 8-10 times more calcium than wheat or rice. The grain carbohydrate have the unique property of slower digestibility and regarded as food for long sustenance. The cooked food prepared from the grains is a preferred diet for the diabetes patients.

The following varieties of ragi (short and medium duration) are suitable for cultivation in rabi and summer season.

Varieties

Variety	Maturity (days)	Average yield (q/ha)	Special features
Dibyasinha	85-90	20-25	Ear heads slightly top incurved
Champavati (VR 708)	90-95	22-24	Medium size incurved ear heads and drought resistant
Suvra (OUAT 2)	100-105	21-25	White coloured grain
Neelachal (B 4-10-56)	105-110	22-25	Light brown and medium bold grain, semi compact panicles
RAU 8	105-110	25-27	Top incurved open fingers
Bhairabi (BM 9-1)	105-110	27-30	Leaves are light green, purple coloured juncture and auricle top incurved ear head, light brown coloured seed
Chilika (OEB 10)	110-115	26-30	Light brown colour bold grains. Moderately resistant to blast
Godavari (PR 202)	115-120	28-30	Medium compact and incurved ear head, orange brown bold grains

Field preparation and sowing of direct seeded crop

Prepare a well pulverized seed bed for direct seeding of ragi. Apply FYM or compost 5 t/ha and incorporate well into the soil along with fertilizer before sowing. Sow the direct seeded crop in lines 22.5 cm apart preferably with seed drill or by opening lines followed by covering the seed furrows by laddering. A seed rate of 10 kg/ha will be adequate for the line sown crops. Treat the seeds with biofertilizer.

Nursery

Seedlings should be raised in well prepared nurseries in an area of 500m^{2} for transplanting one hectare area. Apply 20 baskets of well decomposed FYM and small doses

of fertilizer (10 g each of N and P_2O_5/sq.m. of the nursery area) to help rapid growth of the seedlings. Sow the seeds evenly in the nursery bed and irrigate the nursery, if necessary. The seedlings will be ready within 25 to 30 days, 8-10 kg of seeds will be sufficient for transplanting one hectare.

Transplanting

Apply manures and fertilizers after land preparation. Transplanting should be close. Early varieties should be transplanted 20 x 10 cm apart and medium duration varieties 22.5 cm x 10 cm apart. It is economical to transplant seedlings in plough furrows. Two seedlings may be placed 8-10 cm apart in the furrow at each hill. The base of seedlings will be covered by soil when the next furrow is drawn. Shallow planting within 5 cm depth encourages quick establishment and better tillering.

Fertilizer

It is better to apply fertilizer as per soil test recommendation. If the soil test is not done the fertilizer may be applied @ 40 kg N, 30 kg P_2O_5 and 25 kg K_2O/ha for short duration varieties (less than 100 days) and 60 kg N, 30 kg P_2O_5 and 30 kg K_2O/ha for medium and long duration varieties of ragi. Nitrogen may be applied in two splits, 50% as basal and the remaining 50% as top dressing just before the first hoeing and weeding so as to incorporate the fertilizer into the soil.

Interculture operations

Early weeding of the direct seeded crop is essential for getting good yield. The first hoeing and weeding should be done within 2 to 3 weeks of sowing and the second a fortnight after. Thin out the plants 12-15 days after sowing to maintain proper plant population. One weeding of the transplanted crop between 2 to 3 weeks after transplanting is adequate. Wherever necessary, a second weeding may be done 15-20 days after irrigation. Alternatively pre-emergence application of metoxuron 30% WP @ 0.75 kg/ha and one hand weeding at 3 weeks stage give excellent control of weeds.

Plant protection

Keep an eye over the pest and diseases and adopt the schedule in **Annexure-II and III.**

Water management

Excess irrigation should be avoided. Rabi and summer ragi should be irrigated at 20-25 days intervals.

IMPACT POINTS

1. Transplant ragi in preference to direct seeding.
2. Follow line sowing of the direct seeded crop and resort to early weeding.
3. Apply moderate dose of fertilizer.

PULSES

Pulses are rich source of protein and form an important constituent of human diet. The consumption of cereals and pulses (dal) in the daily diet is considered nutritionally balanced. The cereals being poor in lysine is well complemented by the richness of the same in pulses. On the other hand cereals are rich in methionine as compared to pulses. The availability of pulses (dal) per adult per day at present is only 36 g in our state as against the minimum requirement of 50g/adult/day. These crops are endowed with many desirable characters viz; short in duration, restorative (soil fertility building crops), low water requiring and highly suitable to be grown in mixed/intercropping systems and also as a catch crop to scavenge the residual soil moisture and fertility. However, pulses are very exact in their requirement like neutral soil pH (liming acid soils), phosphate and sulphur manuring, use of rhizobium culture and molybdenum for seed treatment for better nodule activity to achieve maximum yield. The general strategy which needs to be followed to boost pulse production and productivity of rabi pulses are as follows.

1. Expansion of pulse area in the pre-rabi, rabi and summer season where scope exists
2. Growing of gram, pea and lentil in the interior cold prone districts particularly in the moisture retentive heavy soils as cultivated crops or as paira crop
3. Use of improved varieties and growing early maturing varieties under rainfed conditions
4. Sowing at appropriate time
5. Growing of pulses in mixed and inter-cropping systems
6. Inoculation with bio-fertilizer and application of balanced fertilizer (N,P,K & S)
7. Irrigation at critical stage (flowering and pod filling stage)
8. Introduction of new pulse crops like rajmash in the inland districts
9. Efficient plant protection measures
10. Liming acid soils once in every three years

Variety

Many short duration improved varieties of pulses are available for growing in different seasons. There are local varieties which have also established in the cropping pattern in different areas. The crops and varieties have to be chosen according to the cropping pattern, moisture retentive capacity of the soil and local preference.

Some information on the improved varieties of pulses that are recommended for the state are given below.

Crop/ Variety	Approximate duration in days			Remarks
	Pre-rabi (Sept-Oct)	Rabi* (Nov-Dec)	Summer (Mid Feb to 1st week of March)	
Greengram				
TARM 1	60-65	65-70	-	Tolerant to PM, YMV, suitable for paira
TARM 2	60-65	65-70	-	Tolerant to PM, YMV, suitable for paira
Pusa 9531	-	65-70	-	Moderately resistant to YMV
Pusa 9072	70	65-70	-	Resistant to PM and YMV
Pusa Bold 1		65-70	-	Resistant to PM and YMV
Sujata (Hyb 12-4)	70	65-70	-	Tolerant to YMV
Jyoti (Hyb 4-3)	65	65-70	-	Moderately resistant to YMV, PM, black seeded
Kamdev(OUM 11-5)	60	55-60	-	Tolerant to YMV
Dhauli	70	65-70	-	Tolerant to YMV
PDM 11	-	-	60-65	
SML 668	-	-	55-60	
PDM 54	70	-	60-65	Resistant to YMV
HUM 12	-	-	60-65	
LGG 410	-	55-60	-	Suitable for paira
LGG 460	-	55-60	-	Suitable for paira
Pragyan (RUM 1-20)	-	55-60	-	Suitable for paira
Durga(OBGG 52)	70	60-70	60-65	Resistant to YMV, long pods
Samrat(PDM84-139)	65-75	-	65-70	Tolerant to YMV
K 851	-	-	60-65	Tolerant to YMV
Blackgram				
Sarala	85	70-80	65-70	Resistant to YMV and PM
T 9	80	70-80		Susceptible to YMV
LBG 17	-	75-85		Tolerant to PM
PU 30	65-75	70-80	65-70	Resistant to YMV, PM, leaf spot
TU 94-2	-	70-75	-	Tolerant to YMV
PU 35	65-75	70-80	65-70	Resistant to YMV, leaf spot
PU 19	70-75	70-80	65-70	Suitable for paira, resistant to YMV, leaf spot
WBG 26	-	70-80	-	Resistant to PM
LBG 685	-	70-80	-	Suitable for Paira
PDU 1	-	70-80	-	
KU 301	65-75	70-80	-	Resistant to YMV, leaf spot
TU 94-2	-	70-80	-	Suitable for rice fallows
ADT 4	-	70-80	-	Suitable for paira
Prasad	70	70-75	-	Tolerant to leaf crinkle & leaf curl

** varieties mentioned for rabi season is only suitable for coastal districts*

Crop/ Variety	Approximate duration in days			Remarks
	Pre-rabi (Sept-Oct)	Rabi* (Nov-Dec)	Summer (Mid Feb to 1st week of March)	
Horsegram				
Urmi (DS 2-2)	90-95	-	-	Seed mottle grey in colour, yield goes upto 25 q/ha
Cowpea				
SEB 2	90	-	90	Vegetable type
Swarna	80	-	-	Grain type
Utkal Manik*	90	100	90	Vegetable type (pods smooth, long and fleshy)
* Responds to 50-70-50 kg N-P_2O_5-K_2O/ha				
October-November sowing only				
Chickpea				
H 208	-	110-115	-	Seed small & wrinkled, brownish yellow colour, suitable for inland districts
JG 62	-	110-115	-	
ICCV 2 (Swetha)	-	85-90	-	Kabuli type, 100 seed wt. 25g
ICCV 10 (Bharati)	-	85-90	-	
Pusa 372	-	105-115	-	
PG 9531 (Vihar)	-	110-120	-	Kabuli type, 100 seed wt.35g
ICCC 4	-	85-90	-	
C 235	-	130	-	Wilt tolerant, small seeded
Fieldpea				
T 163	-	100	-	Tall type
Rachana(KPMR-10)	-	95-105	-	Tall type, seed round and bold
HFP 4(Aparna)	-	100-110	-	Early duration, dwarf type
HFP 8909(Uttara)	-	100-105	-	Early duration, dwarf type
DMR-7(Alankar)	-	100-110	-	Tall type
DDR 27(Pusa panna)	-	90-95	-	Early
Lentil				
Asha (B 77)	-	80-90	-	
Mallika (K 75)	-	100-105	-	Bold seeds
Lathyrus				
Ratan (Bio 212)	-	85-95	-	Low BOAA
Pusa 24	-	85-95	-	Low BOAA
Rajmash				
Udaya (PDR 14)	-	90-95	-	Tolerant to BCMV*, red variegated
HUR 15	-	90-95	-	White seeded, erect, determinate
HUR 137	-	90	-	Deep pink seeded
Amber(IPR 96-4)	-	90-95	-	Seed red variegated, resistant to BCMV, determinate type

** BCMV = Bean common mosaic virus*

Soil and field preparation

Pulses can be grown in the rabi/summer season on a variety of soils provided drainage is satisfactory. Greengram and blackgram have moderate salt tolerance and these two crops and horsegram can be grown in heavy and light textured soil if the initial moisture is adequate to establish the crop. Cowpea requires more moisture and light irrigation will be necessary if grown on very light textured soils. Gram, lentil and pea require relatively heavy moisture retentive soil. The fields should be ploughed immediately after the harvest of the previous crop and as far as possible a good tilth is obtained for efficient sowing in lines.

Seed treatment

Seed treatment with appropriate Rhizobium culture (bacteria culture) before sowing greatly helps in better germination, emergence and nodulation, consequently increasing the availability of more biologically fixed nitrogen. Yield of all the legume plants are directly proportional to the number of nodules. More the nodules, more shall be the yield. Inoculation of seeds with Rhizobium culture should invariably be done each and every time of sowing of a legume crop.

Suspend 200g of Rhizobium culture and 250g phosphate solubulizing 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. Addition of molybdenum in the form of Ammonium or Sodium molybdate @ 3 g/10kg seeds at the time of seed treatment with Rhizobium culture, facilitates better nodulation. Dry the treated seeds in shade on clean cloth, paper or polythene sheet and sow then immediately, preferably in afternoon.

For obtaining better result and keeping the crop free from seed borne diseases, like damping off of seedlings and seedling blight, seeds should be treated with seed dressing fungicides like vitavax power 1.5g or (carbendazim 1.0 g + thiram 1.5g) per kg of seed. Greengram, blackgram and cowpea under intensive cropping should be treated with carbosulfan 25 EC @ 0.2% one week before Rhizobium treatment against root-knot and reniform nematodes.

Sowing

Sow the seeds in lines soon after land preparation and compact the soil by laddering so that the seeds come in intimate contact with soil which will hasten germination. On lands where the soil is likely to dry up at harvest, pre-harvest (paira) sowing should be done, seeds may be soaked overnight if the soil has low moisture content to hasten germination. Line sowing facilitates interculture to kill weeds. Early control of weeds, within 2 to 3 weeks of germination, lessens competition for nutrients and water and helps growth. The recommended spacing of the crops for rabi/summer sowing and approximate seed rate to be used are as follows :

Crop	Spacing between lines (cm)	Spacing between plants (cm)	Seed rate (kg/ha)
Greengram	25	10	25
Blackgram	25	10	25
Horsegram	30	10	25
Cowpea	45	15	25
Gram	30	10	50
Fieldpea	30	10	50
Lentil	20	05	40
Rajmash	40	10	75

Paira cropping of pulses

Pulses like green gram, black gram, gram, lentil and fieldpea come up well as paira cropping in the rabi season. Where the land after harvest of paddy remains in a slouch state making it unsuitable for tillage, these crops may be broadcasted atleast 15-20 days before harvest using 1.5 times the seed required for normal sowing. Harvest the rice crop leaving about 15 cm height of the stubble for trailing of fieldpea.

Fertilizer use

Pulses respond admirably to liberal doses of phosphate application. A starter dose of 20 kg N/ha helps quick establishment of the crop and root nodule development. Application of 40 kg P_2O_5, 20 kg of K_2O and 20 kg S/ha greatly increases yield of pulses and also benefit the succeeding crop. For cowpea and pea grown with irrigation, a higher dose of 25 kg N and 50 kg P_2O_5/ha may be used along with 25 kg of Potash and some compost. Mix the fertilizer

with the soil thoroughly at final land preparation 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 P_2O_5/ha. Phosphorus can be applied as 50:50 mixture of super phosphate and rock phosphate. For kulthi 10 kg N and 25 kg P_2O_5/ha is recommended.

Unlike other rabi pulses, rajmash is very inefficient in biological nitrogen fixation owing to poor nodulation. It responds to nitrogen and phosphorus application. A fertilizer dose of 80-60-40 kg N-P_2O_5-K_2O/ha is recommended for satisfactory yield. 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.

Interculture

Control of weeds within 2 to 3 weeks not only prevents drawal of nutrients from the soil by weeds but also conserves moisture and helps in quick growth and development of crops. Line sowing will facilitate hoeing and weeding operations between the lines.

Irrigation

The pulse crops in rabi and pre-rabi season are mostly grown on residual soil moisture without irrigation. However, rajmash in rabi season and the pulses in summer season require irrigation. Flowering and pod development stage are critical for irrigation. Rajmash crop requires 5-6 irrigation for satisfactory yield.

Plant protection

Generally defoliators attack suddenly in large numbers and damage the crops. Strict vigilance on incidence of these pests can help to take timely control measures, most effectively with minimum expenditure. If pests appear follow the plant protection measures given in **Annexure-II and III**.

IMPACT POINTS

Seed treatment with rhizobium and PSB culture
Line sowing and weeding within 2-3 weeks
Phosphate fertilization @ 40 kg P_2O_5/ha
Irrigation at flowering and pod formation.

OILSEEDS

Importance of oilseeds

In Orissa, we produce about 33 gram of oilseeds per head of adult population as against the requirement of 45 gram for a balanced diet. The soil and climatic condition of Orissa are ideally suited for growing oilseeds in different seasons. Many oilseed crops have low growth habit and have a short growth period and can be easily accommodated as catch crops between two main crops and as pure crops in two crop pattern in rainfed areas. Groundnut can be grown without irrigation as a second crop on silted river banks and flooded tracts. Mustard can be taken as a catch crop between two paddy crops in the command areas. Sesame can be grown as a summer crop with light irrigation. As an irrigated crop it can follow potato without application of fertilizer. Local sesame varieties can also be grown as second crop with pre-rabi or rabi sowings without irrigation after harvest of the kharif crop. Castor can be grown as a rabi crop without irrigation on silted river banks and flooded tracts. Safflower is a hardy oilseed crop and can be grown on all types of soils and thrives on residual moisture without irrigation.

Amongst the oilseeds mustard and safflower have high salt tolerance and castor is moderately tolerant to salinity. In the context of the world-wide shortage of fats and oils and the great scope for growing different oilseeds in the kharif, rabi and summer seasons in multiple cropping sequence, there is an urgent need for extension of the area and increasing production of vegetable oils.

GROUNDNUT

Varieties

The following varieties are recommended for rabi and summer season in the state.

Variety	Habit	Duration (days)	Av. Yield (q/ha)	Shelling (%)	Oil content (%)	Special character
AK 12-24	Bunchy	105	16.00	70	48	Resistant to leaf spot and rust, seeds rosy in colour having no dormancy
Kissan (OG 13-3)	Bunchy	110	16.00	68	50	15 days dormancy, seed rosy colour
Jawan (OG 71-3)	Bunchy	105	16.00	70	47	Resistant to tikka disease, no dormancy
Smruti (OG 52-1)	Bunchy	110	25.00	72	51	Kernel bold, red in colour, resistant to collar rot and stem rot, no dormancy
Phule Pragati (JL-24)	Bunchy	115	20.00	69	49	Resistant to drought, rust, early leaf spot, seed salmon coloured, no dormancy
ICGS 44	Bunchy	125	25.00	72	49	Bold seeded, rosy in colour and fusiform in shape, resistant to bud necrosis
TAG 24	Bunchy	110	25.00	72	53	Resistant to bud necrosis, leaf spot
TG 3	Bunchy	110	18.00	68	51	Drought resistant, seed rosy in colour, dormancy absent
ICGS 11	Bunchy	125	25.00	70	53	Plants are dwarf with dark green leaves.
TMV 2	Bunchy	115	16.00	70	51	Seed salmon in colour, spheroidal in shape, moderate resistant to early, late leaf spot and rust, dormancy absent
TG 38	Bunchy	110	20.00	70	47.5	Plants semi dwarf, kernels rosy in colour, tolerant to stem rot, stem necrosis and dry root rot.

Soils

Select well drained, sandy loam soil, well supplied with calcium and moderate amount of organic matter. In Orissa such soils are found in the flood receded river valleys of the coastal districts. These soils are ideally suited to rainfed rabi groundnut. The optimum soil pH for groundnut is 6.0 to 6.5, but a range of 5.5 to 7.0 is acceptable.

Field preparation

Plough the land 2 to 3 times at optimum soil moisture to secure good surface tilth to a depth of 15 cm. Follow planking after each ploughing to conserve moisture. Use improved plough (MB plough/bose or rocket plough) and power tiller with rotavator or tractor with cultivator for good seed bed preparation. A good seed bed has a great significance for successful groundnut cultivation as it allows early root penetration and easy pegging and pod formation. Collect the weeds and stubble of the preceding kharif crop. Apply FYM or compost @ 5.0 t/ha and incorporate it before final land preparation. Use chlorpyriphos 1.0% dust @ 25 kg/ha at final land preparation in termite prone fields.

Scope for lime application does not exist in rabi groundnut raised on residual soil moisture. However, lime can be applied in acid soils under irrigated conditions. Apply lime as per soil test result or @ 1.25 t/ha at least one month before sowing.

Decortication

Decortication or removal of kernels from the pod by hand pressing is a tedious job. Use manually operated rotary or oscillating type decorticator to reduce the drudgery of the worker and the labour requirement. Power operated decorticator-cum-cleaner may be used in areas where power is available.

Seed treatment

Treatment with organomercurial compound should not be taken up when the seeds are treated with rhizobium culture. Rhizobium culture treatment should be taken up after seven days of the seed treatment with the mixture of carbendazim 0.1% + thiram 0.15% or with vitavax power (0.15%). Add sodium or ammonium molybdate @ 3g/10 kg kernel along with bacterial culture. About 1.5 kg of rhizobium culture would be required to treat the seeds for one hectare.

Sowing

Sow the rabi crop which is raised on residual soil moisture in the month of November and the irrigated summer crop in the second fortnight of January. Sow the seeds in lines at a spacing of 25 cm x 10 cm for bunchy and semi-spreading types. The seed rate is 125 kg kernel/ha. Use groundnut planter or follow dibbling behind the plough for ensuring line sowing. Ensure depth of sowing within 5 cm of the soil under sufficient moisture conditions and deeper placement at 8-10 cm in light soils with insufficient surface moisture. Follow laddering for better seed soil contact.

Bed and furrow method of sowing in groundnut

Under irrigated conditions, regions of shallow water table and saline soils, bed and furrow method of sowing is advantageous. In this method after every 3 or 4 rows of groundnut spaced at 30 cm, 1 row is left blank which can be used as irrigation or drainage furrow and in between 2 furrows, the bed is raised by about 10-15 cm.

Fertilizer use

Apply 20 kg N and 40 kg each of P_2O_5 and K_2O/ha in the furrows before sowing and mix with the soil so that seeds do not come in direct contact with fertilizer. Phosphorus should be applied in form of single super phosphate which also meets the sulphur requirement of the crop i.e. 30 kg S/ha. Apply well powdered gypsum @ 250 kg/ha close to the base of plants at 20-25 days after sowing on either side and incorporate in the soil, so that it remains in top 3 cm of soil. This is required because calcium has to be supplied to the developing pods independently as movement of calcium from vegetative parts to the pods through gynophore is limited due to narrow xylem vessel in the gynophore. This will improve number of pods and pod filling. Apart from 22.3% calcium, gypsum also supplies 18.6% sulphur to the soil. Sulphur deficiency is likely to develop where groundnut is taken up continuously with high analysis fertilizer like urea and DAP. However, gypsum is not required when SSP or Ammonium sulphate is used as it also supplies sulphur.

Micronutrient use in groundnut

Groundnut is mostly cultivated in light textured soils of loamy sand, sandy loam and loam type. Micronutrients such as Boron is lost from these soils through leaching due to precolation or due to repeated irrigation. The groundnut soils of Orissa are acidic to moderately acidic in reaction. Availability of boron and molybdenum in these soils is restricted, due to precipitation with oxides of iron and aluminum.

Boron deficiency in groundnut causes pollen abortion, hollow heart disease and restricted development of gynophore. Pollen abortion develops sterility due to which more than 50% flowers do not bear pod. Hollow heart disease in groundnut is the depression of inner walls of kernel with development of black colour. Soil application of 15 kg borax/ha along with other NPK fertilizers behind the plough at sowing produces 25-30 per cent higher yield. Boron can also be applied as foliar spray of 0.1% borax solution.

Molybdenum deficiency decreases nitrogen fixation in groundnut as a result of which nitrogen demand of groundnut increases. Seed treatment of 10 kg kernel with 3g ammonium molybdate along with rhizobium culture increases pod yield to the tune of 10 to 12%. Further, combined application of boron and molybdenum as above produce 45 to 50% higher yield.

Interculture

Perform hoeing and weeding within 3-4 weeks after sowing to make the crop weed free. It also helps to conserve the residual soil moisture. Subsequently remove the weeds manually wherever needed so that it will not damage the gynophores and interfere pegging. Alternatively apply pendimethalin or metolachlor 0.75 kg/ha or alachlor 1.0 kg/ha as pre-emergence spray 1-2 days after sowing or fluchloralin 0.75 kg/ha as pre-planting incorporation one day before sowing. Post-emergence spray of quizalofop ethyl 5 EC @ 0.05 kg/ha at 20 days after sowing takes care of the later flush of grassy weeds under irrigated conditions.

Irrigation

It is advisable to sow the crop with a pre-sowing irrigation, or else apply one post sowing irrigation to facilitate germination. Subsequently provide irrigation at 10-15 days interval depending upon soil and weather conditions. The critical growth stages for irrigation are flowering, pegging and pod formation. Early season stress at vegetative stage is helpful for uniform flowering. In flat bed method of sowing, apply irrigation in cross-channels made at an interval of 4-5 metre.

Plant protection

Treat the soil against termites and white grub attack. Monitor the incidence of pest and follow plant protection measures as in **Annexure-II and III**. Hand compression knapsack or low volume sprayer should be used for effective application of plant protection chemicals. For larger area, power sprayer may be used. Power tiller or tractor operated boom sprayer may be used for higher coverage.

Harvesting

Harvest the crop when plants turn yellow and leaves start drying, original seed colour develop on the kernel and the pods develop blackish streak inside the shell. Dry the pods to reduce the moisture to 8-9 percentage before storing to avoid the aflatoxin formation. Bullock drawn groundnut digger should be used for uprooting. Groundnut stripper or power operated groundnut thresher can be used to remove the pods from the plants.

Drying and storage

For seed purpose, special precautions are required during drying and storage to retain viability especially in case of produce from summer crop. Seed viability is impaired when pods are dried at 40^{o}C or higher. Dry the uprooted plants under shade till the pods produce rattling sound. Store the pods in polythene lined gunny bags in a well ventilated room. Anhydrous $CaCl_2$ @ 250 g/30 kg bag may be used as a desiccant. In storage, the stack base should be on raised stands. Stacks should not be more than 10 bags piled one over the other. The pile of bags has to be kept 4-5 feet below the roof and separated from the wall to allow free circulation of air.

IMPACT POINTS

1. Soil amendment to correct acidity
2. Seed treatment with bacterial culture and molybdenum
3. Use seed drill and high seed rate for erect type
4. Maintain optimum plant population and timely control weeds
5. Apply gypsum in sulphur and calcium deficient soils when SSP is not applied
6. Use groundnut digger and thresher for economical harvest and post harvest operation

RAPESEED-MUSTARD

In Orissa, 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.

Variety

The toria and mustard varieties recommended for the state are as follows :

Variety	Duration (days)	Seed yield (q/ha)	Oil content (%)	Remarks
Toria				
Parbati	75	15.0	41.0	Suitable for rainfed & early sowing
Anuradha	75	14.0	44.0	Suitable for irrigated and late sown condition
PT 303	85	12.0	40.0	Suitable for irrigated condition
TS 29	80	9.0	39.0	Suitable for rainfed condition
M-27	75	7.0	40.0	Suitable for rainfed condition
Mustard				
Varuna	110-115	18.0	37.0	Suitable for irrigated and rainfed condition
Kranti	115-130	20.0	38.0	Suitable for irrigated condition
Pusa Bold	110-115	15.0	40.0	Suitable for irrigated condition
Pusa Bahar	105-120	22.0	40.0	Suitable for irrigated condition
Pusa Jaikisan (BIO 902)	90-95	15.0	40.0	Suitable for irrigated 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 kwown as rapeseed and rai as mustard. Generally toria and mustard are cultivated in our state. The distinguishing features of toria and mustard varieties are presented below for ease of field identification.

	TORIA (*Brassica campestris*)
1.	It is popularly known as lahi or maghi lahi.
2.	Plants are dwarf (60-65 cm) with dichotomous branches.
3.	Branching starts from the base of the plants.
4.	Leaves are small and light green in colour. Leaves grasp the stem completely, more often serrated.
5.	Pollination behaviour is cross pollinated (self incompatible)
6.	Short growing period with low potential yield
7.	Seed are small, light brown in colour with thin seed coat and non-mucilagenous in nature.
8.	Oil content : 40-46%

	MUSTARD (*Brassica juncea*)
1.	It is popularly known as rai, raya or laha
2.	Plants are tall (90-180cm), erect, much branched.
3.	Branching starts from the axil of 4^{th} or 5^{th} leaf.
4.	Leaves are stalked, glabrous or hairy, dark green in colour, the leaf blades donot reach the stem, prominently serrated.
5.	Pollination behaviour is self pollinated (self compatible)
6.	Long growing period with high potential yield
7.	Seeds are bold, round, reddish brown in colour with thick seed coat and mucilagenous in nature.
8.	Oil content : 33-40%

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

Fertilizer application

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

Crop	Fertilizer dose (kg/ha)		
	N	P_2O_5	K_2O
Toria (rainfed)	40	20	20
Toria (irrigated)	50	25	25
Mustard (rainfed)	50	25	25
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 P_2O_5 and K_2O as basal and rest 50% N at 3 weeks stage.

The nitrogen should be applied preferably as ammonium sulphate and phosphorus as singe 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 $ZnSO_4$ @ 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.

Plant protection

Major insect pests are sawfly, aphid and hairy caterpillar and diseases are alternaria blight, downy mildew and white rust. For control of these pests and diseases refer **Annexure-II and III**.

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 for 4-5 days or till the moisture content comes down to 8.0 per cent for safe storage.

IMPACT POINTS

1. Timely sowing
2. Line sowing
3. Balanced fertilizer (N,P,K,S,B including organic manure)
4. Thinning at proper time
5. Pest control

SESAME (TIL)

Varieties

The recommended varieties and their characteristics are as follows :

Variety	Duration (days)	Oil content (%)	Seed colour	Seed yield (q/ha)	Remarks
Uma	70	53	Pale white	10.00	Capsules compactly arranged, escape shattering
Usha	75	49	Bright biscuit	12.00	Resistant to diseases and pests
Nirmala	80	50	White	10.00	Resistant to bacterial diseases
Prachi	75	48	Black	12.00	Resistant to major diseases & pest
Vinayak	80	48	Reddish	6.00	Glabrous, resistant to stem rot
Kanaka	80	47	Biscuit	8.00	Pods pubescent
Kalika	80	49	Brown	8.00	Resistant to leaf spot

Land preparation

Sesame is grown as a pre-rabi crop after early rice/jute/pulses and as a summer crop after potato and winter vegetables. Prepare the land to a fine tilth. Apply compost or FYM @ 5 t/ha at final land preparation.

Sowing

Sow pre-rabi crop in September-October and summer crop from February to first week of March for higher yield. Seeds are small and should be sown shallow within a depth of 2 cm. Deep sowing may affect germination. Use a seed rate of 7 kg/ha in case of drilling in lines. Treat the seeds with vitavax power 1.5 g or (carbendazim 1.0 g + thiram 1.5 g) per kg of seed before sowing. Mix the seeds with sand when the crop is sown broadcast to ensure uniform sowing. Sow in lines 30 cm apart and thin plants to 10 cm, between plants. Line sowing permits easy interculture and weed control. In line sowing crop plants come up uniformly.

Fertilizer use

Sesame is an exhaustive crop and responds to fertilizer. Recommended fertilizer dose is 30-20-20 kg N-P_2O_5-K_2O/ha. Apply full P_2O_5 and K_2O and half of N as basal and the remaining nitrogen at first hoeing and weeding. Use single super phosphate as the P source to meet the P as well as S need of the crop. It can be grown after harvest of potato successfully without application of fertilizers.

Interculture

First hoeing, weeding and thinning should be done at 15 days stage. Thinning should be done to keep the plants about 10 cm apart.

Irrigation

When grown under irrigation, pre-sowing watering is preferred to immediate post-sowing application. Subsequent irrigation may be given at intervals of 12-15 days or more depending on soil types, weather conditions and season. The critical stages of irrigation are 4-5 leaf stage, flowering and pod formation. Light irrigation at shorter intervals gives higher yield than heavy irrigation at longer intervals.

Plant protection

Leaf webber-cum-pod borer is the serious pest. Phyllody disease also is very common. Adopt plant protection measures to check the pest and diseases as in **Annexure-II and III**. Avoid application of excessive nitrogen which encourages phyllody disease.

Harvesting

Harvest the crop when the plants start yellowing and drying of capsules commence. Delayed harvesting causes loss in yield due to bursting and shattering of capsules. Harvest the plants and stack them for 3 to 4 days to allow the seeds in the upper capsules to ripe. Dry the plants keeping the plant tip towards the sun so that seeds do not drop from capsules. Threshing may be done after 3-4 days of drying.

IMPACT POINTS

1. Use of seeds from phyllody free crop
2. Line sowing, early weeding and thinning
3. Use of moderate dose of fertilizer

SUNFLOWER

Sunflower is an ideal oilseed crop in the rabi season. It is grown as an irrigated crop. Its oil is considered as a premium oil because of high oleic acid which reduces the blood cholesterol level. The crop is performing well in inland districts. It has been successfully introduced in the super cyclone affected coastal districts of the state. It is a slightly salt tolerant crop.

Variety / hybrid

Variety/hybrid	Duration (days)	Average Yield (q/ha)	Oil content (%)
Variety			
Morden	90	10.0	35.0
Hybrid			
PAC 36	95-100	15.0	38.0
KBSH 1	110	15.0	42.0
MSFH 8	110	15.0	43.0
MSFH 17	110	15.0	43.0
Jwalamukhi	110	18.0	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 photoinsensitive 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^{o}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-P_2O_5-K_2O/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.

Plant protection

Downy mildew, root rot, stem rot and wilt are soil borne diseases while alternaria blight, rust, head rot are foliar diseases. Birds, cutworm, spodoptera, aphid, thrips and jassids are important pests. For control of these diseases and pests refer **Annexure-II and III.** Take precautions against bird damage.

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.

IMPACT POINTS

1. Use quality seeds (certified hybrid/variety seed)
2. Optimum plant population
3. Balance fertilization with N,P,K,Ca,S and B
4. Spray boron at ray floret stage.
5. Hand pollination or bee keeping
6. Protection against bird damage

SAFFLOWER

Safflower is cultivated for its much valued oil. The oil is rich in poly-unsaturated fatty acid (linoleic acid 78%) which plays on important role in reducing blood cholesterol level. An orange red dye (carthamin) is also extracted from its coloured petals. Because of its thorny nature, the crop can be grown in rice fallow without fencing.

Variety

Variety	Duration (days)	Yield (q/ha)	Oil content (%)
Bhima (S4)	125	13.0	32.0
A-300	140	9.0	30.0
A-1	120	9.0	32.0
Manjira	105	9.0	32.0
HUS-305*	115	12.0	30.0

*Spineless variety

Soil

It grows well on deep well drained fertile soils with neutral reaction. In shallow and light textured soils it can be grown with irrigation. It is tolerant to soil salinity.

Land preparation

Plough the land with MB plough and subsequently with desi plough followed by laddering to conserve moisture. Remove the stubble of the previous rice crop.

Sowing

Optimum time of sowing is mid October to mid November. Sowing depth is 5 cm

Spacing

30 cm x 15 cm

Seed rate

20 kg/ha

Seed treatment

(Thiram 1.5 g + carbendazim @ 1.0 g) or vitavax power 1.5 g per kg of seeds.

Fertilizer application

Apply the entire fertilizer dose of 25-25-20 kg N:P_2O_5:K_2O/ha along with FYM @ 2.0 t/ha in deep furrows about 10 cm below the soil as basal under rainfed conditions. Under irrigated situation apply 60-60-30 kg of N:P_2O_5:K_2O/ha. Apply full P_2O_5 and 50% each of N and K_2O as basal and rest 50% N and K_2O at 25-30 DAS.

Interculture

Give one hoeing and weeding at 3 weeks stage for arresting weed growth.

Irrigation

Generally safflower is raised as a rainfed crop. However, with irrigation the yield almost doubles. Under irrigated condition, give a light pre-sowing irrigation wherever soil moisture in the seed zone is not adequate for germination. Subsequent irrigation may be provided at early elongation stage (30 DAP) and at flowering stage (65-70 DAS).

Plant protection

See **Annexure-II and III**

Harvesting

Harvest the crop when the leaves and most of the bracteoles on the flower head become dry and brown preferably in the morning hours. Dry the produce for 3-4 days and thresh by beating with stick. The seeds should be perfectly dried to a moisture content of 8 per cent before storage. A rainfed crop gives seed yield of 8.0 to 10 q and irrigated crop as high as 18.0 to 20.0 q/ha.

IMPACT POINTS

1. Timely sowing
2. Seed treatment
3. Balanced fertilization

CASTOR

Castor is a deep rooted drought tolerant crop which can be grown in rainfed medium lands and in the river beds after recession of flood water.

Variety

Sl. No.	Genotype	Days to maturity (days)	Average yield (q/ha)	Oil content (%)
	Varieties			
1.	Jyothi (DCS 9)	90*-105**	10.50	49
2.	Kranti(PCS 4)	90-150	13.65	48
3.	Aruna	120-150	9.65	50
4.	Bhagya	120-150	10.00	51
	Hybrids			
1.	GCH 4	110-180	12.20	48
2.	GCH 5	120-180	17.50	49
3.	DCH 32	90-180	18.00	49
4.	DCH 177	90-180	15.00	49

*1st picking **Last picking

Soil

Castor can be grown on almost all types of soils which are relatively deep. The economic productivity is better under mild stress conditions of moisture and fertility. Highly fertile soils favour excessive vegetative growth, extend flowering and affect seed yield. Slightly acidic soil of pH 5.0-6.5 is ideal.

Land preparation

Plough the land immediately after harvest of paddy or recession of flood water, 2 to 3 times followed by planking to conserve the residual soil moisture.

Sowing

Optimum sowing time for rainfed castor is from mid September to mid-October after recession of flood water in river banks and from mid October to mid-November in rice fallow. Sow the seeds in line at a spacing of 90 cm x 45 cm for the varieties and 120 cm x 60 cm for the hybrids at a depth of 8-10 cm.

Seed rate

Variety : 12-15 kg/ha
Hybrid : 10 kg/ha

Seed treatment

Treat the seeds with thiram 1.5 g + carbendazim 1.0 g per kg seed or vitavax power 1.5 g per kg seed to protect the plants from seed borne diseases like alternaria leaf blight, seedling blight and wilt.

Fertilizer application

For castor apply 60:40:40 N-P_2O_5-K_2O kg/ha. For rainfed crop apply all the fertilizer as basal preferably in furrows. But for irrigated castor apply one third of the nitrogen as basal and rest in two equal splits at 35-40 and 65-70 days after sowing. It is better to use single super phosphate, which will also meet the sulphur need of the crop.

Interculture

Take up gap filling at 10 days stage and hoeing and weeding at three week stage followed by earthing up. A second weeding and earthing should be given at 6 weeks stage which will provide better anchorage and conserve the residual soil moisture. Pre-emergence application of pendimethalin or pre-plant incorporation of fluchloralin @ 0.75 kg/ha effectively controls weeds.

Irrigation

The most critical period for irrigation is the period of mass flowering. But high moisture during maturity period causes sprout of new leaves and vegetative shoot and delays maturity.

Harvesting and threshing

Castor is an indeterminate plant with perennial habit. On an average, it produces 4 to 5 sequential order spikes, one each at an interval of 30 days. Physiological maturity in castor is attained when any of the capsules in the spike turns brown in colour. The main spike is ready for harvest within 90-120 days after sowing. The subsequent pickings can be taken up at an interval of 30 days. The mature spikes are cut preferably in morning hours and dried in sun for few days for easy threshing. Threshing is usually done by either beating the capsules with stick or alternatively by trampling with bullocks.

IMPACT POINTS

1. Use quality seeds
2. Timely sowing
3. Apply recommended fertilizer dose
4. Timely weed control
5. Control of capsule borer
6. Harvest the spikes at appropriate time

LINSEED

Linseed cultivation is concentrated mainly in Mayurbhanj, Kalahandi, Nawapara, Nabarangapur and Keonjhar districts of Orissa. Its oil being rich in linolenic acid (>66%) is a perfect drying oil which is extensively used in the paint and varnish industry.

Variety

The following varieties are suitable for cultivation in Orissa.

Variety	Duration (Days)	Average yield (q/ha)	Special features
Padmini	120	9.50	43% oil, moderately resistant to wilt and powdery mildew.
Kiran	120	7.50	43% oil, moderately resistant to wilt and powdery mildew.

Land preparation

Usually one ploughing, 2-3 harrowings, followed by leveling are sufficient to prepare the land to the desired tilth.

Sowing

Optimum sowing time : First fortnight of October

Spacing : 25 cm x 5 cm

Sowing depth : 2-3 cm

Seed rate

25-30 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 .

Fertilizer application

Apply full dose of fertilizer i.e. 40-20-20 kg N:P_2O_5:K_2O/ha alongwith FYM @ 2.0 t/ha as basal, in rainfed crop. Under irrigated conditions apply N in two equal splits i.e. 50% basal and rest 50% during first hoeing and weeding.

Interculture

Thin out the plants in the rows 15 days after sowing to maintain plant to plant distance at 5 cm. One hoeing and weeding after 25-30 days of sowing keeps the field weed free.

Apply pronamide (Kerb 50% WP) @ 1.0 kg/ha as post emergence spray against cuscuta at 2-3 weeks stage.

Intercropping system

Linseed + chickpea	…	3:1
Linseed + lentil	…	3:1
Linseed + mustard	…	5:1

Irrigation

Critical stages of irrigation are branching (25-30 days after sowing) and flowering (60 days after sowing).

Plant protection

Rust, alternaria blight, powdery mildew and wilt are common diseases. For control of these diseases refer **Annexure-II and III**.

Harvesting

Harvest the crop when the plants become golden yellow, capsules turn brown, seeds rattle in the capsule and become shiny. Dry the plants for 3-4 days and thresh with sticks or trampling by bullocks. Dry the seeds to 8% moisture before storage.

Yield

An irrigated crop can give seed yield of 12-15 q/ha.

IMPACT POINTS

1. Timely sowing
2. Seed treatment
3. Thinning
4. Balanced fertilization
5. Timely pest control

SUGARCANE

Varieties

A number of improved varieties of sugarcane under different maturity group, tolerant to drought or water stagnation are recommended for growing in Orissa. In choosing varieties for factory areas early (maturing in 10 months) and mid late varieties (maturing in 12 months) should be planted in staggered manner in order to ensure a continuous supply of cane to the factory. The recommended varieties with their characteristics are given in the following table. Any variety planted early in November or December will, however, take longer time to maturity than that indicated in the table. If planted late beyond March their duration (peak maturity period) will be shortened.

Sugarcane varieties for Orissa

Sl. No.	Variety	Colour (exposed cane)	Stem girth	Leaf clasping	Reaction to red rot	Identifying character	Special agronomic character
	EARLY (maturing in 10 months)						
1	CoC 671	Light purple	Thick	Loose	S	Broad leaf, no bud groove, ligular process absent, prominent buds.	High yield (100 t/ha) with high sugar, prone to lodging, suitable for irrigated uplands
2	Co 6907	Light yellow	Medium	Moderate	MR	Bud groove present extending the entire length of internodes	High yield (103 t/ha), high sugar, suitable for all land types, late harvest does not reduce much sucrose, good ratooner
3	Co 7508	Yellow to purplish green cane	Thick	Tight	MR	Distinct ivory and weather markings, merging to give brick red appearance, bud groove often present	High yield, (90 t/ha) high sugar, suitable for irrigated uplands
4	CoC 85036	Light green	Medium thick	Moderate	S	-do-	High yield (110 t/ha) with high sucrose.
5	Co 87263 (Saryu)	Purple	Thick	Loose	MR	Ivory marks present, spines many and soft.	High yield (110t/ha), high sugar, tolerant to drought, good ratooner
6	CoA 89085	Light yellow with light green noses	Medium thick	Loose	R	Bud groove present, ligular process absent	Early variety with high yield (95 t/ha)and high sugar, resistant to all the 3 tropical races of red rot.
7	Co 90017	Green	Thick	Moderate	MR	Ivory marks present, medium waxiness with hard spines on sheath.	Moderately high yield (90 t/ha), high sucrose, suitable for irrigated ecosystem

Sl. No.	Variety	Colour (exposed cane)	Stem girth	Leaf clasping	Reaction to red rot	Identifying character	Special agronomic character
8	Co 87002	Dark reddish pink with yellow tinge	Thick	Moderate	MR	Ivory mark prominent, heavy wax coating, ligular process present, spines present (few and hard)	High yield (92 t/ha) and light sucrose.

	MID LATE (Maturing in 12 months)						
1.	Co 7219	Yellowish green with purple tinge	Thick	Loose	MR	Moderate to heavy bloom, sheath, splitting, growth ring yellow, root zone purplish yellow	High yield (99 t/ha) and high sucrose, suitable for irrigated ecosystem and rice land.
2.	Co 87044 (Uttara)	Greenish yellow	Thick	Loose	MR	Waxiness low, sheath spines few and hard	High yield (104 t/ha) and high sucrose, suitable for irrigated ecosystem and rice land.
3.	Co 86249 (Bhavani)	Greenish yellow with purple tinge	Medium thick	Tight	MR	Spines and waxiness absent, ivory marks present	High yield (107 t/ha) and high sucrose, suitable for irrigated ecosystem and rice land.
4.	Co 86032 (Nayana)	Reddish pink	Medium thick	Loose	MS	Prominent ivory marks, waxiness medium, spines few and hard deciduous	High yield (100 t/ha) and high sucrose. Not suitable for water logging situations
5.	Co 62175	Yellowish green, turns dark on exposure	Very thick	Loose	S	Sheath spine absent	High yield (105 t/ha) with good sucrose, suitable for late crushing, good jaggery type, good ratooner
6.	Co 740	Green	Medium thick	Very loose	MR	Sparse spines on leaf sheath	Profuse tillering, high yield (100 t/ha), good ratooner, resistant to drought, prone to lodging
7.	Co 8021	Purplish green, turns dark green/purple in exposure	Medium thick	Loose	MR	Root zone maize yellow colour, growth ring light green	High yield (100 t/ha) and high sucrose, suitable for irrigated ecosystem

Field preparation

For flat planting of cane or for planting in furrows, thorough land preparation is necessary. But for trench planting, it is not necessary to plough the land more than two times. Planting of cane in trenches is the best method of planting. Trenches should be 30 cm wide, 20 cm deep and 75 cm apart from centre of one trench to the other. Drainage should be provided wherever necessary. Reduce spacing to 60 cm for delayed planting beyond March.

Trench method of planting has the following advantages

- Drainage is facilitated
- Weed growth is considerably reduced
- Early shoot-borer infestation is reduced
- Irrigation becomes easier and also less water is required.
- Better anchorage is provided which prevents the crop from lodging
- Better ratoon crop

Seed rate

- Early varieties (50-55 thousand 3 budded setts) 10 t/ha
- Medium/mid-late varieties (40-45 thousand 3 budded setts) 08 t/ha
- Ensure planting of 12 buds per metre of row length

Sett cutting

A mechanical sugarcane sett cutter should be used for economical sett cutting and to obtain more viable setts.

Sett selection and treatment

Collect setts from the whole cane of a 6-8 month old plant crop free from diseases and insect pests. Select the upper 1/3 of cane if setts are collected from 12-month-old crop for better sprouting. Do not use seeds of ratoon crops. Soak the setts for 30 minutes in 500 lit of water (solution) containing 750 g of carbendazim 50 WP, 1000 ml of chlorpyriphos (Do not add chlorpyriphos if soil drenching is adopted) and 1 kg urea. If possible pass the setts through Aerated steam treatment (AST) at 50^{o}C for a period of one hour for effective control of sett borne diseases like smut, grassy shoot disease (GSD) and ratoon stunting diseases (RSD). This is important for quality seed production programme.

Manures and fertilizer

Sugarcane is a heavy feeder. It is advisable to apply fertilizer on the basis of soil test results. Where this is not done apply FYM @ 20 t/ha along with 250 kg of Nitrogen, 100 kg of P_2O_5 and 60 kg K_2O/ha. Apply 30 kg S/ha, if the phosphorus source is other than SSP. Sulphur requirement can also be met if press mud is applied @ 10 t/ha in place of FYM. Press mud application also economises the phosphate use by 50%.

Apply full P_2O_5 and 50% K_2O at the time of planting in trenches. Topdress nitrogen in three equal splits at 45, 75 and 105 days after planting. Apply the rest amount of K_2O at the time of the third top dressing of N. Do not top dress N 120 days after planting as late application reduces sucrose content. Delay top dressing of N in February planted crop, if irrigation is not available. Apply 10 kg each of Azospirillum and PSB mixed with 1.0 t of FYM/ha in two equal splits at 30 and 60 DAP at the base of the clumps.

Intercultural operation

Use pre-emergence herbicides atrazine 50 WP or ametryn 80% WP @ 2.0 kg/ha or metribuzin 70 WP 1.0 kg/ha 3 days after planting to reduce the cost of weeding. The sprouting of buds is completed within 25 to 30 days after planting (DAP). Perform a light hoeing at this stage to control the weeds to hasten early growth and to prevent the attack of early shoot borer. Complete the successive hoeing, weeding and top dressing of N at 30-45 DAP, 60-75 DAP and 90-105 DAP. Follow light earthing up during the first and second top dressing while heavy earthing up during the third top dressing.

Intercropping

Intercrop toria, radish and coriander in autumn planted crop and green gram, blackgram, cowpea, lady's finger and green vegetables in spring planted crop.

Wrapping and propping

Keeping the canes erect results in better juice quality. For this purpose wrapping and propping are useful practices. When the crop is 4 to 5 months old, remove borer affected tillers and late formed tillers, tie the cane shoots in two's or three's with the partially dried lower leaves. Remove the late tillers and water shoots formed from October onwards as these tillers do not mature in time and spoil the quality of juice if crushed along with the main crop.

Repeat the wrapping process two or more times, each time interlocking more cane shoots. Tie the upper portion of the shoots as the canes grow in height. The recent method of wrapping and propping sugarcane are chain method and T- propping . Wrap the canes by chain method each row separately. T- propping is done tying the canes of adjacent rows. Stripe out the dried leaves to suppress the development of set roots and buds.

Plant protection

Protect the cane crop from pest and diseases. The common pests are early and late shoot borers, pyrilla and white ants. The most common diseases are red rot and smut. The selection of disease free setts is very important to prevent disease infestation through seed setts. Follow the schedule as in **Annexure-II and III**.

Water management

Irrigate the trenches before planting of the setts to ensure quick germination. This should be followed by light irrigation periodically to keep the soil moist for better germination and uniform growth and plant stand. Irrigate the crop at 7-10 days interval in the hot summer depending on the soil texture. The critical period for irrigation is between 45-75 days of planting. Irrigate the crop till the onset of monsoon. In post monsoon period irrigate the crop at 15-20 days interval. Stop irrigation before 20 days of harvest for better juice quality. Avoid waterlogging as it decreases the quality of the cane.

Following measures are to be taken for survival of the crop under water scarcity situations.

- Growing of drought tolerant varieties like Co-87263 and Co 740.
- Soaking the seed materials in saturated lime solution for 2 hours induces hardiness and promotes better root system.
- Early planting by December.
- Deferred N-top dressing till onset of monsoon.
- Top dress K along with N with onset of monsoon
- Apply irrigation in alternate rows in rotation.
- Provide trash mulching in the furrows to conserve moisture.
- Spray 2.5% urea + KCl 1% at 15 days interval during stress period.
- Remove non-functional leaves.

Harvesting

Harvest the mature cane when the brix reading reaches 18 or above. Hand refractometers have been provided in all the important cane growing centres and this should be used for testing of the juice and for advising the farmers to harvest the crop at the right stage.

Transport the cane immediately after harvest to the factory for crushing. Maximum recovery takes place when the cane is crushed within 24 hours after harvesting. Further delay in crushing the cane results in lowering the recovery of sugar. Sugarcane harvesting knife should be used for harvesting. A stripper should be used for removing the cane leaves and detopping.

Yield

Under good management condition, a plant crop of sugarcane yields about 100-120 t/ha.

IMPACT POINTS

- Trench method of planting
- Optimum plant population
- Application of nitrogen fertilizer within 90-105 days of planting.
- Irrigation at the critical period i.e. 45-75 days after planting.
- Control of early shoot borer
- Removal of late tillers and water shoots

RATOONING OF SUGARCANE

Ratooning of sugarcane is one of the important methods of reducing cost of production through elimination of seed cost and preparatory cultivation charges. Ratoon crops in general, mature one month earlier than the plant crop.

Adopt the following practices to raise a successful ratoon crop.

- Harvesting of canes at ground level or below it to avoid upper buds to sprout.
- Stubble shaving operation with a spade within a week to allow lower buds to sprout effectively. Irrigating the field and dismantling the ridges so as to encourage the lower buds to germinate. Avoid trash burning.
- Necessary gap f illing where there is a gap of more than 45cm within the row with poly bag settlings or sprouted single budded setts of equal age as that of ratoon.
- Trash mulching to help quick germination of buds, conservation of soil moisture, suppression of weeds and reduction of incidence of early shoot borer.
- Hoeing of the land for suppression of weeds and better aeration.
- Use of recommended manures and fertilizer. Ratoon crop requires 25% more nitrogenous fertilizer than plant crop. Apply 312 kg of N, 100 kg of P_2O_5 and 60 kg of K_2O/ha as per schedule in the plant crop.
- Irrigate immediately after fertilization and subsequently at an interval of 10-15 days depending on the type of soil and prevailing weather.
- Detrash the leaves as required.
- Wrapping and propping operations to keep the canes erect.
- Harvesting of canes on the basis of hand refractometer reading (more than 18).
- Under proper management condition ratoon crop can yield as much as the plant crop.

Plant protection measures

- Clean the field after harvest of the previous plant crop
- Spray the stubbles with 0.2% carbendazim or benlate immediately after harvest of crop
- Spray endosulfan or chlorpyriphos or monocrotophos @ 1500 ml/ha on the standing crop to check the attack of shoot borers.
- Apply mancozeb @ 3.5 kg or copper oxy chloride @ 5 kg/ha in the standing crop to check red rot and smut diseases.
- Spray 0.2% carbendazim or benlate towards mid June to effectively control rot and smut diseases.

GUR MAKING

The following three main operations are involved in manufacture of gur.

1. Extraction of juice from cane
2. Purification of the juice
3. Concentration of juice into gur

Extraction of juice

Use 5 roller bullock drawn crusher for extraction of juice (Extraction is about 50%). Power crushers can be used for this purpose to increase the efficiency to about 60%. Crushing by 6 roller hydraulic crusher with a crushing capacity of 4 t/hour gives 80% extraction and can increase recovery of gur from 10 to 12%.

Purification of juice

Boil the juice for concentration and removal of dissolved foreign material in a circular or a rectangular pan made up of iron over a furnace. Normally bagasse is used as fuel. Remove the suspended impurities and gummy colloidal substances in juice during first heating lasting for about 30-45 minutes. Then the juice is clarified by adding chemical or vegetables clarificants. Liming to pH of about 6.4 for immature juice, to about 6.0 for mature juice and to 6.8-7.2 for deteriorated juice is optimum for obtaining gur of good colour and hardness, generally 50g of lime is made to solution and added to 40 litres of juice. Crushed bhindi bark @ 20-25g or 1 kg of crushed groundnut kernel is added in 40 litres of juice for this purpose. Chemical clarificant like Sodium hydrosulphate or sodium carbonate may be used @ 50-60 g/600 litres of juice in place of vegetative clarification.

Concentration

The striking point temperature ranges from 118^{o}C to 123^{o}C. Bad quality juice requires a higher striking point. The correctness of striking point is judged in the following manner, when the boiling progresses sufficiently, a small quantity is taken out of the pan and put into a bucket of cold water. If the mass forms a ball with a metalic sound when thrown against the side of the pan, the boiling is taken as complete and gur is collected into containers.

Storage

Gur may be collected into galvanised iron drums, tins and alkathene or alkathenelined gunny bags and stored in closed rooms. Desiccating agents like calcium chloride or calcium oxide in sufficient quantity, if available, may be kept in the room to absorb excess moisture and keep the room dry (RH: 50-60%). Initial moisture in gur should not exceed 6%, as it deteriorates the quality of gur.

BETELVINE

Betelvine (*Piper betel* L.) is a perennial climber which is cultivated for its leaves. It is also important for its medicinal value in addition to normal use for chewing. The cultivation of this crop comprises of over 4000 hectares in Orissa, mainly, confined to the coastal belt of Balasore, Cuttack, Puri and Ganjam districts. Small pockets of its cultivation are also seen in the interior districts of Phulbani, Bolangir and Sambalpur. Cultivation of this crop is highly

specialized which needs adequate skill, traditional ability and heavy investment. A betelvine garden once established is a perennial source of income providing much-needed cash to the grower.

Method of cultivation

The crop thrives under tropical climate which provides a moderate temperature, shade and enough of humidity. In all the districts closed type of gardens are practiced under "*Baraj*" conditions except in Ganjam where open '*Bada*' type of cultivation is followed with live and bamboo standards. In closed '*Baraj*' condition the vines are trailed on dead sticks of *Androprogon muricatus* (Inkad) and the top of the structure is covered with detached tops of the same plant for shade. In open (*Bada*) type of cultivation live plants of *Sesbania grandiflora and Leucaeuna glauca* are grown to provide natural shade by their top canopy. They also serve as standards for trailing of vines alongwith the bamboo stick in between.

Soil

This crop requires a well drained alluvial and sandy loam soil. It can be cultivated in clayey and sandy soil. Coastal sand dunes are also utilised in the sea coast areas for its cultivation.

Varieties

"Bangla" is the main commercial type grown in the coastal districts. It is named as 'Godi Bangla'. 'Naua Bangla', 'Bhainchigodi'. 'Jagannati', 'Balipan', 'Chandrakana' and 'Birikoli' etc. Deshi variety is grown in a small scale in the coastal belt under the name of 'Kapaovi', 'Meetha', 'Sanchi', and 'Alupatria'. This variety exclusively grown in the interior districts is named as 'Kala Mahata' and 'Dhob Mahata', A scented variety 'Bilhari' is also grown in small scale in these districts.

Land preparation and layout

The soil should be well drained, pulverized by repeated ploughing and harrowing to obtain a fine tilth. Construction of '*Baraj*' is essential before planting and shade is necessary to protect the seed vines from withering. In '*Bada*' type of cultivation sowing of 'Agasti' seed is done in line, in the month of June and seed vines are planted during September- October by which time 'Agasti' plants have attained a height of 1.0-1.5 m to provide sufficient shade to the seedvine. Before planting, ridge, (Mandi) of l5 cm high are prepared with pulverized soil at an inter-row distance of 1.0 m. The ridges are thoroughly drenched with water before planting.

Planting materials and method

Seed vine cuttings are obtained from apparently healthy and vigorously growing vines. Generally 3 types of seed vines are used viz. one leaf one node, two leaves two nodes and tender terminals with 4-5 leaves. The vine stand is more in the later. Planting of seed vine is done twice in a year, i.e. during September-October and February-March. The seed vines are planted at an inter plant distance of 15-20cm on the well drenched ridges being buried upto the first or second node keeping the attached leaves on ridges and mulched with damp straw to prevent senescence. The seed vines should be dipped in 0.5% bordeaux mixture (BM) for 30 minutes before planting. Cut end treatment of BM treated seed vines with IAA and IBA (50 ppm) enhance early rooting of the planted vines.

In open type of cultivation similar method is followed except that the seed vines are planted on ridges at the base of previously grown 'Agasti' plants. As 'Agasti' plants grow taller and taller they are thinned out and after one year the shade plants finally maintained at a distance of one meter. In such a fully developed garden the shade plants are kept at a distance of 2 meters from line to line and the vines in between them are supported by bamboo sticks.

After care

After a fortnight of planting young sprouts come out and when they are 15-20 cm in height the mulch is removed and top dressing is done with oil cake powder at the rate of 250g per 'Aud' (an 'Aud' is the space in between two pairs of roof support measuring 1.5 m to

2.0 m in length). The growing sprouts are trailed on *Andropogon* sticks (*Pakhudi*) or on *Sesbania* plants as the case may be. After two months of planting the young vines are arranged alternatively in double row in the same line and trailed on standards at an inter-standard distance of 15 cm. The space in between the double row is known as ‘Gampha' and such alternate arrangement of vines in a double row is called 'Pasha'. After completing 'Pasha' the vines are top dressed with oil cake powder at the rate of 500g per ‘Aud'. Covering with fresh soil in a thin layer must be done one week after each top dressing after the fermentation of oil cake. Sufficient irrigation should be provided in the initial stage of planting to keep the soil always moist by sprinkling.

Manures and fertilizers

Well decomposed cowdung or compost should be given once in each year at the rate of 25 cart loads per hectare. Fertilizers @ 150:100:125 kg of NPK per hectare should be applied in 4-5 splits per year coinciding the lowering period. Apply oil cake and inorganic fertilizers in 50:50 ratio with respect to N fertilizers. Mustard oil cake is mostly preferred to obtain good growth and quality leaf production. However, 'Groundnut', 'Til', 'Neem' and ‘Karanj' oil cakes are in use as per need and availability. In open type of garden extra 50 kg of N and K may be given to nourish the shade plants. Application of phosphobacter @ 5 kg/ha may be made in established ‘*Baraj*’ for release of fixed P with higher leaf yield and keeping quality.

Irrigation and drainage

Betelvine needs moist but well drained soil substratum for its good growth. During rainy season the garden should be made slanting in all directions keeping the mid-space higher by soil application and 'Gamphas' should be filled up and the bases should be earthened up to facilitate good drainage. During winter and summer *vice-versa* arrangement may be made to conserve moisture.

Sprinkle water 2-3 times a day during planting and apply irrigation at an interval of 4-7 days depending on the type of soil in an establish ‘*Baraj’*. Tube well water is the best for irrigation. Tank water may be used after disinfection with commercial bleaching powder.

Plant protection

See **Annexure- III and IV**. Hand compression/knapsack or low volume sprayer should be used for manual spraying of chemicals.

Harvesting, processing and packing

Generally, harvesting starts after 6 months of planting. Plucking of leaves is done once in every fortnight or more depending on the growth of vines and prevailing market conditions. Usually, after each fourth plucking the naked vines are lowered and buried in fresh soil, which is followed by earthing up and top dressing. In open type of cultivation sometimes, the naked vines are twined up and banged on the supporting 'Agasti' plants. On an average condition 60-80 lakh leaves may be harvested annually from one hectare of betelvine garden.

After harvest, the leaves are cleaned, graded according to their size, depetiolated and packed in bamboo baskets. The leaves for local consumption market are packed in bundles of 50 or 100 leaves. But for export to distant cities leaves are packed in 10,000 per basket being carefully wrapped with wet gunnies, banana and 'Inkada' leaves. In some places the leaves are cured and bleached by coal heat and smoke before packing for better keeping quality during storage and transit.

VEGETABLES

POTATO

Potato has very high yield potential and gives good return within a short period of 85-120 days. The crop produces highest biomass per unit area per unit time. Several varieties have been found suitable for cultivation in Orissa. The characteristics of the varieties recommended for Orissa are given below.

Early (70-80 days)				
	Kufri Chandra mukhi	**Kufri Ashoka**	**Kufri Jawahar**	**Kufri Bahar**
Tuber size	Large	Large	Medium size	Medium size
Tuber shape	Oval	Oval	Round oval	Oval
Skin colour	White	White	White	White
Eyes	Fleet eyes	Fleet eyes	Fleet eyes	Deep eyes
Plant	Medium height	Medium to tall	Medium	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 (80-90 days)					
	Kufri Jyoti	**Kufri Sutlej**	**Kufri Pukharaj**	**Kufri Badshah**	**Kufri Lalima**
Tuber size	Large	Large	Medium	Large	Medium
Tuber shape	Oval	Oval	Oval	Oval	Round
Skin colour	White	White	White	White	Red
Eyes	Fleet eyes	Fleet eyes	Fleet eyes	Fleet eyes	Shallow
Plant	Tall, erect, compact	Tall, erect, compact	Tall, semi erect	Tall, erect	Tall, compact & erect
Stems	Vigorous	Medium compact	Medium compact	Vigorous	Erect
Av. yield (q/ha)	200	280	320	300	280
Reaction to disease					
Early blight	MR	-	-	MR	MR
Late blight	MR	MR	MR	-	-

MR= Moderately resistant

Soil

Well drained loam to sandy loam are good for potato.

Land preparation

Land should be ploughed to a fine tilth which is helpful for subsequent development of tubers. For proper tilth use bullock drawn bose plough/ rocket plough/ implement factory slash mould board plough. Tractor or power tiller operated rotavator may be used, if available. At the time of final land preparation apply FYM or compost @ 20 t/ha and mix with the soil. Apply bleaching powder and phorate each @ 10 kg/ha to soil before planting.

Seed treatment

Potato can be planted whole or cut. It is better to plant whole tubers of size 2.5 to 3.0 cm in diameter and each weighing between 20-30 gram. If bigger tubers are used, the same should be cut to pieces having atleast two eyes. 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.

Breaking of seed dormancy in seed potato

Seed potato kept in cold store should be taken out 15 days before planting and spread on the floor of a well ventilated room in dark condition for proper sprouting. If seed potato procured from monsoon harvest of Shimla or any other place then those tubers are to be treated with 1% thiourea + 1 ppm GA_3 for half an hour and then allowed for sprouting. Thiourea and GA_3 helps in breaking dormancy.

Sowing and seed rate

Potato sowing should be done from October to November to get good yield. Earlier sowing may result in rottage of seed materials where as late sowing reduces yield. Normally 15 to 20 quintals of seed materials is required per hectare. Higher seed rate will be required if large sized tubers are used. Planting of unsprouted seed results in non-uniform stand. Before planting the tubers, the land should be divided into strips of 2.5 to 3.0 metre width with provision of irrigation channel in between two strips. Inside the strips, draw furrows at 60 cm and plant tubers 15 to 20 cm apart. The tubers should be covered with soil about 2.5 cm thick after planting. Furrow opening and planting of potato can be done efficiently by a tractor operated semi automatic potato planter.

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.

Manure and fertilizer

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 P_2O_5 and 100 kg K_2O/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 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. Avoid application of urea at sowing. In case of early variety, splits should be reduced to two, i.e. basal and first earthing up.

Irrigation

After planting, sprinkler, splashing or pot irrigation is helpful for sprouting. After the first earthing, subsequent irrigations can be done in the furrows. Light irrigation may be required at an interval of 5 to 10 days depending on the nature of the soil and weather condition. In no case the plants should be allowed to wilt. Over irrigation should be avoided. The safe limit is to allow irrigation water in the furrows to the extent of 2/3rd of the height of the ridges. Irrigation is witheld before 7 to 10 days of harvest.

Plant protection

For controlling early blight spray with Mancozeb (0.3%) at 10 days interval. In severe infected fields spray (Carbendazim 12% + Mancozeb 63%) WP @ 2 g/litre twice at 10 days interval. In case of late blight infection spray (Metalaxyl 8% + Mancozeb 64%) WP 0.2% twice at 10 days interval. For controlling aphids (ETL=50 aphids/plant)/ apply Methyl demeton @ 2 ml/litre or imidacloprid @ 1 ml/5 litres of water. For controlling epilachna beetle, spray the crop with carbaryl @ 4 g/litre of water at 10 days interval. In case of cut worm infestation spray the crop with chlorpyriphos @ 2 ml/litre or use chlorpyriphos 1.0 D @ 25 kg/ha at the evening hours. For details refer **Annexure-II and III**.

Harvesting

Harvest the crop when the leaves start yellowing. Withheld irrigation at 7 to 10 days before harvesting. Sometimes before harvesting dehaulming is done i.e. about 75 days in early crop and at 85 days in medium duration crop. At the time of harvesting care should be taken for minimum damage to the tuber as damage to the skin reduces the keeping quality. All the tubers are kept in the field for 24 hours for hardening of the skin. Damaged and diseased tubers are discarded.

In case of seed crop, well matured and undamaged tubers are sorted out and kept in cold stores till the next sowing season.

IMPACT POINTS

1. Use certified seed potatoes of improved varieties.
2. Treat the tubers before planting and adopt correct spacing.
3. Planting of sprouted tuber help in maintenance of plant population.
4. Use recommended dose of fertilizer.
5. Follow timely plant protection measures.

BRINJAL

Variety

Utkal Tarini (BB-7)	:	Plant medium in height, fruit purple in colour, oblong shape, medium in size, resistant to bacterial wilt, yield- 340 q/ha.
Utkal Keshari (BB-26)	:	Plant tall, fruit oblong in shape, deep purple, medium large in size, tolerant to bacterial wilt, less susceptible to fruit borer, yield-322 q/ha
Utkal Madhuri (BB-44)	:	Plant medium in height, fruit long, medium in size and green in colour, resistant to bacterial wilt, sowing time- September to October, yield-316 q/ha.
Utkal Jyoti (BB 13)	:	Plant tall, fruit purple in colour, medium to small in size, fruits bear in cluster 3-4 in nos, tolerant to bacterial wilt, yield-381 q/ha.
Utkal Anushree (BB 45C)	:	Plant medium in height, fruit oblong in shape, green in colour, small in size and bears in cluster. This variety can be grown throughout the year, yield-386 q/ha.
Pusa Purple Cluster	:	Plant tall, compact sturdy with purple pigmentation on stem, leaves purple, nonspiny, fruits borne in clusters of 4-9, 10-12 cm long and deep purple in colour. Moderately resistant to bacterial wilt, good yielder (250-300 q/ha.).
Pusa Purple Long	:	Plant dwarf, leaves light green, fruit long (20-25cm), purple glossy tender, droop and touch the ground, fruit yield- 280-300 q/ha
Pusa Kranti	:	Plant medium tall, non-spiny, thick oblong 15-20 cm long, dark purple with shining green calyx and less seeded. Good yielder (270-280 q/ha).
ARU-2C	:	Plant medium tall, fruits are cylindrical, long, small, bright violet in colour, bearing in clusters (4 to 6) tolerant to bacterial wilt. Average yield 300 q/ha.
KT-1	:	Medium sized plant, fruits borne in cluster of 3 to 5 fruits. Fruits are cylindrical, purple colour which decrease with fruit aging. Tolerant to bacterial wilt. Average yield 370 q/ha.
Mukta Keshi	:	Plant medium tall, fruit long, bold, deep purple, nonspinous, spongy, less seeded, yield 250-260 q/ha.

Seed rate

500 g/ha

Seed treatment

Treat the seeds with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Nursery

Seedlings to be raised from 15th September to end of September in raised beds.

Land preparation

3-4 ploughings, incorporate FYM at the time of final land preparation.

Planting time

15th October to end of October

Spacing and planting

60 cm row to row, 45 cm plant to plant. Transplanting of 15 cm tall or one month old seedlings.

Manure and fertilizers

Apply 12.5 tonnes of FYM, N:P_2O_5 :K_2O @ 125:50:75 kg/ha. Full dose P_2O_5 and 20%each of K_2O and N at planting. Two weeding and hoeing at 20 days interval and apply 40% N and K_2O each at 20 days and rest 40% N and K_2O at 40 days after planting and earthing up should be done after each top dressing.

Plant protection

Root-knot nematodes apart from causing direct damage by itself form wilt complex with fungi and bacteria and help breaking of wilt resistance. Give a bare-root dip of seedlings for 6 hours in 0.05% of carbosulfan 25 EC or monocrotophos 36 SL.

Spray Mancozeb 1500 g/ carbandazim 500g in 500 litres of water/ha against fruit rot disease and twig blight. Spray 1.5 kg carbaryl 50% WP in 500 litres of water at 20 and 40 days after planting against the epilachna beetle. In fruiting stage fenvalerate 20 EC, 500 ml/ha and trizophos @ 1250 ml/ha alternatively be applied against the fruit and shoot borer twice at 20 days interval. Fenvalerate should not be applied more than twice during the growth period of the crop. Subsequently dichlorvos @ 500 ml/ha be applied. After 7-10 days of planting apply carbofuran 3G @ 30 kg/ha in the soil by placement method near the root zone and irrigate. On incidence of epilachna beetle spray carbaryl 50 WP @ 1.5 kg/ha and in the fruiting stage spray any synthetic pyrethroid twice at 20 days interval @ 1 ml/litre followed by dichlorvos @ 1000 ml/ha. Synthetic pyrethroids should not be sprayed more than 2 times. Refer **Annexure-III and IV**.

Harvesting

15th December to end of April.

TOMATO

Punjab Chhuhara	:	Early maturity. Fruit medium small in size, pear shaped. Rich in Vitamin-C. Resistant to blossom end rot and sun burnt injury. Yield about 350 q/ha.
Utkal Kumari (BT-10)	:	Indeterminate type. Fruit medium to large size, resistant to bacterial wilt. Fruit round shape, yield 410 q/ha.
Pusa Early Dwarf	:	Ripens early. Does well in both kharif and rabi season
Pusa Ruby	:	Early variety. Plants are medium in height. Medium size fruit, uniformly red when ripe.
Utkal Urbashi (BT-12)	:	Indeterminate type. Fruit medium large size, pear shaped very pulpy, good keeping quality. Yield 450 q/ha.
Arka Saurabh	:	Multipurpose, variety suited both for fresh market and processing. Resistant to fruit crack. Yield about 350 q/ha.
Arka Vikas	:	Attractive red colour. Uniform ripening habit. Suitable for fresh market. Yield 350 q/ha.
Shakti	:	Wilt resistant variety. Yield 300 q/ha. Fruits are round.
Utkal Pallavi (BT-1)	:	Bacterial wilt resistant, early maturity group, medium to small size fruit, very good yielder (375-400 q/ha) pear shaped good keeping quality, pulpy.
Utkal Deepti (BT-2)	:	Bacterial wilt resistant, early maturity group, medium to small size fruit, round shape fruit pulpy, good keeping quality. 410-430 q/ha
Hybrid	:	Sheetal, Karnatak, Vaishali, Roopali, Maitri, Rishi, ARTH-3, DTH-4, NA 601

Land preparation

Well drained high and medium lands are suitable for tomato cultivation. Land should be ploughed three to four times and levelled properly for providing irrigation.

Seed rate

500 g/ha

Seed treatment

Seed treatment should be done with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Sowing

All determinate varieties can be planted early where as indeterminate varieties can be planted either in early, mid and late season depending on the variety. Seedlings of 25 to 30 days age are to be transplanted. Determinate types are to be planted to 60 cm x 30 cm

spacing and indeterminate are to be planted with 60 cm x 45 cm spacing where as F_1 hybrids are to be planted at 75 cm x 50 cm under staking.

Manuring

Apply well decomposed FYM/compost @ 25 to 30 t/ha alongwith $N:P_2O_5:K_2O$ @ 125:50:100 kg/ha. Incorporate 25 kg N, 50 kg P_2O_5 and 20 kg K_2O at the time of transplanting. Rest 100 kg N and 80 kg K_2O should be applied in two equal splits at 15 and 30 days after transplanting. For better soil health, apply FYM @ 40 t/ha along with only half dose of NPK fertilizer.

In boron deficient soils, apply borax @ 10 to 15 kg per hectare as basal.

Interculture

Tomato produces good quality of fruit under staking. Staking is a must for tall F_1 hybrid varieties and all tall growing cultivars. Provide 2 to 3 hoeings, weedings and earthing. Hoeing, weeding and earthing should coincide with top dressing. Care should be taken to cause less injury to root as it increases incidence of wilting. Depending on the varieties, tomato requires 6-8 irrigations. Lack of irrigation produces empty locule and light colour fruits.

Plant protection

Bacterial, fungal and nematode wilts are important problems in tomato. Tomato variety like BT-1, BT-2 and Selection 120 are resistant to wilt complex. Wilt diseases can be checked by soil amendments and maintaining soil pH between 6-7. Root knot in tomato is a serious problem which apart from damage by itself form a complex with fungi and bacteria in causing wilt and helps breaking of wilt resistance. Give a bare root dip of seedlings in 0.1% of carbosulfan 25 EC or monocrotophos 36 SL for 6 hours before planting. Spray endosulfan 35 EC @ 1000 ml/ha at initial fruiting stage against fruit borer. In case the infestation continues in the fruit ripening stage spray carbaryl 50 WP @ 2 kg/ha and maintain a minimum waiting period of 5 days for harvesting. For managing fungal blights spray with copper oxychloride (0.3%) or indofil M-45 (0.3%) or carbendazim (0.15%). Refer **Annexure-III and IV.**

Harvesting

Harvest fruits at turning stage (green to red) for better storage and marketing. Late planting produces sun scald fruits with poor colour development.

IMPACT POINTS

1. Stake the plants if possible for better fruits
2. Try to minimise injury to roots
3. *In situ* planting minimise wilting
4. Rotate the crop regularly and always prefer new field where no solanaceous crops were grown previously.

CAULIFLOWER

Varieties

Snow Ball-16	:	Medium size solid curds of attractive white colour. Requires 110 to 120 days to harvest.
Pusa Snow Ball -K 1	:	Straight upright leaves, covering the curd very tightly. Solid, medium size, white curd. Requires 105 to 130 days to harvest, yields about 220 q/ha.
Pusa Snow Ball -K 2	:	Late variety with good quality curd. Requires 110 to 135 days to harvest.
Pusa Deepali	:	An inbred with uniform, medium long, erect foliage with rounded tip, curds are white and deep, more number of plants can be accommodated per unit area. It is a self blanched variety.
PSBK-25	:	Late group, curds are white with uniform colour

Land preparation

Medium to high land should be preferred and 3-4 ploughings should be given to get a fine tilth.

Seed rate

500 g/ha

Seed treatment

Seed should be treated with thiram (0.3%) + streptocycline (0.15%) @ 3g + 1.5 g/kg of seed, respectively. To avoid bacterial rot, treat the seed with hot water at 52^{o}C for 10 minutes.

Sowing

Raise early crop seedlings under polythene or thatch removable covers. Raise seedlings from 500 g seeds in an area of 100 sq.m. for supplying seedlings to one ha. of land. Treat the nursery soil with 300 g furadon 3G or 100 g of thimet 10G at the time of sowing. Seedling of 25 days age should be transplanted at a spacing of 60 cm x 45 cm. Frequent gap filling is required to maintain high plant population.

Manuring

Incorporate FYM/compost @ 25 t/ha during final ploughing. The recommended dose of fertilizer is 120-60-60 kg N-P_2O_5 -K_2O/ha. Apply 24 kg N, 60 kg P_2O_5 and 12 kg K_2O at the

time of transplanting and rest 96 kg N and 48 kg K_2O in two equal splits at 15 and 30 days after planting.

Boron deficiency causes brown rot and red rot in curds and stems of cauliflower. Spray 1.5 kg of boric acid at a concentration of 0.05% to plants two weeks after transplanting and another 2 weeks before curd formation. Molybdenum deficiency causes whip tail and blindness. Apply 2 kg of sodium molybdate/ha as basal. In molybdenum deficient crop, make foliar spray with ammonium molybdate @ 0.6g/litre of water.

Interculture

Light hoeing, weeding and earthing up should be done coinciding with each top dressing. 6-8 irrigations are given to the crop. When curds attain maturity but delayed for marketing, blanching should be done with last leaves by covering the curds with rubber strap or straw. Exposure of matured or lately formed curds to sunshine for long period produces bitter taste. Succession sowing should be done for better marketing.

Plant protection

Leaf webber (crocidolomia), mustard saw fly, mustard aphid are important insects. Spray carbaryl 50 WP @ 2.0 kg against the leaf webber and sawfly and spray malathion 50 EC @ 1000 ml/ha against the aphid in curd stage and wait for 7 days for harvesting the curds. In pre-curd stage endosulfan @ 1000 ml may be sprayed on observing pest incidence. To restrict blight and bacterial rots, spray mancozeb (0.3%) alternatively with plantomycin (0.15%). Refer **Annexure-III.**

IMPACT POINTS

1. Use good and healthy seeds
2. Use 3-4 weeks old seedlings
3. Blanch the curds
4. Go for succession sowing for easy marketing.

CABBAGE

Variety

Golden Acre	:	Early variety, uniform, solid, round heads, interior portion of the head is white and of excellent quality. Yield is about 220 q/ha.
Drum Head	:	Uniform, flat, solid small framed and short stalked head. Yield is about 400 q/ha.
Pride of India	:	Solid head, Matures in about 85 days and yields about 240 q/ha
Pusa Synthetic	:	Medium maturity group, medium size head, compact, yield 350 q/ha.
Sri Ganesh Gol	:	Late maturity group, 2.5-3.0 kg/head weight, compact head, round, good quality, yield 400-450 q/ha.
Hybrid varieties	*:*	*Konark, Meenakhsi, Sri Ganesh Gol, Keertiman, Green Boy, Green Express, Quisto*

Land preparation

Medium to high land should be preferred and 3 to 4 ploughings followed by laddering should be given to get a good tilth.

Seed rate

500 g/ha

Seed treatment

Seed should be treated with thiram (0.3%) + plantomycin (100 ppm) or hot water treatment ($54^{o}C$) for 10 minutes to check bacterial rot.

Transplanting

Raise early crop seedlings under polythene or raised beds. 500 g of seeds are sufficient for one ha. 4 weeks old seedlings should be transplanted at a spacing of 40-60 cm from row to row and 20 to 30 cm from plant to plant depending on variety and soil.

Manuring

Apply 25 t/ha FYM at the final ploughing The recommended dose of fertilizer is 150-50-75 kg N-P_2O_5 -K_2O/ha.. 20% N, full P_2O_5 and 20% K_2O should be applied as basal. 40% each of N and K_2O should be applied as first top dressing 15 days after planting. Rest 40% each of N and K_2O to be applied 30 days after planting. Three foliar sprays of $ZnSO_4$ @ 2.5 g in 10 litres of water starting from 30 DAP gives better yield.

Interculture

Seedlings should be watered immediately after transplanting and thereafter irrigation at an interval of 7 days would be adequate. Weeding should be done frequently.

Plant protection

Treat the nursery soil with 300 g of furadon 3G or 100 g of thimet 10 G for each 100 sq.m. of nursery area before seed sowing against root knot nematode infestation. Against leaf webber apply acephate 650 g or carbaryl 50 WP @ 2.0 kg/ha and malathion @ 1000 ml/ha against aphid, Waiting period of 21 days for acephate and 7 days for other two compounds be maintained. Refer **Annexure-III**.

Harvesting

Harvest in properly matured stage. Irrigation to matured crop causes cracking of heads. Always harvest with few outer leaves to minimize the damage of heads during transit.

Yield

20 to 50 t/ha.

IMPACT POINTS

1. Collect better seeds to prevent bolting
2. Do not cultivate high chilling requirement varieties.

KNOLKHOL

Variety

Early : Early White Vienna
Late : Purple Vienna

Land preparation

Deep, well pulverised and fine seed bed.

Seed treatment

Treat seeds with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Raising of seedlings

Prepare raised seed bed of convenient length, 3' width and 6" to 9" height. A nursery area of 100 square meter is required for planting one ha. of land. Add adequate quantity of FYM. Sow seeds at one cm depth. Drench the soils with 0.2% captan solution to avoid damping off, 10 days after germination spray on the seed bed 18 ml of endosulfan in 9 litres of water.

Seed rate

750 g of seeds/ha

Transplanting

Use 25 to 30 days old seedlings for transplanting.

Spacing

Row to row 45 cm and plant to plant 20 to 25 cm

Manuring

Apply 25 t FYM/ha at final ploughing. The recommended dose of fertilizer is 100-50-50 kg N-P_2O_5 -K_2O/ha. Apply 50% N at planting and rest 50% N in 2 equal splits 25 days and 40 days after transplanting.

Interculture

One hoeing and weeding at 20 days after transplanting. Follow this with top dressing and earthing up.

Irrigation

Two hand waterings for 2 days after transplanting. Afterwards 3 to 4 irrigations are needed at weekly intervals. Weeding is to be frequently done.

Plant protection

Two weeks after transplanting, spray the crop with 750 ml methyl demeton against aphid. Atleast one and half month before harvest methyl demeton should not be applied instead malathion @ 1000 ml be sprayed, if necessary. Refer **Annexure-III**.

Harvesting

Knolkhol is harvested when it is full grown and tender. The fibrous ones deteriorate the market value.

Yield

20 t/ha.

GARDEN PEA

Varieties

Bonneville, Arkel, J.P-3, J.P-4, J.P. 83, Azad P-I, Azad P -3

Seed treatment

Treat the seeds with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Seed rate

75 to 100 kg/ha

Land preparation

Plough the land 3 to 4 times to get good tilth. Level the land for better irrigation.

Sowing

October-November

Spacing

30cm row to row and 6 to 10 cm plant to plant

Manuring

Apply well decomposed FYM/compost @ 20 t/ha at the time of final ploughing. The recommended dose of fertilizer is 50-50-50 kg N-P_2O_5 -K_2O/ha. Incorporate 25 kg N, 50 kg P_2O_5 and 25 kg K_2O at the time of sowing. Another 25 kg N and 25 kg K_2O should be applied after 20 days of sowing.

Interculture

Hoeing, weeding, application of 25 kg N and K_2O and earthing up should be done after 20 days of sowing. Second earthing up should be after 15 days of first one. Irrigate the crop in furrows.

Plant protection

Powdery mildew and rust disease cause major loss in pea. Apply sulphur dust 30 kg/ha after the appearance of the diseases. Against leaf miner, monocrotophos @ 0.4 kg/ha may be sprayed (in fruiting stage, malathion @ 0.5 kg/ha should be used). Avoid late sowing, since late sown crops are severely damaged by the stem fly. Tridemorph 80% EC (0.1%) may be applied against the rust disease.

Harvesting

60 to 70 q/ha (green pod)

FRENCH BEAN

Variety

Contender, Pusa Parvati, Arka Komal, Pant Anupama, IIHR 909.

Seed treatment

Treat the seeds with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Seed rate

75 kg/ha.

Land preparation

Plough the land 3 to 4 times and level properly for better irrigation.

Sowing

September-October

Spacing

40 to 45 cm row to row and 20 cm plant to plant

Manuring

Apply 25 to 30 t/ha of well decomposed FYM/compost at the time of final ploughing. The recommended dose of fertilizer is 50-80-50 kg N-P_2O_5 -K_2O/ha. Incorporate 25 kg N, 80 kg P_2O_5 and 50 kg K_2O at the time of sowing. Second dose of nitrogenous fertilizer should be applied 20 days after sowing @ 25 kg N/ha.

Interculture

Hoeing, weeding application of N fertilizer followed by earthing up should be taken up after 20 days of sowing. Earthing up for second time may be taken up after 15 days of first earthing.

Plant protection

Spay the crop with malathion 50 EC or anthio 25 EC @ 1000 m/ha in 500 litre of water against pod borer and aphid in the fruiting stage. To avoid leaf spots and blights spray with copper oxychloride @ 0.3% or Mancozeb @ 0.3%.

Harvesting

60 to 70 q/ha.

RUNNER BEAN

Variety

Kentucky Wonder, Local Land Races (black and brown seeded)

Seed treatment

Treat the seeds with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Seed rate

25-30 kg/ha.

Land preparation

Plough the land 3 to 4 times and level properly for better irrigation.

Sowing

October-November

Spacing

50 cm x 30 cm

Manuring

Apply 25 tonnes of well decomposed FYM/ha at the time of final ploughing. The recommended dose of fertilizer is 50-75-50 kg N-P_2O_5 -K_2O/ha. Apply 20% N, full P_2O_5 and full K_2O as basal, 40% N as first top dressing 20 days after sowing and rest 40% N 35 days after sowing as second top dressing.

Interculture

Hoeing, weeding application of N fertilizer followed by earthing up should be taken up after 20 days of sowing. Staking must be done as soon as the plants start vining.

Plant protection

Spay the crop with malathion 50 EC or anthio 25 EC @ 1000 m/ha in 500 litre of water against pod borer and aphid in the fruiting stage. To avoid leaf spots and blights spray with copper oxychloride @ 0.3% or Mancozeb @ 0.3%.

Harvesting

Harvest tender pods before they become fibrous.

Yield

120 to 150 q/ha.

CAPSICUM

Variety

Califonia Wonder, Chinese Giant, World Bitter, Yellow Wonder, KT-1, Arka Mohini, Bharat (F_1 hybrid), Indira (hyb), Lerico (Hyb).

Seed rate

750 g/ha

Seed treatment

Treat the seed with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Land preparation

3-4 ploughing. FYM at ploughing.

Sowing time

October to November

Spacing and planting

60 cm row to row and 30 cm plant to plant within the row. Transplant 30-35 days old seedlings.

Manures and fertilizers

Apply FYM @ 20 t/ha along with N:P_2O_5:K_2O @ 120:60:120 kg/ha. Full dose P_2O_5 and 50% K_2O and 20% N at planting. Apply 40% N and 50% K_2O at 20 days and 40% N at 40 days after planting and earth up each time after each top dressing.

Plant protection

Give a base root dip of seedlings for 6 hours in 0.01% of carbosulfan 25 EC or monocrotophos 36 SL against root-knot and other nematodes at the time of planting. Spray Mancozeb @ 1500 g/ carbendazim @ 500 g in 500 litres of water/ha against fruit rot disease. Methyl demeton or dimethoate @ 1 litre in 500 litres of water to check aphids and thrips. In fruiting stage if the pests continue, malathion 50 EC @ 1000 ml/ha may be applied.

Harvesting

Harvesting starts 90-100 days after sowing. Average yield 20 to 23 t/ha

PUMPKIN

Varieties

Arka Chandan, CM-350, Baidyabati, Guamal, CM-14, Pusa Vishwas and any good local variety

Seed rate

Seed rate: 5.0 kg/ha

Seed treatment

Treat the seeds with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Land preparation

Plough the field for 3 to 4 times & prepare pits of size 45x45x45 cm and 1.8m apart.

Sowing

Rabi season-November-December. Sow 5 to 6 seeds in each pit and allow 2 to 3 vines to train.

Manuring

Apply 2.5 tonnes well rotted FYM along 75-75-75 kg N-P_2O_5-K_2O/ha. Incorporate 15 kg N, 75 kg P_2O_5 and 15 kg K_2O/ha per ha at sowing. 30 kg each of N and K_2O should be top dressed 15 to 18 days after sowing. Same dose of N and K_2O should be top dressed once again 30 days after sowing.

Inercultural operation

Spray ethrel 200 ppm, when the vine is at 5-6 leaf stage which encourages more no of female flowers. Fifteen percent of the plant population should be left unsprayed. These unsprayed (control) plants should remain and the middle of ethrel sprayed plants.

Plant protection

Treat the seeds before sowing with carbosulfan LST (marshall 25 ST) @ 6% W/E against root knot nematode. Moisten the seed slightly for better attachment of the chemical. Spray sulfex 0.4% or carbendazim 0.15% to control powdery mildew atleast 2-3 times at an interval of 10-14 days.

Methyl parathion 2D or chlorpyriphos 1.5 D dust @ 25 kg/ha to be applied to the soil during land preparation and carbaryl 0.15% concentration be sprayed when adult red pumpkin beetles and fruit flies are noticed in the field. Apply carbofuran @ 0.2 g/pit at sowing against root knot and reniform nematodes.

Harvesting

200 to 250 q/ha.

POINTED GOURD

Variety : Swarna Alaukik, Land races, Swarna Rekha, Bihar Sarif.

Pointed gourd (*potal*) varieties have not been assessed so far. Long tapering types are preferred and found fleshy and tasteful. Oval types crack during transit and on over maturity.

Land preparation

Pointed gourd prefers a well drained sandy loam and loamy soil. Early and medium paddy land should be ploughed to get a fine tilth. Apply FYM @ 12.5t/ha in pits or trenches. Row to row spacing should be one metre. Pits or long trenches should be dug in the row and roots planted at 50 cm distance.

Planting material

Collect tuber roots along with swollen nodes and plant it as quickly as possible. Invariably, male roots are having rough nodular surface whereas female roots are smooth and slender.

Planting

Maintain 10 male plants in 90 female plants for better production. Planting should start by end of October and continue upto January. Tip of the root should be on soil level and should be mulched with paddy straw for better sprouting.

Staking

Yield can be doubled under staking. High well drained lands should be preferred for growing the crop under staking which can extendt fruiting upto October and the crop can also be ratooned. The crop should be grown on flat beds in medium land. Fruiting is earlier under flat method.

Fertilizer

Apply 120 kg N, 80 kg P_2O_5 and 80 kg K_2O/ha. Apply 1/3 N alongwith full P_2O_5 and ½ K_2O at planting. Remaining N should be applied in 2 to 3 splits at an interval of 20-25 days while ½ K_2O should be mixed and applied 3 months after planting. In case of prolonged fruiting, nitrogen top dressing should be continued at monthly intervals.

Interculture

Hoeing, weeding and earthing should be done in early stage. Crop yields more fruits with frequent irrigation during summer.

Plant protection

Epilachana beetle and red pumpkin beetles infest in early stage during February-April. So spray carbaryl @ 0.75 kg a.i. ha at flowering stage. Blister beetle eat away the flowers. So dust carbaryl 5% @ 25 kg/ha. Vine borer is an important pest of pointed gourd which persists on the crop all round the year specially in western Orissa. The infestation can be reduced by

- Planting insect free healthy roots.
- Spraying the infested vines with quinalphos or phosphamidon or endosulfan @ 0.5 kg/ha. In fruiting stage insecticides should be applied after plucking of the fruits and a minimum waiting period of 21 days for quinalphos and endosulfan and 5 days for phosphamidon is to be maintained.
- To check the borer infection in the ratoon crop, soil treatment with chlorpyriphos or methyl parathion dust i.e. 25 kg/ha should be made in the month of November-December.
- Vines also suffer from fungal wilt and leaf blight, sometimes even fruits are affected. To avoid this, plants should be sprayed with carbendazim 0.15% at 10 days intervals. Soil drenching with same compound should also be followed.
- Root-knot nematode is one of the most serious nematode pest problems. Always select healthy looking roots. Root cuttings should be given a 6 hours dip in 0.05 per cent carbosulfan 25 EC or triazophos 40 EC before planting. The growing bud should not come in contact with the chemical which needs to be taken as a thin layer in a tray for treatment. In the ratoon crop carbofuran/phorate should be applied @ 0.2 g/pit. Refer A**nnexure-IV**.

Harvesting

Fruits get ready for harvest after 3-4 months of planting. In ratoon crop harvesting is possible by end of January.

Yield

125 to 150 q/ha

Selection and preservation of important types

The cultivators may select improved types from their field. These types may be propagated through one or two-node stem cuttings in pure sand. Rooted cuttings are planted in the backyard to develop tubers and maintained there till next planting season. Male and female plants should be grown separately.

IMPACT POINTS

1. Maintain male and female ratio 1:10.
2. Stake the plants, if possible
3. Second year crop will give early and better yield.

BHINDI (OKRA)

Variety

Pusa Sawani	:	Plant medium in height, good yielder (75 q/ha), fruit medium size, green, 5 ridges/fruit.
Parbhani Kranti	:	Plant tall, fruit long, green 5 ridges/fruit, 80-83 q/ha, resistant to YVMV disease.
Utkal Gaurav	:	Plant tall, resistant to YVMV disease, fruit long, green, tender, 5 ridges/fruit, very good yielder(95 q/ha)

Seed rate

10-12 kg/ha

Seed treatment

Treat the seeds with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Land preparation

3 ploughings

Sowing time

Within 15th September and 1st week of February

Spacing and sowing

50 cm row to row and 30 cm from plant to plant within the row. Sow two seeds in one place in the line by hand. Thinning should be done 15 to 18 days after sowing coinciding with first top dressing time.

Manure and fertilizer

7.5 tonnes of FYM, 80-40-40 kg N-P_2O_5 -K_2O/ha. Apply full dose of P_2O_5, 20% each of N and K_2O as basal. Apply in line and cover little soil. Rest N and K should be applied in two equal splits 15 and 30 days after sowing.

Interculture

Hoeing, weeding and earthing up should coincide with top dressing.

Plant protection

Root-knot nematode is a serious pest in bhindi. Treat the seed with carbosulfan (Marshall 25 ST) @ 3% w/w, moist the seeds with a little water before treatment for better chemical attachment. Spray monocrotophos 36 SL or phasphamidon 375 ml in 500 litre of water against jassid, fruit borer, red cotton bug. In fruiting stage carbaryl 50 WP @ 2.0 kg/ha can be sprayed. Dust 25 kg sulphur to check powdery mildew if required.

Spray the crop with carbendazim (0.2%) 2-3 times at 12 days intervals against Cercospora blight at the initiation of the disease (August-October). Growing of resistant varieties like Utkal Gaurav and Arka Anamika. All the varieties above are resistant/tolerant except Pusa Sawani to YVMV.

Harvesting

November 1st week to 2nd week of December and 15th March to end of April. It gives 75 to 100 q/ha.

AMARANTHUS

Variety

Utkal Mayuri: Green with deep purple mosaic colour. Prolonged harvesting period.

Co_1 *(A.deeblees)*	Leaves	Dark green with ridged appearance
	Stem	Dark green, round, succulent
	Yield	1.5 t/ha
Co_2 *(A.tricolour)*	Leaves	Green, lanceolate, slightly elongated
	Stem	Green, succulent
	Yield	2.8 t/ha
Co_3 *(A.tristi)*		Suitable for clipping of tender greens
	Yield	3.0 t/ha
Chhoti Chaulai		Suitable for leafy shoots
(A.blitum)	Leaves	Small, green colour
	Stem	Thin stemmed, dwarf, responds well to cutting
	Yield	3.0 t/ha.
Badi chaulai		Suitable for leafy shoots
(A.tricolour)	Leaves	Large and green
	Stem	Thick and green, responds to cutting

Land preparation

The field is prepared to a fine tilth and beds of 2m x 1.5m size are usually made for growing the crop.

Seed rate

2.0 kg khada/ha, 5-10 kg Kosala per hectare

Seed treatment

Treat the seeds with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Sowing

In the prepared beds, the seeds are sown in rows, spaced at 20 cm and later 10-15 days after sowing thinned to a spacing of 20 cm between plants, leaving one or two plants per hill.

Planting

One month old seedlings of khada are planted at 50 cm x 30 cm spacing.

Manuring

Apply 25 tonnes of FYM at the time of last ploughing with a basal application of 50 kg N, 40 kg P_2O_5 and 30 kg K_2O/ha. Full P_2O_5 and 50% each of N and K_2O to be applied as basal. Rest 50% of N and K_2O should be top dressed 15 days after sowing in case of koshala and leutia. In case of khada, similar top dressing should be done 20 days after transplanting.

Interculture

First watering is to be given soon after sowing the seeds and further irrigations are to be given once a week with a gentle flow of water. The field should be kept weed free by hoeing and weeding as and when necessary.

Plant protection

Leaf webbing caterpillar and amaranthus weevil poses serious problem to amaranthus cultivation in certain years. Carbaryl @ 0.75 kg/ha against the webber and DDVP @ 0.5 kg/ha against the weevil can be sprayed. Minimum waiting period of 7 days between application of insecticides and harvest should be maintained. The leaves should be thoroughly washed before cooking. Care should be taken to utilise the amaranthus when it is succulent. Spray Mancozeb or any copper fungicides @ 1.25 kg/ha in 500 litres of water to control blight. To restrict white rust, spray (Metalaxyl 8% + Mancozeb 64%) WP (0.2%) or carbendazim (0.15%).

Harvesting

In green stage, the plants are pulled as whole, washed and sent to the market as tender greens. The amaranthus are ready for harvest within 20 to 25 days. In *A.tristis* type a total of 10 clippings can be obtained with the first clipping starting on the 20^{th} day and thereafter at weekly intervals.

RADISH

Variety

Pusa Himani, Pusa Rashmi, Pusa Chetaki, Pusa Desi, Japanese White, Bombay Red.

Pusa Chetaki and Pusa Desi can be grown in kharif season.

Seed rate

10-12 kg/ha

Seed treatment

Treat the seeds with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Land preparation

Prepare the land with 3-4 ploughings. Apply FYM at ploughing.

Sowing time

September to November

Spacing and sowing

30 cm from row to row. Proper thinning should be done at 18-20 days after sowing to maintain plant to plant distance of 10 cm.

Manures and fertilizer

Apply 7.5 tonnes of FYM and $N:P_2O_5:K_2O$ @ 50:50:75 kg/ha. Mix full dose of P_2O_5, K_2O and 50% N and apply in line and cover little soil as basal. Apply rest half of the nitrogen after 20 days.

Interculture

Hoeing, weeding and 50% N fertilizer application and earthing up after 20 days of sowing.

Plant protection

On incidence of aphids and leaf webber in early growth period of the crop spray methyl demeton 25 EC @ 750 ml and acephate 75 SP @ 650 g/ha, respectively. In later growth stage malathion 50 EC @ 1000 ml/ha may be sprayed if pest incidence persists. Refer **Annexure-III**.

Harvesting

150-200 q/ha. Yield depends on the variety.

CARROT

Variety

Pusa Kesar, Nantes, Pusa Meghali.

Land preparation

Deep, loose, loamy soil is ideal. Prepare the land with 3 to 4 ploughings.

Seed rate

5 to 6 kg/ha.

Seed treatment

Treat the seeds with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Sowing time

September to November

Spacing

Row to row 30 cm and plant to plant 10 cm

Manures and fertilizer

Apply 7.5 tonnes FYM alongwith N:P_2O_5:K_2O @ 50:50:75 kg/ha. Mix entire P_2O_5, K_2O and 50% N apply as basal. Rest 50% N is applied 30 days after sowing.

Interculture

One hoeing accompanied by weeding and thinning at 2 weeks after sowing. Follow the top dressing 50% N and follow up irrigation. Frequent weeding is to be done.

Irrigation

3 to 4 irrigation.

Plant protection

Two weeks after transplanting, spray the crop with 750 ml/ha of Methyl demeton against aphid . Atleast one and half month before harvest Methyl demeton should not be applied instead malathion @ 1000 ml be sprayed, if necessary.

Yield

20 t/ha.

BEET

Variety

Crimson Globe, Detroit Dark Red

Land preparation

Deep loose, loamy soil is ideal. Prapare the land with 3-4 ploughings

Seed rate

5.0 to 6.0 kg/ha

Seed treatment

Treat the seed with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Sowing time

September to October

Spacing

Row to row 30 cm, plant to plant 10 cm

Manures and fertilizers

Apply 15 cart load FYM and N:P_2O_5:K_2O @ 50:50:100 kg/ha. Full P_2O_5 and K_2O and 50% N are applied as basal. Top dress rest 50% N at 2 weeks stage after completing heoing, weeding and thinning operation. Beet has high boron requirement. Therefore, apply borax @ 10 kg/ha as basal.

Interculture

One hoeing accompanied by weeding and thinning at 2 weeks after sowing. Then top dress the rest 50% N and irrigate. Frequent weeding is necessary in beet crop.

Irrigation

8 to 10 irrigations are required.

Plant protection

To control beet leaf miner and aphid apply malathion @ 1000 ml/ha. To control leaf spot apply Mancozeb @ 0.25%.

Yield

25 t/ha.

TURNIP

Variety

Purple top, White globe, Snowball, Golden ball, Early Milan, Red-top.

Seed rate

4 kg/ha.

Seed treatment

Treat the seed with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Sowing time

September

Spacing

Row to row 30 cm, plant to plant 10 cm

Manures and fertilizers

Apply 10 tonnes FYM alongwith $N:P_2O_5:K_2O$ @ 50:50:75 kg/ha. Full P_2O_5 and K_2O alongwith 50% N are applied as basal. Rest 50% N is applied at 2 week stage coinciding with hoeing weeding and thinning operation.

Interculture

One hoeing accompanied by weeding

Irrigation

7 to 8 irrigations are required

Plant protection

Methyl demeton @ 1000 ml in 500 litre of water/ha to control aphid and thrips, but one and half month before harvest malathion at the same dose should be used.

Yield

20 t/ha.

ONION

Variety: Important onion varieties are :

Pusa Red	:	140-145 days duration, medium size bulb, flattish in shape purplish red, less pungent, keeping quality good, yield 250 q/ha.
Pusa Ratnar	:	125 days duration, bulb is large, round and deep red in colour, average keeping quality, higher yield potential of 300 q/ha.
N-53	:	110 days duration. Bright scarlet red colour bulbs. Suitable for planting in kharif season, average keeping quality, yield 200-250 q/ha.
Arka Niketan	:	145 days duration. High pungency, very good storage life of 5-6 months. Suitable for both kharif and rabi. Good keeping quality. Yield 340 q/ha,
Arka Pragati	:	140-145 days duration. Early variety. Yield 200-300 q/ha.
Arka Kalyan	:	Suitable for planting in kharif season. 100-110 days duration. Average keeping quality. Yield 335 q/ha.
Agri-found dark red	:	160-165 days. Average keeping quality. Suitable for kharif and rabi season. Yield 300-400 q/ha.
Agri-found light red	:	160-165 days. Good keeping quality, winter crop. Yield 300-325 q/ha.

Land preparation

Medium land should be ploughed after the harvest of paddy for 4-5 times till a fine tilth is obtained. Remove the root stubbles. Incorporate the FYM/compost at the time of final land preparation.

Seed rate

10.0 kg/ha.

Seed treatment

Seed should be treated with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Raising of seedlings

Raise seedlings in 3m x 1.5 m nursery bed and incorporate 20 kg of well decomposed FYM/bed. Nursery of 0.05 ha with 10 kg of seed will be sufficient for raising seedlings for transplanting one ha. of land. First week of October is considered to be the best time for sowing the seeds in the nursery.

Transplanting

Prepare 30 m x 3 m size beds and transplant 45-60 days old seedlings of 15-20 cm height at a distance of 15 cm row to row and 10 cm plant to plant. Transplanting should be completed in the first fortnight of December.

Manuring

Apply 25 to 30 t of FYM/compost, 120 kg N, 60 kg P_2O_5 and 100 kg K_2O/ha. 50% of N, full dose of phosphorus and 50% K_2O should be applied as basal. The remaining quantity of N should be given in two splits i.e. at 3 weeks and 6 weeks after transplanting. Rest 50% K_2O should be given at second top dressing alongwith second split of N.

Interculture

Three weedings and light hoeings are required for the crop. In early stage, irrigate crop at short interval and increase the frequency of irrigation with the increase in age of the crop and decrease with maturity. Moisture stress, decreases yield.

Plant protection

To check leaf blight/spot, spray the crop with Mancozeb 0.3% or Copper oxychloride @ 0.3% at 14 days intervals. Refer **Annexure-III**.

Harvesting

Onion is matured in 4 months. Harvesting should be done when 50% tops fall. Onions are made into bundles and dumped in the field for curing. Spraying of 250 ppm MH, 15 days before harvesting suppresses sprouting.

IMPACT POINTS

1. Use 45-60 days old seedlings.
2. Use potassium sulphate as the source of K_2O.
3. Harvest the crop at 50% tops falling over.

GARLIC

Variety

Important garlic varieties are DARL-52, G-282.

Fawari -	Bigger bulbs, white colour, compact cloves.
Rajalle Gaddi-	Medium sized bulb, high pungency
T 5641-	Medium sized bulb, white colour
Jamnagar-	Biggest bulbs, white colour, compact cloves

Land preparation

Medium land should be ploughed after the harvest of paddy for 4-5 times till a fine tilth is obtained.

Seed rate and seed treatment

Seed rate is 500 kg/ha. Garlic cloves should be treated with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Planting

The cloves should be dibbled at a spacing of 15 cm between the rows and 7.5 to 8 cm within the rows. Ideal time of planting is second fortnight of October.

Manuring

Apply 40-50 t of FYM/ha at the time of field preparation and mix it thoroughly in the soil. Apply 120 kg N, 60 kg P_2O_5 and 120 kg K_2O/ha. 50% N, full dose of P_2O_5 and 50% K_2O should be applied as basal dressing. The remaining quantity of N should be given in two split doses i.e. 3 weeks and 6 weeks after planting. Remaining dose of K_2O should be applied as second top dressing along with second split of N.

Interculture

Three weedings and light hoeings at 20, 40 and 60 days after planting are required for the crop. In early stage, irrigate the crop at short interval and increased the frequency of irrigation with the increase in age of the crop and decrease with maturity. Moisture stress decreases yield.

Plant protection

Dimethoate 30 EC @ 1000 ml/ha against thrip incidence. To check fungal blights, spray Mancozeb @ 0.3% or Copper oxychloride @ 0.3% or carbendazim @ 0.15%.

Harvesting

The crop is ready for harvesting when the tops turn yellow or brownish and show signs of drying up and bend over. The bulbs begin to mature in about 4 to 5 months. The bulbs are lifted, cleaned and the leaves are tied at the top. The bulbs are dried for a week or so under shade. Then they are stored in a well ventilated store room.

Yield

50 to 75 q/ha. Recovery of cloves from the bulbs ranges from 86 to 96%.

CHILLI

Variety

Pusa Jwala	:	Resistant to virus disease. Attains maturity in 120 days. Fresh weight and dry weight yield 81.0 q and 15.0 q/ha, respectively.
N.P. 46A	:	Fruits are long, thin, green and pungent. Turns bright red in ripening stage. High yielder, 18 q/ha.
Lam-X-235	:	Attains maturity in 130 days with an yield of 91.9 q and 24.0 q/ha on fresh and dry weight basis, respectively.
Pant-C-1	:	Resistant to virus, high yielder. Good for green chilli
BR-red	:	Attains maturity in 130 days, suitable for dry chilli, 19-20 q/ha as dry chilli
Utkal Ava	:	Attains maturity in 125 days, suitable both for green and dry chilli purpose. Yield 31.0 q/ha as dry chilli
Utkal Ragini	:	Attains maturity in 140 days. Suitable for green chilli, cluster fruiting habit 102 q/ha as green chilli
Pusa-Sadabahar	:	Disease resistant, multipurpose, perennial chilli, 15-20 q/ha as dry chilli
Utkal Rasmi	:	High yielder, 22-24 q/ha as dry chilli. Very good for dry chilli

Land preparation

High medium land having more organic matter is suitable for chilli. Plough the field for 3-4 times.

Seed rate

750 g/ha.

Seed treatment

Treat the seeds with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Sowing

Sow 750 g of seeds in 100 sq.m. nursery to raise seedlings for one ha. Transplant 40 days old seedlings. Plant the seedling at a spacing of 50 cm x 30 cm in the main field.

Fertilizer

Incorporate 12.5 tonnes of well decomposed manure at the time of ploughing and apply 120 kg N, 50 kg P_2O_5 and 75 kg K_2O/ha. Basal dose should consist of full P_2O_5 and 20% each of N and K_2O. Next 40% each of N and K_2O should be applied 15-20 days after

planting and 2nd top dressing should be done with 40% each of N and K_2O after 30-40 days after planting .

Interculture

Three hoeings and weedings should be given to the crop. Hoeing, weeding and earthing should coincide with each top dressing. As most of the chilli crops are taken during the period from October to June, 10-12 irrigations are required. Water scarcity may cause fruit drop. Apply two sprays of planofix (@ 50 ppm. NAA/ 5 ml Planofix/4.5 litre of water) for better fruit setting one at the time of flowering and second spray 10-12 days after first spray. Chilli can be planted as an intercrop in banana plantations.

Plant protection

Give a bare-root dip to the seedlings at the time of planting with 0.05% of carbosulfan 25 EC or monocrotophos 36 SL for 6 hours against root-knot nematode Thrip incidence cause considerable loss to the crop at all stages. Spray monocrotophos 36 SL or dimethoate 30 EC @ 1000 ml/ha in 500 litres of water. In fruiting stage malathion 50 EC @ 1000 ml/ha be sprayed and a minimum period of 7 days should be maintained between application and harvesting of the fruits. Damping off is a disease at early stage and twig blights are seen in later stages. Spray any copper oxychloride preparation at 0.3% concentration or captan 0.2% or Mancozeb (0.3%). For die back and anthracnose spray Ziram @ 0.2% at 10-14 days intervals. Seed treatment with 0.3% thiram. Refer **Annexure-III and IV**.

Harvesting

Chillies should be harvested in full ripe stage and should be dried at 130°F under full sunshine for 10-15 days. Under ripe fruits turn white on drying.

IMPACT POINTS

1. Maintain proper plant population
2. Spray planofix
3. Harvest chillies at full ripening stage.

ORNAMENTAL CROPS

GLADIOLUS

Variety

Friendship White, Friendship Pink, American Beauty, Vincka's Glory, Vinka's Beauty, Psittanus Hybrid, Red Beauty, Her Majesty, White Prosperity, Wild Rose, Apple Blossom, Cherry Blossom, Black Jack, Oscar, Yellow stone, Rose Supreme, Mayur.

Soil

Well drained sandy loam to clay loam fertile soil with slightly acidic nature is ideal

Propagation

Propagated by means of corms and cormels. About 4-5 cm dia corms give best flowering. About 1,00,000 corms will be required for planting 1 ha of land.

Time and method of planting

Deep ploughing (20-30 cm) and incorporation of FYM@ 50 t/ha in soil one month before planting is good. Second ploughing should be done 2-3 weeks before planting. Phosphatic and potassic fertilizers should be incorporated during the last ploughing. Scales of corms are removed, treated with 0.2% carbendazim or captan or 0.1% benlate for 30 min, dried under shade and spread on wet sand bed for sprouting. Planted in flat beds of size 10 m x 1.5m, prepared 1 m apart. Thus 400 beds/ha are prepared during September-October.

Spacing

Plant the corms at a spacing of 30 cm x 20 cm and 7 cm deep.

Manure and fertilizers

Apply FYM @ 50 t/ha alongwith 200 kg N, 200 kg P_2O_5 and 200 kg K_2O/ha. N is applied in 4 equal splits i.e. during planting, at 2-3 leaf stage, spike emergence stage and 2 weeks after harvesting of the flowers.

Interculture

Manual weeding 4-5 times is required to raise a crop successfully. Weedicides like atrazine or simazine @ 1.0kg a.i./ha in 500 litre of water should be applied one day after planting. Earthing up should be done twice, once at 3 leaf stage and another just before spike emergence stage. Staking must be provided 6-8 weeks after planting.

Irrigation

For better growth, flowering and development of corms irrigation should be provided at 7-10 days interval.

Plant protection

Leaf blight	:	Spraying of Maneb @ 0.2%
Wilting	:	Soil drenching with 0.2% Captan
Aphids	:	Spraying Dimethoate or Endosulfan @ 0.2%
Thrips	:	Spraying Dichlorvos @ 0.1%
Mites	:	Spraying Dicofol spray @ 0.05%

Harvesting and yield

Harvested 60-100 DAP (varies accordingly to cultivar) 1,00,000 plants/ha produce >1,10,000 spikes. Corms and cormels are harvested 6-8 weeks after harvesting of spike. About 1-2 corms and 10-15 cormels are produced per plant.

MARIGOLD

Variety

African marigold	:	Giant Double African Yellow, Giant Double African Orange, Snow Bird, Golden Age, Sirakole, Spun Gold, Spun Yellow, Sweet 'n' Yellow, Sweet 'n' Gold, Pusa Basanti Gainda, Pusa Narangi Gainda
French marigold	:	Red Pygmy, Happy Orange, Happy Yellow, Queen Sophia, Orange Sophia, Honey Sophia, Goldie, Star Dust, Rusty Red, Lemon Drop, Honey Comb, Golden Boy, Harmony, Susana and Little Devil

Soil

Well drained fertile sandy loam soil is best. African types need well manured moist soil and french types perform well on a light soil.

Propagation

Propagated by means of seed and cuttings.

Seed rate

2.0-2.5 kg/ha. sown in nursery beds of 3 m x 1 m size and for 1 ha of land 8-10 beds are required. African marigold when propagated by cuttings, about 1,00,000 rooted cuttings/ha are required. For seed treatment use (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0g + thiram 1.5g)/ kg of seeds.

Time and method of planting

Seeds are sown in mid August-September and the seedlings are planted in the field during mid September-October. Before planting the land should be thoroughly ploughed for 2 to 3 times. FYM is to be incorporated during final land preparation.

Spacing

40 cm x 30 cm for African Marigold

30 cm x 20 cm for French Marigold

Manure and fertilizers

Apply FYM @ 50 t/ha alongwith 200 kg N, 200 kg P_2O_5 and 200 kg K_2O/ha. FYM is mixed in the soil during land preparation 50% N, full dose of P_2O_5 and K_2O should be applied as basal and rest 50% N after one month after planting.

Interculture

Hoeing and weeding should be done twice during the cropping season. Pinching is done 40 days after transplanting.

Irrigation

In sandy loam soil irrigation is applied at an interval of 7 days.

Plant protection

Leaf spot and bud rot: spraying of 0.2% mancozeb.
Red spider mite : Spraying of 0.2% sulfex or dicofol 0.05%.
Caterpillar : Spraying of 0.1% dichlorvos or 0.2% endosulfan.

Harvesting and yield

Harvest fully opened flowers irrigate the crop in the previous day of harvesting.

Yield

120-150 q/ha.

ROSE

Variety

Hybrid Tea	:	Gladiator, Minu parle, Itoel La France, Montezuma, Papa Meilland, Taj Mahal, Confidence, Grand Opera, Gold Medal, Lal Bahadur,

		Montrel, Paradise, Super Star
Floribunda	:	Blue Perfume, Golden Jubilee, Shocking Blue, Lutin, Summer Snow
High quality cutflowers	:	Sonia, Motria, Golden Times, Norwa, Mercedes, Kanchi, ICO -Ambassador

Soil

Well drained, medium loam soil having a pH of 6.0-7.5 is ideal. Heavy clay soil is unsuitable for rose growth.

Propagation

Roses are generally propagated by 'I' or 'T' budding. *Rosa multiflora*, IIHR thornless *R.indica* are suitable rootstocks and budding is done during winter months.

Time and method of planting

Roses are planted at a spacing of 60cm x 60 cm in the beds of size 6.0 m x 1.2 m. prepared at 0.75 to 1.0m apart. The beds should be dug deep during summer and exposed to sun. For planting individually in pits the size should be 60cm x 60cm x 60cm. Ideal time for planting is September-October and can be continued upto December. During planting, 4-5 kg of well rotted cowdung manure and one handful bonemeal or sterameal and 3-5 g chlorpyriphos dust per pit should be applied.

Pruning

Ideal time for pruning is mid October to mid November. During pruning 6-8 numbers of shoots per bush should be retained and each shoot should have 6-8 number of eyes. Newly planted rose plants should not be pruned. Bordeaux paste or Blitox-50 paste should be applied to the cut end.

Manure and fertilizers

5 kg well rotted cowdung manure should be applied per plant during pruning. After 1 week of pruning each plant should be provided with 20g Urea, 60 g SSP and 25 g MOP. Deficiency of micronutrient can be managed by application of Manganese Sulphate 5g + Ferrous Sulphate 5g + 2.5 g slaked lime dissolved in 1 litre of water and sprayed.

Interculture

Hoeing and weeding should be carried out 3-4 times during a year

Irrigation

During summer twice a week and during winter once in a week.

Plant protection

- Powdery mildew : Spraying of Wettable Sulphur WDP 85% 0.2% or Ziram WDP 80% @ 0.1%
- Leaf spot : Mancozeb @ 0.2%
- Dieback : Mancozeb 0.2% or Captan 0.2%
- Scale insects/aphids/thrips: Spraying Methyl demeton @ 0.2%
- Mite : Dicofol @ 0.05%

Harvesting and yield

40-50 flowers/plant or 200-300 flowers/m^2 produced in each year. Flowers should be harvested at tight bud stage after showing colour for distant market and half open bud stage for local market.

CHRYSANTHEMUM

Variety

For field planting small flowered double Korean type such as Jyotsna, Khushrru, Flirt, Lalkila, Tara, Lilith, Priya, Purity, Criterion, Red Gold, Man Bhawan, Fatima, Lalpari and Sonali are suitable.

Soil

Well drained sandy loam soil of good texture, neutral to slightly acidic pH (6.5 to 7.0) with high organic content is ideal.

Propagation

Commercially propagated by means of cuttings and suckers. Rooted suckers are planted in nursery during January as stock plants. Pinching is done 5 times for profuse branching, during April, May, June, August and mid September. After 3rd pinching, terminal cuttings of 7-13 cm long are taken from stock plants and planted in sand for rooting. The basal portion of the cuttings are treated with seradex/ keradex (rooting hormone powder).

Time and method of planting

The field is ploughed 2-3 times before preparation of beds for planting. Rooted cuttings are planted in the field during August-September at a spacing of 30cm x 20cm distance on ridges. After 4 weeks of planting, when plant attains 8-10 leaves stage first pinching is done by removing the terminal portion, second pinching is done 3 weeks after first pinching.

Manure and fertilizers

Apply FYM @ 50 t/ha alongwith 62.5 kg N, 100 kg P_2O_5 and 100 kg K_2O/ha. FYM is mixed in the soil during land preparation, 50% N, full dose of P_2O_5 and K_2O should be applied as basal and 50% N after 40 days of planting

Interculture

Weeding is done to protect the crop from weeds. Normally in field condition staking is avoided to save manpower.

Irrigation

Irrigation should be provided at an interval of 7-10 days during winter season.

Plant protection

Aphids : Spraying the crop with Dimethoate or Methyl demeton 0.2% at 10 days interval.

Septoria leaf spot : Spraying the crop with 0.1% carbendazim or 0.3% difolatan or at monthly interval

Leaf blight : Spraying the crop with 0.2% mancozeb at an interval of 10 days.

Harvesting and yield

Flowers are harvested 5-6 times per crop and a well managed crop gives yield of 8-10 t/ha.

TUBE ROSE

Varieties	**:**	Single: Calcutta Single, Coimbatore Single, Bangalore Single, Sringar, Prajnol, Vaibhar Double: Suvasini, Pearl, Calcutta Double.
Soil	**:**	Fertile well drained clay loam soil is ideal for tuberuse
Propagation	**:**	Propagated by means of bulb and suitable size is 1.5 to 2 cm.
	:	Bulbs (1,00,000 bulbs/ha) planted in 10m x 1.5m beds. For 1 year crop, 2-3 bulbs/hill and for 3 years crop, 1 bulb/hill in single type and 2 bulbs / hill for one year crop and 1 bulb/hill for 3 years crop in double type are needed.
Spacing	**:**	30 cm x 20 cm
Time of planting	**:**	March-May Provide irrigation on need basis.
Manure and fertilizer	**:**	FYM 50 t/ha, Neem cake-4.0 q/ha N 300 kg/ha P_2O_5 200 kg/ha K_2O 200 kg/ha
Basal	**:**	Full P_2O_5 , $K_2$0 and 1/3rd N
Top dressing	**:**	1/3rd N 30 Days after planting 1/3rd N after 60-90 Days after planting
Interculture	**:**	Weeding at monthly interval and light earthing up at two month stage.
Plant Protection	**:**	Stem rot & Bud rot : Spraying of 0.3% Copper oxychloride or Zineb Aphids & Thrips :Spraying of 0.1 % Dimethoate or Malathion.
Yield	**:**	Flowering starts after 130-150 days of planting 50 q loose flowers/ha or 2.5 lakh spikes/ha

PRESERVATION OF FRUITS AND VEGETABLES

BEVERAGES

Name of the product	Type of fruit required	FPO specification		% of acidity	Preservatives
		TSS minimum brix	Minimum juice content		
Juices					
a. Natural	Pineapple, mango, orange, lemon, grape	Natural	100	Natural	Canning Chemical
b. Sweetend	-do-	10	85	1.5-3.5	-do-
Ready to serve beverage	-do-	10	10	1.5-3.5	
Squash	-do-	40	25	1.5-3.5	350 ppm of Potassium metabisulphite. or 600 ppm of sodium benzoate for coloured Juice.
Cordial	Lemon,	30	25	1.5-3.5	-do-
Crush	pine apple, mango, orange, lemon, grape	55	25	1.5-3.5	-do-
Syrup (natural)	-do-	65	25	1.5-3.5	Same as squash when TSS 68% No preservatives when TSS 68%
Nectar (pulpy fruits)	Mango, guava	15	20	-	Cannning

PREPARATION MANUAL FOR BEVERAGES

Washing

- Soak the fruits in chlorinated water for 12 hours @ 25-50 ppm of Cl_2
- Wash in chlorinated water of 5-10 ppm solution. Spray washing at 15-20 PSI spray or still washing or agitation washing.

Peeling

- Hand peeling
- Steam peeling (boiling water)
- Mechanical
- Lye peeling (1% lye solution 200^o to 205^o F for 45 to 60 seconds)
- Explosion peeling (100 PSI for 3 seconds or 75 PSI for 60 seconds)
- Flame peeling (1000^oF/one second)

Slicing

According to required size.

Extraction of juice

Use screw type or bucket type of roser type juice extractor or by netting the green fruits (mango).

Straining

Straining through muslin cloth in case of watery juice and through mosquito neating cloth in case of pulpy juice.

Syruping

Mix sugar and water, dissolve by warming and strain through muslin cloth and cool.

Mixing

Mix the extracted juice with syrup and add citric acid.

Preservative

- Potassium meta-bisulphite is added for SO_2
- Sodium benzoate is added for benzoic acid for natural coloured fruit.

Colour

- 0.02 g to 0.06 g/kg
- Mango- Orange red or golden yellow colour or green colour.
- Pineapple- pineapple yellow or lemon yellow colour
- Orange- Orange red colour
- Lemon- Lemon yellow colour

Essence

2 ml/kg (essence of concerned fruit)

Bottling

Narrow mouthed bottle is used for filling by leaving a head space of ½-1.0 inch.

JAM

Type of fruit	:	Fruits having pectin (Apple, guava, papaya, mango, pineapple)
Quality of fruits needed	:	Garden fresh, matured, well ripen, disease and pest free, not over ripen
F.P.O. specification	:	Minimum TSS should not be less than brix-68.5^0 Minimum juice content – 45 to 50 Percentage of acidity – 0.5 to 0.6 Preservative – No preservative required as TSS exceeds 68%
Washing	:	Soaking (Chlorinated water for 12 hours) @ 25 to 50 ppm of Cl_2 Washing (chlorinated water of 5 to 10 ppm solution) Spray washing 15 to 20 PSI of spray Still washing Agitation washing
Peeling	:	Hand peeling
Slicing	:	Slicing
Extraction of juice	:	By boiling the slices in 250 ml of water/kg of pulp for 45 minutes.
Straining	:	Meshing through mosquito neeting cloth
Syruping	:	Pulp + sugar boiled in 105^{o}C or 68^o brix. Sugar (1:1 pulp: sugar)
Addition of acid	:	Citric acid (4 g/kg of pulp)
Bottling	:	Wide mouthed bottles allowed to cool and set for 12 hours. wash and seal

JELLY

Type of fruit	:	Fruits rich in pectin (Apple, guava, papaya) or having minimum 1% pectin
Quality of fruits needed	:	Garden fresh, fully matured, firm ripe, disease and pest free with 50-100g wt. Fully ripe fruits but not over ripen
F.P.O. specification	:	Minimum TSS : Not be less than 65^0 brix Minimum juice content : According to the pectin strength of juice by jelmeter reading *1 ¼ = 1.250 kg sugar, 1 = 1 kg sugar, ¾ = 0.750 kg sugar* Percentage of acidity – 0.5 to 0.6 Preservative: should not be less than 40 ppm SO_2
Washing	:	Soaking (Chlorinated water for 12 hours) @ 25 to 50 ppm of Cl_2 Washing (chlorinated water of 5 to 10 ppm solution) Spray washing 15 to 20 PSI of spray Still washing Agitation washing
Slicing	:	To convenient size
Extraction of juice	:	By boiling the slices in 1:1 ratio water for 30 minutes
Straining	:	Straining through mosquito netting cloth or muslin cloth
Syruping	:	Pectin extract + sugar boiled in 104^oC or 65^o brix.
Addition of acid	:	Citric acid (5,6 g/kg extract)
Preservative	:	No preservative
Bottling	:	Wide mouthed bottles allowed to cool and set for 12 hours. wash and seal

CHUTNEY

Type of fruit	:	Tomato, lime, mango, apple, ginger and pineapple
Quality of fruits needed	:	Well matured, garden fresh sound fruits
F.P.O. specification	:	Minimum TSS : Not less than 50^{o} brix Minimum juice content : Entire fruit Percentage of acidity – 0.5 to 3.0 Preservative: 250 ppm Benzoic acid
Washing	:	Soak the fruits in chlorinated water for 12 hours @ 25 to 50 ppm of Cl_2 Wash the fruits in chlorinated water of 5-10 ppm solution Spray washing 15 to 20 PSI of spray Still washing Agitation washing
Peeling	:	Steam peeling
Syruping	:	Same as jam preparation, chopped onion and garlic are added
Addition of acid	:	Acetic acid to be added
Preservative	:	Sodium benzoate to be added
Bottling	:	Wide mouthed bottles allowed to cool and set for 12 hours. wash and seal

PICKLES

Type of fruit	:	Mango, lemon, aonla, dilenia, ber, jack fruit, mixed vegetables
Quality of fruits needed	:	Well matured, garden fresh sound fruits
F.P.O. specification	:	Percentage of acidity : 3.0 Preservative: chemical Benzoic acid (250 ppm)
Washing	:	Soak the fruits in chlorinated water for 12 hours @ 25 to 50 ppm of Cl_2 Wash the fruits in chlorinated water of 5-10 ppm solution Spray washing 15 to 20 PSI of spray Still washing Agitation washing
Peeling & Slicing	:	Peeling is done if necessary but slicing is essential. Curing is done except some fruits like jack fruits, mixed vegetables, ber and dilenia (21 to 23 days) by using 8-10% brine solution.
Preparation of spices	:	Prepare spices powder, paste of ginger, garlic and fry with edible oil
Mixing	:	Mix the dried peels with spices preparation
Addition of acid	:	Acetic acid to be added (2-4%)
Preservative	:	As in case of chutney and add boiled and cool oil to prevent aeration.
Bottling	:	Fill in wide mouthed bottles or jar.

MURABBA, CANDIED FRUITS, GLACED FRUITS AND CRYSTALLISED FRUITS

Type of fruit	:	Ash gourd, carrot, ginger, papaya (Green), aonla and cooking varieties of fruits
Quality of fruits needed	:	Matured but not over ripen
F.P.O. specification	:	Minimum TSS : Not be less than 70 to 80 brix Minimum juice content : Entire fruit or vegetables. Percentage of acidity : 0.1
Washing	:	Soak the fruits in chlorinated water for 12 hours @ 25 to 50 ppm of Cl_2 Wash the fruits in chlorinated water of 5-10 ppm solution Spray washing 15 to 20 PSI of spray Still washing Agitation washing
Peeling & Slicing	:	Peeling is done in case of thick skin fruits and vegetables. Slicing is required in case of big size fruits and vegetables and pricking is necessary.
Straining	:	Boiling or calcium hydroxide treatment is given to soften the texture
Syruping	:	Slices are dipped in 50% syrup in every alternate day and the strength of syrup made upto 70 brix.
Addition of acid	:	Citric acid
Packing	:	Remove the slices from syrup, dry in the air and pack in polythene packets or in jars.

ASH GOURD PETHA

Select sound, fully ripe gourd with tough texture. Cut it into slices and remove the seeds and inner soft pulp. Remove outer hard surface with a stainless steel knife, cut the peeled slices into cubes or pieces of desired shape and size.

Prick the cubes or pieces of petha with a stainless steel fork or wooden or bamboo pricker and keep them completely immersed in fresh lime water (prepared by mixing 60g. of quick lime in 1 ltr. of water, stirring vigourously and allow it to settle down, finally decanting and filtering is done) for 3-4 hours depending upon the softness of the petha. Softer the petha longer is the period for which it is to be left. Drain off the lime water and wash the fruit pieces thoroughly in running water.

Soften the petha pieces by placing them in boiling water for about 15-30 minutes. This helps them to absorb sugar from the syrup. Drain off the water and spread the pieces on a clean white sheet for removing some moisture.

Prepare sugar syrup by dissolving 2 parts of sugar in 3 parts of water. Heat to boil the solution, remove the scum and filter through thick cloth to get a clear syrup. The quantity of syrup prepared should be equal to three times the quantity of the prepared fruit.

Add the fruit pieces to be boiling syrup and continue heating till the temperature reaches 107^{o} C (at sea level) or the syrup becomes thick enough to give 2-3 threads when drawn between two fingers. Allow the whole mass to stand overnight, drain off the syrup through a stainless steel sieve. Dry the pieces in shade, roll them in finely ground sugar powder and store it in a clean dry glass container till consumption.

BAMBOO CANDY

Select tender Bamboo shoots 45-60 cm long. Remove the sheaths or outer covering leaves with a sharp knife. Cut the tender portion into rings or pieces of suitable size. Thinly scrap off any green portion on the pieces. (leafy portions towards the growing tip may be used for making chutney).

Boil the rings or pieces of shoots in water 2-3 times for 30 minutes each time to remove the bitterness. Change the water every time, prick the boiled pieces with a S.S. needle or fork. These prepared pieces may be used for candies, chutney and for canning.

Then prepare syrup of 30^{o} brix by mixing 3 parts sugar with 7 parts of water and stirring. Use about 1.75 Kg of syrup per Kg. of bamboo pieces, cover the pricked rings of shoots with the syrup and boil for a few minutes. Allow them to stand in syrup for 24 hours. If possible, determine the TSS by means of brix hydrometer. The brix will be stightly less than 30^{o} brix due to the absorption of sugar by the bamboo pieces.

Then drain the syrup and increase the concentration (TSS) by about 10^{o} brix by adding more sugar. Bring the syrup to boil and pour it back on pieces. Repeat this every day till the concentration reaches about 60^{o} brix. At this stage, add a small amount of citric acid / tartaric acid (about 0.1% of the total weight of syrup). Increase the strength of syrup by 5^{o} brix each day till it reaches 75^{o} brix and keep it as such for a week.

Recipe:

Bamboo rings or pieces	-	1kg.
Sugar Syrup 30^{o} brix	-	1.75 kg.
Citric / Tartaric acid (0.1%)	-	1.75 g.

After a week boil the pieces along with the syrup for 5 minutes. While still hot, drain the syrup and roll the pieces in finely ground sugar powder. Add any flavour, if needed. Then place the pieces in a wooden tray and allow to dry it in shade. Then pack in a air tight container, store in a dry and cool place. If desired, each piece may be wrapped in cellophane paper.

MARMALADE

(Santras & Malta)

Type of fruit	:	Orange, Rough lemon, pumello, grape fruits
Quality of fruits needed	:	Garden fresh, matured, well ripen disease, pest and blemishes free, not over ripen
F.P.O. specification	:	Minimum TSS : Less than 65^{o} brix Minimum juice content : According to the pectin strength of juice by jel meter reading, as per caliberation, every cup of extract needs *1¼ cup of sugar, 1 cup of sugar, ¾ cup of sugar* Percentage of acidity : 0.7 to 0.8 Preservative : should not be less than 40 ppm of SO_2
Washing	:	Soak the fruits in chlorinated water for 12 hours @ 25 to 50 ppm of Cl_2 Wash the fruits in chlorinated water of 5-10 ppm solution Spray washing 15 to 20 PSI of spray Still washing Agitation washing
Peeling	:	Hand peeling with the help steel knife, retaining as much of albedo portion as possible
Slicing	:	In convenient size or thin slices
Extraction of juice	:	By boiling the slices in 1:1 ratio of water for 30 to 45 minutes
Straining	:	Straining through coarse muslin cloth, then add 1/3 to1/4 the quantity of water and take second & third extracts, mix all the extracts & keep mixture overnight in a deep vessel for settling. Draw out the clear extract and discard the residue.
Addition of sugar	:	To every cup of clear extract which contains high or medium quantity of pectin, add ¾ or half cup of sugar.Then boil the mixture to 103^{0}C. Add boiled shreds of orange peel & continue boiling till the product reaches 105^{0}C.
Addition of acid	:	Citric acid
Bottling	:	Wide mouthed bottles allowed to cool and set for 12 hours. Close them tightly with screw caps.After cooling store in cool & dry place.

TOMATO PRODUCTS

Puree, paste, ketchup, sauce

Quality of fruit needed	:	Red coloured, well plant-ripened firm fruit, garden fresh, disease, pest & blemishes free fruits
F.P.O. specification	:	Minimum TSS brix : less than 9 in case of puree and less than 25 in case of paste, ketchup and sauce Minimum juice content : Entire juice. Percentage of acidity : 1.2 to 1.5 in case of puree and paste and 1.2 in case of ketchup and sauce Preservative : 250 ppm on Benzoic acid in case of puree and paste and 750 ppm of Benzoic acid in case of ketchup and sauce
Washing	:	Soak the fruits in chlorinated water for 12 hours @ 25 to 50 ppm of Cl_2 Wash the fruits in chlorinated water of 5-10 ppm solution Spray washing 15 to 20 PSI of spray Still washing Agitation washing
Peeling	:	Steam peeling
Extraction of juice	:	Cold break method (Slicing and extraction) Hot break method (slicing, heating and extraction)
Straining	:	Meshing through mosquito net cloth
Syruping	:	In case of ketchup and sauce ½ of sugar at initial stage rest 2/3 at 16^{o}. Boiling of the concentrates grinded spices bag of clove, cinnamon, cardamum onion paste, garlic paste to be boiled simultaneously
Addition of acid	:	Acetic acid
Preservative	:	Sodium benzoate
Bottling	:	Narrow mouthed bottle and inverted immediately

GINGER MURABBAH

Type of fruit	:	Ginger, aonla, pineapple, orange peel, lemon, cherry
Quality of fruits needed	:	Matured but not over ripe
P.O. specification	:	Minimum TSS : 75^{o} brix Minimum juice content : Entire ginger Percentage of acidity : 0.2 to 0.8% of sugar taken
Washing	:	Usual way, wash in light warm water twice to remove all sand particles.
Peeling & Slicing	:	To remove the exocarp peeling and slicing is required.
Straining	:	Cooked slightly in water to make it soften to absorb sugar
Syruping	:	Add half of its weight sugar, 106^{0}C boiling in syrup and allowed for 24 hours. Then its brix reading will be 40^{0}. Then add more sugar so that brix reading will be around 68^{0} brix in 3^{rd} day. Then left in this way for 3 to 4 days to obtain a brix of $70^{0} – 75^{0}$ brix.
Addition of acid	:	0.2 to 0.8% of sugar taken
Packing	:	Remove the slices from syrup, dry in the air and pack in polythene packets or in jars.

VALUE ADDED PRODUCTS OF GINGER

DRY GINGER

- Harvsting of the ginger rhizomes at maturity when the skin is partially dry and hard with dried scale leaves.
- Immediately after harvesting select healthy bold pieces for dry ginger
- Cleaning of ginger rhizomes from soil and roots and washing thoroughly in clean flowing water for 30 minutes, start peeling within 12 hours of harvesting.
- Light careful peeling of the skin of fresh rhizomes with sharpened wood or bamboo should be done carefully without rupturing the oleoresin cells below the skin avoiding the joints with finger. Size of each piece should be 50-60 gm.
- 50-60 gm piece fresh rhizomes are good for preparation of dry peeled ginger.
- Washed in clean water and dried under sun on a clean floor till the moisture per cent is 8-10% (un bleached dry ginger).
- Washed in clean water after peeling of skin then dipped in 20% lime slurry for at least 4-6 hours and dried under sun over a hard floor for 10 days (bleached dry ginger) and the process of drying and dipping in lime slurry is continued till uniform white colour (bleached dry ginger) is obtained.
- Drying peeled ginger on clean surfaces like bamboo mats/coconut leaves/tarpaulin for 10-15 days under dry sun till the moisture content of dry ginger is 8-10% level. Solar cabinet drier/Tunnel drier at 60^0 C for 46 hours up to 8-10% moisture content.
- Dried ginger (unbleached) can be polished by rubbing with gunny bags or a hard cement floor for smooth dry ginger.
- Packed and stored in air tight polythene lined gunny bags for 6-8 months.

Storage

Dried ginger should be stored in dry godowns free from dampness. Wooden racks are used for keeping and stacking the polythene lined gunny bags. 60 cm from wall and above ground. Stored dry ginger should be periodically exposed to sun in order to prevent damage from insects.

GINGER IN BRINE/SALTED GINGER

- Early harvesting of rhizomes when the skin is tender.
- Cleaning of the rhizomes from soil, roots and washing in water.
- Peeling of the skin by bamboo/stainless steel knife.
- Washing of the peeled rhizomes in clean water.
- Dipping of the rhizomes in 16% NaCl (common salt) for 2 weeks.
- Removal from salt solution and washing in water and then drying for 1-2 days under partial shade.
- The packing is made in bottles (plastics)/ glass jars.

GINGER CANDY (FRESH GINGER IN SUGAR SYRUP)

- Select only very tender, fibreless & large sized rhizomes.
- Early harvesting of the rhizomes with tender skin.
- Cleaning of the rhizomes from soil and roots
- Peeling of the skin (tender) of rhizomes by bamboo/wooden knife cut the ginger into shape of your choice. (cubes, round pieces or even sticks of equal slices, each slice of 1-1.5cm thickness)
- Washing of the peeled rhizomes in clean cold water.
- Boiling of rhizomes in 0.5% (by wt. of rhizomes) citric acid solution for 30 minutes in pressure cooker.
- Pricking of the pieces by a bamboo / stainless steel fork and then separate from water. Prepare sugar syrup by taking 30% sugar solution & boil with ginger for 15 minutes and leave them overnight.
- Utilising already used sugar, prepare 40% syrup in cold filter water and ginger (1.5 cm pieces dipped in sugar for overnight) pieces are boiled in 40% sugar syrup for 10 minutes and kept in cool syrup for overnight.
- Then the syrup after measuring the volume more sugar is added to raise to concentration of syrup to 50% and then the ginger is boiled for 10 minutes and then left overnight in syrup.
- Then the concentration of the syrup is raised to 70-75% by adding 20-25% more sugar to the used syrup and boiled for 10 minutes and kept overnight.
- Lastly it should be rolled in sugar powder & kept in room temperature in dry place.
- Then the ginger candy (Sweet) is prepared and kept in glass bottle at room temperature in a dry place.

GINGER PASTE

- Harvesting of ginger at 8 months after planting.
- Clean of the rhizomes from soil and roots etc.
- Peeling skin of the rhizomes with a sharp bomboo piece/stainless steel shape knife and cut into small pieces of 1.0”-2.0” (2.5-5.0 cm length) rhizomes.
- Washing of the 1” peeled rhizomes pieces in cold clean filtered water.
- Blanching of the peeled pieces in filtered water by boiling for 5 minutes and drain water.
- Mixing with common salt (NaCl) @ 2% wt/wt cut rhizomes. Grinding in a grinder to prepare paste without water. The paste is passed through a sieve to detect unmacerated piece of ginger.
- Then 0.06% sodium benzoate will be mixed in the macerated sieved ginger paste.

Storage of ginger paste for longer period

Dry clean glass bottles are kept over boiling water in a sauce pan and then filled with preservative added ginger paste. The mouth of the bottle is closed with the cap and bottles are removed from the boiling water.

Sealing of bottles

Bottle cap can be sealed air tight by molten way or adesive tape (Cello tape) and kept for 6 months.

NATURAL RESOURCE MANAGEMENT

Natural resource management envisages the judicious use of natural resources viz; soil, water, climate, crop and bio-diversity to support the food need of the present population without endangering the natural resource base for the future generation. The food grain demand is mounting each year with the rise in population. The per capita cultivated land:man ratio is decreasing thereby compelling us to resort to intensive cultivation measures. This has resulted in the emergence of new generation problems like soil degradation, lowering of soil fertility, declining of factor productivity, depletion of resources, yield plateauing in crops, development of secondary and micronutrient deficiency symptoms, shift in weed flora and new disease and pest problems. These are the concerns for the food security of the future. It is estimated that food grain production has to be increased from the highest level of production 82.30 lakh tonnes achieved during 2001-02 to 137.92 lakh tonnes to support the projected population of 5.08 crores by the year 2020 AD in Orissa.

In this endeavour, the various options to increase production include enhancement of genetic potential of crops (developing HYV/hybrids) and to harness the untapped potential of existing technologies and resources in an integrated manner. The latest developed HYV/hybrids in respect of crops are being dealt in the package of practices of different crops.The INM (management of plant nutrients from soil, inorganic, organic and bio-fertilizer sources), pest management technologies and other ancillary measures are of prime importance. The INM holds the key to sustain production and productivity. But field experience has shown that unbalanced use of chemical fertilizers and their chemical properties have disrupted the optimum nutrient balance in soil. Besides the major plant nutrients, there has been development of deficiency symptoms of nutrients like Ca, Mg, S,B and Zn in many areas. The ways to overcome these problems through the use of fertilizers in conjunction with organic manures (vermi-compost, enriched compost and bio-fertilizers) has been outlined.

Pests cause considerable losses to the potential production. Around 15% of the attainable agricutlural output is estimated to be lost due to pests despite use of pest management measures. The losses would be huge if crops are left unprotected. Therefore, integrated approach has been enshrined as the cardinal principle in the overall IPM programme. The threshold limits of pest attack, use of new pesticides and other alternative measures like bio-pesticides and bio-agents are covered for effective pest control.

Water management including rain water conservation and efficient utilisation, soil sampling, soil test rating, fertilizer recommendation, amelioration of nutrient deficiency symptoms, post harvest storage of food grains, post harvest technology on preservation of seed quality, food processing and value addition are being dealt in this section.

MANAGEMENT OF RESIDUAL SOIL MOISTURE FOR RABI CROPS

The water (soil moisture) is the basic necessity for any crop. The water received from rain during kharif is lost to a large extent in various ways such as;

- Surface runoff
- Percolation and seepage
- Evaporation and
- Transpiration

The following strategies are to be taken up during kharif season to conserve moisture for a successful rabi crop :

- Summer ploughing wherever possible to increase intake rate of rainwater.
- Development of water harvesting technology through on-farm reservoir (OFR) in rainfed upland. Renovation of natural depressions into such OFR can mitigate drought. Lining the reservoir with soil cement (6:1) mortar/100 gauge LDP is also beneficial in checking seepage loss.
- Putting embankment on natural streams/nallahs to store water.
- In-situ moisture conservation like contour cultivation, compartmental bunding, mixed/ intercropping establishment of vegetative bunds (Vetiver grass) across slope, mulching, interculture etc.
- Terracing (sloping inward)
- Contour trenching at 7-8 m interval
- Gully plugging stacking of locally available pebble filled in empty cement bags across water ways, growing of grasses in water ways alongwith the water ways are helpful in reducing soil erosion.
- Construction of percolation tanks
- Growing of erosion checking tanks
- Crop diversification
- Weed control
- Strengthening field bunds and raising the dyke height to 45 cm with provision of weir at 20 cm height for spilling over excess water to runoff collection tanks at the lower reaches of medium and low lands.
- Construct refugees or ditches at the lower reaches of medium land by devoting $1/10^{th}$ area of the cultivable land to provide the life saving irrigation at critical dryspell period and to promote rice-cum-fish cultivation. In favourable year, water stored in the refuge can be used to raise a second crop. The size of the refuge is top width 3m, bottom width 2m and depth 1.8 m. The length of the refuge is equal to the width of the plot.

The following measures should be adopted for successful rabi cropping with the residual soil moisture management.

1. Soon after the harvest of kharif crop, ploughing should be done early in the morning to break the top and capillary pores and preserve maximum

moisture by preventing evaporation loss and controlling weeds. Use of harrow/cultivators will help to cover larger areas in short period.

2. After sowing the seeds, a light roller or laddering may be drawn for better seed-soil content to bring up soil moisture to upper layers to facilitate germination of seeds.
3. Compaction of soil : The ground water from lower layer of the soil rises upto the soil surface through pore spaces in between soil particles and is called capillary rise of water. As per the principle of capillary action the narrower the tube the higher and quicker is the rise of water upwards. The more the soil is compacted the narrower becomes the pore space between soil particles and consequently the greater quantity of water that comes up.
4. Line sowing with the help of seed drill or behind plough is better than broadcasting because of assured placement of all the seeds in the moist zone and uniform germination. If the moisture adequacy is doubtful, inter-row spacing may be wider, because reduction of plant population will minimise transpiration loss. As far as practicable the rows should be along the contour i.e. across the slope to prevent surface run-off in sloppy land if there is rain.
5. Hoeing should be done within 2 to 3 weeks after planting (i) to control the weeds and save the main crop from competition for moisture and nutrients, (ii) to create dust mulch to minimise evaporation loss from lower layer and facilitate infiltration of post planting rain water.
6. Harvest the kharif crop just at maturity or even slight earlier where the soil moisture is quickly depleted so that a second crop can be sown with residual moisture.
7. In fields where kharif crop is sown in lines, hoeing in inter row spaces will help in conserving soil moisture. If possible rabi crops may be planted in the alleys of standing row crops before the moisture disappears.
8. In rainfed uplands, horsegram can be dibbled in lines 10-15 days before harvest of rice crop. Pulses like gram, fieldpea and lathyrus can be taken as paira crop in moisture retentive heavy soils of inland districts. In coastal districts blackgram and greengram are suitable for paira cropping.
9. Spray 2% urea/DAP to the paira crop twice at pre-flowering and flowering stage for better yield.

WATER MANAGEMENT

The technology of irrigation application at farm level

An understanding of the relationship between soil, plant and soil water is essential to make a decision concerning the timing and amount of irrigation application, selection and design of application methods and other water related aspects of crop management (usually weeds and pests). While dealing with irrigation application we generally come across a term called 'Water holding capacity' which is the capacity of soil to hold water, a part of which is ultimately available for plant use. A knowledge of the meaning of following terms is essential to have a clear idea about the "available water" in the soil.

Wilting point

The wilting point is the moisture percentage on a dry weight basis of a soil at which plant can no longer extract sufficient moisture to satisfy their moisture requirement and wilt permanently unless moisture is added to the soil.

Field capacity

The field capacity is the moisture percentage on a dry weight basis of a soil after rapid drainage has taken place following an application of water, provided there is no water table within the capillary reach of the root zone. This moisture percentage is usually reached within one to three days after application of irrigation, the time interval depending on the physical characteristics of the soil (sandy soils attain it faster compared to heavy soils).

The difference in moisture percentage at field capacity and wilting point is taken as moisture available to the crop plant.

Calculation of available water holding capacity

A field officer would be required to estimate the total water that would be available in a particular situation and also how fast it depletes so as to recommend a safe interval between two consecutive irrigations. For that matter one should know how the available moisture is found out. Available water capacity or moisture available for crop plants is calculated by the formula :

Available moisture(cm) = P & D./100

P = Per cent moisture held in the soil between field capacity and wilting point

& = Bulk density of soil in g/cc

D = Depth of soil in centimeters.

Bulk density is determined by dividing the oven dry weight in gram of a soil sample by its volume in cubic centimeters in its natural state at the time of sampling. The formula can be used when laboratory facilities exist. In its absence the data given in the following table can be used. The approximate available water content in different types of soils are given below.

Soil	Moisture holding capacity in cm per every cm of soil depth	Remarks
Coarse sand	0.03	These figures have to be multiplied by effective root zone depth in cm to arrive at the total available water in cm
Sand	0.03	
Loamy sand	0.06	
Coarse sandy loam	0.09	
Sandy loam	0.10	
Fine sandy loam	0.11	
Loam	0.18	
Sandy clay loam	0.13	
Clay loam	0.15	
Clay	0.15	

Root zone depth

Various crops have varying root zone depths in which the roots are normally spread. This may vary between 60 cm to 180 cm provided the growth of roots is not restricted by shallow soils, presence of hard pan or high water table.

It is also relevant to note that root density sharply decreases downwards and unless the top half of the root zone soil depletes beyond available range, the absorption by the lower half of the roots is comparatively very low. Thus for the purpose of irrigation we may asses depletion based on those of samples taken from a depth varying from 15 to 45 cm (mid point of the top half of the effective zone) below the surface and not on one taken from the surface.

Effective root zone depth of some common crops

(grown on very deep, well drained soils)

Shallow rooted	Moderately deep rooted	Deep rooted	Very deep rooted
(60 cm)	(90 cm)	(120 cm)	(180 cm)
Rice	Wheat	Maize	Sugarcane
Potato	Tobacco	Cotton	Citrus
Cauliflower	Castor	Sorghum	Coffee
Cabbage	Groundnut	Pearl millet	Apple
Onion	Sunflower	Soybean	Grapevine
	Muskmelon	Sugarbeet	Safflower
	Carrot	Tomato	Lucerne
	Pea		
	Bean		
	Chilli		

Estimating depth of irrigation to be applied in each application

Depletion starts after irrigation. It is not good to allow too much depletion nor it is desirable to apply water while it is still sufficiently available. Since in a command it is other wise necessary to operate the irrigation system at prefixed intervals it may not be possible to get water for any particular plot while it just depletes below available range. Therefore, it is safe to apply irrigation when depletion values lies anywhere between 25% to 75% of available moisture. Thus in representative land types when 50% depletion is recorded that is the time irrigation system should be operating. The schedules of operation of irrigation systems should be suggested basing on such observations.

Thus, if we take the extreme case of the soil of heaviest texture say clay loam or clay and a crop of very deep root system say sugarcane the calculation for depth of water required under representative conditions would be as follows :

Available moisture holding capacity in cm per cm depth of soil (from the table)	= 0.15 cm
Total capacity for the effective root zone depth of 180 cm which is the value for very deep rooted crops	= 0.15 x 180 = 27 cm
At the time of 50% depletion observed at 45 cm depth the lower half would have kept the moisture intact, thus actual depletion would be	= 27 x ½ x ½ = 6.7 cm

Thus actual application depth required would be 6.7 cm in an extreme condition only. In practice, our common crops such as potato, wheat, groundnut and pulses are shallow to deep rooted and soils are rarely clay. Thus in most operating conditions it would work out much less than 6.7 cm.

On the other hand, practically speaking, except for very well managed furrow irrigation it is difficult to cover the entire field adequately with a depth less than 6 cm which includes field losses also. In fact, application of more than 6 cm is very common and it should be avoided as far as possible because any amount applied beyond 6 cm would only be a waste.

Methods to estimate depletion

There are a number of ways to estimate depletion. Temporary wilting during hottest part of the day could be taken as an indicator. When this symptom is noticed, it may be inferred that it is time to irrigate. But this requires considerable experience and it is not always reliable unless it is supported by suitable studies in the local agroclimate. At present such data are not available. The other method is to use a moisture meter. Though this is very reliable, wide spread use of meters would take time.

A practical method suggested is feel method. According to this a handful of soil from a depth of about 15 to 45 cm (depending on root zone depth) is taken and formed in to a ball by firmly squeezing it in the palm. If the ball is held on the open palm the ball will show characteristics signs depending upon the soil texture and the moisture percentage present in it. A table which has been prepared after extensive trial is given below which would enable one to determine the moisture percentage in any given sample sufficiently accurate for the purpose it is intended to be applied. The important thing to be considered while applying this method is that the textural group of the soil should be assessed as accurately as possible. It may be remembered here that heavier soils give a visual appearance to be wet because of their larger holding capacity while the available moisture may not be as much as it would other wise indicate and vice-versa.

PRACTICAL INTERPRETATION CHART FOR SOIL MOISTURE FOR VARIOUS SOIL TEXTURES AND CONDITIONS

Available moisture in soil	Feel or appearance of soil			
	Coarse textured soils	**Moderately coarse textured soils**	**Medium textured soils**	**Fine and very fine textured soils**
75% to field capacity	Sticks together slightly, may form a very weak ball under pressure	Forms weak ball that beaks easily, does not stick	Forms ball very pliable, sticks readily if relatively high in clay	Ribbons out between finger easily, has a stick feeling
At field capacity (100%)	On squeezing, no free water appears on soil but wet outline of ball is left on hand	Same as for coarse textured soils at field capacity	Same as for coarse textured soils at field capacity	Same as for coarse textured soils at field capacity
Above field capacity	Free water appears when soil is bounced in hand	Free water is released with kneading	Free water can be squeezed out	Puddles free water forms on surface
0% availability	Dry, loose and single grained flows through fingers	Dry and loose flows through fingers	Powdery dry, in some places slight crusted but breaks down easily into powder	Hard, backed and cracked, has loose crumbs on surface in some places
50% or less	Appears to be dry, does not form a ball under pressure	Appears to be dry, does not form a ball under pressure	Somewhat crumbly but holds together under pressure	Some what pliable ball under pressure.
50-75%	Appears to be dry, does not form a ball under pressure	Balls under pressure, but seldom holds together	Forms a ball under pressure somewhat plastic, sticks slightly under pressure	Forms a ball, ribbons out between thumb and forefingers

Water requirement, critical stages of various crops and their use in irrigation plans

It is established through experiments that the crops have certain specific critical stages during which period shortage of water reduces the crop yield drastically. Apart from the soil moisture regime being in the available range, the soil consistency is sometimes agronomically important. For example soil should be soft enough to facilitate pegging of groundnut. It may, therefore be necessary to take precaution that the optimum sowing period, critical stages of various predominant crops being grown in the commands and the operating periods of canals are kept compatible with each other. The water requirement of different crops, the number of irrigation necessary as well as critical stages for each are listed in the table below for guidance. This table deals with non-paddy crops only. It may however, be remembered that during the critical stages, it is sufficient if the soil moisture regime is in the optimum available range. It is not essential that irrigation should be given on those days only unless there is specific otherwise requirement.

Crop	Approx. requirement of water in ha (cm)	No. of irrigation *	Critical stages
Wheat	35-40	4-6	Crown root intiation, flowering, milk stage.
Maize	50-60	6-7	Tasseling, silking
Ragi	40-60	5-6	Tillering, heading, flowering, milk stage.
Greengram & blackgram	15-20	2-3	Flower initiation, pod formation
Chickpea	15	2-3	Flower initiation, pod formation
Fieldpea	15-20	3-4	Flower initiation, pod formation
Rajmash	40-45	5-6	Branching, flowering, pod development
Groundnut	48-55	6-8	Flowering, pegging, pod development
Mustard	30	3-4	Flowering, siliquae development
Sesame	25	2-3	Branching, flowering, pod development
Sunflower	45	3-4	4-5 leaf, button, flowering, seed filling
Sugarcane	200	20-25	Early growth phase, tillering
Potato	50	6-8	Stolonisation, tuberisation
Brinjal	50-65	6-8	Seedling, vegetative growth flowering, fruiting
Tomato	50	5-6	Flowering, fruit setting
Chilli	50-75	10-12	Vegetative growth, flowering, fruit setting
Cabbage	60	6-8	Vegetative growth, heading
Cauliflower	60	6-8	Vegetative growth, curd initiation
Knolkhol	60	6-8	Vegetation growth, bulking
Pointed gourd	60	8-9	Vegetative growth, flower initiation, fruiting

* For situations where groundwater contribution is negligible.

INTEGRATED NUTRIENT MANAGEMENT

The integrated nutrient management is the maintenance and possibly the increase of soil fertility for increased crop productivity through optimal use of all possible sources of plant nutrients both organic and inorganic, required for crop growth and quality in an integrated manner. It should be appropriate for each cropping system and farming situation.

The main aim of the integrated approach to plant nutrient management is to tap all the major sources of plant nutrients in a judicious way and to ensure their efficient use. The major sources of plant nutrients are (i) soil source, (ii) fertilizer source, (iii) organic source and (iv) biological source. Among these four sources, the soil source need careful manipulation so as not to deplete the plant nutrients by over exploitation through intensive cropping or through defective management. In fact, plant nutrients should be added to the soil through the other three sources in such a way that the nutrients removed by cropping are less than that are added and there is a gradual increase in soil reserve.

The second source i.e. inorganic fertilizers should be used in such a way that there should be maximum use of the nutrient required by the plant with a minimum loss, since this is the most expensive input of the four sources.

The organic source is the oldest source used by the farmers for supply of plant nutrients. However, this source has low nutrient content and has to be applied in bulk to meet the nutrient requirement of a crop. With the introduction of high nutrient requiring high yielding varieties, it has become virtually impossible to meet the complete nutrient requirement of a crop through this sources.

The biological source includes green manuring, *in-situ* application of microbial inoculants, azolla etc. These sources can supply or make available a limited quantity of plant nutrients which fall far short of the requirements of high yielding crop variety. Since most of the biological sources can be managed by the farmers themselves with low investment, those constitute cheaper source of plant nutrients. In addition to the biological sources mentioned above, the adoption of a proper cropping sequence so as to conserve or slightly improve the nutrient reserve of soil can be accepted as another biological source for plant nutrient management.

The integrated approach to nutrient management, thus aims at a judicious use of all the four sources mentioned above in an integrated manner, taking into account the farming situation and the ecological, social and economic factors of a locality. It has now also been established that some of the components of integrated nutrient management such as organic manures and biofertilizers can be used alongwith appropriate doses of inorganic fertilizers to maximize yield. Such conjuctive use can also minimize the adverse effects on ecology as apprehended from long term use of lone sources of fertilizers.

VERMICOMPOST

Vermicompost is an organic manure produced through bioconversion of organic waste materials into nutritious compost by earthworm activity. Some specific earthworms act as bioreactors to decompose the wastes. *Eisenia foetida*, *Eudrillus eugeniae* and

Perionyx excavatus are the suitable species most widely used for the purpose. It is prepared in less time (generally 3-4 months) in comparison to the compost preparation by

conventional method. The decomposition process depends on several abiotic/biotic factors. Basic requirements for vermicompost preparation are the availability of organic waste, water source, cowdung as a preferred substrate, suitable earthworm species, shading to prevent direct sun and the rain and the accurate knowledge regarding the vermcomposting technology.

The systematic steps in vermicomposting include

(a) Collection of farm waste/municipality waste followed by sorting out of the materials of organic nature and discarding the non decomposable materials. (Glass, polythene bags and iron pieces)
(b) Preparation of composting tank (2 m x 1 m x 0.75 m)/heap with provision of drainage facility.
(c) Preparation of vermi-bed at the base of the pit. The thickness of the bed should be 10 cm with materials like coir dust, sugarcane trash over which 10 cm layer of FYM should be spread uniformly.
(d) Arranging organic waste layer wise sand-witched with cow dung.
(e) Covering the waste surface with layers of old gunny bags and allowing for partial decomposition of the wastes for 3 weeks.
(f) Release of specific adult earthworms when temperature is at normal (25-30°C) @ 10 nos/kg waste or 1-2 kg/pit (1kg = 1000 nos if each one is 1 g). Release of more numbers of worms quickens the process of vermi-composting. Do not add fresh cowdung after release of earthworm in the pit.
(g) Maintenance of moisture at 50-60% by sprinkling water regularly over the gunny bags up to 5-7 days before harvesting of vermi-compost
(h) Periodic removal of the vermicasts formed
(i) Collection of vermi-compost in morning and heap it in the shape of pyramid under sun for 4-6 hours.
(j) The worms remaining at the bottom of the compost mass can be collected for further use of the next batch of organic waste composting. Under good management condition, 1 kg live earthworm multiplies in to 5-6 kg after a period of 3 months which can be sold to new entrepreneurs at the rate of Rs.250.00 per kilogram of earth worm.
(k) The compost produced includes vermicasts, as a source of available form of plant nutrients alongwith vitamins and growth promoting hormones. The oven dry basis nutrient content is N (1.2-1.8%), P (0.3%), K (0.6%) and organic carbon (18.2%). However, the quality will depend on the nature of the substrate and the stage of the decomposition.

Vermicompost is used for the field crops @ 2.5 t/ha, for orchard trees @ 5.0 kg/tree and in the potted plants and kitchen garden @ 250 g/plant/pit.

ENRICHED COMPOST

The compost commonly prepared from the organic wastes is nutritionally imbalanced particularly in respect of the phosphorus. To make the compost balance, attempt has been made to apply single super phosphate (SSP) to the composting materials @ 25 kg SSP per tonne of the compost. This practice not only enriches the product with P but also checks the volatilization loss of ammoniacal nitrogen.

Phospho-compost can also be prepared out of paddy straw, sugarcane trash and other organic wastes. In this method a pit of any convenient size is dug (about 10m x 5m x 1m) preferably under shade and about half ton of trash or paddy straw is spread at the bottom. Generally paddy straw is chopped and soaked in water overnight for release of organic acid. Urea – N @ 1% and the Rock Phosphate @ 4% (Mussoorie, 100 mesh) is added to the straw material and inoculated with PSM (*Aspergillus awamori)* and the cellulose docompsing fungi (*Trichoderma viridae*) @ 1 kg each/ton of compost. It is then covered with gunny bags, moisture is maintained at 60% level. After 60-75 days the material become ready for use.

GREEN MANURING

Dhanicha (*Sesbania cannabina*) and sunhemp (*Crotalaria juncea*) are mainly used for green manuring *in situ*. The crop is sown in the first fortnight of June by availing the pre-monsoon rains. The seeds are treated with 12g of sodium molybdate and 1.2g of cobaltous chloride for 30 kg seed required for one hectare of land. The entire quantity of phosphatic fertilizer of the succeeding rice crop is applied to the green manure crop. By this the green manuring crop put up a good growth and during their decomposition both N and P are available to the rice crop and phosphate application is not needed to rice. Sunhemp is suitable for well drained soil condition whereas dhanicha is adaptable to medium and low land situations. The crop grows with the pre-monsoon rains.

When the crop is 6-7 weeks old and just begin to flower, it is burried in the soil with the help of the plough and water is impounded for 5-7 days. Thereafter final puddling is done and paddy is transplanted. This practice adds about 12-15 t of green manure per hectare which adds 60-70 kg N/ha. Cowpea and cluster bean also can be used as green manuring crops. *Sesbania rostrata,* stem nodulating dhanicha, also can be taken as a green manuring crop, which adds more nitrogen as compared to *Sesbania cannabina*. Due to hollow stem of the rostrata species some times it creates problem because it floats when chopped to pieces while incorporation with water.

Green leaf manuring: The green vegetative parts of the trees or bushes growing on barnyard, field bund, road sides and fallow land are collected and incorporated in the soil at the time of puddling @ 5-6 t/ha. Plant species like *Pongamia pinnata, Pongamia glabra, Gliricidia maculata, Cassia tora, Sesbania speciosa, Ipomoea cornea* can be selected for green leaf manuring. Weeds like *Croton sparsiflorus, Leucas aspera,* Thornless Mimosa are also utilised for green leaf manuring.

Addition of green matter and the N content on dry weight basis of some green manure crops are as follows :

	Green matter (t/ha)	Moisture (%)	N content (% of dry wt)
Crotalaria juncea (Sunhemp)	16.50	73.00	3.01
Sesbania cannabina (Dhanicha)	14.80	78.00	2.67
Vigna unguiculata	10.00	85.00	2.63
Cyamopsis tetragonoloba (guar)	7.00	60.00	3.53
Gliricidia maculata	3.00	75.00	3.46
Sesbania punctata	3.70	73.00	2.42
Cassia tora	5.20	71.00	2.13

BIO-FERTILIZER

RHIZOBIUM INOCULATION

Legume crops such as pulse, groundnut, soybean and some fodder crops do not receive significant chemical nitrogen input and invariably depend on nitrogen from nodules formed by native rhizobia. Biological nitrogen fixation by symbiotic associations of such crop plants with micro organism is more economic and eco-friendly than nitrogen fertilizer use. Efforts to spread the technology of *Rhizobium* application have been sporadically undertaken by extension agencies. The extensive survey of legume root nodulation has shown lack of adequate nodulation of grain legumes by an indigenous population of *Rhizobia*. The *Rhizobium* population is drastically reduced in the soil as most of the winter pulses follow kharif rice which is grown under anaerobic condition. So there is need to inoculate seeds with *Rhizobium* bio-fertilizer. Symbiotic nitrogen fixation by *Rhizobium* with nodulated legumes contributes significantly to the total biological nitrogen fixation. On an average 30 kg of nitrogen per hectare can be fixed by use of such inoculant in grain legumes, although the amount is much higher under favourable conditions. It is a cheaper method to meet the nitrogen demand of the crop. The yield of the grain legume can be increased significantly by inoculating with right strain of *Rhizobium*.

Approximately, 20 g R*hizobium* culture is required to inoculate one kg of seeds. For small seeded pulses like greengram, blackgram, cowpea, arhar and lentil 500g culture is required per hectare. For groundnut crop 1.5 kg culture is to be inoculated with seeds per hectare. In case of soybean and bengal gram 1.0 kg of culture is used for one hectare. Ten grams of Sodium molybdate and 1g of cobaltoschloride are required for 25 Kg of seeds for seed treatment while inoculating with *Rhizobium*. In order to get better response from *Rhizobium*, the soil reaction should be near neutral (liming is needed for acid soil), low N status, high organic matter content, and no deficiency of P,K & S in soil. Required quantity of culture is suspended in about double the quantity of water to prepare a thick paste. Measured quantity of seeds is heaped on clean floor or on gunny bags or on polythene sheet and the culture paste is thoroughly mixed with the seed. The treated seeds are dried under shade and sown duringthe colder part of the day i.e in the afternoon.

AZOTOBACTER AND AZOSPIRILLUM

These are free living aerobic bacteria capable of fixing nitrogen in soils. Though, free living in nature, *Azospirillum* is recognized as associative symbiotic soil organism capable of colonizing effectively near the roots of a wide variety of plants. These organisms are found in the rhizosphere of plants. Encouraging results on yield response have been reported from different parts of the country for a number of crops with application of *Azotobacter* and *Azospirillum* inoculants either alone or combinedly. *Azospirillum* performs well both in aerobic and semi-aerobic soil habitat. Therefore, it is recommended for rice with alternate wetting and drying and other cereals.

Besides, nitrogen fixation, the ability of both the organisms to synthesize vitamins, auxins, growth promoting substances like nicotinic acid, pantothenic acid, biotin, gibberellins etc. which help in better seed germination and plant growth. Phosphorus solubulising micro-organism (PSB) is compatible for co-inoculation. It has the ability to secrete organic acid which help in the solubilization of insoluble phosphate in the soil to available forms for plants. These organic acids also chelate the Fe, Al and Mn in acid soil and release the P for plant availability.

Method of application

Cultures of *Azotobacte*r, *Azospirillum* and PSM can be applied as soil inoculation, seed inoculation or seedling root dip in case of transplanted crops.

The method of seed inoculation with carrier based cultures is similar to that of rhizobial inoculation in pulses. But for transplanted crop, the seedings are dipped in the slurry of carrier-based inoculum for 20 to 30 minutes and then planted immediately. For sugarcane, set treatment is recommended before planting of sets. The second and subsequent inoculations are done through the application of incubated FYM.

Soil inoculation

One packet (500g) of carrier-based culture is mixed with about 12.5 kg of cattle manure/FYM seven days before sowing the seeds. The mixture is moistened with water to maintain 40 to 45% moisture and then covered with gunny bags to maintain higher temperature required for rapid multiplication of bacteria. The culture inoculated and incubated FYM @ 150 kg/ha is used for rhizosphere application in different crops. The dose of *Azotobacter* and *Azospirillum* for different crops are as follows :

Crop	Dose per ha (kg)		Crop	Dose per ha (kg)
Rice	6.0		Wheat	6.0
Ragi	6.0		Maize	6.0
Sugarcane	10.0		Mustard	6.0
Vegetables	6.0		Potato	6.0

BLUE GREEN ALGAE (BGA)

Blue green algae is one of the various types of chlorophyllus, autotropic micro-organisms belonging to the lower plant group *Thallophyta* found in wet land soils. The most important property with them is biological nitrogen fixation. This nitrogen is added to the soil increasing the fertility status of soil. About 25-30 kg N/ha can be added through BGA inoculation.

Adaptability

Blue green algae grow well in neutral to alkaline soil. It is adaptable to rice eco-system. The available phosphorus content of the soil should be high. The BGA inoculation can be successfully adopted in heavy soils, mixed red and black soils, coastal saline soils and in low lying areas of coastal belt.

Recommendations for field application

1. Apply algal culture (flakes) @ 10 kg/ha over the standing water in the rice field 5-7 days after transplanting or beushaning. Maintain standing water at least for a couple of days immediately after algae application.
2. If the soil is deficient in phosphorous or molybdenum, apply the recommended doses of phosphorus and molybdenum in form of Single Super Phosphate(SSP) & sodium molybdate.
3. Apply the algal culture at least for three to four consecutive seasons in a particular field.

Techniques of multiplication

1. Prepare shallow cemented tanks of size 5 m long, 1.5 m wide and 0.25 m deep pits lined with polythene sheets in an open space. The size can be increased if more material is to be produced.
2. Place about 20 kg soil and mix it with 40 g of lime if soil is acidic. Apply 200g super phosphate mix thoroughly.
3. Fill water upto 5 cm height depending upon the local conditions and rate of evaporation, the pH of the soil should be around neutral, if acidic (adjust it with lime).
4. After the soil settles down, sprinkle a handful of sawdust and the starter culture on the surface of the standing water. Keep the whole assembly exposed to sun.
5. In hot summer months, the growth of the algae will be rapid and in about a week, thick algal mat will be formed on the surface of the soil and sometimes even float up. If the rate of evaporation is high, add water intermittently. When the algae growth becomes sufficiently thick, stop watering.
6. Allow the water to dry up in the sun or drain out.
7. Collect the dried algal flakes from the surface or scrape them off and store them in bags for future use in the field.
8. Each pit can yield 10 kg BGA per harvest and the annual production is 120-150 kg which is suffient to inoculate 12-15 hectatre of rice fields.
9. Fill the pits again with water and add a small amount of dry algal flakes, about a handfull, as further inoculum. Continue the process as above. Once the soil in the tray

is exhausted (usually 3-4 harvest) put fresh soil, mix with super phosphate and lime. Continue as before.

10. To prevent the breeding of insects, add Carbofuran (3% granules) 15 g/pit.
11. The sun dried algal material can be stored for long and used in the field. Do not store the algal material in direct contact with chemical fertilizer or other agricultural chemicals.

AZOLLA

Azolla is a water fern that grows in shallow water bodies like ponds, ditches and channels. The plants are branched with bilobed leaves and long suspended roots. It is found as a weed growing in the low land rice fields of some tropical and temperate countries like Vietnam, China, Thialand etc. Out of the several species, *Azolla pinnata* is found growing in some parts of India.

The fern is having special leaf cavities in the dorsal side where in nitrogen fixing BGA (*Anabaena azollae*) lives in symbiotic association. The endophyte fixes atmospheric nitrogen residing inside the cavity of the water fern.

Low land/irrigated rice fields can be inoculated with fresh Azolla. Under favourable field conditions, Azolla multiply very rapidly which can cover the whole surface of the standing water. It multiplies 2 fold during a week. The optimum temperature for multiplication is 25-30^{o}C. Upon incorporation of the biomass in the rice field around 20-30 kg N/ha is added besides the organic matter.

For rapid multiplication of Azolla in the rice field, the soil should have a high available P status or adequate amount of phosphate fertilizer (60 kg P_2O_5/ha) should be applied at the time of puddling. At least 7.5 cm of standing water should be maintained for 15 days after inoculation of Azolla. Green manuring and green manuring *in-situ* are two methods of using Azolla. The former method is suitable in areas where adequate water is available before planting. Azolla is inoculated @ 1 t/ha, 15-20 days before planting for green manuring and 7 days after planting for dual cropping. The temperature of the standing water in the field should not exceed 35^{o}C. Special care should be taken to maintain the inoculum in partially shaded shallow ditches or ponds during summer. Fresh azolla inoculum for multiplication may be obtained from the field of other farmers, if available. Other wise it may be obtained from the Central Rice Research Institute, Cuttack ; the State Bio-Chemist, Bhubaneswar or from Krushi Vigyan Kendras of OUAT.

The farmer can multiply Azolla in shallow ditches, channels or ponds. He may also multiply Azolla in a small field and inoculate other fields by harvesting Azolla from the former. Water must be made available to the multiplication field for maintaining at least 10 cm of standing water during the multiplication period.

<u>Techniques for multiplication</u>

1. Divide the field into one cent plot (20 m x 2 m) by providing bunds/bamboo frames which will facilitate to maintain atleast 10 cm standing water.
2. Sprinkle 10 kg of cattle dung suspended in 20-25 litres of water.
3. Add 4 kg of Azolla to each plot (100 g fresh Azolla /m^2).
4. Apply super phosphate in three split doses at the rate of 100g/split at 4 days interval as top dressing fertilizer for azolla.

5. Apply furadon granules on 7th day after inoculation at the rate of 100 g/plot to control the insect pests of azolla.
6. Maintain water level at 5-10 cm.
7. Allow it for 10-15 days till a thick mat of azolla is formed, which will float on the surface of water.
8. After 15 days of inoculation azolla can be harvested from the plot. The azolla biomass yield per plot is 40-50 kg. It can be incorporated *in situ*.

Field inoculation

Azolla is inoculated 5-7 days after transplanting/beushaning @ 2 t/ha. The inoculated azolla multiply and cover the entire field in 25 days after inoculation. The developed azolla mat can be incorporated during first weeding after draining out the field. Azolla incorporated into the soil decomposes and benefits the rice crop.

Collection of composite soil sample

1. Collect samples when the field is in ploughable condition.
2. Divide the area into sampling units. One sample will represent one unit. Usually individual fields are taken as one unit. But, when adjacent fields are similar in physiography, colour, texture and previous history of cropping and managmeent, they may be included in one unit, provided the total area do not exceed 2.0 ha (5.0 acres).
3. Locate spots randomly for drawing samples, by drawing “Z” or “N” shaped imaginary lines in the field. At least 15 spots per acre should be located excluding unusal parts of the field (near to bunds, roads, manure pits, manure heaps shades of trees and lines of row cropped plants). Soils should not be collected from recently manured or fertilized / limed fields.
4. Scrape the surface litter and weeds from the selected spot. Draw an uniform core by soil tube or auger or take a thin slice from the exposed face of small pit by means of a khurpi or shovel. Put it in a bucket and repeat the process for all the choosen spots.
5. Mix the soils collected from all spots and reduce the quantity, if necessary, by quartering process to 500g size. Spread the soil on a clean polythene sheet and allow to dry under shade. Avoid contamination with foreign materials. After the sample is dry put about 500 gm of soil in the sample bag and label it with following information.

    a) Name of the cultivator.
    b) Plot no./local name
    c) Name of the village / Block & District
    d) Crop history
    e) Crop to be grown
    f) Signature and date of collection.

Soil test values of nutrients

Nutrient	Method	Low	Medium	High
Organic carbon (g/Kg of soil)	Walkley and Black wet oxidation	5.0	5-7.5	7.5
Available N (kg/ha)	Alkaline permanganate	<250	250-500	>500
Available P (kg/ha)	Olsen*	<9.0	9.0-22.0	>22.0
	Bray's**	<14.0	14-40.0	>40.0
Available K (kg/ha)	Neutral 1N Amm. Acetate	<118.0	118-280	>280

Conversion factor : P to P_2O_5 – Multiply by 2.3, K to K_2O – multiply by 1.2
* suitable for paddy ** suitable for non-paddy crops

The soil pH and salinity are rated as per the following chart.

pH	<6.5	Acidic
	6.5-7.5	Neutral
	>7.5	Alkaline

Salinity (EC)	<1dSm^{-1}	Normal
	1-2 dSm $^{-1}$	Critical
	>2 dSm^{-1}	Injurious

Recommendations

If the soil test value of a particular nutrient (N, P_2O_5 and K_2O) is high, there will be 25% deduction from the general recommendation in respect of that nutrient. Simultaneously, if the soil test value for a particular nutrient (N, P_2O_5 and K_2O) is low, there will be 25% extra addition of that nutrient over the general recommendation.

Liming of acid soils

- Determine lime requirement of acid soil by Woodruff's buffer method.
- Soils having pH < 5.5 need immediate lime application for amelioration for sustainable crop production.
- Moderately acidic soils pH 5.6 to 6.5 be limed for Ca-nutrition of the crops
- Docot crops (Pulses / Oilseeds/ Vegetable crops) be limed @ 0.2 LR and the Monocot crops (Maize / Ragi/ Fodder) with 0.1 LR lime.
- Liming materials of desired quantity be mixed with FYM, should be applied below the seed zone on the day of sowing or planting of crop.
- Lime should be applied annually. Locally available liming materials be preferred (Paper Mill Sludge, Press Mud) over pure lime, based on the neutralizing value given in the following table

Assessment of liming materials

Name of the material	**Neutralizing equivalence (%)**	**% P_2O_5 (approx.)**
Ground lime stone	100	-
Dolomitic lime stone	109	-
Quick lime	179	-
Paper mill sludge	75	1.0
Basic slag (Phosphate & silicate of lime)	60	4.0
Press mud (Sugar factory)	45	2.0

VISUAL SYMPTOMS OF DEFICIENCY OF ZN, FE, B AND MO AND TOXICITY OF IRON IN CROP AND THEIR REMEDIAL MEASURES

Micro nutrient	Crop	Deficiency symptoms	Remedial measures
Zinc	Rice	Zn deficiency occurs in heavy clayey and calcareous soils and other soils under condition of imbalanced fertilizer use or growing HYV intensively. The symptoms appear with reddish brown pigments on central part of leaves, bleaching of lamina of young leaves followed by apical necrosis, short internodes, reduced plant height and restricted growth.	Soil application of Zinc sulphate @ 25 kg/ha at sowing/transplanting Or Three foliar sprays of 0.25% Zinc sulphate/ 0.05% Zinc EDTA commencing from 30 days after sowing at 10 days interval.
	winter vegetables (brinjal, okra)	New leaves abnormally small and mottled with yellow or uniformly chlorotic necrotic and later become dead.	Soil application of Zinc sulphate @ 20 kg/ha Or Two foliar sprays of Zn sulphate @ 0.25%/ Zinc EDTA @ 0.05%
	Cotton	Affected plants fail to develop normally. Bronzing and interveinal chlorosis in the leaf. Leaves become thick, brittle with their margins curved upward	Soil application of Zn sulphate @ 25 kg/ha Or Three foliar sprays of Zinc sulphate @ 0.25%
Iron	Rice	When soil is calcareous, yellowing of younger leaves in between veins, gradually entire leave becomes chlorotic and then whitish, in severe cases plant dies.	Three foliar sprays of 0.4% ferrous sulphate + 0.2% lime on appearance of yellowing at 10 days interval
	Toxicity	Improper drainage in lateritic soils causes reduction of Fe-oxides, a scum of iron having brickish red colour observed on the surface of standing water. Iron intoxified rice plants shows tiny brown spots starting from the tips of lower leaves after 25 days of planting. The spots spread towards the base and become purple or reddish brown to give bronzing appearance.	Application of paper mill sludge @ 2.5 t/ha. Or Application of N-P-K 80-40-80 kg/ha Or Application of Zinc sulphate @ 50 kg/ha at planting Growing tolerant rice varieties like Mahsuri, Mahalaxmi, Samalei, Parijat, Lalat, CR-1009, Kalinga-III, Annada, Birupa, Bhoi, T 1242, Panidhan and Mahanadi
Boron	Ground nut	In groundnut apical growth severely retarded, internodes condensed, water soaked areas appear in the margin	Soil application of 10 kg borax/ha along with fertilizer at sowing.

PLANT GROWTH REGULATORS AND CHEMICAL REGULATION OF GROWTH

Plant hormones are regulators produced by plants which in low concentration regulate various physiological and biochemical processes. There are five categories of growth hormones like (i) Auxin (ii) Gibberellins (iii) Cytokinins (iv) Ethylene, and (v) Inhibitors. Each type of growth regulator has its distinct role in various metabolic process leading to plant growth and development and some of the important uses of the above mentioned growth regulators are given below:

Auxin

1. Inhibition of leaf and fruit abscission
2. Induction of flowering and fruiting
3. Promotion of parthenocarpy
4. Thinning of flowers and fruits
5. Overcoming sterility
6. Sweetening of fruits
7. Acceleration of rooting in cuttings

Gibberellins

1 Increase length of internodes
2 Induce parthenocarpy
3 Increase size of fruits
4 Improve the fruit quality
5 Promote germination
6 Overcome dormancy
7 Increase fruit set
8 Induction of flowering

III Cytokinins

1 Delaying of senescence
2 Increase resistance for drought, high and cold temperature
3 Breaking of dormancy
4 Induce flowering in photo-sensitive plants
5 Facilitate nutrients movement inside plants

IV Ethylene

1 Induces ripening of fruits
2 Breaks dormancy
3 Induces rooting in cuttings
4 Stimulates flowering
5 Induces female sex

PRACTICAL APPLICATION OF GROWTH REGULATORS FOR DIFFERENT CROPS

	Name of growth Regulators	Concentration	Purpose of use	Type and Time of Application	Crop
I. Auxin	NAA	10-100 ppm	Control of pre-harvest fruit drop	Fruit setting period	Fruit crops
	NAA	10-100 ppm	Control of cotton boll shedding	Fruit setting period	Cotton
	NAA	25 ppm	Check fruit drop in mango	Spray at 4 week stage of fruit setting	Mango
	NAA	20 ppm	Reduction of pre-harvest fruit drop in orange and lemon	Spray 2 months before harvest	Orange & Lemon
	NAA	40-60 ppm	Increase fruit set in tomato	Spray at flowering	Tomato
	NAA	12 ppm	Prevention of fruit drop in lemon	Spray at initial fruiting stage	Lemon
	NAA	500 ppm	Delaying post harvest de-greening	Apply to harvested lemon prior to storage	Lemon
	NAA	200-400 ppm	Increase flower shoot in litchi	Spray on the foliage	Litchi
	NAA	10-100 ppm	Stimulate flower induction in pine-apple	Spray at end of Vegetative stage.	Pine-apple
	IAA	10-100 ppm	Prevention of leaf and fruit drop in some fruits and vegetable crops	Spray during vegetative stage	Some fruits and vegetable crops
	IBA	100-1000 ppm (Higher conc. for hardy cuttings)	Stimulate rooting in cuttings	Dipping of cutting before planting	Some fruits and ornamental plants

	IBA	100-1000 ppm (Higher conc. for hardy cuttings)	Promote budding and sprouting	Spraying on foliage	Some fruits and ornamental plants
	2,4-D	10 ppm	Increase yield of lemon and citrus fruit	Spray 4-10 weeks after flowering	Lemon and citrus
	2,4-D	25 ppm	Promote fruit setting in brinjal	Spray at flowering stage	Brinjal
	TIBA (2,3,5-T)	5 ppm	Increase yield in soybean	Foliar spray at vegetative stage	Soybean
	4, Chlorophenoxy acetic acid	50 ppm	Increase fruit set in tomato	Spray at flowering	Tomato
II. Gibberellin	$(GA)_3$	500-1500 ppm	Induce staminate flower in Gynoecious type	Spray at 2-4 leaf stage	Cucumber
	$(GA)_3$	10 ppm	Delay fruit maturity in lemon	Spray prior to loss of green colour	Lemon
	$(GA)_3$	200 ppm	Promote growth of stalk in sugarcane and increase sugar yield	Spray twice before 3 months of harvest	Sugarcane
	GA_3	10 ppm	Increase fruit size in tomato	Spray during flowering and fruit formation	Tomato
	GA_3	100 ppm	Induce seedless fruits in tomato and brinjal	Spray before flower opening	Tomato and Brinjal
	GA_3	1 ppm	Break dormancy and uniform crop emergence in seed potato	Spray or dip seed pieces before planting	Potato

	GA_3	1000 ppm	Induce maleness in Gynoecious lines of cucumber	Spray 2 to 3 times before flowering	Cucumber
III. Ethylene	Ethrel (2, Chloroethyl phosphonic acid)	500-1000 ppm	Enhance colouration in tomato	Spray at mature green fruit stage	Tomato
	Ethrel	100-250 ppm	Induce femalencess in cucumber and melon	Spray at 2 to 3 leaf stage	Cucumber and Melon
	Ethephon	125-130 ppm	Induce female flower development and early fruit set	Spray when plants have developed 2 leaves	Cucumber
IV. Other growth regulators	Alar or B-9 (N.N dimethyl aminosuccinic acid)	4000 ppm	Increase yield in peanut	Spray at flowering	Groundnut
	Alar or B-9	3000-6000 ppm	Increase yield in potato	Spray during tuber formation	Potato
	Alar or B-9	2500-5000 ppm	Enhance early flowering in budding plants	Spray on young plants	Petunia, Marigold and Zinia
	Alar or B-9	1000-5000 ppm	Promote rapid rooting in ornamental plants	Dipping of stem cuttings overnight	Ornamental plants

INTEGRATED WEED MANAGEMENT

Weeds are unwanted and undesirable plants which interfere with the utilization of land and water resources and thus adversely affect human welfare. Of the total annual loss of agricultural produce from various pests in India, weeds account for 33%, insects 26%, diseases 20% and others 21%. Depending upon the degree of competition, weeds may reduce crop yield to the tune of 90%. Various methods of weed control are manual or mechanical, chemical and biological. Considering the diversity of weed problems, no single method of weed control whether it is cultural, manual, mechanical, biological or chemical could reach the desired level of efficiency under all situations. The new approach to weed management is the integrated weed management. Integrated weed management system is basically an integration of effective, dependable and workable weed management practices that can be used economically by the producers as a part of sound farm management systems. Integrated weed management system is not meant for replacing selective, safe and efficient herbicides but is a sound strategy to encourage a judicious use of herbicides along with other safe, effective, economical and eco-friendly control measures.

Major components of integrated weed management system (IWMS) are

Tillage
Stale seed bed technique
Use of weed competitive crop and cultivars
Crop rotation
Intercropping
Plant geometry and plant density
Nutrient management
Water management
Soil solarization
Herbicides
Biological control measures

CHEMICAL WEED CONTROL

Chemical weed control refers to the judicious use of herbicides to kill or inhibit the growth of weeds. Herbicides may be selective or non-selective. Selective herbicide is one that kills some plant species when applied to a mix population without serious injury to other species. A non-selective herbicide is one that kills plants irrespective of species. Herbicides may be either contact or translocated as per their mode of action. They may also be soil active or foliage active as per their method of application. Based on chemical nature, herbicides are classified as organic or inorganic.

Formulation of herbicides and dosages

Herbicides are available in the form of solution, emulsions, wettable powder and in granules. The doses of herbicides can be calculated by using the following formula :

$$\textit{Kg or litre of herbicide required per hectare} = \frac{\text{Dose of active ingredient in kg/hectare X 100}}{\text{Percentage of active ingredient in the product}}$$

The type of sprayers and nozzles are very important for uniform spraying of herbicides. Knapsack type of sprayer with flood jet or flat fan type of nozzle should be used for thorough coverage and uniform application.

Precautions to be taken while handling herbicides

1. Nearly all the herbicides are potentially dangerous. They are to be used properly.
2. Read the label on each container before using the contents.
3. Disposed off the empty containers by burying them atleast 18" deep in an isolated area away from water supplies.
4. Apply the herbicides within the time specified on the labels. It is very necessary to observe the recommended intervals between treatment and pasturing or harvesting of the crops.
5. Always consult the product label or technical bulletins before applying the chemical with which you are unfamiliar.
6. Use goggles, rubber gloves and other protective clothing as recommended on the label.
7. Guard against the possible injury to near by susceptible plant by herbicides drift.
8. The herbicides should be kept in a safe place where the children and other unauthorized persons do not have access.
9. Weeds should be identified before selecting a herbicide.
10. The selective herbicides should not harm the crop to any extent at its stage of application.
11. For best result, apply herbicide when there is little or no wind blowing and no rain expected for several hours.
12. Rinse out sprayers thoroughly after each use. It is best to use a separate sprayer for application of herbicides.
13. The quantity of water per unit area needs to be predetermined by blank spraying depending on the nozzle type.
14. Before spraying of herbicides , field should be completely drained off and again flooded within 2-3 days.
15. Granular herbicides should be applied with assured standing water in the field (4-5 cm) before emergence of weeds. Standing water must be maintained atleast for a week after application.
16. Clear water should be used for spraying @ 500 litres per hectare.

COMMON NAME, TRADE NAME, MANUFACTURER, TIME OF APPLICATION AND RATE OF APPLICATION OF SOME POPULAR HERBICIDES MARKETED IN INDIA

Common name	Trade name & formulation	a.i.	Time of application	Rate (kg/ha)	Manufacturer
Alachlor	Lasso-EC	50%	Pre*	1-3	Monsanto
	Lasso-G	10%	Pre	5-8	Monsanto
Atrazine	Atrataf-WP	50%	Pre	1-3	Rallis, India
	Sugarazine-WDP	50%	Pre	1-3	Rallis, India
	Aatres		Pre,early post****	0.25-0.4	Syngenta
Anilophos	Anilophos-EC	30%	Pre,early post	0.3-0.4	Aventis
	Aniloguard-G	2%	Pre	0.3-0.4	Gharda Chemicals
Benthiocarb/ Thiobencarb	Saturn-EC	50%	Pre, early post	2-4	Pesticide India
Butachlor	Delchlor-EC	50%	Pre	1-2	Coromandal Indag
	Hiltachlor-EC	50%	Pre	1-2	H.I.L.
	Teer-EC	50%	Pre	1-2	Rallis India
	Punch-EC	50%	Pre	1-2	Herbicide India
	Weedkill-EC	50%	Pre	1-2	Sudarsan Chem
	Machete-EC	50%	Pre	1-2	Monsanto
Dalapon	Hexapon-WP	85%	Post**	2-5	BASF
	Dowpon-WP	80%	Post	5-10	Dow
	Dulapon				
Diuron	Karmex-WP	80%	Pre	0.5-1	Dupont
	Hexuron-WP	80%	Pre	0.5-1	B.P.M.
Fluchloralin	Basalin-EC	45%	PPI***	.75-1.25	BASF
Glyphosate	Roundup-EC	41%	Post	0.5-2	Monsanto
	Glycel-EC	41%	Post	0.5-2	Excel Industries
	Weed off-EC	41%	Post	0.5-2	Nocil
Isoproturon	Arelon-WP	75%	Post	0.5-1.5	Dupont
	Nocilon-WP	50%	Pre, early post	0.75-1.5	Nocil
	Tolkan-WP	50-75%	Pre	0.75-1.5	Aventis
Methabenz-thiazuron	Tribunil-WP	70%	Post	1-3	Bayer
	Yield-70-WP	70%	Post	1-3	Bayer
Metoxuron	Dosanex-WP	80%	Post	0.75-1	Syngenta
Metolachlor	Dual-EC	50%	Pre	0.5-1	Syngenta
Oxyfluorfen	Goal-EC	23.5%	Pre	0.05-0.5	De-Nocil
	Oxygold	23.5%	Pre	0.05-0.5	Endofil
Oxadiazon	Ronstar-EC	25%	Pre	1-2	Rhone Poulene
Paraquat	Gramoxone-WSC	24%	Post	0.3-1	Syngenta
Pendimethalin	Stomp-EC	30%	Pre	1-2	Cyanamide
Pretilachlor (+safener)	Sofit-EC Safener-CGA123407	30%	Pre	0.5-0.75	Syngenta
Pretilachlor	Refit-EC	50%	Pre	0.75-1	Syngenta
Simazine	Hexazine-WP	50%	Pre	1-3	BPM
	Tefazine-WP	50%			Rallis India
Triallate	Avadex-EC	50%	PPI	1-2	Monsanto
Terbutryn	Igram-WP	50-80%	Pre	0.5-2.5	Syngenta

Common name	Trade name & formulation	a.i.	Time of application	Rate (kg/ha)	Manufacturer
Trifluralin	Treflan	48%	PPI	.75-0.25	De-Nocil
2,4-D	Atul-WSC	80%	Post	0.25-2	Herbicide India
Amine salt	Agrodore-95-WP	58%	Pre	0.5-1	Herbicide India
EE	Weedone-EC	18%	Pre	0.5-1	Pesticide India
	Knockweed-EC	36%	Pre	0.5-1	Rhone Poulenc
	Knockweed-G	4%			
Metsulfuron + Chlorimuron	Almix WP	20%	Early post	0.004	Dupont
Clomazone	Command-EC	50%	Pre	0.5	Rallis India
Metribuzin	Sencor-WP	70%	Pre	0.5-1	Bayer
Oxadiargyl	Topstar-WP	80%	Pre	0.07-0.1	Bayer
Quizolfop-p-ethyl	Targa Super EC	5%	Post	0.07-0.1	Dhanuka
Sulfasulfuron	Leader WP	75%	Post	0.025	Monsanto
Imazapic	Cadre AS	24%	Pre	0.12	Cynamide
Diclofop-methyl	Illoxan EC	28%	Post	0.5-0.75	
Fluazifop-butyl	Fusilade EC	28%	Post	0.25-0.5	

** Pre-emergence, ** Post emergence, *** Pre-plant incorporation, **** 8-10 DAYS AFTER SOWING/DAT*

CHEMICAL WEED CONTROL FOR MAJOR CROPS OF ORISSA

Crop	Name of the herbicide	Rate (kg a.i /ha)	Time of application	Weeds to be controlled
Transplanted rice	Pretilachlor	0.75	Pre	Grasses & BLW
	Butachlor	1.25	Pre	Annual grass & BLW
	2,4-D Na salt	0.40	Post	BLW
	Oxyfluorfen	0.04	Pre	Grasses & BLW
	Anilophos	0.40	Pre	Annual grass & BLW
	Cyclosulfamuron	0.03	Post	Annual grass & BLW
	Oxadiargyl	0.06	Post	Annual grass & BLW
	Almix	0.004	Post	Annual grass & BLW
Puddled rice	Pretilachor+safener	0.45	Pre	Grass &BLW
	Butachlor	0.50	Pre	Grass, BLW & sedges
Wheat	2,4-D	0.75	Post	BLW
	Sulfasulfuron	0.025	Post	Grass & BLW
	Isoproturon	0.75-1.00	Post	Grasses
	Metoxuron	1.2-1.6	Post,pre	Grasses
	Metribuzin	0.175	Post	Grasses & BLW
	Methabenzthiazuron	1.2-1.6	30 DAS	Grasses

	Pendimethalin	1.0	Pre	Grasses
Maize	Pendimethalin	0.75	Pre	Annual grass & BLW
	Atrazine	0.50	Pre	Grasses & BLW
	Fluchloralin	1.00	PPI(1DBS)	Grasses & BLW
	Butachlor	1.00	Pre	Annual grass & BLW
	Alachlor	1.00	Pre	Annual grasses
	2,4-D-Na Salt	1.00	Post	Annual grass, Sedges & BLW
Ragi	Butachlor	0.50	3 DAT	Annual grass
	Anilophos	0.20	Pre	Grasses & BLW
	Oxyfluorfen	0.02	3 DAT	Annual grass & BLW
Greengram &	Alachlor	0.75	Pre	Annual grass & BLW
Blackgram	Fluchloralin	0.75	Pre-plant	Grasses
	Pendimethalin	0.50	Pre	Annual grass & BLW
	Quizolfop-p-ethyl	0.05	Post	Grasses
Peas & Chickpea	Pendimethalin	0.5	Pre	Grasses & BLW
	Fluchloralin	0.75	PPI	Grasses & BLW
Lentil	Pendimethalin	0.50	Pre	Grasses & BLW
	Alachlor	0.75	Pre	Grasses & BLW
Groundnut	Alachlor	1.00	Pre	Annual grass & BLW
	Pendimethalin	1.00	Pre	Annual grass
	Napropamide-45SC	0.50	Pre	Grasses & BLW
	Fluchloralin	1.00	PPI	Grasses
	Oxyfluorfen	0.05	Pre	Grasses & BLW
	Imazapic 24AS	0.12	Pre	Grasses & BLW
	Quizolfop-p-ethyl	0.05	Post	Grasses
Mustard	Alachlor	0.75	Pre	Annual Grass & BLW
	Fluchloralin	0.50	PPI	Grasses
Sesame	Alachlor	1.00	Pre	Annual grass
	Butachlor	0.75	Pre	Annual grass, BLW & Sedges
	Fluchloralin	0.50	PPI(1DBS)	Grasses & BLW
	Quizolfop-p-ethyl	0.05	Post	Grasses
Potato	Metribuzin	0.5-1.0	Pre	Grasses & BLW
	Methabenzthiazuron	1.5	Pre	Grasses & BLW
Sugarcane	Atrazine/simazine	1.00	Pre	Grasses
	Alachlor	1.25	Pre	Grasses
	Pendimethalin	1.00	Pre	Grasses

	Metribuzin	0.75	Pre	Grasses
	Picloram	2.00	Post	BLW
	Silvex	0.75	Post	BLW
	2,4-D Na Salt	1.00	Post	BLW
Tomato	Napropamide	1.5	4 DAT	Grasses & BLW
	Fluchloralin	1.0	PPI	Grasses & BLW
	Oxyfluorfen	0.04	4 DAT	Grasses & BLW
Brinjal	Fluchloralin	0.75	PPI	Grasses & BLW
	Alachlor	1.00	4DAT	Grasses & BLW
	Butachlor	1.00	4DAT	Grasses & BLW
	Quizolfop-p-ethyl	0.05	Post	Grasses

Legends :

Pre=	Pre emergence	Post=	Post emergence
PPI=	Pre-plant incorporation	BLW=	Board-leaf weeds
DBS=	Days before sowing	DAS	Days after sowing
DAT	Days after transplanting	Early post=	8-10 DAS

Some aquatic weeds and their control measures

Sl. No.	Name of the aquatic weeds	Name of the Herbicides (kg/ha)	Stage at which herbicides to be sprayed
1.	*Eichhornia crassipes* (Bilati dal)	Mixture of Glyphosate 0.5 + 2,4-D Na Salt 2.0	Active vegetative stage
2.	*Scirpus grossus* (Santara)	Mixture of Glyphosate 1.0 + 2,4-D Na Salt 2.0	Active vegetative stage
3.	*Pistia stratiotes* (Borjhanji)	Glyphosate 0.5	Active vegetative stage
4.	*Salvinia natans* (Kuji dala)	Glyphosate 0.5	Active vegetative stage

Problematic weeds and their control

Sl. No.	Name of the aquatic weeds	Name of the Herbicides (kg/ha)	Stage at which herbicides to be sprayed
1.	*Mikania micrantha* (Mile-a-minute/Indian hempvine)	Glyphosate 1.0 kg	Active growth stage
2.	*Parthenium hysterophorus* (congress grass)	Metribuzin 0.3 kg	Active growth stage before flowering

PARASITIC WEEDS AND THEIR CONTROL

Orobanche: *Orobanche cernua*

Host crops: Brinjal, tomato , tobacco

A. Cultural method

- Growing of trap crops such as sunflower, sesame, cotton, soybean and finger millet stimulates the germination of orobanche seed and these afterwards die in absence of the host.
- Adoption of crop rotation with non-host crops like redgram, horsegram, cowpea, gram, cotton and sesame minimizes the weed infestation.
- Excess irrigation should be avoided to crops like tobacco, brinjal and tomato.
- Growing of green manure crops like sunhemp and green gram before planting brinjal and tobacco also has been found useful to minimize orobanche infestation.

B. Chemical method

- Spray oxyfluorfen 0.1 kg/ha or pendimethalin 1.0 kg/ha or metribuzin 0.5 kg/ha three days after planting.
- Direct spray of 10% copper sulphate solution to orobanche shoots.

Cuscuta spp.

Host crop: Niger

A. Cultural method

- Use dodder (cuscuta) free clean seeds.
- Thin the crop and destroy the infested plants at the early stage.
- Remove the vegetative parts of the weed and destroy them completely by drying or burning.
- Adopt crop rotation with crops- maize, bean, cowpea and cereals atleast for 5 years.

B. Chemical method

- Pre-plant incorporation of trifluralin 48EC @ 2.5 kg/ha or pre-emergence application of pendimethalin @ 1.0 kg/ha.

Striga spp.

Host crop : Sugarcane

A. Cultural method

- Eradicate the weed *Digitaria ciliaris/ D. sanguinalis* (crab grass) completely in the area striga spp is seen by using herbicides or by cultural operations. Grow trap crops such as soybean, cowpea, sunflower, groundnut and castor.

B. Chemical method

- Spray 2,4-D amine salt directly to striga @ 0.5 to 0.75 kg/ha two to three times during the crop growth period to destroy flushes of striga in its vegetative phase.

INTEGRATED PEST MANAGEMENT

Until quite recently the control of insect pests was focussed mainly on use of insecticides on calendar basis. This has resulted in suppression of parasitoid population,

decrease in benefit cost ratio, pest resurgence, development of insecticide resistant strains of insects and environmental pollution. The minor pests are now gaining foothold due to indiscriminate use of pesticides. There is much concern about the persistence of harmful pesticide residues which poison the food grains of human and domestic animals. Thus the emphasis is now on integrated pest management (IPM), where the use of insecticide is minimized by combining with other methods, including varietal resistance, cultural practices such as crop rotation and removing of crop residues to prevent pest survival, fertilizer, water management and use of bio-control agents.

Integrated pest management (IPM) as suggested by the FAO panel of experts refers to “The pest management system that, in the context of associated environment and population dynamics of pest species, utilizes all suitable techniques and methods in as compatible a manner as possible and maintains the pest population at a level below those causing economic injury”.

In IPM three aspects are emphasized viz;

- Multiple control tactics used in a compatible manner.
- Pest populations maintained below levels that cause economic damage and
- Conservation of environmental quality.

Procedures of integrated pest management implementation

Pest surveillance

One of the most important requirements for successful pest management is pest surveillance. This envisages systematic monitoring of the pest population or damage by plant pathogens in different stages of crop growth. With a view to forewarning the extension functionaries as well as the farmers to take timely and need based measures.

Objectives

- Detect species of pests or pathogens present.
- Assess levels of population/damage/infection.
- Study the influence of weather parameters on incidence of pests.
- Know new species of pests
- Monitoring the behaviour of minor pests in attaining major status.
- Find out natural enemy population
- Watch the behaviour of pests under changing cropping pattern/ new varieties
- Assess resistance/susceptibility/breakdown of resistance in crops to pests
- Monitor build-up of resistance in pests to pesticides
- Demarcate endemic areas/pest calendar
- Launch timely plant protection measures on need basis.

- ❖ Reduce cost of cultivation
- ❖ Avoid contamination to agro-ecosystem and
- ❖ Forewarn farmers.

Methodology

The surveillance programme should be conducted through fixed plot survey and roving survey.

❖ Fixed plot survey

The Gram Panchyat is the basic unit for collection of information by the VAWs at 5-7 days intervals. In each G.P. 8 fields of 0.5 ac to 1.0 ac area is selected in 4 villages/units @ 200 villages for this survey. These fixed plots are selected in such a manner that they represent different land situations existing in the locality. Where there is more than one VAW in any GP each VAW is required to select fixed plots in 4 of his villages/units.

In each of these fixed plots 5 micro plots of the size of 1 sq.metre each are to be located, while one micro plot is located at each corner, the 5^{th} micro plot is located at the centre of the field. Care should be taken to locate these micro plots at about 10 metres away from the bunds.

The observations from these micro plots are taken by the VAWs at weekly intervals in the main cropping season and at fortnightly intervals in lean season. In each of these micro plots, 4 hills are selected and the presence of insects and diseases on these hills are recorded in survey card No.1 by the VAW.

The AAO/JAO who would be touring to VAW circles for 4 days in a week would make it a point to test check atleast 2 fixed plots in each GP to ensure correct reporting by the VAW. Thus each AEO would test check 8 fixed plots besides taking a roving survey in 8 road side plots of 4 GPs each circle.

❖ Roving survey

The AAO(PP)/PPO/PP Asst. posted at the office of the DAO/ADAO are required to take up roving survey for 4 days in a week in the vulnerable areas to keep a close watch on the overall pest situation. During roving survey, two roadside plots per GP are selected. In each plot assessment of pest and diseases are made on 10 selected hills. In selection of these 10 hills, the officer should get into the field from the southwest corner, walk diagonally 10 steps inside the field and select 10 consecutive hills diagonally. The pest and disease incidence on these hills are recorded.

Sampling techniques and assessment

Nursery pests

❖ BPH, GLH, stem borer

Record observations at weekly intervals commencing from 10th day of sowing. Sweep with an insect net 25 times over the seedlings in the nursery area meant for planting one acre and asses the population of adults.

❖ Thrips

Pass a wettable tennis bat (painted with white paint) over the foliage in 5 places in the nursery area meant for planting one acre and record the population.

❖ GLH, BPH, Nymphs

Select 100 seedlings from 5 plots @ 20 per plot and count the nymphs / adults present in the seedlings and record. The 5 plots are to be selected at random from the nursery area to plant an acre.

Case worm, Gall midge, Stem borer

Count the stem borer, egg mass, galls and cases in two sq. meter area in the nursery meant for planting one acre.

Main fields

Observations to be made in each micro plot are presented below.

❖ GLH, BPH

Tap vigorously 4 hills selected at random in each micro plot and count the insects that have fallen on the water surface and asses the population per hill/tiller.

❖ Stem borer, Dead hearts

Count the total number of tillers and affected tillers in 20 hills and work out the percentage.

❖ White ears

Count the total number of white ears and healthy ears in 20 hills and work out the percentage.

❖ Whorl maggot, Leaf folder, Case worms

Count the total number of leaves and affected leaves in 20 hills and workout the percentage.

❖ Gall fly (Gall midge)

Count the total number of tillers and number of affected tillers showing silver shoots in 20 hills and work out the percentage.

❖ Earhead bug

Count the total number of earhead bugs in each micro plot and arrive at the number per square meter or number per hill.

In the case of BPH and leaf folder it is desirable to assess the population/ damage in the selected field in the damaged areas manifesting the symptoms if the micro plot is not exhibiting the true infestation level.

DISEASES

Blast

❖ Leaf blast

Select 10 hills from each micro plot. Observe the leaves showing disease intensity and assign grade values as follows

Grade	Intensity
1	Less than 1% of leaf area affected
3	1-5% of leaf area affected
5	6-25% of leaf area affected
7	26-50% of leaf area affected
9	Above 50% of leaf area affected

The average of grades and the mean grade should be reported.

Neck blast

Select 5 hills in each micro plot. The percentage of panicles infected is calculated for each field and the grades are assigned as follows.

Grade	Intensity

1	Less than 1%
3	1-5%
5	6-25%
7	26-50%
9	More than 50%

Brown spot

As in the case of leaf blast assessment.

Sheath blight

Select 10 hills in each of the micro plots. The grades are assigned as follows.

Grade	Disease intensity
1	Spots limited to lower ¼ of leaf sheath area
3	Spots present on lower ½ of leaf sheath area
5	Spots present on more than ½ of leaf sheath area
7	Spots present on more than ¾ of the leaf sheath area and severe infection on upper leaves.
9	Spots upto top of tillers, severe infection on all leaves and death of plants.

Bacterial leaf blight

As in the case of leaf blast assessment.

Virus and mycoplasma diseases

Select 10 hills in each micro plot and calculate the percentage of hills infected

Grade	Percentage of infection
1	Less than 1%
3	1-10%

5	11-30%
7	31-60%
9	61-100%

Reporting

The VAW should fill up the survey card No.1 during the fixed plot survey and handover the survey card to the concerned AAO/JAO personally on Friday/Saturday in the biweekly training or in the block level review meeting. On the basis of the survey cards and on his own assessment through test check and roving survey, the JAO/AAO should prepare weekly pest surveillance card indicating the scope/population of pest/diseases and send the card to the DAO/ADAO; range DDA and the pest surveillance Officer, Office of the DDA (PP), Orissa, Bhubaneswar. Different colour of card bearing different line nos. have been specified for submission of reports in the regard.

White card (Card No.2)

White card should be used for sending information when the pest situation is normal.

Yellow card (Card No.3)

Yellow card should be used for communicating information when the pest population and disease intensity are about to reach 50% of ETL.

Red card (Card No.4)

Red card should be used for reporting when the pest population and disease intensity has crossed ETL and warants immediate control measures.

Action on pest surveillance report

The AAO(PP)/PPO posted in the office of the DAO/ADAO, on receipt of weekly pest surveillance report, would compile and interpret the data to take suitable action in consultation with the DAO/ADAO. When the pest situation assumes dangerous proportions the matter is to be brought to the notice of the concerned DDA. The range DDA on receipt of such information would, in consultation with the range PPO and the scientists of the RRS and DDA(PP), to decide the course of action. At the level of DAO/ADAO and the range DDA weekly pest situation reports should be maintained block wise and GP wise. The range PPO should submit the weekly pest situation report of the range indicating availability of pesticides and measures taken to the DDA (PP) on the Friday and Saturday of every week.

When the situation is abnormal this report should be sent to the DDA(PP) through special messenger. If the situation so warrants, the DDA of the range should form a mobile plant protection squard for making roving survey for pest prone areas so that the situation is

monitored and action as deemed proper is taken at the right time.

At the state headquarters, the pest surveillance Officer is in charge of the control room to monitor the pest situation throughout the state. The pest surveillance report of different districts after receipt at the state headquarters would be critically analysed by the State Level Coordination Committee consisting of Professor of Entomology, Professor Plant Pathology, DDA (PP) under the chairmanship of JDA (ER). The Coordination Committee should meet on every Friday of the week during the main cropping season and at monthly intervals for the lean seasons to review the overall pest situation of the state. The committee would work out operational strategy and provide guidance to the field functionaries for pest control through news letter and mass media.

Tools of pest management

The available techniques for controlling insect pests are conveniently categorized in increasing order of complexity as given below.

a. Cultural methods
    1. Use of resistant varieties
    2. Crop rotation
    3. Crop residue destruction
    4. Tillage of soil
    5. Adjustment in time of planting or harvesting
    6. Pruning and thinning
    7. Fertilization
    8. Sanitation
    9. Water management
    10. Planting of trap crop, intercrop, barrier crop and boarder crop

b. Mechanical methods
    1. Hand destruction
    2. Exclusion by screen and barriers
    3. Trapping, suction device, collecting machine
    4. Crushing and grinding
    5. Use of light trap, pheromone trap, baits

c. Physical methods
    1. Heat
    2. Cold
    3. Humidity
    4. Sound

d. Biological methods
    1. Conservation and encouragement of natural enemies

2. Introduction and colonization of specific parasitoids and predators
3. Propagation and dissemination of specific bacteria, virus, fungi and protozooides

e. Chemical methods
1. Attractants
2. Repellents
3. Insecticides
4. Sterillant
5. Growth inhibitors

f. Genetic method
1. Propagation and release of sterile or genetically incompatible insect population

g. Regulatory methods
1. Plant and animal quarantine
2. Eradication and suppression programme

Economic threshold limits of crops

Sl.No.	Pest	ETL
Paddy		
1.	Yellow stem borer	Early and mid tillering stage, 5% dead hearts per square metre, 1 adult/eggmass/M_2 at flowering
2.	Gall midge	Early stage-one gall per sq.metre, mid tillering stage 5% affected tillers.
3.	Brown plant hopper	5 to 10 insects per hill in vegetative stage and 15-20/hill in flowering stages.
4.	Hispa	One insect or damaged leaf per hill
5.	Leaf folder	Early and mid tillering stage two damaged leaf per hill, panicle initiation one damaged leaf per hill
6.	Climbing cut worm	Flowering and after one larvae per hill
7.	Leaf hopper	Early state-5 to 10 insects per hill. mild tillering stage-20 insects per hill (in tungro endemic areas 20 hoppers/hill)
8.	Whorl maggot	15 to 20% damaged hills upto 20 days of planting.
	Diseases	
1.	Blast	Disease score upto 3 on 1-9 scale
2.	Sheath blight	10% or more tillers affected
3.	Sheath rot	1 to 5% affected tillers
4.	Brown leaf spot	1 to 5% leaf area affected
5.	Bacterial leaf blight	1 to 5% leaf area showing necrosis

6.	Tungro virus	One to two infected plants in 25 hills.

MANAGEMENT OF PLANT DISEASES

During rabi season, the field crops as well as vegetable crops suffer from a large number of plant diseases. These may be soil, seed or air borne in nature. As a consequence, heavy crop losses are encountered during the season. Unless it is an epidemic covering a large area, a sound approach to protect the crop by applying recent technology of integrated disease management may minimize the yield losses. For this the use of certified seed, pre-treatment of seed with effective fungicides, growing of tolerant/resistant varieties, application of balanced fertilizer, proper water management, preventive schedules of spraying crops with fungicides, maintenance of satisfactory sanitary conditions and follow up of suitable dates of sowing/ transplanting of the crops are extremely necessary . Besides, these consideration, it is also of utmost importance to collect seed material from disease free crops and regions. A large number of cases are known where in a region, incidence of a newly introduced disease has become established and they threaten the high productivity of economically important crops like vegetables, cereals, millets, pulses and oilseeds etc.

Recently enough information is available which shows to minimize some seed borne and air borne diseases by using selected natural products (developed from plants) and also by applying the principle of biological control. Wherever such materials are known to show promise and depending upon their availability they could be used even of a limited scale to restrict the crop diseases.

Keeping in view the above, a brief resume of symptoms and best possible management practices of some key diseases of important rabi season crops are categorised in **Annexure-III**. Regarding the recommendations made for use of fungicides, several have been listed so that if a particular product is not available, the alternative one may be used.

MANAGEMENT OF NEMATODE

It is an established fact that although plant parasitic nematodes often act as limiting factors in agricultural production, the nematode damage to crops is mostly ignored or

attributed to other causes such as lack of soil fertility, deficient soil moisture or soil exhaustion. The role of these tiny thread like animals in agriculture has remained under-estimated due to their soil borne nature, microscopic size, hidden mode of life and non-typical and insidious feeding symptoms. Therefore, nematodes are one of the most confusing soil pest problems to identify, demonstrate and control. However, on an average, plant parasitic nematodes cause 10% loss in major crop plants. Each soil will contain its own nematode fauna and in every place and in every crop there will be problems caused by plant parasitic nematodes which are mostly root feeders.

Symptoms of nematode disease on plants include poor growth, chlorosis, yellowing, premature leaf drop, stunting, patchiness, reduction in quality and quantity of produce, dieback, incipient, wilting and death of plants. The nematode affected plants produce symptoms which are more or less similar to conditions when the plants are deprived of properly functioning root systems. Moreover, the diseased plants lack vigour and have reduced ability to withstand drought, lack of nutrients and other adverse conditions. Moreover, roots damaged by nematodes are easily parasitised by fungi and bacteria resulting in root decay and causing various disease complexes including wilt. Intensity of damage depends on the number of individuals of a particular parasitic species or several such species present per unit volume of soil.

Various control measures have been successfully attempted against nematodes on different crops. But it has been found that the aim of merely killing or eradicating nematodes is neither economically feasible nor ecologically suitable. Therefore, it should be aimed at managing the crop losses due to nematodes to obtain maximum profit with the least disturbance to the ecological balance. The sole purpose of nematode management is to keep the nematode population sufficiently below the economic threshold limit or the injurious level. It can be achieved by various methods and practical nematode management technology consisting of a multitude of cultural, physical, chemical, biological and genetic methods, which can be categorised under four broad groups such as soil, crop pesticide and integrated management practices. The management of nematode diseases of rabi crops are given in **Annexure-IV**.

POST HARVEST STORAGE OF FOOD GRAINS

At farmers' level

Application of improved methods to agriculture in recent years is resulting in steady increase in the production of foodgrains in the country. The upward trend in the production of foodgrains will continue with adequate supply of fertilizers, pesticides, improved irrigation facilities, high yielding and disease resistant varieties etc. However, the increased production of foodgrains may lag behind in feeding the growing population, if the grain produced with so

much of labour is not conserved properly.

It is well known that during post harvest period of handling and storage considerable quantities of foodgrains (about 10%) are lost between harvest and consumption. Major portion of the foodgrains produced in the country is stored at the level of farmers, the quantity being 70% of the total production. The storage methods at farmers level are not satisfactory and as a result, losses take place both in quantity and quality. The principal causes of losses in quantity and quality of stored grains are insects, mites, rats, fungi, birds and moisture. The losses in foodgrains, particularly during storage can be reduced to a great extent if the scientific methods are appropriately followed for storage of the foodgrains.

CAUSES OF LOSS

Insects

Insects, bred in large number in foodgrains can cause loss quantitatively and qualitatively. Insect infested grains emits bad odour. Heat spots develop in the gain. Food grains contaminated due to uric acid of insects, dead bodies of egg, larvae, pupae and adult are mixed up with the grains. They eat away the embryo causing loss in germination. They also eat away other portions of the foodgrains causing loss in weight and market value. The aesthetic value of the foodgrains is also lost due to their presence. Presence of insects can be detected by the presence of (a) webbings (b) cocoons, dead or living insects (c) weevilled grains (d) white powdery materials on the bags and floor (e) heating and general rise in the grain temperature. The important stored grain insects are rice weevil, lesser grain borer, khapra beetle, angoumois grain moth, rice moth, pulse beetle, red flour beetle etc.

Rats

Rats not only ear away our foodgrains, they also damage foodgrains qualitatively. They are the source of many diseases. Rats contaminate food grains with their stool, urine, hairs and dead bodies. A pair of rats multiply to 800 in a year. Rats presence can be detected by (a) loose earth (b) shiny dropping or rat faeces (c) gnawed bags and split grains (d) foot print mark on dusty floor (e) greasy mark on wooden beams (f) irregular holes in wooden doors and windows.

Moisture

High moisture can damage the embryo of the seed and cause heating and rotting of the grains. High moisture favours growth of fungi and micro-organisms. Grains are discoloured and bad odour is produced.

Birds

Birds not only eat away the foodgrains from granaries and fields, they also contaminate food grains with their faeces and feathers. They also prepare their nests in the vicinity of the stored grains. Effective steps are required to be taken for protection of grains

from damaged by insects, rats, moisture, fungi and birds.

Control measures

a. Steps to be taken before storage

1. Select suitable structure or receptacle which should be moisture, rodent, bird and gas proof. Pucca kothi and metal storage bins are suitable storage receptacles. Traditional storage structures can also be improved so as to make it functionally scientific.
2. Collect all debris, webbing and refuses from the storage structure godown and burn them.
3. Remove all domestic articles from the vicinity of storage premises in case of large scale storage.
4. Close all cracks and crevices of the storage structures/godown with mud and cement plaster and white ash the storage compartment with lime
5. Spray deltamethirn 0.025% @ 3 litres per 100 square meter on grain bags, dunnage materials, empty storage receptacles, wall ventilators of the godown. Close the rat holes with broken glass, stone, mud and cement.
6. Prevent entry of rats to storage premises by using tight fitting doors and windows and also fixing metal sheets of 20 gauge to the door upto height of 12 inches from bottom leaving no gap between floor and sheet.
7. Use dunnage materials like wooden crates, bamboo mats or polythene sheet in case of bag storage to protect from seepage of ground moisture.
8. Use new gunny bags as far as possible if storage is undertaken in bags. If not possible, disinfect the bags with deltamethin 0.025% @ 3 litres per 100 square meter.
9. Dry the grains properly before storage. Remove foreign matters and broken grains as far as possible. Try to keep the moisture content of the grains below 12%.

b. Steps to be taken during storage

1. Maintain hygienic condition in and around the storage premises.
2. Spray the food grains bags/ receptacles, alleyways and walls of the godowns with deltamethirn as suggested above at an interval of 3 to 4 weeks to check cross infestation.
3. If insect infestation is noticed, fumigate the stock with Al-phosphide @ 1-2 tablets & per metric tones of paddy/rice, wheat and pulses.
4. Aerate the grains properly in case of any heating or rise in temperature of the grain mass.
5. Open the doors and windows daily for aeration purpose except during rainy days.
6. Undertake rodent control operation by trapping, caging and poison baiting with 2% Zinc phosphide or with anticoagulant (ratio 1:10) with some attractive bait materials.
7. Undertake rodent control operation in the vicinity of the godown by fumigating rat burrows with Aluminium phosphide tablets at the rate one tablet per live burrow.
8. Inspection of food grains at fortnight interval helps finally detection of any deterioration to grains in storage by insect, moisture etc and to take timely curative measures.
9. Use single dose anticoagulant like Bromadiolone (Roban, musmus, mortein cake) and Brodifacoum.
10. For storing pulse grains, mix edible oil @ 5-10ml per Kg of seeds after proper drying or mix begunia leaf powder or wood ash @ 5%.

Pucca kothi

Pucca kothi is primarily an indoor structure suitable for storage of cereals having low moisture content. It can be constructed in different capacities and sizes. But the structures of 2 MT capacity made up of two compartments is quite convenient. A storage structure of this size would be 2.35 m (7.7 ft) x 1.2 m (4 ft) x 1.45 m (4.9 ft) with a central partition wall. Two

different commodities or varieties of the same cereal can be stored separately. Each compartment is provided with an outlet. The outlet can be of straight type for slow discharge of the food grains or slanting type for quicker discharge. The inlets have sliding lids with locking arrangement. Similarly there is rectangular inlet for each compartment which is fitted with a timber lid with locking arrangement. The pucca kothis can be constructed either with an elevated floor resting on brick masonary column or with solid floor provided with a water proofing barrier.

Metal storage bin (*Domestic design*)

These bins are most suitable for safe storage of food grains by farmers. In this group, different types of domestic designs of metal storage bin have been developed, the capacity of which ranges from 3.0 to 27.5 quintals. These metal storage bins can be kept in a room or Varandah under a roof. All these bins are fabricated either 22 gauge or 24 gauge G.I. sheets. These bins are also provided with inlets at the top and outlets at the bottom to facilitate easy loading and unloading.

POST HARVEST TECHNOLOGY FOR PRESERVATION OF SEED QUALITY

Post harvest technology encompasses the operations like drying, processing and storage of harvested produce. Any lapse in post harvest management practices results in

loss of physical, genetical, physiological and health qualities which eventually reduces the planting value of seeds. In order to preserve seed quality, scientific methods of drying, processing and storage should be adopted as far as practicable.

The initial seed quality depends on growing conditions of the seed crop. For growing a seed crop the breeder or foundation or certified seed should be procured from any authentic sources. While selecting the plot and season seed production principles should be strictly adhered to. Besides, selecting the most suitable plot and season, modern seed crop management practices like fertilizer application, irrigation and pest and disease control should be adopted for quality seed production.

Harvest time of the seed crop often affects the seed quality. At physiological maturity the seed has its highest vigour. A non-dormant seed if germinated at this stage produces the most vigorous seedling. But seeds are never harvested at physiological maturity. Harvesting is necessarily delayed till the seed moisture content is reduced to safe limits (around 15% in cereals) to facilitate easy post harvest operations. The stage of harvestable maturity can be judged by observing the morphological characters of the plants. This stage is achieved when the paddy stalk turns yellow and seeds in panicle achieve original colour, lower leaves of groundnut plants turn yellow, blackgram and greengram pods turn brown and sunflower head droops down and the peduncle turns brown. Seeds no doubt deteriorate to some extent during the period between physiological maturity and harvestable maturity. Such deterioration becomes highly remarkable when harvesting is delayed beyond the stage of harvestable maturity.

Post harvest operations like threshing, cleaning and drying influence the initial seed vigour which is reflected in field emergence and stand establishment as well as longevity of crop seeds in storage. Mechanical injuries during threshing, shelling etc. should be avoided. Threshing of paddy seeds by pedal thresher, hand threshing of blackgram and greengram

pods, stripping of groundnut pods with a knife leaving a small portion of pedicel attached to the pod etc. are found to be highly effective to maintain maximum vigour of seed. Slow drying is always advocated to preserve better quality of crop seed. In case of groundnut shade drying method is adopted to prolong seed viability in storage. Groundnut pods if covered by haulm of other plants while drying in the sun can preserve seed, vigour as good as those dried under shade. Shade drying, however, takes longer period to reduce seed moisture to safe limits. Cleaning and grading are also necessary to maintain quality of crop seeds.

The majority of our common agricultural seeds belong to orthodox group. The orthodox seeds are to be dried to a low moisture level to maintain viability for longer period. The rate of deterioration of these seeds is relatively slower as compared to that of recalcitrant seeds.

Seed moisture content, is a very important factor for maintenance of viability in storage. At high seed moisture contents (over 30%) non-dormant seeds may germinate and from 18% to 30% moisture content seed deterioration by micro-organisms may occur particularly in the presence of oxygen. Fungi can grow and destroy many seeds stored at 12% to 18% moisture content. Besides, heat production due to high rate of respiration at 13-18% moisture content affects seed quality. Seeds can reasonably be stored for 6-15 months at 10-15% moisture content but the possibility of insect attack can not be ruled out. Below 8% moisture content there is little or no associated insect activity. With 4-8% moisture content seeds can be stored in moisture proof containers. Seeds dried below 4-5% moisture content, although immune from attack by insect and fungi, may deteriorate faster than those maintained at a moisture content 1-2% higher. As per the thumb rule, for each 1% increase in seed moisture content between 5 and 14% the life of the seed is halved.

It is well known that suitable storage conditions must be used if seeds are to be held in good viable condition for longer period. Low relative humidity and low temperature has

been considered most suitable to prolong viability in storage. Seeds can maintain viability and vigour for longer period in a storage environment having temperature and RH below 20^{o}C and 65% respectively.

Selection of container is essential during storage of crop seed especially under conditions of high RH. Containers like gunny bags, cloth bags etc. those can not prevent the seeds to come to equilibrium with atmospheric relative humidity indirectly reduced the storage life of seeds. The storage life of seeds increases when stored in laminated poly-vinyl bags, polythene (700 gauges) bags, polycoated aluminium pouches and paper coated aluminium pouches. However, the moisture content should be below 8%. Seed treatment with thiram (@2.5 g/kg) can increase the longivity of seeds when stored in moisture proof containers.

FARM EXTENSION SERVICE

Technology transfer is as important as technology generation. Tehnology developed in research station is of no use, unless it is appropriately transferred and adopted by the end users. The persons working in extension system have great responsibility for brining out

improvement in the economic and social status of farmers. For the purpose of transferring appropriate technology to the farming community, development of competence, consciousness about the roles, possession of certain qualities and knowledge on methods for effective transfer of technology are essential. There is growing need and realization on strengthening of technology generation, its dissemination and adoption in agriculture. Co-existence of public and private extension services and involvement of voluntary agencies for better technology transfer is felt necessary for accelerating the agricultural growth and social change.

Competency development

1. Technical competency

    a. Interest for collection of information from various sources.
    b. Good understanding about the technical information
    c. Skill in application of technologies.
    d. Utilization of the technologies in appropriate situation.

2. Economic competency

    a. Developing programme as per the market demand
    b. Develop interest among farmers and organize them properly.
    c. Liasoning with credit institutions for credit facilities to the farmers.
    d. If possible, develop self help groups, cooperatives, thrift groups among the farmers for exploring financial assistance and benefits.

3. Scientific competency

    a. Proper diagnosis of farmers' problem.
    b. Anticipate future consequences of the proposed programme.
    c. Appropriate measures for solving the problems.

4. Occupational competency

    a. Physical and mental strength for implementation of programme.
    b. Conducting demonstrations and trials in a simpler way in farmers' field for modification / refinement and establish the technology to the situation.
    c. Convey the results of the technology to the farmers in an easy and

understandable way.

5. Communication competency

   a. Collect, select and simplify the technologies.
   b. Communicate to the farmers as per their level of understanding.
   c. Select appropriate methods for technology transfer.
   d. Use demonstrations, meetings, discussions etc. for better understanding and rapid transfer of the technologies.

6. Social competency

   a. Good understanding of the social system.
   b. Mix with people and develop friendly atmosphere.
   c. Involve people for successful implementation of programmes.

Role to Play

1. Empowerment role

   a. Improvement of self

      i. Develop own competency by updating knowledge and skills.
      ii. Explore facilities and opportunities available in the organization as well as in the operation area.

   b. Empowerment of people

      i. Develop cooperation among people
      ii. Create community participation and joint problem solving attitude among the people.

2. Community organizing role

   a. Good knowledge about rules, policies and methods of community organization.
   b. Skill and competency in group management.
   c. Good understanding of the group structure, by-laws, rules and various roles to be performed.

3. Human resource development role

   a. Develop technical competency of the people and its use.
   b. Skill development of people in programme formulation, implementation and management.
   c. Encourage people to analyse resources and its proper utilization.
   d. Train people in management of self as well as community.

4. Problem solving role

   a. Assist people in identification of their problems.
   b. Discuss with people about the ways to solve the problems in an easier way.
   c. Develop solutions basing on past experience and improve practices.
   d. Solutions must be related to the proper use of their resources.
   e. Discuss with people about the solution for better understanding.
   f. Organize training, demonstrations and other extension approaches for effective implementation of the programmes.

Characteristics of an extension personnel

i. Do not be impatient or frustrated under any circumstances.
ii. Do not be suppressed and fully participate in discussion.
iii. Do not argue while discussing.
iv. Show interest to take responsibilities.
v. Do not avoid if additional work assigned.
vi. Be cheerful, always create humorous environment while working with people.
vii. Do not be excited when praised and depressed in failure.
viii. Do not disturb people while they are discussing. Wait for the opportunity and slowly intervene.
ix. Face challenges and solve complicated problems.
x. Vision to frame future plans and programmes.
xi. Do not be dubious
xii. Do not be worried or harassed.
xiii. Do not educate people by instructing them. Use participatory approach.
xiv. Always search for new ideas, techniques and problems.

Techniques for successful transfer of technology

Strategy

Follow a system approach and apply a systematic, rational and pragmatic approach to planning, implementing, managing, monitoring and evaluating regular or routine programme. The following approach may be analyzed before transferring technologies.

1. Advocates a participatory planning approach.
2. Need based and demand driven orientation.
3. Use strategic planning and integrated systems approach
4. Consider human and behavioral dimensions.
5. Problem solving orientation.
6. Employ cost effective multimedia approach.
7. Provide specific extension support materials and training.

Techniques

Technology is the application of knowledge for practical purpose. It is used to improve the human condition, natural environment or to carry out other socio-economic activities. The users require thorough understanding and skill competency in use of the technology. We should develop a system for effective transfer of technology. Planning, implementing and follow-up are the major aspects of transfer of technology.

Planning

1. Have participatory discussion with the farmers sufficiently ahead.
2. Analyse internal and external resources.
3. Organise farmers and form various groups on enterprise basis.
4. Chalk out a tentative programme for the area.
5. Ensure availability of quality inputs.

Implementing

1. Assess the knowledge and adoption level of the farmers.
2. Discuss the lapses and equip them with up to date knowledge.
3. Organize exhibitions, farmers fair to develop confidence in the farmers.
4. Distribute related literatures in simple language for reference.
5. Organise training programme in critical stages for skill upgradation.
6. Timely application of inputs.
7. Regular monitoring and close supervision of each activity.
8. Timely and appropriate advice in the adverse situation.

Follow-up

1. Interact with users about the results.
2. Remedial measures for inconveniencies.
3. Constant touch with the farmers for sustainable use.
4. Incorporate additional technologies gradually.
5. Replace old technologies with better ones.

Methodologies to be followed

1. Use participatory rural appraisal tools for problem identification and prioritization.
2. Diagnose problem, find root cause, and assess intervention.
3. Predict the solution and prescribe remedial measures.
4. Make planning and programming with active involvement of respective farmers.
5. Monitor and supervise the programme
6. Use experimental learning techniques while imparting training.
7. Involve people in designing and implementing while conducting trials and demonstrations.
8. Use interactive demonstration while imparting new skills
9. Organise field days, tours in critical stages of the demonstration.
10. Assist farmers in keeping records of each activity for evaluation of any programme/activity.

FARM IMPLEMENT AND MACHINERY

Name of the Implement	Features	Weight (Kg)	Field capacity/ output	Energy saving

Name of the Implement	Features	Weight (Kg)	Field capacity/ output	Energy saving
Mould Board Plough	* Suitable for dry and wet land cultivation * Replaceable share at nominal cost * Operated by pair of bullock and oneperson	6.5	0.3 hectare per day	5.87 hp-hr per hectare
Heavy soil plough	* Works well in heavy soil condition * Bar share ensure proper penetration * Operated by pair of bullock and one person	9.0	0.29 hectare per day	4.85 hp-hr per hectare
Notch Type Disk harrow	* Used for breaking clods during fields preparation * Used for puddling in wet land field preparation * Operated by a pair of bullock and one person.	82	0.4 hectare per day	13.2 hp-hr per day hectare
Improved Leveller	* Used for levelling of puddle field * Operated by a pair of bullock and one person	33	2.0 hectare per day	
Seed – cum-fertilizer drill	* Line sowing of seed and simultaneous application of fertilizer * Suitable for paddy and wheat crop	15.5	0.3 hectare per day	9.07 hp-hr per day
Bullock drawn seed drill (three row)	* Used for sowing of paddy seeds in upland * Seed distribution is uniform through a cell type metering device * Operated by a pair of bullock and one person	24	1 hectare per day	29.6 hp-hr per hectare
Tractors drawn seed drill	* Used for line sowing of paddy or wheat in one pass * Operated by 25-30 hp tractor	200	3 hectare per day	28.36 hp-hr per /ha
Pregerminated seeder(five row)	* Used for line sowing of pre germinated paddy seeds in wet land conditions	12	0.5 hectare per day	12.04 hp-hr per /ha

Name of the Implement	Features	Weight (Kg)	Field capacity/ output	Energy saving
Pulse seed drill	* Used for line sowing of seeds of green gram, black gram, horse gram, arhar, cowpea and soyabeans * Covers four rows in one pass * Operated by a pair of bullock and one person	26	0.6 hectare per day	23.73 hp-hr
Interculture plough	* Used for thinning plants in direct seeded paddy and for weeding * Operated by a pair of bullock and one person	4.25	0.8 hectare per day	
Garden rake	* Used for cleaning leaves, stones etc from garden and also suitable for interculture operation in ragi crop * Operated by one person	2.25	0.25 hectare per day	
Trench hoe	* Used for weeding in line-sown crops * Can be used either as phowrah or as pickaxe.	2	0.1 hectare per day	
Gujarat hand hoe	* Suitable for furrow making in row crops and earthling up operation in groundnut,potato,cotton and vegetables	1.25	0.1 hectare per day	
Wheel finger weeder	• Used for weeding in upland line sown crops (paddy,groundnut,mustard,pulse) • Operated by one persons	12	0.20 hectare per day	7.1 hp-hr per hectare
Rotary peg weeder	• Used for weeding in line sown upland crops(groundnut,mustard,paddy, wheat) • Operated by one person	4	0.1 hectare per day	3.10 hp-hr per day
Cone weeder	• Used for weeding in line transplanted or line sown paddy in low land • Incorporates the weeds into the soil and results in increase of soil fertility	4.5	0.1 hectare per day	3.10 hp-hr per hectare
Rake and blade weeder	• Used for weeding in upland line sown paddy in light soil crop • operated by one person	8	0.1 hectare per day	3.10 hp-hr per hectare

Name of the Implement	Features	Weight (Kg)	Field capacity/ output	Energy saving
Zigzag puddler	• suitable for puddling in light soil • operated by one pair of bullock and one person	30	0.8 hectare per day	25.66 hp-hr per hectare
Rotary blade puddler	• suitable for puddling in light and medium soil conditions • operated by a pair of bullock and one person	51	1.2 hectare per day	29.99 hp-hr per-hectare
Float disc harrow	* Suitable for puddling in light soil * erated by a pair of bullock and one person	128	1.0 hectare per day	26.40 hp-hr per hectare
Transplanting guide	• Used as a marker for line transplanting of paddy seedlings as per recommended spacing • Can be prepared out of locally available materials by village artisans	3	0.12 hectare per day	7.3 hp-hr per hectare
Prilled Urea Applicator	• Used for placement of prilled urea at a depth. Of 3-5cm in line transplanted paddy. • Increases urea fertilzer use efficiency • Increses yields of paddy by 15 percent • Operated by one person	12	0.5 hectare per day	0.98 hp-hr per hectare
Urea super granule applicator	• Used for deep placement of urea super granules(USG) in the line transplanted paddy • Increases the urea fertilizer use efficiency • Increases yield by 30 percent • Operated by one person	10	0.5 hectare per day	0.85 hp-hr per day

Name of the Implement	Features	Weight (Kg)	Field capacity/ output	Energy saving
Low volume sprayer	• Used to spray pesticides in all fields crops / horticultural crops • Needs only 15 liters of water per hectard in stead of 500 liters. • Operated by one person and four dry cells(6.0 volts)	3.5	0.62 hectare per day	8 hp-hr per hectare
Knap sack sprayer	• Used to spray pesticides in all crops/ horticultural crops. • Provision of automatic agitation • Operated by one person	5	0.76 hectare per day	
Power sprayer-cum - duster	• Ideal for quick spraying in orchards, tea, coffee, paddy, and other crops • Also used for economic, effective and quick applications of pesticides in dust form	6.5	1.76 hectare per day	0.6 hp-hr per hectare
Improved sickle	• Used for harvesting of paddy crop • Replaceable serrated of blade at nominal cost	0.22	0.08 hectare per day	
Pedal operated paddy thresher	• Used for threshing of paddy • Threshing efficiency is 98.5 percent • Operated by one person	45	250kg per day	
.Power operated paddy thresher .	• Used for threshing of paddy • Threshing efficiency is 99.50 percent • Operated by 1.0 hp single phase electric motor and 3 persons	88	1500 kg per day	0.3 hp-hr per quintal.
Paddy thresher-cum-winnower(power operated)	• Used for threshing and clearing of paddy • Operated by 1.0 hp single phase electric motor and 3persons	98	1500 kg per day	
Hand operated winnower	• Used to clean chaff and other light foreign materials from threshed paddy. • Cleaning efficiency is 90 percent	29	2400 kg per day	0.38 hp-hr per quintal

Name of the Implement	Features	Weight (Kg)	Field capacity/ output	Energy saving
Parboiling unit	• Used for parboiling of paddy • Two persons are required for its orking	36	75 kg per day	
Low lift hand pump	• Lifts water from dug well, farm pond, cannal • Most suitable for vegetable crops • Useful to give life saving irrigation for crops • Replacable diaphragm at nominal cost • Operated by one person	40	5000 liters per hour (from a depth of 3m)	
Krushak bandhu pump	• Used to lift water from dugwell, borewell, pond, and canal. • Most suitable for vegetable crops • Useful for giving life saving irrigation • Valves last 900 hour of operation and are replaceable at nominal cost. • Operated by one person	18	4500 liters per hour (from a depth of 3.6 m)	
Groundnut planter (two row)	• Used for planting of groundnut seeds by cup type metering device • Row spacing of 25 cm and hill spacing of 10 cm is maintained • Pulled by one person	12	0.4 hectare per day	14.66 hp-hr per hectare
Groundnut digger	• Used for digging of groundnut and also suitable for potato digging • .Ploughing of the land for the subsequent crop is achieved without expenditure • Operated by a pair of bullock and one person	54	0.4 hectare per day	13.09 hp –hr per day

Name of the Implement	Features	Weight (Kg)	Field capacity/ output	Energy saving
Pedal operated groundnut thresher	• Used for removing groundnut pods from the uprooted plants • Threshing effienecy is 98.5% • Operated by one person	45	220kg per day	2.3 hp-hr per quintal
Power operated groundnut thresher	• Used for removing pods from the uprooted plants • Threshing efficiency is 99% • Operated by 0.5 hp electric motor and two persons	27	265 kg per day	2.4 hp-hr per quintal
Groundnut decorticator (oscillating type)	• Used for removing groundnut seeds from the pod • Operated by one person	14	400 kg per day	1.6 hp-hr per quintal
Groundnut decorticator-cum-cleaner(power operated)	• Used for decortication of groundnut pods and cleaning of kernels • Decortication efficiency is 98% and cleaning efficiency is 96% • Operated b y 1.0hp electric motor and person	72	5 quintal per day	
Solar cabinet dryer	• Used for drying of vegetable and spices • Used direct sunlight for drying	36	75 kg per batch	
Self propelled rice transplanter (8 row)	• Used for line transplanting of rice • Row spacing of 23.8 cm and hill spacing of 12 or 14 cm is maintained	320	0.15 ha. Per hour	
Power tiller operated axial flow thresher	• Used for threshing of paddy • Operated by 9-14 hp power tiller • Two persons are required for cleaning grains from outlet end • Threshing efficiency 98.50	450	3.80 quintal per hour	

Name of the Implement	Features	Weight (Kg)	Field capacity/ output	Energy saving
Self propelled Reaper	• 1m cutter bar which harvest cereal crops of 75cm. and above height • Operated by 4 to 5 hp diesel engine or petrol start kerosene engine	180kg	1.6 ha/day	
Tractor mounted Rotavator	• Suitable for seed bed preparation • Working depth of 10 to 12 cm and width of 160cm		0.2 to 0.3 ha/hr	

FODDER CROPS

` In Orissa, availability of green fodder (2.65 million tonnes) and dry fodder (11.7 million tonnes) is quite inadequate for 23.66 million (2001-02) livestock population. The requirement of green and dry fodder has been estimated to be 117.5 and 16.65 mt, respectively. Hence, emphasis should be given to increase the fodder production in the State for maintaining better health of livestock and higher returns. The package of practices of the important Rabi fodder crops of the State are as follows:

Package of practices of different Rabi Fodder Crops

Crop	Varieties	Time of Sowing	Spacing (cm)	Depth of Sowing (cm)	Seed Rate (kg/ha)	FYM (t/ha)	Fertilizer (NPK kg/ha)	Yield (q/ha)	Utiliza-tion	Remarks
Cereal										
Maize	African tall, J-1006, Jawahar, Vijaya composite, Moti composite	November	30 x 10	4	40-50	10	80:40:40	350	Green, silage and hay	Harvest at tasselling stage to cob formation for green fodder and at dough stage for silage
Oat	Kent OS-6 JHO-822 JHO-851	November	25 x 10	4	80-100	10	80:40:40	350	Green fodder Silage & Hay	Harvest at 50% flowering in case of single cut and in multi cut 1st cut at 50 DAS & 2nd cut at 50% flowering

Legume										
Cowpea	EC-4216, Russian Giant, UPC-4200, UPC-5287 & Bundel Lobia-1	October	30 x 15 or broadcast	4	30-35	5	20:40:20	250	Green fodder	Harvesting at 50% flowering
Rice bean	Bidhan –1	October	30 x 15	4	30	5	20:40:20	200	Green fodder	Harvesting at 50% flowering
Berseem	Wardan (S-99-1) Mescavi	November	Broadcast or line sowing at 25 cm from line to line	2	20-25	10	20:80:40	700	Green fodder	First cut at 45-50 days after sowing and subsequent cuts at 30 days interval
Maintenance of Cultivated Perennial Grasses										
Napier Bajra hybrid	NB-21, CO-1,CO-3 IGFRI-7	-	-	-	-	-	40kg N/ha as top dress after each cut	300 per cut	Green, Silage & Hay	-
Guinea grass	PGG-9, PGG-14, Hamil, Macuini, Riversedale Green Panic	-	-	-	-	-	40kg N/ha as top dress after each cut	200 per cut	Green, Silage & Hay	Suitable for growing under partial tree shade of coconut
Para grass	Local	-	-	-	-	-	40kg N/ha as top dress after each cut	150 per cut	Green, Silage & Hay	Suitable for wet condition

umidicola	Local	-	-	-	-	-	15 kg N/ha as top dress after each cut	100 per cut	Green, Silage & Hay	Suitable for both dry and wet condition

OYSTER MUSHROOM

The fruit body looks like an oyster, hence it is named as oyster mushroom. It is also known as 'Dhingri' mushroom. A number of species under the genus *Pleurotus* are also cultivated. Of these, *Pleurotus sajor-caju* is most popular. The fruit bodies are grey in colour.

Climatic requirements

Temperature - 20 - 30^{0}C

Humidity - 80-85%

Light - 200 lux (at vegetative stage darkness is required)

oxygen requirement is more in fruiting stage than vegetative stage.

pH - 6.5 to 7.0

Moisture content of substrate - 65%

Materials required

One polythene bag of 80 cm x 40 cm size

Spawn - 200 g (Content of one 375 ml glass bottle)

Straw - 1.5 -2.0 kg (dry, hand threshed and not too old)

Wheat grain- 250 g

Procedure

Cut the straw bundles into 1.5-2.0" size. Soak it in clean & cold water for 12- 16 hours depending upon the stiffness of the straw. Steam sterilize the cut pieces for one hour and spread to drain out excess water. Try to maintain 65% moisture in the substrate. Boil the wheat grains to make them soft. Tie one end of the polythene tube to make it a bag. Remove the spawn from the bottle and divide it into 4 parts. Likewise, divide the boiled wheat into four parts. Fill straw pieces in the bag upto 6" thickness make it compact. Put spawn and boiled what (one part each) towards the periphery only to facilitate the emergence of fruit bodies. Likewise other three layers are made with straw, spawn and wheat grains. Top of the polythene bag is then tied up. For gas exchange, 10-20 holes are made around the bag by a clean nail. This type of spawning is called layer spawning. One can raise the bags without wheat grain supplement also.

After care

The bag is incubated in darkness for 15 days for mycelial growth. After that the mycelial mat is removed from the polythene bag and hanged in a rack. From the second day

onwards bags are watered to maintain substrate humidity. 20-25 days after spawning small buds develop and 3-4 days after they reach harvestable stage. Mushrooms are harvested in 3-4 flushes at 7-10 days interval. Total yield obtained from a single bag is 1.5 kg - 2.0 kg. Bioefficiency is more than 100%.

Economics

Expenditure for a single bag (4 sq.ft area)	
Straw - 1.5 -2.0 kg	Rs. 2.00
Spawn - 200 g	Rs. 8.50
Wheat grain - 250 g	Rs. 2.50
Polythene bag - One	Rs. 3.00
Misc. expenditure including labour	Rs. 4.00
	Rs. 20.00

Yield - 1.5 to 2.0 kg

Price of produce	Rs. 30.00 per kg
Gross return	Rs. 45.00
Net return	Rs. 25.00

(From 4 sq.ft. area a farmer will get a profit of Rs. 25.00 within 45 days)

Advantages

It grows on a wide range of temperature and substrate.

High biological efficiency (100-150 per cent)

Very good shelf life.

Good for health

PREPARATION OF INSECTICIDAL SPRAY SOLUTION

It is necessary to know the method of preparing insecticidal sprays and dusts of the required strength from preparatory formulations, which are usually available in higher concentration except in case of dust formulations.

For preparing spray solutions of a desired strength from commercial product, we have to work out the quantity of diluent and the total quantity of proprietary insecticide required.

1. In order to obtain the quantity of insecticide needed to give a desired strength in the diluted spray, the following formula may be applied.

$$\frac{\text{Total quantity of spray solutions required} \times \text{Strength in percentage of the final spray solution desired}}{\text{Known strength in percentage of the proprietary insecticide}}$$

This will give the quantity of proprietary insecticide required to make the desired strength. *For example*, if 200 litres of 0.07% spray is desired to be prepared from 35% Endosulfan emulsion, the above formula can be applied as follows :

$$\frac{200 \text{ litres} \times 0.07}{35} = 0.4 \text{ litre or } 400 \text{ ml}$$

It means that 400 ml 35% EC Endosulfan will be required to prepare 200 litres of 0.07% Endosulfan spray.

2. To obtain the strength of a finished spray solution in per cent when the amount of spray solution and the per cent strength and quantity of the proprietary insecticide used are known, the following formula may be applied.

$$\frac{\text{Quantity of proprietary insecticide added} \times \text{Strength of proprietary insecticide in percent}}{\text{Quantity of finished spray solution}}$$

This will give the per cent concentration of the finished spray solution.
For Example, if 400 ml of 20 per cent Chlorpyriphos emulsion is added to 200 litres of water, the concentration of the solution according to the above formula can be worked out as follows :

$$\frac{0.4 \text{ litres} \times 20}{200 \text{ litre}} = \frac{1}{25} = 0.04 \text{ per cent}$$

3. When quantity of actual insecticidal (a.i.) to be applied per acre is known, the following formula can be used to find out the quantity of formulated insecticide required equivalent to the quantity of actual insecticide:

$$\frac{\text{100 (cent per cent purity of actual insecticides)} \times \text{Quantity of actual insecticide required}}{\text{Per cent of formulate insecticide available}}$$

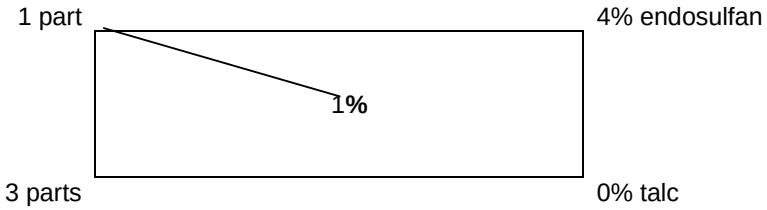
This will give the quantity of formulated insecticide required.
For Example, if 50 ml of actual Chlorpyriphos is to be sprayed per acre, the quantity of 20 per cent Chlorpyriphos emulsion required would be :

$$\frac{100 \times 50}{20} = 250 \text{ ml}$$

Dilution of dust

To reduce the concentration of an insecticidal dust by adding inert dust, the rectangular method of dilution may be followed as given below.

Example: If 4 % endosulfan dust is required to be diluted to 1% dust by adding talc, write the percentage concentration of endosulfan and talc dust at the right hand corners of the rectangle and desired final concentration (1%) in the centre of the rectangle.



Subtract along the diagonal lines taking the smaller from the large number in each case and place the figures on the left hand corners of the rectangle as shown in the diagram. It means that 3 parts by weight of talc powder will be required to be mixed with 1 part of endosulfan 4% dust in order to get desired 1% endosulfan dust.

CHIEF MINISTER'S PACKAGE FOR AGRICULTURE SECTOR

AGRICULTURE DEPARTMENT

Seed

1. To achieve higher production and productivity, Seed Replacement Rate (SRR) would be enhanced from present 7% level to 12% in 2007-08, 18% in 2008-09 and 25% in 2009-10 by production of quality seeds in farmers' fields.
2. Seed Village Programme will be taken to every block. The production of certified seeds will be taken to five lakh quintals in the next two years.
3. All districts would have a seed processing plant by end of 2009-10. To achieve this 3 more Seed Processing Plants would be installed in Gajapati, Kendrapara and Jharsuguda by 2009-10.
4. Five De-humidified Chambers would be set up at Balasore, Jeypore, Berhampur, Angul and Bargarh within three years to ensure preservation of quality and maintenance of viability of sensitive seeds.
5. All districts would be covered with storage godown facilities for safe storage of quality seeds in three years. As such, 17 new godowns would be constructed.
6. The Orissa State Seeds Corporation will open outlets for sale of seeds in every G.P. This will be done either through private dealers or institutions such as Pani Panchayats, Self Help Groups etc.

Organic Farming

Emphasis would be given on development of Organic Farming.

1. One Vermi Hatchery Unit would be set up in each Block and the State Govt. will promote Vermi Compost Unit at village level.
2. 1.00 lakh hect would be covered every year under Bio-fertilisers (Rhizobium culture and PSB) in pulses and oilseed crops.
3. To encourage green manuring 10,000 ha. of land would be covered under Dhanicha every year.
4. Districts like Kondhamal and Koraput having huge potential in organic farming will be provided all the necessary linkages for such farming. The Government will **establish a Corpus Fund** for organic certification.

Soil Testing Facilities

1. Soil testing facilities have been extended to all the blocks. At least 1.50 lakh farmers would be supplied soil health cards every year.
2. Subsidy on transportation and cost of lime, basic slag, paper mill sludge and gypsum

would be provided to farmers for soil amendment in 2.5 lakh hectares in three years.

Farmers Training & Extension

Crop planning will start from village level with participation of farmers.

Farm Mechanisation

1. 50% subsidy on purchase of Manual and Bullock drawn implements would be provided limited to Rs.2500/- per set.
2. 30,000 diesel pump sets would be supplied in TSP Blocks, KBK and WODC district with 33% subsidy limited to Rs.5000/- in three years.

Agri Clinic

1. Agri clinics would be set up in every district as a one stop shop for providing different inputs such as seeds, fertilizers, farm implements etc. In case of Self-employed youths, SHGs and Pani Panchayats etc. intending to set up such clinic, assistance will be 1. 1000 nos of farmers shall be provided training in each block in the coming four years.
2. Lead farmers will be trained under the Krushak Sathi Programme, who will act as contact point for dissemination of agriculture technology and information to other farmers in all G.P.s in the coming three years.
3. Demonstration and Training on System of Rice Intensification(SRI) will be conducted in all **feasible** villages in the Command Areas of Irrigation Projects.
4. Farm Information and Advisory Centres (FIAC) will be opened in all Blocks by 2008-09.
5. Selected Best farmers would be given cash awards at Block, District and State level every year.
6. Refresher trainings would be organized for Extension Officers at all levels for skill upgradation.

7.provided under State Employment Mission.

Irrigation

1. 35,000 numbers of Private Lift Irrigation Points (PLIP) will be promoted with subsidy in the State in 2 years.
2. Two lakh Farm Ponds will be executed free of cost in the field of BPL farmers in the State by June,2008 under NREGS .
3. The drawal of electrical line up to one kilometer from the existing L.T. line will be subsidized to the extent of 80% in case of small and marginal farmers of KBK districts and tribal sub-plan Blocks and 70% in case of small and marginal farmers of other areas for the purpose of installation of electrical pump sets on dug well / individual private L.I. points.
4. A minimum of 35% irrigation potential in each Block will be created over a period of five years.

Horticulture

1. Plantation of 25,000 ha of Mango, 15,000 ha of Cashew and 2,500 ha of Banana on farmers' field will be taken up in 2 years by 2008-09 with 75% subsidy.
2. 8,100 ha Drip Irrigation and 6,000 ha Sprinkler Irrigation will be promoted in 2 years in the State with 50% subsidy.
3. To supplement the nutritional level of rural areas, subsidized seedlings of Papaya, Drumstick and Kaggi lime wi!! be distributed among 15,000 Educational Institutions and 2.50 lakhs rural households.
4. 5,000 farmers will be provided subsidy for construction of low cost onion storage structures in 2 years.
5. Training would be imparted to one lakh unemployed youths on Commercial Horticulture in 3 years, 35,000 in 2007-08 , 35,000 in 2008-09 and 30,000 in 2009-10.
6. Nursery-cum-Kitchen Garden Sale Centers would be established at each Block Headquarters by end of 2008-09 , 215 nos. in 2007-08 and 99 nos in 2008-09.

Watershed Development

1. Rs. 135 crores would be utilized for developing and improving 2.35 lakh ha. of marginal, degraded and rainfed land under watershed programmes during 2007-08.
2. Rs.72.00 crores would be provided under Western Orissa Rural Livelihood Project for Livelihood Improvement Activities in additional 387 Micro Watersheds over next three years in Bolangir, Kalahandi, Nuapada and Bargarh districts.
3. Rs.90.50 crores would be provided under Orissa Rural Livelihood Project for Livelihood Improvement Activities in 460 Micro Watersheds over 3 years in Koraput, Nawarangapur, Malkangiri , Rayagada , Kandhamal and Mayurbhanja districts.

FISHERIES AND ARD DEPARTMENT

Fisheries Sectors

1. Short-term credit facilities towards working capital available to agriculture farmers would be extended to fisherman for pisciculture.

   Short-term credit facilities as per NABARD approved refinance norm was introduced in Fishery sector in 2006-07 and about a sum of Rs.3.00 crores was provided as short term credit by Nationalized Banks, Gramya Banks and Cooperative Banks. During 2007-08, a target of Rs.29.38 crores has been fixed and the target has been communicated to SLBC for circulation among all the Banks and periodical review would be conducted through District Level Bankers Committee and SLBC.
2. Aqua-shops would be promoted in every Block for facilitating availability of inputs for pisciculture and counseling for Scientific Pisciculture. Subsidy would be provided by

APICOL under the scheme “Promotion of Agro-enterprise”.

Aqua-shops would serve as a single window centre where all kinds of inputs for Scientific Pisciculture and technical advices would be provided to the fish farmers and fishermen. This scheme is a bankable scheme and the outer ceiling of the project is fixed at Rs.3.00 lakhs. The project can be taken up by Fisheries Entrepreneurs/ Agriculture Graduates either individually or jointly on group basis. The matter would be taken up in SLBC meeting and progress would be reviewed from time to time.

Animal Resources Development Sector

1. Health Coverage would be provided to the entire livestock population through application of preventive vaccine.

While FMD and PPR vaccines would be procured from outside the State, other vaccines like HSV, BQV, Anthrax and ENT would be produced at Orissa Biological Product Institute (OBPI) at Bhubaneswar and its satellite unit at Berhampur. About 2 crore 1 lakh doses will be produced.

The immunization programme would help prevent occurrence of contagious diseases among livestock.

2. Diagnostic Laboratory would be set up in every district for easy access of livestock farmers for disease diagnosis.

The District Diagnostic Laboratory (DDL) would serve as a centre to take up examination of blood/ stool/ skin scrapping/ milk samples drawn from all over the districts so as to help the farmers to resort to immediate treatment. The proposal for construction of 30 DDL at a total cost of Rs.767.40 lakhs @ 25.58 lakhs for each DDL (Civil work Rs.8.58 lakhs and equipment Rs.17.00 lakhs) has been approved by High Power Committee to be taken up under RIDF. After NABARD approval, construction work would be taken up.

3. Establishment of Poultry Hatchery in all the districts.

Poultry hatcheries would be set up in PPP mode in all the districts which would ensure availability of day-old chicks to the farmers. This would promote backyard poultry conserving native germplasm of poultry breeds available in Orissa.

COOPERATION DEPARTMENT

1. Revival of the short-term Co-operative Credit Societies.

To ensure flow of agricultural credit, the Cooperative Credit Societies in the State would be provided financial assistance to wipe out their accumulated losses. Implementation of the revival Package in terms of the Vaidyanathan Committee recommendations would begin this year.

2. Agricultural Credit Support to all farmers through the cooperatives.

Nine lakh agricultural families in the State having no access to institutional credit would be brought under the fold of cooperative credit by providing Kisan Credit Cards to eligible

farmers in three years covering three lakh families per year.

3. Providing fresh credit to all farmers with default free status.

During 2007-08, the Cooperative Banks would provide fresh finance to all the balance eligible 2.10 lakh farmers whose arrear loans have earlier been re-scheduled.

4. Credit Linkage for Cotton Farmers.

The District Central Cooperative Banks in Bhawanipatna, Koraput, Berhampur and Aska covering the main cotton-producing districts would provide credit to cotton farmers for their agricultural operations during the current Kharif so as to prevent their dependence on high-cost loans from money lenders and consequent exploitation.

5. Crop Insurance for Cotton.

The "Block" instead of the "District" would be declared as the unit for crop insurance in case of cotton from the current Kharif to ensure that cotton farmers get the maximum benefit by way of compensation in case of crop loss.

6. Marketing tie-up for Cotton

Contract Farming in Cotton to be encouraged for assured market linkage and remunerative prices to farmers to prevent exploitation.

7. Special Cotton Markets

Establishment of two Special Cotton Markets with processing facilities at Paralakhemundi in Gajapati district and at Digapahandi in Ganjam district.

8 . Special Maize Markets

Establishment of two Special Markets for Maize at Umerkote and Raighar in Nawarangapur district for the benefit of tribal farmers.

9. Market Linkage for Oilseeds.

Encouraging Contract Farming in oilseeds like groundnut and sesamum through NAFED.

10. Establishment of Market Yards in all Blocks.

Market Yards would be established by the RMCs in all the 120 Blocks without Market Yards during the next two years.

11. Rural Producers' Organization

Formation of commodity specific Rural Producers Organizations and enabling them to form federations at the Block/ RCMS level to enable appropriate market linkages to be established for different agricultural produce.

12. Improving Connectivity.

Physical linkage of production centres to the markets by rural link roads.

13. Expansion of the co-operative credit network.

The network of the Primary Cooperative Credit Societies in the tribal areas whose growth has remained restricted due to the LAMPs approach would be expanded, making agricultural credit highly accessible for the tribal population. This would bring the grass root level cooperative credit societies nearer to the farmers in the tribal areas.

***

ANNEXURE-I

CHARACTERISTICS OF HIGH YIELDING RICE VARIETIES SUITABLE FOR SUMMER SEASON IN ORISSA

Sl. No	Varieties	Dura-tion (days)	Grain type	Average yield (t/ha)	Reaction to diseases and insect pests									
					B	ShB	ShR	BLB	HM	SB	GLH	GM	BPH	
I.	Extra early													
1	Heera (CR 544-1-2)	85	LS	3.0	R	-	-	-	-	-	R	R	-	Hul ker lim
2	Kalinga-III (CR 237-1)	90	LS	3.0	MR	-	-	S	R	MR	MR	-	MR	Sel sui irri Ma gur
3.	Dhala Heera (CR544-1-3-4)	90	LB	3.0								R		Sus
II.	Early duration													
4	Vandana	100	SB	3.0	-	-	-	-	-	-	-	MR	-	Sel pos pes sus
5	Jogesh (OR 1519-2)	95	MB	3.0	T	T	-	R	R	-	-	T	T	Sel col Tol
6	Sidhanta (OR 102-4)	95	SB	3.5	T	-	T	-	R	-	-	T	T	Inte hul rice RT
7	Parijat (OR 34-16)	100	MS	4.0	MS	-	-	MR	MR	MR	MR	S	S	Sui irri Ma esc

Sl. No	Varieties	Dura-tion (days)	Grain type	Average yield (t/ha)	Reaction to diseases and insect pests									
					B	ShB	ShR	BLB	HM	SB	GLH	GM	BPH	
8	Khandagiri (OR 811-2)	100	MS	3.5	R	MR	-	-	R	R	-	MR	-	Sel col mo RT hav mic
9	Udayagiri (OR 752-38-1)	100	MB	3.7	R	MR	-	MR	R	R	-	MR	-	Sel col
10	Nilagiri (OR 163-104)	100	MB	3.4										Sel col for fac res
11	Anjali	100	MS	3.5	-	-	-	-	-	-	-	-	-	Sel are upt
III.	Medium Duration													
12	Naveen (CR 749-20-2)	125	MB	5.0	MR	MS	-	-	MS	-	R	-	-	Sel pos
13	Sebati (OR 776-SSD-26)	130	MS	5.0	R	-	MR	MR	R	-	-	R	MR	Sel col res
14	Satabdi (CR 146-7027-224)	130	MB	5.0										Sui sea
15	Bhoi (OR 987-13)	135	MB	5.0	R	-	-	MR	R	-	-	R	-	Sel col res WE
16	Konark (OR 1143-230)	135	MS	6.5	MR	-	-	MR	R	R	-	R	MR	Sel col res yie lan

Sl. No	Varieties	Dura-tion (days)	Grain type	Average yield (t/ha)	Reaction to disease and insect pests									
					B	ShB	ShR	BLB	HM	SB	GLH	GM	BPH	
17	Kharavela (OR 815-3)	135	MS	5.0	R	-	R	-	R	R	-	R	-	Sel col res WE me
18	Pusa-44	135	LS	5.00										Sui stif inp for goo
19	Radhi (CRM 40)	130	LB	4.5	S	-	-	-	-	S	-	-	-	Tal sui me
20	Srabani OR 367-SP-II)	130	MS	4.5	R	-	-	MR	MR	MR	MR	MR	MR	Sui me
21	Lalat (ORS 25-2014-4)	135	LS	5.0	R	-	-	R	R	MR	R	R	R	Sel N-r res and irri
22	Gajapati (OR 820-29)	140	MS	5.0	R	-	R	-	R	R	-	R	-	Sel col to i
23	Cottondora sannalu (MTU-1010)	140	LS	6.0	-	-	-	R	-	-	-	-	R	Sui wh upt
24	Surendra (OR 447-20-P)	140	MB	5.5	R	-	R	-	R	R	-	R	R	Sel col api res
25	Tapaswini (CR 333-6-1)	135	MS	5.0	MR	-	-	R	-	MR	-	MR	R	Sel sus and irri

Sl. No	Varieties	Dura-tion (days)	Grain type	Average yield (t/ha)	Reaction to diseases and insect pests									S
					B	ShB	ShR	BLB	HM	SB	GLH	GM	BPH	
26	Jajati (OR 47-2)	115	SS	4.0	MR	-	-	MR	MR	S	S	R	MS	Intern well ir Suite land, recon
27	Meher (ORS 26-2008)	145	MB	6.0	R	-	-	-	-	-	-	R	R	Semi most mediu grain flatter
28	Vasundhara (RGL-2538	140	LB	5.5	R	-	-	-	-	-	-	R	-	Semi- lodgir
29	Swarna (MTU-7029)	145	SF	5.0	-	-	R	-	-	-	-	-	-	Seed kerne and b
30	Vijeta (MTU-1001)	125	MS	5.5	MR	-	-	-	-	-	-	R	R	Seed 6-8 w and r days. mediu

* *To break dormancy soak the seeds in 0.2% nitric acid or 250 ppm GA_3 for 24 hours and then follow normal procedure of incubation to induce sprouting for nursery sowing.*

N.B.:

MS	Medium slender	B	Blast	GLH	Green leaf hopper	R
MB	Medium bold	Sh.B	Sheath blight	BPH	Brown plant hopper	MR
LS	Long slender	Sh.R	Sheath rot	RTV	Rice Tungro virus	S
SS	Short slender	BLB	Bacterial leaf blight	WBPH	White backed plant hopper	MS
SB	Short bold	HM	Helminthosporium leaf spot	LF	Leaf folder	
LB	Long bold	SB	Stem borer	WM	Whorl maggot	
SF	Super fine	GM	Gall midge			

ANNEXURE-II

INSECT PEST MANAGEMENT IN CROPS

RICE

Stem borer

Occurrence and damage

It is the most important pest of summer paddy. Infestation begins soon after the transplanting of seedlings in February. Larvae-bore into tillers, cause **dead heart** in the vegetative stage and **white earhead** at the flowering stage, becomes serious from March to April end. Threshold: 5% dead heart in vegetative stage or one egg mass or one moth/sq.m. in the heading stage.

Control measures

While harvesting the kharif paddy, cut the crop close to the ground. After harvest, plough up the land properly. Dispose off the stubble either by burning in the field or letting in water into the field and decomposing them. Stubble destruction by the 3rd week of January destroys the hibernating larvae and pupae. Rice transplanted within mid January minimises borer attack in the heading stage. Spray nursery beds once at 15 to 25 days after germination with chlorpyriphos 20 EC or monocrotophos 36 SL or phosphamidon 40 SC or phosalone 35 EC @ 40 ml or quinalphos 25 EC @ 40 ml in 20 litre of water for 10 cents of nursery.

or

7 to 10 days before transplanting apply granular insecticides such as phorate 10G @ 0.5 kg or carbofuran 3 G @ 1.2 kg or cartap hydrochloride 4G @ 1.0 kg or fipronil 0.3G @ 0.5 kg per 10 cent of nursery area.

or

Apply seedling root dip treatment with 0.02% chlorpyriphos solution (1ml in 1 litres of water) for 8-10 hours before transplanting or in 0.02% chlorpyriphos with 1.0% urea (10g urea in litre of water) for 3 hours.

In the main field 10-15 days after transplanting, if stem borer moths are observed and egg laying noticed, then apply phorate 10G @ 15 kg or carbofuran 3G @ 30 kg or cartap 4G 25 kg/ha or fipronil 0.3G @ 12.50 kg/ha and keep water impounded in the field for 6-7 days. At the boot leaf stage of the crop, spray triazophos 40 EC or monocrotophos 36 SL or chlorpyriphos 20EC @ 1000 ml/ha or cartap 50 SP@ 500 g/ha. Use pheromone traps for yellow stem borers @ 25 traps/ha for mass cupturing of adults. .

Brown plant hopper

Occurrence and damage

These hoppers congregate at the basal portion of paddy plants and they suck sap and cause hopper burn. Plants become yellow and dry up in circular patches. This is known as “hopper burn”. It transmits grassy stunt virus disease. It occurs sporadically between mid March and May. Threshold 5-10 hoppers/hill.

Control measures

Transplant moderately resistant rice varieties viz-Parijat, Annapurna, Neela, Sarasa, IR-36 and Gouri.

- Finish transplanting latest by 15th January in BPH endemic areas. Duration of the varieties should preferably be within 125 days.
- Alternate wetting and drying of the field at 3-4 days interval is beneficial to combat the pest menace.
- Apply moderate dose of fertilizers (60:30:30 kg N:P_2O_5:K_2O/ha).
- Surveillance for BPH at 3-5 days interval is a vital step. Spraying should be done when 5-10 nymphs or adults per clump in the vegetative stage and 15-20 nymphs or adult/clump in heading stage. Leave alleys by skipping one row for a strip of 10 rows if transplanting is done in lines.
- Spray any one of the following insecticides viz. triazophos 40 EC @ 1000 ml/ha or ethofenprox 10EC @ 500 ml/ha or imidacloprid 17.8 SL @ 125 ml/ha. Never use under dose of insecticides.
- Synchronous planting is better to break the life cycle of the pest.
- Withhold the insecticidal spray if the spiders, mirid bug, lady bird beetle are abundant in the field. (pest defender ratio is 2:1)
- As a long term control strategy rotate summer rice with a pulse, oilseeds crops.
- Do not spray resurgence causing insecticides like decis, methyl parathion and chlorpyriphos etc.

Leaf folder

Occurrence and damage

Greenish caterpillars fold and stitch leaves length wise or from tip downwards and feed on the green matter by remaining inside. Affected leaves show whitish patches. Occurrence is regular now a days. Threshold:2 freshy damaged leaves/hill. Peak incidence in Orissa is observed in mid April.

Control measures

Follow same recommendation suggested for stem borer above. If stem borer and leaf folder infestation is there. If this pest occurs alone, spray triazophos 40 EC or monocrotophos 36 SL @ 1000 ml or ethofenprox 10 EC @ 500 ml/ha or cartap 50 SP @ 500 g/ha. Resease Trichogramma Chilonis @ 50,000/ha.

Grass hopper

Occurrence and damage

Occasionally becomes serious in summer paddy. Hoppers devour leaves and feed upon the developing grains.

Control measures

Dust the affected fields in the heading stage with carbaryl 5% or malathion 5% @ 25-30 kg/ha.

Cut worm

Occurrence and damage

Earhead cutting caterpillars appear in the ripening stage of the crop. The caterpillar cuts earheads particularly in the night hours and hides in the cracks, crevices and under debris during day time. Threshold: 1 larvae/hill.

Control measures

Affected fields be first segregated by applying around the field a heavy dusting with Chlorpyriphos 1.5% dust @ 25-30 kg./ha during evening hour. Alternatively, spraying Chlorpyriphos 20EC @ 1000 ml. /ha or DDVP @ 500 ml or endosulfan @ 1000 ml/ha be done in the evening hours.

WHEAT

Termite

Occurrence and damage

Attacks plants, feeds on roots and underground parts causing wilting and death of plants. Severe in well-drained light soils.

Control measures

Before sowing apply Chlorpyriphos 1.5% D dust @ 25-30 kg/ha uniformly to the field and incorporate by ploughing. If termites destroy in the earlier growth stage or later, drench the soil with Chlorpyriphos @ 5 ml./liter of water or 0.1% lindane and followed by irrigation. If the crop is regularly irrigated, termites do not pose any threat to wheat crop.

Pink borer

Occurrence and damage

Pinkish caterpillars bore into the shoots, causing dead heart and white earhead.

Control measures

Incidence of this borer can be reduced by application of the insecticides those are recommended for control of the stem borer of rice.

Aphid

Occurrence and damage

This is a soft-bodied insect. It sucks sap and weakens the plants.

Control measures

Spray methyl demeton 25 EC or dimethoate 30 EC @ 1000 ml/ha or imidacloprid 17.8 SL 125 ml/ha.

Release *Chrysoperla carnea* @ 50,000 first instar larvae / ha, 1-2 times as per need.

MAIZE

Stem borer

Occurrence and damage

The damage is similar to wheat stem borer. Although Kharif maize is attacked by *Chilo partellus*, the Rabi maize is attacked by the pink borer which infests wheat and ragi.

Control measures

Spray triazophos or profenophos @ 1000 ml/ha. Carbofuran 3G be applied to the leaf whorl of affected plants. Release Trichogramma Chilonis @50,000/ha at 10 days interval 1-2 times as per need.

Aphid

Occurrence and damage

Damage is similar to that caused by wheat aphid.

Control measures

Spray methyl demeton 25 EC or dimethoate 30 EC @ 1000 ml/ha at the early stage and malathion @ 1000 ml/ha in cob stage.

Defoliating caterpillars

Occurrence and damage

They are polyphagous pests, they cut the young plants or devour the leaves and tender plant parts.

Control measures

Spray endosulfan 35 EC @ 1000 ml or carbaryl 50 WP @ 2.0 kg/ha.

Termite

Occurrence and damage

Damage is similar to that described under wheat crop.

Control measures

Follow recommendations suggested under wheat or incorporate (Carbaryl 4% + Gamma BHC 4%) granule @ 20 kg/ha into the soil at the time of sowing.

RAGI

Armyworms and cutworms

Occurrence and damage

They appear during early stages and continue upto harvest. The caterpillars cut seedlings at the base which appear as if grazed by domestic animals. They are active during night and hide under stones and clods during the day.

Control measures

When the symptoms are noticed take up dusting with Chlorpyriphos 1.5% @ 25-30 kg./ ha. or endosulphan 4% dust @ 25-30 kg/ha.

Stem borer

Occurrence and damage

Infestation begins soon after the transplanting. Larvae bore into the tillers causing dead hearts in the vegetative stage.

Control measures

* Spray nursery beds once at 15-20 days after germination with chlorpyriphos 20 EC or monocrotophos 36 SL or lambda-cyhalothrin 2.5% E.C. @ 40 ml for 10 cents of nursery
* Alternatively 10 to 15 days before transplanting apply phorate 10G @ 0.5 kg or carbofuran 3G 1.2 kg or cartap hydrochloride 4G @ 0.5 kg per 10 cent nusery and keep the field thoroughly moist for 6-7 days.
* In the main field spray lambda-cyhalothrin 2.5% EC @ 1000 ml/ha or cartap hydrochloride @ 500 g/ha. Two to three sprayings at 10-15 days intervals may be required depending upon the severity of the insect pest. Release *Chrysoperla carnia* @ 50 000 first instar larvae / ha 01-02 times as per need.

Aphids

Occurrence and damage

These are minute soft bodied insects. They suck the sap and weaken the plants.

Control measures

Spray methyl demeton or dimethoate @ 1000 ml/ha or endosulfan 1000 ml/ha in pre-flowering stage.

Ear caterpillars

Occurrence and damage

Ear caterpillars remain in side the ear heads and feed on developing grains.

Control measures

Dust the crop with malathion 5% or endosulfon 4% or phosalone 4% dust @ 25 kg/ha.

PULSES

Leaf eating caterpillars and pod borers

Occurrence and damage

They defoliate the plants and feed on the pods. Affect seed setting and reduce yield.

Control measures

For control of pod borers and defoliators spray, the crop with endosulfan @ 1000 ml. or monocrotophos @ 1000 ml/ha or carbaryl @ 2.0 kg/ha.

In pigeonpea against *H.armigera*, spray NPV @ 125 LE with endosulfan @ 500 ml/ha in the evening hours or spray endosulfan @ 1000 ml/ha, thrice at 15-20 days interval commencing from the pod initiation stage. Spray Bt. product @ 1.0 kg/ha.

On chickpea one spraying at 65-70 days after sowing with endosulfan @ 1000 ml/ha protects the crop against *H.armigera*. Setting of heltilure @ 20 no./ha to catch and kill the adult males of *H.armigera* is helpful.

Aphids

Occurrence and damage

Nymphs and adults desap the plants causing stunted growth, yellowing of leaves and withering incase of heavy attack.

Control measures

1. Seed treatment with imidacloprid 17.8 SL @ 7 ml/Kg of seed protects the crop against aphids and other sucking pests in early growth stage.
2. Atleast 21 days before harvesting these insecticides should not be applied.
3. Spray the crop with methyl demeton 25 EC or dimethoate30 EC @ 1000 ml/ha.

White fly

Occurrence and damage

Nymphs and adults desap the plants. It acts as a vector of YMV.

Control measures

Peak incidence is observed in 1st fortnight of April on greengram.Neem oil and custard apple oil (3:1) at 2% + 0.5% teepol spray could effectively control the vector. Alternately, spray the crop with 1000 ml/ha of dimethoate or 125 ml/ha of imidacloprid 17.8 SL.

GROUNDNUT

Termites

Occurrence and damage

Damage is similar to that described under wheat.

Control measures

Use certified seed to have a uniform ripening crop. Treat seed before sowing with thiram DSD @ 3g/kg of seed. For regular and heavy attacks, treat soil with sevidol granules @ 20 kg / ha. BHC should not be used for soil treatment. Avoid water stress.

Thrips

Occurrence and damage

Nymphs and adults suck the sap mainly from the leaf buds and retard growth and reduce yield. The crop at 35-45 days age from sowing date is vulnerable to thrips attack. In summer peak incidence is observed either in 4th week of February or 1st week of March.

Control measures

Apply imidacloprid 17.8 SL @ 125 ml in 500 litres of water per hectare.

Leaf miner

Occurrence and damage

Caterpillar mine into leaves producing blister like mines. Protective enclosures of webbing are formed. Drought condition favours rapid multiplication. Usually leaf miner incidence is not observed on rabi or summer groundnut crop.

Control measures

Spray the crop with methyl demeton or dimethoate @ 1000 ml/ha alternately at 20 days interval. Early and synchronous sowing of groundnut avoids pest attack. The spraying schedule also controls the thrips and aphids.

Aphid

Occurrence and damage

Nymphs and adults suck sap. Leaves curl and plant get stunted.

Control measures

As suggested in case of maize.

Pod borer

Occurrence and damage

Earwigs and millipedes and soil dwelling insects like white grubs damage the pods underground.

Control measures

Apply endosulfan 4% or chlorpyriphos 1.5% dust @ 25 kg/ha at sowing time or in the root zone at 21 days after sowing, or drench soil with chlorpyriphos 20 EC @ 5ml/ lt of water. In areas having high pod borer menace furrow application of sevidol granule @ 20 kg/ha at the time of sowing is suggested.

RAPESEED-MUSTARD

Aphids

Occurrence and damage

Light, soft bodied insects appear from early growth stage and continue upto pod maturing stage. They desap plants causing heavy loss in yield. Heavy aphid incidence is observed from mid December to end of January.

Control measures

Spray the crop with methyl demeton or dimethoate @ 1000 ml or imidacloprid 125 ml/ha ensuring thorough coverage. Spraying must be done in the afternoon hours to save honeybees. Complete mustard sowing before 1st week of November to reduce aphid infestation. Non irrigated crop should be at short duration and sowing be done within the first fortnight of October, particularly in hilly districts. Release *Chrysoperla carnea* @ 50,000 first instar larvae 01-02 times at per need.

Saw fly

Occurrence and damage

Dark coloured larvae looking like caterpillars defoliate plants.

Control measures

Spray endosulfan @ 1000 ml or carbaryl 50 WP @ 2.0 kg/ha ensuring thorough coverage.

Larger cabbage moth

Occurrence and damage

Small pale green caterpillars feed on terminal shoots by webbing the leaves, bore into the green pods also.

Control measures

In Orissa aphid and leaf webber incidence is observed simultaneously. Hence, alternate application of acephate or quinalphos and methyl demeton or dimethoate can check both the pests satisfactorily. Acephate is to be applied at 500 g/ha. The rest of the insecticides are applied @ 1000 ml/ha.

SUNFLOWER

Leaf caterpillar

Occurence and damage

Pest like *Spodoptera, Diacrisia* and grass hoppers defoliate the leaves.

Control measures

Follow clean cultivation and trim the field bunds. Regular scouting is needed to identify egg stage or gregarious stage to remove and destroy. Install pheromone trap (spodolure @ 15/ha) from one month stage to final harvest. Spray with endosulfan @ 1000 ml/ha or endosulfan 500 ml + Sl-NPV 250 ml/ha. Spray 2 times at an interval of 7 days with the initiation of infestation.

Sucking pests (hoppers, thrips, aphids, jassids and white fly)

Control measures

* Seed treatment with imidacloprid 17.8 SL. @ 7 ml/kg seed.
* Chemical spray with systemic insecticides.

Inflorescence pests (*Helicoverpa armigera*)

Control measures

* Maintain/ retain natural enemies.
* Use NPV @ 500 LE/ha and conduct 3 sprays
* Spray Monocrotophos 36 SL @ 1000 ml/ha or cypermethrin 25 EC @ 500 ml/ha or fenvalerate 20 EC @ 1000 ml/ha.

Bird pests

Control measures

* Grow on a larger area for rotational watching.
* Use reflector ribbons
* Manual bird scaring during morning and evening hours.

SAFFLOWER

Safflower caterpillar and Bihar hairy caterpillar

Occurrence and damage

Larvae defoliate plants and bore into tender shoots and capsules.

Control measures

Spray the crop with endosulfan or quinalphos @ 1000 ml/ha alternatively if both the pests occurs.

Safflower aphid

Occurrence and damage

Nymphs and adults suck sap from shoots, leaves, flowers and capsules and reduce yield.

Control measures

Spray the crop with methyl demeton or dimethoate @ 1000 ml/ha. Alternatively spray with neem based pesticides 300 ppm @ 5ml/lit at 7-10 days intervals.

SESAME

Leaf and pod caterpillar

Occurrence and damage

Medium size caterpillars feed on leaves and later bore into shoots and pods. Late August or September sown crop is very badly damaged by this pest.

Control measure:

Apply Endosulfan 35 EC @ 1000ml/ha. Or Carbaryl 50 WP @ 2.0 kg./ha.

Hawk moth

Occurrence and damage

Very large size, stout caterpillars, completely defoliate plants.

Control measures

Two spraying, 1st spraying at 25 days after germination and 2nd at the beginning of pod formation with endosulfan 1000 ml or carbaryl @ 2.0 kg/ha.

White fly

Occurrence and damage

Adults and nymphs suck the cell sap from underside of the leaves. Peak activity on summer crop is observed in 1st fortnight of March.

Control measure

Spray Imidacloprid 17.8 SL @ 125ml./ha.

CASTOR

Semilooper *(Achaea janata)*

Occurrence and damage

Caterpillars feed on foliage and growing points. Heavy attack results in complete defoliation.

Control measures

Apply endosulfan 35 EC @ 1000 ml or fenvalerate 20 EC @ 500 ml or carbaryl 50 WP @ 2.0 kg/ha in 500 litre of water.

Shoot and capsule borer *(Conogethes punctiferalis)*

Occurrence and damage

Caterpillars bore into tender shoots and capsules. Their presence is detected from the mass of black faecal matters deposited on capsules.

Control measures

Spraying the inflorescence with endosulfan 35 EC @ 1000 ml or carbaryl 50 WP @ 2.0 Kg/ha can provide effective control.

SUGARCANE

Termites

Occurrence and damage

Most serious in the dry season, while planting setts in the early growth stage. Feed on eye buds of setts and sprouted plants causing failure in germination or death of plant.

Control measures

At the time of planting, spray the setts with 0.1% chlorpyriphos or 0.1% lindane emulsion thoroughly drenching the soil around.

or

In furrow apply with phorate @ 10 kg or sevidol @ 20 kg or carbofuran @ 30 kg/ha at the time of planting. This will also help to suppress the early stalk borer. Alternative dust

formulation of chlorpyriphos or lindane may be dusted over the setts in the trenches @ 30 kg/ha.

Early shoot borer

Occurrence and damage

Hot weather species are very destructive to the young crop during April-June. Larvae bore in to the plants and cause dead heart.

Top shoot borer

Occurrence and damage

Appear after the break of monsoon. Larvae bore into the stalks at the top region. Affected plant gives a bunchy appearance at the top.

Control measures

Spray the crop with monocrotophos @ 1000 ml/ha at 50 days after planting ensuring thorough coverage. Repeat this 3 weeks after the first spray. Light earthing up within 45 DAG, applying sevidol G @ 20 kg/ha or phorate G @ 10 kg/ha is effective. Besides release of *Trichogramma* parasitoids @ 50,000/ha at 7-10 days intervals for 5-6 times commencing from 45 DAG is helpful.

Root borer

Occurrence and damage

Hot weather species. Larvae bore into the underground parts of the plant causing dead heart.

Control measures

As suggested in case of early shoot borer (granule application).

White fly

Occurrence and damage

Numerous dark coloured nymphs attack the leaves and desap the plants causing yellowing of leaves.

Control measures

Between September and December, if white fly population increases, drain excess water to prevent the build up of white fly population. Set up light traps to attract adults of leaf hopper.

Leaf hopper (Pyrilla)

Occurrence and damage

Adults and nymphs congregate under the leaves and desap the plants. Affected leaves lose turgidity, wither and dry. Sooty mould develops.

Control measures

In areas where the leaf hopper attack, release of *Epiricania melanoleuca* parasitoid @ 5000 cocoons and 4-5 lakh eggs/ha is recommended. The parasitoid can be transported from its areas of availability to the infested areas with the supervision of PPO.

Spider mite

Occurrence and damage

Minute pink coloured mites are found in large number under the webbings made on the leaves, affected plants dry up. If severity of attack is more, spray the crop with dicofol 18.5 EC @ 2000 ml/ha.

Mealy bug

Control measures

Detrashing and spraying the crop with monocrotophos @ 1000 ml/ha in 500 litre of water.

General recommendations for preventing pest built up

- Plant the setts in December-January to minimise early shoot borer incidence.
- Adopt timely earthing up (May and June)
- Remove the egg masses of the top shoot-borer and the dead hearts of the early shoot borer during March to June and destroy.
- For early shoot borer release *Trichogramma chilonis* @ 50,000/ha, 3-4 times releases at 10 days interval starting from 45 days after planting or at appearance of the pest.
- For top borer *T.japonicum* can be released at the same rate and frequencies, usually starting from 60 days after germination.
- In pyrilla endemic areas, resistant varieties viz; Co 510, 718 may be grown.
- Harvesting by end of February and ploughing the fields which are not meant for ratooning in February to reduce top shoot borer menace.
- The cane trash should be removed from the field after harvest and utilised for composting or burnt.

POTATO

Epilachna beetle

Occurrence and damage

The adults and larvae feed on the leaves from the lower side. In case of heavy attack plants die.

Control measures

For control of the epilachna beetle and other foliage feeders spray the crop with endosulfan @ 1000 ml or carbaryl @ 2.0 kg/ha.

Aphids and Jassids

Occurrence and damage

Minute nymphs and adults suck the sap and the retard the plant growth. Affected leaves curl and yield is reduced.

Control measures

Spray methyl demeton or dimethoate @ 1000 ml/ha or imidacloprid 17.8 SL @ 125 ml/ha or thiamethoxam 25 WG @ 125 ml/ha. Application of these compounds should be stopped six weeks before harvest.

Cut worm

Occurrence and damage

Larvae becomes active during night and hide during day. They cut the branches.

Control measures

Banding the affected field with chlorpyriphos 1.5 % dust @ 25-30 kg/ha at the time of attack prevents spread to other fields. Spraying the affected crop with Chlorpyriphos 20 EC @ 1000 ml./ ha in the evening hours is effective.

ANNEXURE-III

DISEASE MANAGEMENT IN CROPS

RICE

Blast

Symptoms

It occurs from January to March. Small brown coloured spots appear on the leaves which later become spindle shaped with pointed ends and reddish or purplish brown margin and ashy coloured centre. In severe cases the spindle shaped spots coalesce and wither. If the infestation starts early, the culm and nodes are also affected causing chaffy grains. In severe cases, dark brown to almost black lesions appear on the rachis at panicle base and at joints of rachilla and rachis, as a result of such neck infestation the grains in the affected panicles may become chaffy or shrivelled. The affected panicles become lighter in weight and dry up soon.

Control measures

* Treat the seeds with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g or (carbendazim 1.0 g + thiram 1.5g) per kg of seeds.
* Spray the crop with Ediphenophos @ 0.2% or tricyclazole 0.1% or kasugamycin 0.2% or Ziram 0.25%. Two hundred litres of fungicidal solution may be sprayed per acre. Three sprayings at tillering, boot leaf and grain formation stage may be given.
* Restrict application of over doses of N fertilizer.
* Grow moderately resistant varieties like Annapurna, Parijat etc.

Bacterial leaf blight

Symptoms

It occurs from February to April. Linear yellow to straw coloured undulating lesions appear on leaf margin progressing downwards from the tip with wavy irregular margin demarcating the green and blighted yellow areas. In severe cases the whole field shows a dried up appearance. Even in the nursery stage seedlings may show wilting. When infection is severe the grains may be chaffy and tan in colour.

Control measures

* Before sowing, soak the seed in streptocycline 0.01% (0.1g in 1 lit) or plantomycin 0.1% (1g in 1 litre) mixed with (Carboxyn 37.5% + Thiram 37.5%) DS 1.5g/1 litre of water for 12 hours.
* Dip the root of seedlings in the solution of streptocycline (0.01%) or plantomycin (0.1%) for 30 minutes before transplanting.
* Potash application at tillering and pre-flowering stage will reduce severity of disease.
* Alternate drying and filling of water in rice fields will help in reducing the infection.
* Lalat, Parijat, IR-36, Mahsuri, Pathara and Kasturi are the moderately resistant varieties and should be encouraged for endemic areas.

Brown spot or Helminthosporium disease

Symptoms

It occurs from January-March. Oval shaped brown spot with darker centre and brown margin appear on leaves, leaf sheath and glumes. In severe cases the grain become shrivelled and discoloured. Small leaf spots may coalesce. If seedling infection is severe they may die at young stage even before transplanting.

Control measures

* Treat seed with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5 g/kg of seed.
* Spray the crop with Ziram or Mancozeb @ 1 kg/ac in 200 litres of water. A second spray be given 12 days after the first. Combined fungicides containing Mancozeb 63% + Carbendazim 12% may be sprayed at a concentration of 0.2%.
* Grow tolerant varieties. Use of diseased grains for seed should be avoided.

Grain discolouration disease

This has been emerged as a serious disease of rice since last few years.

Symptoms

The disease symptoms appear at different stages of grain development till its maturity. The disease symptoms developing on affected grain are of different types depending on stages of infection and asociation of different types of fungi and bacteria. The symptoms may be found in the form of dark brown discolouration, necrotic spots, eye shaped elliptical lesion, linear streaks and tip discolouration. The kernel from affected whole seed become black and shrivelled and can easily be cracked. The disease symptoms affect seed germination and grain weight reducing its commercial value to a large extent.

Control measures

* Seed treatment with carbendazim 0.1% + thiram 0.15% or (Carboxin 37.5% + Thiram 37.5%) DS 0.15% or Thiophanate Methyl 0.2%.
* Spraying the crop twice at the time of tillering and before flowering with carbendazim 0.2% or 0.2%(Mancozeb 63% + carbendazim 12%)+ streptocycline 0.01%.

WHEAT

Loose smut

Symptoms

The disease appears in earhead stage of the crop. The grain is replaced by blackish powdery mass of spores (sorus) covered by a thin membrane. Diseased plants generally mature earlier than healthy ones and are shorter in their height.

Control measures

* Soak the seeds in ordinary water for 6 hours and then for 10 minutes in warm water (52^{o}-54^{o}C). Dry in shade. Alternatively expose the seeds under sun light for 4-5 hours in a thin layer on cemented floor or tarpaulin during a sunny day. The seeds may be treated with (Carboxyn 37.5% + Thiram 37.5%) DS (0.2%) or carbendazim @ 1.5g/kg of seeds before sowing.
* Grow resistant varieties such as Kalyansona, Sagarika etc.

Helminthosporium leaf blight/glume blotch

Symptoms

It occurs from February-March. First appear on leaves and leaf sheath as linear to oblong yellowish brown spots which later turn brown. Occasionally shoot infection occurs which is indicated by development of brown lesions on the glumes of the gains as a result of which the grains are shrivelled and sometimes discoloured. Generally rain followed by high humidity promotes the disease.

Control measures

* Treat the seeds with captan (0.25%) or thiram @ 3 g or (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g per kg of seed.
* Grow resistant varieties like OW-6, Janak.
* Spray with Ziram (0.2%) or Mancozeb 750 g/ac in 200 litres of water for 2-3 times at an interval of 10 days, commencing from boot leaf stage.
* Use of seeds from only healthy crops.

Alternaria leaf blight

Symptoms

It occurs from February-March as spindle or irregularly shaped leaf spots which generally appear on lower leaves. These spots have a yellow halo. Smaller lesions may coalesce and cause blighting symptoms. Young plants are not affected. Mixed infection with *H.sativum* may occur. Disease is generally supported by low temperature.

Control measures

For control of this disease, follow the recommendation as given in helminthosporium leaf blight. As the disease is internally seed borne, use of seeds from infected plants should be avoided.

Selerotium wilt

Symptoms

It occurs from February to March. The affected plants wilt and die. On uprooting the affected plants, cottony fungal growth can be seen on the stem at ground level or basal portion of the plants. Mustard like bodies (sclerotia) may be formed on the cottony growth later on.

Control measures

Soil drench with (Metalaxyl 8% + Mancozeb 64%) WP (0.15%) or with carbendazim (0.15%) to avoid seedling infection. Spraying with carbendazim (0.15%) may be followed.

MAIZE

Turcicum leaf blight (*Helminthosporium turcicum*)

Symptoms

It occurs from January to February. Oval to elliptical yellowish brown to ashy coloured spots appear on the leaves with yellow halo. The affected leaves dry up and gives a burnt appearance. Disease may appear on young crop, however, it is generally more severe during maturity stage of crop.

Control measures

* Seed treatment with (Carboxyn 37.5% + Thiram 37.5%) DS (0.15%) or Ziram (0.25%) or thiram (0.3%) is useful.
* Spray Ziram or Mancozeb @ 750 g/ac or (Mancozeb 63% + Carbendazim 12%) @ 400 g/ac in 200 litre of water for 2-3 times at an interval of 10 days. Collection of seeds from diseased crop should be avoided. Before sowing, crop residue should be removed. Grow resistant varieties.

RAGI

Blast *(Pyricularia grisea)*

Symptoms

Blast is a major disease. It attacks the crop both at vegetative and reproductive stages as leaf blast, neck blast and finger blast. Small brown spots appear on the leaves which later become spindle shaped with pointed ends, with reddish or purplish brown margin and ashy coloured centre. High temperature along with high humidity favour the spread of disease.

Control measures

* Grow resistant varieties
* Treat the seed with thiram or mancozeb or carbendazim @ 2 g/kg seed 24 hours before sowing. Spray the crop with Ediphenophos @ 500 ml/ha or carbendazim 50% WP @ 500 g/ha or with difenoconazole 25% EC @ 500 ml/ha or propiconazole 25% EC @ 500 ml/ha in 500 litre of water or with neem based products (2 ml/ 1 litre of water)
* Spray any of the above fungicides at the time of 50% flowering and again after 10 days to control neck and finger blast.

Helminthosporium leaf spot

Symptoms

It usually occurs at the time of grain maturity. Oval shaped brown spots with dark centre and brown margin appear on the leaves and leaf sheaths.

Control measures

* Treat the seeds with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5 g/kg of seeds
* Spray the crop at tillering stage with mancozeb or zineb (0.25%)
* Grow resistant varieties.

PULSES

Powdery mildew

Symptoms

It occurs from December to March. Small patches appear on the leaves which later spread on the entire leaf surface. Plants look as if dusted with talcum power. Infected leaves become dull in colour and necrotic. The disease causes heavy damage in mung, pea, khesari, lentil and pigeonpea.

Control measures

Spray with wettable sulphur @ 1.0 kg or carbendazim @ 300 g in 200 litres of water per acre or use sulphur dust @ 12 to 15 kg/acre. Alternatively, calixin (0.1%) or karathane (0.1%) may be sprayed.

Seed rot and seedling damage

Symptoms

It occurs from November to December. When untreated seeds are sown there is heavy pre-emergence damage to the germinating seeds causing seed rot. Rotting is caused by many fungi i.e. *Aspergillus, Colletotrichum, Fusarium, Sclerotium rolfsli, Rhizoctonia and Pythium*, There is heavy mortality in young seedlings due to these fungi. Excess soil moisture favours seed root and even post emergence damping off.

Control measures

* Treat the seeds with thiram or captan 3g or (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5 g or Thiophanate methyl @ 1.5g/kg of seeds.
* Alternatively treat the seeds with carbendazim 0.10% + thiram 0.15% per kg of seed.
* Drainage should be provided in field.

Wilt

Symptoms

It occurs from November to March. In wilt disease the most striking symptom is of wilting of the entire plant. The leaves and other green succulent parts lose their turgidity, become flaccid and drop. Black streaks can be seen under the bark. These effect are first seen in some of the leaves. Later young growing tip or the whole plant may suddenly or gradually dry up. In arhar and bengal gram, wilt is a severe and common disease. The fungal wilts appear in few patches initially among plots. In some cases only partial wilt of few branches of bengal gram is also predominant.

Control measures

Seed treatment with thiram (0.15%) + carbendazim (0.10%). The seeds are to be dipped in the fungicidal suspension for 30 minutes and air dried for 2 hours. Dry seed dressing can also be done by mixing requisite quantities of fungicides with the seed and

shaking thoroughly. Grow resistant varieties. Drench the soil around plants with 0.15% carbendazim suspension i.e. 1.5g of carbendazim in one litre of water.

Collar rot

Symptoms

It occurs from November to January. In collar rot, the stem just above root crown is affected by soil inhabiting fungi. The affected portion of roots and whole plants show symptoms of wilting. The affected plants ultimately die.

Control measures

Seed treatment with thiram (0.15%) + carbendazim (0.10%) or (Carboxyn 37.5% + Thiram 37.5%) DS (0.15%). Spray Mancozeb @ 750 g/acre in 200 litres of water or carbendazim 0.15% or spraying with Thiophanate Methyl @ 0.2%. Eradicate weed plants. Grow available resistant varieties.

Yellow mosaic virus

Symptoms

It occurs from December to February. Affected leaves exhibit yellow and green patches with slight pucker and young leaves reduced in size. In severe cases the whole leaf completely turns yellow. The yield is very much reduced. This disease is very common in green gram and black gram.

Control measures

Spray methyl demeton @ 400 ml/acre in 200 litres of water to control white fly, the insect vector. Grow tolerant varieties such as Hyb-12-4/ Hyb-4-3 in mung and T-9 and K-10 in biri. Remove the weeds. In earliest stage of infection diseased plants should be uprooted and disposed off from the plots.

Leaf spot

Symptoms

It occurs during January to March. Dark brown circular to irregular spots appear on the leaflets. In severe cases of attack elongated lesion may appear on petioles and stems. The disease cause heavy damage in green gram and black gram.

Control measures

Spray the crop with Mancozeb @ 750g or carbendazim @ 150 g or copper oxychloride @ 500g dissolved in 200 litres of water at an interval of 10 days commencing from 3 weeks age of the plant. Alternatively, (Mancozeb 63% + Carbendazim 12%) @ 0.2% or Ziram may also be used for spraying.

GROUNDNUT

Tikka disease

Symptoms

It occurs from January to March. Dark brown to almost black circular spots appear on leaves, petiole and stem. In severe cases the spots coalesce causing defoliation of the plants. Some leaf spots are surrounded by a yellow halo. Disease is more predominant on older plants. Lower leaves are first infected. Disease is caused by two fungal species resulting in early leaf spot and late leaf spot.

Control measures

Before sowing treat the seed with thiram or (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5 g/kg of kernel. Spray with Ziram (0.2%) or chlorothalonil (0.25%) or Mancozeb @ 750 g or Copper oxychloride @ 0.6 kg or carbendazim @ 150 g/acre in 200 litres of water 2-3 times at an interval of 10 days. Grow tolerant or moderately resistant varieties. Crop residue of previous season should be completely eliminated. High doses of N fertilizer should the discouraged.

Aspergillus seedling blight or collar rot/foot rot/afla rot

Symptoms

It occurs from January to February. The disease appears in two phases i.e. the pre-emergence and post emergence phase. In the former, the pathogen causes rotting of the seeds in the soil where as in the later, the disease in characterised by wilting and death of seedlings accompanied by a rotting of hypocotyl region and development of black lesions. Affected seedlings show chlorotic appearance and reduced vigour and are stunted. High soil moisture and continuos flooding cause serious damage.

Control measures

Seed treatment with carbendazim (0.15%) + thiram (0.3%) or carbendazim @ 1.5 g/kg of kernel or with Thiophanate Methyl (0.15%). Grow resistant varieties such as J-11 and Polachi. Restrict over irrigation during seedlings stages of crop in field. Use healthy seeds. Destroy crop residues. Spray the crop with mancozeb (0.25%) or carbendazim (0.15%) or Copper oxychloride (0.25%) or (Mancozeb 63% + Carbendazim 12%) @ 0.2%. Storage of pods after drying.

Stem rot

Symptoms

It occurs from August to October and February to March. This disease is caused by the fungus, S*clerotium rolfsii*. The pathogen attacks almost all parts of the plants, but stem infection is more serious. Diseased plants turn yellow necrotic and ultimately may wilt. Diseased tissues develop yellowish brown mustard like sclerotia, mixed with white cottony mycelium.

Control measures

Grow resistant varieties such as J-11 and Polachi. Treat the seed with carbendazim (0.15%) + thiram (0.3%) or (Carboxyn 37.5% + Thiram 37.5%) DS @ 0.15%. Spraying with carbendazim (0.15%) or with Thiophanate Methyl (0.2%). Use healthy seeds free from diseases. Remove crop residue from soil before sowing the crop. Soil drenching around root zone of the plants with Thiophanate Methyl (0.15%) is effective.

Rust

Symptoms

It occurs from September to November and December to March. Rust appears on leaflets. The yellowish brown pustules on lower leaf surface, corresponding upper surface showing yellow dots, turning brown. Leaves dry and prematurely shed. Pods are stunted, lesser in number and with shrivelled seeds.

Control measures

Remove diseased plant materials. Spray with Mancozeb (0.2%), sulphur dusting @ 12 kg/ac or spray with Tridemorph (0.15%) or Hexaconazole (0.2%). Use available rust resistant varieties. Application of N fertilizer is to be avoided.

RAPESEED-MUSTARD

Downy mildew

Symptoms

It occurs from December to January. The disease is characterized by appearance of purplish brown spots on the under sides of the leaves, accompanied by the downy growth on the under surface of these lesions. Later leaves become pale and may dry up. In severe cases the plants die before maturity.

Control measures

Spray the crop with (Metalaxyl 8% + Mancozeb 64%) WP (0.1%) or any copper fungicide @ 1.0 kg or Ziram @ 1 litre in 200 litres of water for 2 times at an interval of 10 days. Metalaxyl may also be used for spraying at a concentration of 0.2% at 10 days intervals.

Leaf spot or blight

Symptoms

It occurs from January to February. Yellow coloured spots appear on leaves which later become grey or brown. Several small spots may coalesce, covering larger leaf area and leaves dry up. The pods also show diseased lesions.

Control measures

Spray with 0.25% Mancozeb or Ziram (0.25%) or Copper oxychloride (0.25%) or (Carbendazim 12% + Mancozeb 63%) @ 0.2% at 14 days interval.

White rust

Symptoms

It occurs from February to March. Plants bear stunted leaves and flowers become white and discoloured. Floral parts atrophied, deformed. Infection become severe when plants are in the flowering and seed forming stage. Infected inflorescence and pods are covered with white fungal mass containing diseased tissues.

Control measures

Seed treatment with Metalaxyl @ 0.1% and spraying with Copper oxychloride (0.25%) or with (Metalaxyl 8% + Mancozeb 64%) @ 0.1% at 14 days interval helps in controlling the disease. Seeds from diseased crop should not be used.

SUNFLOWER

Soil borne diseases

Downy mildew (*Plasmopara halstedii*)
Root and collar rot (*Sclerotium sp*. and *Rhizotonia sp*.)
Stem rot or wilt (*Sclerotinia sclerotiorum*)
Vascular wilt (*Pseudomonas sp*. and *Fusarium sp*.)

Control measures

* Clean cultivation by removing crop debris.
* Adopt deep summer ploughing
* Avoid irrigation from plot to plot
* Uproot and burn the downy mildew affected plants
* Treat the seeds with thiram @ 3g or carbendazim @ 2 g/kg seed. Metalaxyl @ 5g/kg seed may be used in downy mildew areas.

Foliar diseases

Alternaria blight and leaf spot (*Alternaria sp.)*
Rust (*Puccinia helianthi*)
Head rot (*Rhizopus, Botrytis, Cladosporium*)

Control measures

* Follow clean cultivation by removing crop debris.
* Apply right quantity of P_2O_5 to reduce disease intensity
* Spray mancozeb @ 0.25% for alternaria and rust
* Spray 0.2% wettable sulphur for powdery mildew and botrytis.
* Spray 0.4% copper oxychloride for rhizopus rot.

SAFFLOWER

Leaf spot/head blight

Symptoms

It occurs from February to March. The symptom appears as isolated round brown spots on the lower leaves. Spots are slightly sunken with yellowish tinge at the border. Entire leaves may show blight. Flower could also be affected and dry up.

Control measures

Spray the crop with mancozeb (0.25%) @ 750 g/acre or spray 1% Bordeaux mixture or Copper oxychloride @ 0.25%. Healthy seeds should be used. Do not use the seeds from the diseased crop. Pre-treatment of seeds with thiram (0.3%) or carbendazim (0.15%) or chlorothalonil (0.2%) or Thiophanate Methyl (0.15%) or (Carbendazim 12% + Mancozeb 63%) @ 0.2%.

SESAME

Phyllody (M*ycoplasma*)

Symptoms

It occurs from September to October. The disease is caused at the flowering stage and the floral parts are transformed into leafy structure which grow profusely. The entire floral parts appear leafy and the flower is sterile. No capsule formation occurs.

Control measures

Spray with Monocrotophos / Methyl demeton @ 2 ml/ ltr. for insect vector control. At early stage when infection is on few plants only, diseased plant should be rogued.

Leaf spot

Symptoms

It occurs from August to November. Brown spots appear on both surface of the leaves just before flowering, lesion enlarge forming blight symptoms and drying of plants.

Control measures

Spray the crop with Bordeaux mixture 4:4:50 or Mancozeb @ 750 g or Carbendazim @ 0.15%. For bacterial blight, spray plantomycin at a concentration of 0.1% or streptocycline at 0.01%.

LINSEED

There are three important diseases of linseed viz; wilt, alternaria blight and powdery mildew in Orissa.

Wilt

Control measures

Follow deep summer ploughing in the month of April-May. Treat the seeds with thiram or Thiophanate Methyl 2.5 g or carbendazim 1.5 g/kg of seeds.

Alternaria blight

Control measures

Provide 2-3 number of need based spray of mancozeb 0.25% with the appearance of the disease.

Powdery mildew

Control measures

Avoid late sowing. Provide 2-3 number of sprays with wettable sulphur @ 0.3%.

POTATO

Early blight

Symptoms

It occurs from January to March. Small isolated pale concentric brown spots appear on tips and margins which later on enlarge with concentric rings. The affected lower leaves are affected first and the disease progress upwards.

Control measures

Use disease free seeds. Grow resistant varieties viz; Kufri Sindhuri and Kufri Jyoti, K. Lalima. Dip the tubers in the suspension of (Carboxyn 37.5% + Thiram 37.5%) DS (0.15%) + streptocycline 0.01% for 15 minutes. Spray with Mancozeb @ 750 g/acre in 200 litres of water for 3 times at an interval of 10 days. Alternatively spray captan @ 0.25% or Copper oxychloride (0.25%) or mancozeb (0.25%). In severe infection spray (Carbendazim 12% + Mancozeb 63 %) @ 2g/litre of water at an interval of 10 days twice.

Late blight

Symptoms

It occurs from January-February. Brown irregular patches appear on the margin and tip of the leaves which enlarge later on and cover the entire leaf. In cool cloudy weather with rain, these spots grow rapidly and spread other leaves and stem. Tuber infection is also possible during storage. Diseased seed tubers are the primary source of infection.

Control measures

Use disease free seeds. Treat the seed tuber as in the case of early blight. Plant the seed potatoes early in October or latest by November to avoid injury and attack of the disease before tuber formation. Spray the crop with Copper oxychloride (0.25%) or (Metalaxyl 8% + Mancozeb 64%) @ 0.15% or captan (0.25%) or Mancozeb @ 750 g in 200 litres of water/acre for 3 times at an interval of 10 days. Grow tolerant varieties viz; Kufri Alankar, Kufri Kundan etc. As preventive measures, seed tuber should be stored in cold storage after drying in air immediately after harvest. Remove adhering soil on tubers before storage or transit.

Common scab

Symptoms

It occurs from January to February. Common scab is more severe when temperature is comparatively high during growing season. The disease can only be recognized at the time of harvest as the pathogen mainly infect tubers and produce dark brown corky circular or star shaped lesions when several such lesions coalesce. Cracks or furrows 3-4 mm deep may be seen on the tubers. Common scab infection thus render the tuber unfit for use as seed and reduces the quality for table purpose. The market value of affected tubers is reduced.

Control measures

Treat the tubers before planting with streptocyclin 0.01% alongwith mancozeb 0.25%, copper oxychloride 0.3% or 0.25% for 20 minutes. Regular irrigation of the field beginning from the time of tuber initiation to maturity and prevention of soil from drying reduces the disease intensity . Addition of sulphur and acid forming fertilizer like sulphate of ammonia and superphosphate reduces scab infection. Apply sulphur fungicide 1 kg wettable sulphur in 200 litres of water per acre. Grow resistant varieties such as Patna red, Kufri Alankar, Kufri Sindhuri, Kurfi Dewa and Kufri Lalima. Use of scab free seed tubers in raising new crop. In scab sick soil when disease is of annual occurrence follow 2-3 years rotation.

SUGARCANE

Red rot (*Colletotrichum falcatum*)

Symptoms

It occurs from October to November. First symptom of the disease is seen in the field after rainy season, when growth of the plants stop and sucrose formation begins. Loss of colour i.e. yellowing and drooping of leaves (third or fourth) from the top, are the earliest symptoms and then the entire tip withers. In later stages, the affected canes become shrivelled, shrinks and longitudinally wrinkled. Such canes become lighter in weight and are easily broken. Dark reddish spots with brown margin appear along the mid-rib. Black specks appear on the rind. On splitting open of the diseased canes red blotches with transversely elongated patches are seen and the dried cane gives a sour smell due to conversion of sucrose to glucose. Quality of juice is reduced in diseased canes.

Control measures

* Select healthy disease free setts. Dip the setts in suspension of carbendazim or Thiophanate Methyl @ 150 g/100 litres of water for 30 minutes before planting. Avoid ratooning of the infected crop. Provide adequate drainage in he field. Grow resistant varieties viz; Co-975, Co-1007 and Co-1748.
* Uproot the dead clumps and burn them outside the field. Soil drench the left over pit and adjacent area with carbendazim at a concentration of 0.15%, spray the crop with benomyl 0.15% or carbendazim 0.15% or Thiophanate Methyl 0.2%.
* Avoid ratooning and adopt crop rotation with rice.

Smut (*Ustilago scitaminea*)

Symptoms

It occurs from September to October and April to May. Affected plants produce a whip like black shoot several feet in length from the central axis at the apex. In some systematically infected canes the eyes sprout into lateral shoots which also produce the smut whip.

Control measures

Control measures same as above. Grow resistant varieties such as Co 527, 997, 872, 1111, 1148 and 1118. Removal and destruction of smutted floral parts (whips). Before planting dip the seed setts in Carboxyn (0.3%) for 30 minutes before planting. Spray the same before flowering.

BETELVINE

Anthracnose-bacterial complex

Initiating from February, it reaches its peak period of destruction in the rainy months. The disease is characterized by marginal blight of leaves and production of deep brown colour chlorotic irregular spots on leaf lamina, densely surrounded by a water soaked margin followed by a bright yellowish halo. Ariel internodes may be blackened and rotted and the top vine may be wilted during rainy days.

Foot and leaf rot

Circular leaf rot comprising of concentric rings of deep grey colour alternating with pale grey areas are seen following summer showers in the month of May and June. Late in rainy season i.e. during September-October vines used to droop with loss of leaf lustre following root rot symptoms. The vines permanently wilt and die.

Basal rot

Naked vines exposed on the soil are covered with fan like spreading white cottony mycelia mat having mustard like sclerotial bodies intermingled at a later stage. Affected vines wilt and die. The fungus spreads quickly to adjacent healthy vines along the root.

Management practices

1. Remove diseased vines, leaves and affected internodes with mycelia growth and dispose them away by burning. Adopt clean sanitary practices by the timely replacement of shading, trailing and walling baraj materials.
2. Plant healthy seed vines dipping the cutting in a solution of bordeaux mixture (0.5%) + streptocyclin (250 ppm) + carbofuran (0.1%) for 30 minutes.
3. Soil drench with bordeaux mixture (1%) at monthly intervals along with eight foliar spray of the same (0.5%) fortified with streotocyclin (250 ppm) or bacterinol (0.1%) starting from June to control both anthracnose bacterial complex, leaf and root rot diseases.
4. Disinfect water of the nearby tank periodically with bleaching powder if it is used for irrigation.
5. Follow integrated disease management practices like proper sanitation, soil drenching with Bordeaux mixture (1%), application of *Trichoderma viride* one month before and after the bordeaux mixture. Use commercially available products like bioderma/ bioguard/ niprot @ 2.0-2.5 kg/ha.
6. Substitute neem cake to mustard cake in nematode prone areas at the same dose.
7. Use well decomposed FYM .
8. Take up timely pesticidal measures against white flies, aphids and red spider mites.

VEGETABLES

Damping off of seedlings in brinjal, tomato and chilli (*Pythium spp. Phytophtora spp. and Rhizoctonia spp)*

Symptoms

It occurs from September to November. This disease occurs in two phases (a) Pre-emergence phase- the young seedlings are killed before they reach he surface of the soil (b) In post-emergence phase the infected seedlings topple over at any time after they emerge from the soil until the stem has hardened sufficiently to resist infection. Infection occurs at or below the ground level and the infected tissue appears water soaked. As the disease advances, the stems become constricted at the base and the seedlings collapse.

Control measures

- Disinfect the soil of the nursery bed with formalin which should be diluted in the proportion of 1 part in 50 parts of water and sprinkled over the loose soil in sufficient amount to soak it to a depth of 4 inches and covered with plastic sheet. About 1 gallon will be required for 3 sq.ft. of soil. alternatively treat the soil with formalin dust (15 parts formalin 85 parts of carcoal ash) @ 30 g/sq.ft. Sowing should be done after 10 days. Alternatively, burn some saw dust and small pieces of wood over the loose soil for 15 minutes to kill the pathogens of damping off. Disinfection of soil can also be achieved by drenching the soil with Bordeaux mixture 5:5:50 or with any copper oxychloride fungicide (0.4%) or with carbendazim solution (0.15%) @ 1 litre per sq.mt.
- Treat the seeds with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5 g/kg or captan @ 3g or carbendazim @ 1.5 g/kg of seed or soak seed in 0.25% solution of emesan (2.5g dissolved in 1 litre of water) for 10 minutes.
- Sow the seeds thinly
- Spray the seedlings with 4:4:50 Bordeaux mixture or (Metalaxyl 8% + Mancozeb 64%) @ 0.15% or with any copper oxychloride fungicide or carbendazim in the strength of 1.5 g/litre of water.
- Light irrigation at frequent intervals should be given.
- Rotation of seed bed.

BRINJAL

Leaf spot (*Alternaria spp*. and C*ercospora spp*)

Symptoms

The Alternaria leaf spot is characterised by the presence of brown, irregular spots on leaves. Concentric rings are present in the spots. Spots coalesce to form necrotic patches and defoliation may occur. Sunken spots appear on fruits. Fruits turn yellow and drop prematurely. In case of Cercospora infection, irregular or circular brownish/greyish spots appear on leaves and fruits. The spots are relatively small with brown or deep coloured margin. The infected leaves drop off.

Control measures

* Maintain proper field sanitation.
* Spray mancozeb (0.3%) or Copper oxychloride (0.3%) or (Carbendazim 12% + Mancozeb 63%) @ 0.2%.

Bacterial wilt and fungal wilt (*Ralstonia solanacearum* and *Fusarium oxysporum*)

Symptoms

The bacterial wilt is characterised by quick wilting of the foliage followed by collapse of the entire plant. The lower leaves droops before wilting and vascular system becomes brown. But in case of fungal wilt (*Fusarium oxysporum*) the leaves become yellow and dry. Stem near the soil line shrinks and blackish/brownish lesions may be observed. The barks may be detached easily. Lateral roots show black rot infection. Fungal growth can be seen on dead tissues in humid condition.

Control measures

* Seed treatment with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5 g or carbendazim @ 2 g/kg seed.
* Seedling root dip treatment with streptocycline (1 g/10 litre water) for 20-30 minutes.
* Drenching with Metalaxyl (0.2%) or carbendazim (0.2%) in case of fungal wilt or with streptocycline or plantomycin (0.1%).
* Grow resistant varieties like Pusa purple cluster, Muktakeshi or BB-45-C.

TOMATO

Late blight (*Phytophthora infestans*)

Symptoms

Water soaked brown to purple black lesions develop on leaf let, rachis, petiole, stem or leaf. Dark olivaceous spots are found on fruit.

Control measures

* Seed treatment with carbendazim (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5g/kg of seeds.
* Spray mancozeb (0.3%) or Metalaxyl (0.15%).

Early blight *(Alternaria solani)*

Symptoms

Circular to angular dark brown spots in concentric ridges appear on the leaves. Narrow chlorotic zone are found around necrotic spots. Leaves wither, droop and fall off. Sunken dark coloured spots appear on stem and fruits.

Control measures

* Seed treatment with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5 g or carbendazim @ 1.5 g/kg of seeds.
* Spray mancozeb (0.25%) or (Carbendazim 12% + Mancozeb 63%) @ 0.2%.

Bacterial wilt and Fungal wilt (*Ralstonia solanacearum* and *Fusarium oxysporum*)

Symptoms

The bacterial wilt is characterised by quick wilting of the foliage followed by collapse of the entire plant. The lower leaves droops before wilting and vascular system becomes brown. But in case of fungal wilt (*Fusarium oxysporum*) the leaves become yellow and dry. Stem near the soil line shrinks and blackish/brownish lesions may be observed. The barks may be detached easily. Lateral roots show, black rot infection. Fungal growth can be seen on dead tissues in humid condition.

Control measures

* Seed treatment with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5 g or carbendazim @ 1.5g/kg seed.
* Seedling root dip treatment with streptocycline (1 g/10 litre water) for 20-30 minutes.
* `Drenching with Metalaxyl (0.2%) or carbendazim (0.2%) in case of fungal wilt or with streptocycline (0.01%) or plantomycin (0.1%) in case of bacterial wilt.
* Grow resistant varieties like Utkal Kumari, Utkal Urbashi, Utkal Pallavi and Utkal Deepti.

Leaf curl (Tobacco virus 16 or Nicotiana virus-10)

Symptoms

Severe stunting of plants. Downward rolling and crinkling of the leaves. Chlorosis of young leaves. The infected plants show bushy appearance.

Control measures

* Spray methyl parathion 0.05% or Methyl demeton @ 1.5 ml/litre.
* Soil treatment with carbofuran @ 30 kg/ha.

CHILLI

Bacterial wilt and Fungal wilt *(Ralstonia solanacearum* and *Fusarium oxysporum)*

Symptoms

The bacterial wilt is characterised by quick wilting of the foliage followed by collapse of the entire plant. The lower leaves droop before wilting and vascular system becomes brown. But in case of fungal wilt (*Fusarium oxysporum*) the leaves become yellow and dry. Stem near the soil line shrinks and blackish/brownish lesions may be observed. The barks may be detached easily. Lateral roots show black rot infection. Fungal growth can be seen on dead tissues in humid condition.

Control measures

* Seed treatment with (Carboxyn 37.5% + Thiram 37.5%) DS or carbendazim @ 1.5g/kg seed.
* Seedling root dip treatment with streptocycline (1 g/10 litre water) for 20-30 minutes.
* Dreching with Metalaxyl (0.2%) or carbendazim (0.2%) in case of fungal wilt or with streptocycline (0.01%) or plantomycin (0.1%) in case of bacterial wilt.
* Grow resistant varieties like Utkal Ava, Utkal Rashmi and Utkal Ragini.

Leaf spot and blight (*Cercospoera capsici* and *Alternaria solani)*

Symptoms

Circular to angular dark brown spots in concentric ridges appear on the leaves. A narrow chlorotic zone are found around necrotic spots. Leaves wither, droop and fall off. Sunken dark coloured spots appear on stem and fruits.

Control measures

* Seed treatment with (Carboxyn 37.5% + Thiram 37.5%) DS or carbendazim @ 1.5 g/kg of seeds.
* Spray mancozeb (0.25%) or (Carbendazim 12% + Mancozeb 63%) @ 0.2%.

Die-back and fruit rot (*Colletotrichum capsici*)

Symptoms

Necrosis of tender twigs from tip downward and the infected twigs become strain coloured. Larger number of black dots containing fruiting bodies of the fungus are seen on the nectotic parts. The top or side branches or sometimes the entire plant may be withered. The stalk of the fruit maybe attacked. Small, black, circular spots may appear on the fruit. The spots are sunken with black margin which are covered with pinkish mass of fungal spores. There is premature dropping off of the fruits. The infected seeds are rusty in colour.

Control measures

* Seed treatment with carbendazim/(Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5 g/kg of seeds.
* Foliar spray or Copper oxychloride (0.3%) or chlorothalonil (0.15%) or thiophanate methyl (0.1%) or carbendazim (0.2%).

Leaf curl (Tobacco leaf curl virus)

Symptoms

Downward curling of leaves. Leave size reduced, pale yellow in colour and internode shortened, stunting of plant growth, small and deformed fruits are formed.

Control measures

* Soil application of Phorate 10G (0.1%)
* Foliar spraying with imidachloprid @ 1 ml./ 5litres of water or Acetamiprid @1 gm./ 5 litres of water.

CABBAGE, CAULIFLOWER, KNOL-KHOL AND BROCCOLI

Damping off (*Rhizoctonia solani*)

Symptoms

Water soaked spots appear on the base of the stem, close to the soil line. The young seedlings are collapsed. In old cabbage plants, there is rottening of bottom under high humidity.

Control measures

* Seed treatment with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5 g or carbendazim @ 1.5 g/kg of seed.
* Soil drenching with carbendazim (0.2%) or Metalaxyl (0.2%)

Downy mildew (*Peronospora parasitica*.)

Symptoms

Purple brown spots appear on the under surface of leaves. The upper surface of the leaf on the lesion is tan or yellow colour. During bolting, the seed stalks show blackish patches and in severe cases the whole curd is spoiled.

Control measures

* Seed treatment with carbendazim / (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5 g/kg seed.
* Spray cauliflower with mancozeb 0.25% or Metalaxyl 0.15%.
* Grow resistant varieties cauliflower like Snowball, MGS 2-3, MGS 1-6-1-4 and MGS 1-6-1-2, MGS 12C etc.

Powdery mildew (*Erysiphe cruciferarum*)

Symptoms

Silvery white patches appear on the upper surface of leaves and cause defoliation.

Control measures

* Spray Dinocap 0.2% or Tridemorph 0.1% or chlorothalonil 0.15% or Hexaconazole 0.1%.

Black leg of cabbage (*Phoma lingam*)

Symptoms

Oval or linear depressed light brown cankerish spots appear on the base of the stem which girdle the stem. The whole root system decays. Blackish spots also appear on the leaves.

Control measures

* Seed treatment with (Carboxyn 37.5% + Thiram 37.5%) DS /carbendazim @ 1.5 g/kg seeds.
* Grow tolerant vareity Pusa Drum head.

Leaf spot (*Alternaria spp*.)

Symptoms

Small, dark coloured circular spots with concentric rings appear on the leaves, stem, petioles and pods. When the cauliflower heads are infested show browning of individual flower or flower clusters. On cabbage, there is black mouldy growth.

Control measures

- Seed treatment with (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5 g/kg seed.
- Spray mancozeb (0.25%) / (Carbendazim 12% + Mancozeb 63%) @ 0.2% or Copper oxychloride (0.3%).

White rust (*Albugo candida*)

Symptoms

Isolated whitish, shiny, raised pustules appear on the leaves which become powdery in appearance. The inflorescence axis and flower stalk become thickened. The floral organs swell and become, fleshy, green or violet in colour. The inflorescence axis twisted.

Control measures

* Spray Mancozeb 0.25% or Difolaton 0.25% or Metalaxyl 0.15%

Black rot (*Xanthomonas campestris*)

Symptoms

Chlorotic lesions appear near leaf margin and progress towards centre in the form of V-shaped yellowish spots. The vein and veinlets turn brownish/blackish. Leaves turn yellow and drop off. The heads of cabbage and cauliflower are discoloured.

Control measures

* Seed treatment with Streptocycline @ 0.01%
* Spray Streptocycline @ 100 ppm
* Soil application of bleaching powder @ 10 kg/ha

Bacterial soft rot (*Erwinia carotovora*)

Symptoms

The affected plants show soft, shining and bad smelling rot. The basal portion of stems rot. Cauliflower seedlings are mostly affected specially when damaged by hails.

Control measures

* Seed treatment with Streptocyclin @ 0.01%
* Spray Streptocycline @ 100 ppm
* Soil application of bleaching powder @ 10 kg/ha

OKRA

Damping off (*Pythium aphanidermatum*)

Symptoms

The seedlings are attacked at the ground level and the diseased tissue are constricted resulting in falling of the seedlings.

Control measures

* Seed treatment with thiram/captan @ 3 g/kg seed or (Carboxyn 37.5% + Thiram 37.5%) DS 1.5 g/kg seed.
* Drenching the soil with captan 0.25% or Metalaxyl 0.2% or carbendazim 0.1%.

Fusarium wilt (*Fusarium oxysporum* and *F. vasinfectum*)

Symptoms

Yellowing, stunting of plants followed by wilting and rolling of leaves. The leaves hang down during day time. The whole stem is blackened.

Control measures

* Seed treatment with carbendazim / (Carboxyn 37.5% + Thiram 37.5%) DS @ 1.5 g/kg seeds.
* Soil drenching with carbendazim / Metalaxyl @ 0.1%
* Grow resistant varieties Pusa Sawani, Pusa Makhmali, CS 3232, CS 8899, CS 6653 and IS 7194

Leaf spot (*Cercospora abelmoschii*)

Symptoms

Brown irregular spots with grey centre and dark coloured margin appear on the leaves. Sometimes shooty mould growth of the fungus is also found on the lower surface of the leaf.

Control measures

* Spray Copper oxychloride / Mancozeb @ 0.3%

Powdery mildew (*Erysiphe spp*.)

Symptoms

Characteristic white greyish powdery coating is discernible on the surface of affected leaves. The leaves turn yellow and droop.

Control measures

* Spray Wettable Sulphur @ 0.3% / Dinocap @ 0.1%

ONION

Purple blotch (*Alternaria porri*)

Symptoms

Small, sunken, whitish, flecks with purple coloured centres develop on the leaves and flower stalks. The margin of the spot is a shade of purple and surrounded by yellow halo that extends upwards and downward. The surface of the spot is covered with brown/black sporulation of fungus in moist weather. The leaves shrivel, turn yellow and dry. Bulbs decay during storage.

Control measures

* Seed treatment with thiram @ 2.5 g/kg seed.
* Spray mancozeb 0.3% / (Carbendazim 12% + Mancozeb 63%) @ 0.2%
* Spraying with malathion @ 2 ml/litre of water will keep the thrips population under check and help in reducing the attack of the disease.

Downy mildew (*Peronospora destructor*)

Symptoms

Oval to cylindrical pale green spots are found on the leaves. White to purplish downy growth of fungus develop on the lower surface of leaves. The plants become stunted distorted and pale green.

Control measures

* Spray mancozeb 0.3% or Ziram 0.2% or (Carbendazim 12% + Mancozeb 63%) @ 0.2%

Smut (*Urocystis cepulae*)

Symptoms

Elongated dark, thickened lesions develop on the cotyledons of young seedlings. The affected leaves bend downwards. Streaks develop in the tissue of leaves, leaf sheaths and bulbs, exposing black powdery mass of fungus.

Control measures

* Seed treatment with thiram / (Carboxyn 37.5% + Thiram 37.5%) DS 1.5 g/kg seed
* Seed bed soil can be treated with methyl bromide @ 1 kg/25 sq.m.

Soft rot (*Erwinia caratovora*)

Symptoms

Rotting develop at the neck of the bulb and emit foul sulphurous smell. Some outer scales affected show slime yellow appearance and during handling the scales slips off readily.

Control measures

* Proper curing and drying at harvest time.
* Discard all the infected bulbs before storing.

RADISH

Leaf blight (*Alternaria raphani*)

Symptoms

Small, slightly raised yellowish lesions appear on the leaves, stem and pods. In moist weather the stylar end becomes black and shrivelled.

Control measures

* Spray Copper oxychloride / mancozeb @ 0.3% or (Carbendazim 12% + Mancozeb 63%) @ 0.2%

White rust (*Albugo candida*)

Symptoms

Whitish raised powdery pustules develop on the undersurface of leaves and the leaves get devitalised. The flowering shoot become deformed and bear only malformed flowers.

Control measures

* Spray mancozeb / Copper oxychloride @ 0.3% / Metalaxyl @ 0.15%

ANNEXURE-IV

NEMATODE MANAGEMENT IN CROPS

RICE

Root-knot nematode (*Meloidogyne graminicola*) "Chera Ganthi roga"

It occurs throughout the year in nursery, upland as well as medium land.

Symptoms and nature of damage

Small to moderate sized spindle shaped galls are formed on roots. Number of adventitious roots are reduced. Plants exhibit chlorosis and reduced vigour. Stand of seedlings is poor in nursery beds.

Management practices :

i. Soaking paddy seeds with Carbosulfan 25 EC @ 0.1% for 12 hours.or treat the nursery with Cartap Hydrochloride @ 7.5g/m^2 10 days before uprooting the seedlings.

or

Apply neem cake @ 100g/m^2 before planting followed by application of Cartap Hydrochloride or Carbofuran @ 0.4 kg a.i. per acre 20 days after planting is very effective.

ii. Use tolerant varieties of Paddy such as Ramakrishna, Manika, Rasi and Badami.

Root nematode (*Hirschmanniella oryzae/H.mucronata*) "Chera Sadha Sutrajiba Roga".

It occurs throughout the year in medium and low land rice

Symptoms and nature of damage

Infected roots exhibit rusty brown discoloration of cortical tissue followed by rotting. Plant growth and vigour is reduced with subsequent reduction in yield. Symptom of zinc deficiency is more pronounced in heavily infested soils.

Management practices

i. Treat the nursery bed with Cartap Hydrochloride @ 7.5g/m^2 or Carbofuran @ 10g/m^2 10 days before uprooting the seedlings.

or

Seedling roots are dipped in Carbosulfan 25EC or Monocrotophos 36 SL @ 0.1% for 12 hours.

ii. Follow rice-groundnut rotation to reduce the nematode population.

iii. During land preparation of the main field apply neem cake @ 100g/m^2.

iv. If the main field is found heavily infested with *Hirschmanniella,* apply Cartap Hydrochloride or Carbofuran @ 0.4 kg. a.i./acre.

White tip nematode (*Aphelenchoides besseyi*) "Patra Sukha Roga"

It occurs throughout the year.

Symptoms and nature of damage

2-5 cm tip of upper leaf becomes yellow and later turns white and then brown in colour in early tillering stage. During emergence of earhead, flag leaf is shortened and appears curling at the base. Infected panicles are shorter than healthy panicles bearing sterile florets or partial formed grains at the terminal portion of the panicle.

Management practices

i. Sun dry the seeds on a cemented floor for a fortnight during April-May

or

Treat the nursery with Cartap Hydrochloride @ 7.5g/m^2 or Carbofuran @ 10g/m^2 at 10 days before uprooting seedlings.

or

Soaking seeds with Carbosulfan 25 EC or Monocrotophos 36 SL @ 0.1% for 12 hours or Cartap Hydrochloride 50 SP @ 0.15% for 12 hours followed by foliar spraying- 2 sprayings for short duration paddy and 3 sprayings for long duration paddy starting from 20 DAT with Quinalphos or Monocrotophos @ 0.3% alternatively at an interval of 20 days.

ii. Apply FYM @ 200g/m^2 or Neem cake @ 100g/m^2 during field preparation.

PULSES
(Greengram, blackgram, horsegram and cowpea)

Root-knot nematode (*Meloidogyne incognita*) "Chera Ganthi Roga"

It occurs throughout the State round the year.

Symptoms and Nature of Damage

Affected plants are stunted, exhibit reduced vigour and chlorosis. Affected roots bear root galls or root-knots of varying sizes.

Management practices

i. Apply FYM @ 200g/m^2 or Neem cake @ 100g/m^2 during field preparation
ii. Follow crop rotation using sesame and paddy prior to legume in the cropping schedule.
iii. Treat the seeds with Carbosulfan 25 ST @ 3g/kg seed before sowing.

or

Treat the seeds with *Tricoderma viride* @ 4g/kg seed before sowing and sow the treated seeds in the afternoon hour.

Reniform nematode (*Rotylenchulus reniformis*).

It occurs throughout the year

Symptoms and Nature of Damage :

Plants exhibit poor growth and appear stunted. Infected roots at their point of invasion leave brown scar or young females remain attached to the root when these roots are examined under microscope.

Management Practices

i. Broadcast FYM @ 200g/m^2 or Neem cake @ 100g/m^2 during preparatory cultivation.

ii. Treat the seeds with Carbosulfan 25 ST @ 3g/kg seeds before sowing.

Or

Treat the seeds with *Tricoderma viride* @ 4g/kg seed before sowing and sow the treated seed in the afternoon hour.

POTATO

Root-knot Nematode (*Meloidogyne incognita*) "Chera Ganthi Roga"

Symptoms and Nature of Damage

The affected plants are having chlorosis and stunted growth. These exhibit temporary wilting in mid hour of the day. Tubers exhibit numerous wart like galls in short winter conditions. If the temperature rises during tuberisation, size and number of tubers per plant are reduced.

Management practices

i. Follow Rice – Potato – Sesame rotation

Or

Sesamum – Potato – Maize rotation

Or

Groundnut – Potato – Sesame rotation

ii. If the land is found infested with root-knot nematodes, apply Cartap Hydrochloride or Carbofuran @ 0.4 kg. a.i./acre before planting potato or apply *Tricoderma viride* @ 1kg/ acre as furrow application during planting.

BETELVINE

Root knot nematode (Champa-foolia roga)

Occurrence

The nematode is extremely serious in the plantation of Balasore district, where it is known as 'Champa phulia roga'. The incidence of the disease is more particularly in flat beds where annual soil filling is not done.

Symptoms

Above ground symptoms are yellowing of leaves from bottom upward, stunting, small leaves and retarded top growth. Roots inside soil show small to large galls, often adventitious roots in contact with soil show galls. Necrosis of root tissue leads to death of plants. Incidence of fungal root-rots is more in nematode infested plantations.

Management

1. Use disease free vines
2. Avoid sites used for vegetable cultivation within the preceding three years for new plantations.
3. In case of root-knot infestation in standing crop, apply Neem cake @ 2 t/ha in heavy soil or mustard cake @ 2 t/ha in light soil i.e. 200g./m^2.

VEGETABLES
(Brinjal, tomato and chilli)

Root-knot nematode (*Meloidogyne incognita*) "Chera Ganthi Roga"

It occurs throughout the year.

Symptoms and Nature of Damage

Plant growth and vigour is reduced. Roots exhibit numerous galls of different sizes. Size and number of fruits per plant are reduced. At mid-hour of the day, incipient wilting of shoot occurs.

Management Practices

i. Use of resistant or tolerant varieties, Brinjal – Utkal Madhuri, BB-45C, Ghatikia white, Tomato – Sl.120 and BT-17, Chilli – Pusa Jwala, Pusa Sadabahar, Suryamukhi.

ii. Follow crop rotation with Rice-brinjal/tomato/chilli-sesame or Groundnut-brinjal/chilli/tomato-sesame or Brinjal-marigold var. Calcutta yellow/ Cabbage/ Cauliflower/ Mustard-Sesame

iii. Treat the infected nursery with Cartap Hydrochloride @ 7.5g/m^2 or Carbofuran @ 10g/m^2 at 10days before uprooting the seedlings.

or

Bare roots of seedlings should be treated with 0.05% Carbosulfan 25EC or Monocrotophos 36 SL in case brinjal, chilli and tomato for one hour.

iv. In the main field, broadcast fresh Neem cake @ 100g/m^2 during preparatory cultivation.

Reniform Nematode (*Rotylenchulus reniformis*)

It occurs throughout the year.

Symptoms and Nature of Damage :

Plants exhibit poor growth and appear stunted. Infected roots at their point of invasion leave a brown scar or young females remain attached to the root, when these roots are examined under microscope.

Management practices :

Excluding resistant or tolerant varieties, other methods of management practices are same as brinjal.

POINTED GOURD

Root-knot Nematode (*Meloidogyne incognita*) "Chera Ganthi Roga

Symptoms and Nature of Damage

Same as Brinjal, Chilli and Tomato

Management practices

i. Always select healthy looking roots free from any root-knot or galls.

ii. Pit treatment : Burn trash over pulverised soil. Add 250 g Neem or Karanj cake or FYM. Apply 20g Bioderma or Sanjeevani in the pit before planting root cuttings.

Or

Root cuttings are dipped in 0.05% Carbosulfan 25EC or Triazophos 40EC for 6 hours and the treated root cuttings are planted in the pit containing 250g Neem or Karanj cake or FYM.

Prefer staking method of planting.

FLOWERS

TUBEROSE

Foliar nematode (*Aphelenchoides besseyi*) "Kadha Sukha Sutrajiba Roga"

Symptoms and Nature of Damage

Affected plants become stunted. The tip of upper leaves become dry and gradually drying of leaves proceed from tip downwards. During emergence of spike, there occurs bud necrosis, which does not allow the necrotic buds to bloom further. So flowers do not blossom at all.

Management practices

i. Use healthy propagating materials
ii. Clean bulbs should be dipped in mud slurry treated with Carbofuran @ 10g/litre or Cartap Hydrochloride 7.5g/litre followed by drying in shade. Before planting care should be taken not to allow bud sprouts to come in contact with slurry.
iii. Apply Carbofuran @ 12kg/acre or Cartap Hydrochloride 10kg/acre in the main field at the time of final field preparation.
iv. Foliar spray of Carbosulfan @ 0.2% as prophylactic measures against foliar nematode at 2 months after planting.

Root-knot nematode (*Meloidogyne incognita*) "Chera Ganthi Roga"

Symptoms and nature of Damage

Plant growth and vigour is reduced. Roots of the infected plants exhibit galls or knots of varying sizes.

Management practices

i. Use healthy bulb free from galls
ii. Dip the bulb in Carbosulfan @ 0.05% for 4-6 hours before planting
iii. If the main field is found infested with root-knot nematodes, apply Cartap Hydrochloride or Carbofuran @ 1kg a.i/ha before planting bulbs.

BANANA

Banana crop in Orissa is affected by four important plant parasitic nematodes namely *Meloidogyne incognita*, *Radopholus similis*, *Pratylenchus coffeae* and *Helicotylenchus multicinctus*.

1. *Meloidogyne incognita* (Chera Ganthi Sutrajiba)

Meloidogyne incognita, commonly so called Root-knot nematode causes Root-knot disease (Chera Ganthi Roga) in Banana where galls or knots are noticed in affected plant roots. Wherever profuse galls are formed in banana roots, lower leaves of affected plants turn yellowish and plants appear stunted as compared to healthy plants. This causes ultimately reduction in size of bunch and the fingers.

2. *Radopholus similis* (Gartak Sutrajiba)

Rhizome rot of Banana (Kanda Pacha Roga) is caused by this nematode. While feeding on roots, this nematode produces brown necrotic lesions and girdling. Heavy infection causes stunted growth, premature defoliation, unthriftiness and bears small bunch and fingers. Affected plants are likely to be toppled down during windy weather because of inadequate anchorage as roots are mostly destroyed by nematodes. Plants become susceptible to drought. At times this results in annual replanting increasing the cost of production and loss to the farmers. Affected roots are also predisposed to *Fusarium oxysporum*, *F. cubens* resulting panama wilt of banana.

3. *Pratylenchus coffeae* &
4. *Helicotylenchus multicinctus* (Chera Daga Sutrajiba)

These nematodes produce brown necrotic lesions on roots. When several lesions coalesce, dark brown to black coloured sunken areas develop in roots. Affected plants become stunted and lanky in growth because of destruction of affected roots. Older leaves turn yellow. This leads ultimately to reduction in yield.

Management practices against plant parasitic nematodes affecting banana

1. Nematode disease free suckers should be selected for planting. Nematode free disease suckers should be purchased from the Government and certified agencies.
2. Suckers should be disinfected following mud slurry treatment. In this method pare the black coatings of suckers and pared suckers are dipped in mud slurry treated with Carbofuran @ 20g / lit. mud slurry.
3. Follow crop rotation including Sesame, Mustard, Cabbage, Cauliflower, Rice and Marigold in the cropping schedule.
4. Smouldering of pits are undertaken by burning unwanted materials in the pits before planting suckers. Apply Neem Cake @ 1 Kg. /pit or Carbofuran @ 0.5g a. i. / pit before planting suckers in the pits.

ANNEXURE-V

PESTICIDES: THEIR COMMON NAMES, FORMULATIONS *AND TRADE NAMES*

Common Name	Formulation	Trade Name
1. INSECTICIDES		
A. Chlorinated Hydrocarbans:		
1. Lindane	WDP 6.5-25%	Lindane,Hexamar
	EC 20%	Lindane
	Gr.6-10%	Krishi Lindane,Utkal Lindane
2. Endosulfan	EC 35%	Thiodan, Parrysulfan.Krishi Endosulfan,Utkal Endosulfan
	Dust 4%	Hildan, Endocel,Endotaf, Thiotox,.
3. Dicofol	EC 18.5%	Endosol, Kelthane, Hilfol
B. Organophosphates		
4. Diazinon	EC 20% WDP 10% Gr.10%	Bazanon 20EC, Suzon 20EC, Basudin Agroziron 20EC
5. Dimethoate	EC 30%	Rogor, Cygus,Hexagor,ParryDimet, Corothate, Krogar-30
6.Dichlorvos	EC 76%	DDVP,Nuvan,Marvex,Vapona,Suchlor,DIVAP,Agro DDVP,Luvon 76
7 Fenitrothion	EC 50 100% Dust 2%	Sumithion, Accothion, Hexafen, Folithion Utkal Fenitrothion
8.Malathion	EC 50% Dust 2-5% Solution 90-99% (*Tech.Grade*)	Malathion, Sandoz,Latholrock Meltex,Malathion,Malmar,Malatox Krishimalathion, Cythion, ParryMalathion, Hilthion,Kthion
9.Phosphamidon	EC 40% SL 40%	Dimecron,Sumidon,Cildon,Kinadan,Umecron Hiton
10.Phorate	Gr.10% Dust 6%	Thimet,Foratox,Phorate,Granutox Agrophorate,Volphor
11.Menazon	EC40% WDP 75%	Sayfos
12.Thiometon	EC 25%	Ekatin,Hexatin
13. Disulfoton (Thiodemeton)	Gr.10%	Solvirex, Dysyston, Systox.
14. Acephate	SP 75%	Asataf,Starthane,Aimthane
15. Ethofenprox	EC10%	Trebon, Nukil
16. Ethoprofos	Gr.10%	Mocap
17. Isazofos	Gr.3%	Miral
18. Triazophos	EC 40%	Hostathion, Sutathion, Trizer, Trizocel, Tarzan, Ghatak, Fulstop.

Common Name	Formulation	Trade Name
19. Ethion	EC 50%	Tafethion, Phosmite, Mitekill, Dhanumit
20. Methyldemeton	EC 25%	Metasystox, Hexametasystox, Hymox, Dhanusystox
21. Trichlorofon	Dust 5%	Dipterex
22. Formothion	EC 25%	Anthio, Ekatin-M
23. Monocrotophos	SL 36%	Nuvacron, Parryfos, Balwan, Sufos,
	WSC-36	Corophos, Monocil, Agromonare,Cadet, Aimocron, Monophos, Lufos, Hycrophos, Hilcron, Monodhan
24. Quinalphos	Dust 1.5%	Ekalux, Suquin, Kinalux
	EC 25%	Quinatox, Ekalux, Suquin.
	Gr.5%	Agroquin, HLX-25, Quinilaux, Dhanulux
	21 AF	Ekalux
25. Phosalone	Dust 4%	
	EC 35%	Zolone
26. Fenthion	EC 50-100%	Lebaycid
27. Phenthoate	EC 50%	Elsan, Phedal, Delthion, Delsan
	Gr.5%	Phenlac
	Dust 2%	
28. Chlorpyriphos	EC 20%	Dhanusban, Coroban, Durmet, Ruban, Sacoban, Pyriban, Classic, Coroban, Tafaban, Rus Ban, Chlordel, Kri-Shan, Lentrek, Lethal, Trishul
29. Methyl Parathion	EC 50%	Metacid, Kaydol, Paratox, Parataf, Ekatox, Corocid, Paramar, Dhanumar, Klofos
	Dust 2%	Folidol, Profit, Rusdol-2
30. Chlorfenvinphos	Gr.5%	Eiralane, Sapecron, Sypors, Birlane
31. Profenofos	EC 50%	Curacron, Prowess, Profenovip, Profex, Carina, Prahar
32. Phenthoate	EC 50%	Amaze
C. Carbamates		
33. Carbofuran	Gr.3%	Furadan, Diafuran, Furacarb
34. Carbaryl	Dust 5%	Sevin, Carbaryl, Hexavin
	Gr.6% &10%	Sevinflo
	WDP 50%	
35. Aldicarb	Gr.10%	Temic
36. Methomyl	40% EC	Dunnet, Lannate, Nuprin
	12.5%	
37.Propoxur	EC 20%, Bait	Baygon
	Aerosol 20%	
38. Carbosulfan	EC 20%	Posse
	ST 25%	Marshal
39.Thiodicarb	WP 75%	Larvin
40.Fenobucarb(BPMC)	EC 50%	Mahakill, Bipvin, Knock, Merlin
41. Indoxacarb	SC 14.5%	Avaunt
D. Combination insecticides		
42.Triazophos(35% EC)+ Deltamethrin (1% EC)		Spark 36% EC
43. Quinalphos (20% EC)+Cypermethrin(3%EC0		Viraat 23 EC
44.Acephate(25%EC)+Fenvalerate(3%EC)		Koranda 28EC

Common Name	Formulation	Trade Name
45.Chlorpyriphos(50%EC)+Cypermethrin(5%EC)		Anaconda 55EC, Nurelle D, Nuracombi,Cannon, Super-D,Stampede,Ulka 505, Anth.
46.Buprofezon + Deltamethrin		Dadeci 5.9 EC
47.Profenofos (40% EC) +Cypermethrin (4% EC)		Roket 5.9EC,Polytrin C
48. Phosalone(24%EC)+Cypermethrin(5%EC)		Sherlone 29 EC
49. Ethion (40%EC)+Cypermethrin(5% EC)		Nagata 45 EC, Colfos 405 EC
2. FUNGICIDES		
50. Copper oxychloride	WDP 50%	Blitox, Fytolan, Cupramar, Captox, Zencap, Krishicopper,Shell Copper, Micop, Hexamar copper, Anrucop, Cupro Kylt, Blue Copper 50, Capex, Dhanu cop, Cupravit, Blimix, Parrycop, Devi copper, Nagcoper
51. Cuprous oxide		Copper Sandoz dust, Coppesan, Fungimar, Fytomix, Trust.
52. Captan	WDP 75-83%	Captan, Hexacap, Delfron, Deltan Dhanutan
	WP 50%	Captaf
53. Ferbam	WDP 50-80%	Ferbam, Hexaferb
54. Mancozeb	WDP 75%	Indofil M-45, Shield 75WP, Aimcozeb,Uthane M-45, Luzen, Dhanuka M-45, Hilthane, Luzim, Spic Mancozeb, Zeb,Manzate, Zebthane, Abic M-45, Agromanco, Sparsh, Saviour
55. Thiram	WDP 75%	JK thiram, Hexathir, Thiride Vegfru thiram
56. Zineb	WDP 75%	Hexathane Blitane, Miltox, Devizeb, Disconz.
57. Ziram	WDP 80%	Zirade, Cuman-L, Hexazir, Zirlate, Ziride, Zitox
58. Maneb	WDP 50%	Dithane M-22
59. Wettable Sulphur	WDP 85%	Cosan, Micro Wettable Sulphur, Insulf, Dhanusulf, Thiovit, Spersul, Microsul, Sulcol, Sultaf. Sulphosan, Solfar, Spitox, Sulfex, Sulphotox, Hexasul.
60. Ediphenophos	EC 50%	Hinosan
61. Sulphur dust	Dust 70%	Sulphur dust
62. Difolatan	WDP 80%	Difolatan
63. Carbendazim	WDP 50%	Bavistin, Bengard, JK stein, Derosal, Subeej, Zoom, Aimcozim, Agni, Dhanustin, Calzin, Benzin Benfin, Carzim, Zen, Nirmool, Agrozim, Arrest.Stare
64.Organomercurials		
i) Phenyl mercuric acetate	Dust 1% Dust 20%	Ceresan dry
ii) Methoxyethylchloride	WDP 2.5%	Ceresan wet.
iii) Phenyl mercuric acetate+Ethyl mercuric chloride	Dust 1%	Emisan, Hexason, Agrosan, G.N
iv) Methoxyethyl	WDP 3 & 6%	Aretan
v) Mercury chloride	WDP 3 & 6%	Tafsan, Agallol, Seed rex, Tillex

65. Carboxin	WP 75%	Vitavax-75 W.P
66. Kitazin	EC 48% Gr.17%	Kitazin
67. Dinocap	EC 48%	Karathene
68. Hexaconazol	SC 5% SC 2% EC 5%	Contaf Plus Samarth Trigger
69. Captafol	WP 80%	Captafol, Captaf
70.Difenoconazole	EC 13%	Score
71.Dodine	WP65%	Syllil 65 WP, Syllet
72.Fenarimol	EC 12%	Ratrigan
73. Fosetyl-AL	WP 80%	Allette
74. Iprodione	WP 50%	Rovral
75 Isoprothiolane	EC 40%	Fujione
76. Metalaxyl	WS 35%	Krilaxyl,Apron,Glazer,Galaxy, Himil Gold
77.Oxycarboxin	EC20%	Plantvax
78. Penconazole	EC10%	Topas
79.Propiconazole	EC 25%	Radar,Tilt
80.Triademifca	WP 25%	Bayleton, Krylfon
81.Tricylazole	WP 75%	Beam, Trooper,Blastin.
82. Tridemorph	EC 80%	Calixin
83.Thiophanatemethyl	WP 70%	Topsin-M,Cercobin, Mopsin-M, Roko, Maxim, Prism
84. Tebuconazole	2 DS	Raxil 2 DS

Combination fungicides

85. Carbendazim(12%)+Mancozeb(63%)	Companion,Saaf,Sixer,Toptoo Care,CM75,Safaya
86.Metalaxyl (8%) + Mancozeb(64%)	Krilaxyl MZ 72 WP, Dhanuxyl, Master,Sanchar,Spectra,Himil,Ridomil MZ 72 WP
87. Carboxin (37.5%) + Thiram(37.5%)	Vitavax Power
88.Carbendazim(8%)+Mancozeb(63%)	
89.Carbendazim(8%)+Mancozeb(48%)	
90. Metalaxyl(8%) + Mancozeb(42%)	

3. ACARICIDES		
91. Dicofol	EC 18.5%	Colonel S, Hilfol, Klin, Delcofol
92. Proparigite	EC 57%	Omite, Allmite, Simbaa
4. FUMIGANTS		
93. Aluminium Phsophide	70%	Phostoxin, Celphos
94. Ethylene Di-bromide(EDB)		EDB ampules, Celmide, Grain Safe.
5. RODENTICIDES		
95. Zinc phosphide	80%	Ratox, Zinctox, Catch
96. (a) Anticoagulants		Ratafin, Warfarin, Coumachlor,
(b) 2nd generation Anticoagulant		Bromadiolone, Broadifacoum Roban

6.ANTIBIOTICS			
97. Streptocycline		90%, 10%	Aureofungin, Agrimycin, Plantomycin, Streptomycin, Kasumin
98. Bramonitropropanediole		100%	Bactrinol (Multiplex)
99. Kasugamycin		SL 3%	Kasumin, Kasu-B, Biomycin
100. Validamycin		L 3%	Validacin, Rhizocin, Sheathmar-3
101. Streptomycin sulphate(9%)+ Tetracycline hydrochloride			Krosin-AG
7. SYNTHETIC PYRETHROIDES			
102. Permethrin		EC50%	Ambush
		EC 25%	Permasect
103. Cypermethrin		EC 10% & 25%	Cymbush, Colt, Super killer, Bilcyp, Cropmaster, Ripcord, Cypercin, Cyper kill, Tatacyper
104. Deltamethrin		EC 2.8%	Decis
105. Fenvalerate		EC 20%	Fenval, Sumicidin, Triumphcard, Tatafen, Fenrio, Field Marshal, Agrofen, Hyfen.
106. Alphamethrin		EC 10%	Axis, Stop
107. Alpha-cypermethrin		EC 10%	Farsa, Alphaguard, Alphakill
108. Lambda-cyhalothrin		EC 5%	Karate
		EC 2.5%	Kung Fu,Reeva, Warrior
109.Fluvalinate		EC 25%	Mavrik, Spur
110.Beta-cyfluthrin		EC 2.5%	
		SC 0.25%	Bullduck
8. MISCELLANEOUS GROUPS			
111.Cartap hydrochloride		G 4%	Sanvex, Caldan
		SP 50%	Padan, Wartap 50 SP, Kritap, Sanvex 50SP, Indan-S.P, Dollar, Catriz, Josh *(Parry's*)
112. Fipronil		G 0.3%,SC5%	Regent
113. Diflubenzuron		WP 25%	Dimilin, Hilmilin
114. Buprofezin	*Chitin synthesis inhibitors*	WP 25%	Applaud
115. Diafenthiuron		SC 50%	Polo
116.Teflubenzuron		SC 15%	Nomolt
117. Flufenoxuron		WDC 10%	Cascade
118.Novaluron		EC 10%	Rimon
119. Imidacloprid	*Neo-nicotinoids*	SL 17.8%	Confidor 200 SL, Tatamida, Tez, Admire, Merit, Hilmida, Victor, Media, Ultimo, Imicon, *Josh (Krishi Rasayan Exports Ltd.)*
		WS 70%	Gaucho
120. Thiamethoxam		WG 25%	Actara, Anant,Evident
121. Acetamiprid		SP 20%	Pride, Ekka, Manik, Bismark, Tackil
122. Spinosad		SC 2.5%	Success *(Biological insecticide by De- Nocil Crop Protection Pvt.Ltd)*
		SC 45%	Tracer

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