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FARM EXTENSION SERVICE

Technology transfer is as important as technology generation. Technology 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 bringing out improvement in the economic and social status of the 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 about methods for effective transfer of technology are essential. There is growing need and realization on the 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 the felt necessary for accelerating the agricultural growth and social change. Some of the important consideration about the extension functionaries is presented here.

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.
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 programmes.
 - b. Conducting demonstrations or research 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 programme.

Role to Play

1. Empowerment
 - 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 operation area.
 - b. Empowerment of people
 - i. Develop cooperation among people
 - ii. Create community participation and joint problem solving attitude of the people.
2. Community organization
 - 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
 - a. Develop technical competency of the people.
 - b. Skill development of people in programme formulation, implementation management and evaluation.
 - c. Encourage people to analyse resources and its proper utilization including conservation.
 - d. Trained people in management of self as well as community.
4. Problem solving
 - 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 improved 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 discussions in all sphere.
- iii. Do not argue while discussing.

- iv. Show interest to take responsibilities.
- v. Do not avoid, if additional work assigned.
- vi. Be cheerful and 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 programmes. The following approaches 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 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 demonstrations.
8. Use interactive demonstration while imparting new skills
9. Organise field days and tours in critical stages of the demonstration.
10. Assist farmers in keeping records of each activity for evaluation of any programme/activity.

PACKAGE OF PRACTICES OF CROPS

CEREAL CROPS

RICE

Varieties

- (i) A good number of high yielding and improved varieties of paddy in different maturity groups, grain quality and resistance to pest are available (*Annexure-I*). Selection of variety for any situation should be made depending on topography, texture of the soil, availability of rainfall, irrigation water and crops to follow in the cropping sequence.
- (ii) Choose relatively shorter duration varieties for high, medium lands from which water can be drained at harvest. This will enable to grow a second crop on rainfed lands with residual moisture. On irrigated land, it will provide adequate time for land preparation for wheat or potato and will enable to grow three crops in sequence. Follow agro-climatic zone wise recommendations while selecting rice varieties for different land situation.

AGROCLIMATIC ZONE WISE VARIETY RECOMMENDATION

Sl No	Name of the Zone	Land type	Suitable variety
1.	North Western Plateau, Sundargarh	Up	Khandagiri, Heera, Ghanteswari, Kalinga-III, Annada, Jogesh, Sindhanta, Parijata
		Medium	Lalat, Konark, Naveen, Surendra, Swarna, Pratikshya, Gajapati, MTU-1001
		Low	Savitri, Mahanadi, Prachi, Indravati, Jagabandhu, CR-1014
2.	North Central Plateau, Keonjhar	Up	Khandagiri, Vandana, Kalinga-III, Ghanteswari, Jogesh, Sindhanta
		Medium	Lalat, Surendra, Konark, Tapaswini, Swarna, MTU- 1001, Naveen Aromatic rice: Kalajeera, Pimpudibasa, Geetanjali
		Low	Mahanadi, Prachi, Kanchan, Savitri, Moti, Padmini, Jagabandhu, Ketakijoha.
3.	Mid Central Table Land, Mahisapat	Up	Vandana, Kalinga-III, Khandagiri
		Medium	Lalat, Surendra, Konark, Naveen, Tapaswini, Ranjit, Swarna, BPT-5204
		Low	Savitri, Mahanadi, Indravati, Kanchan, Moti, Padmini, Upahar
4.	North Eastern Coastal Plain, Ranital	Up	Parijat, Khandagiri, Ghanteswari, Pathara, Badami, Annada & Lalitagiri
		Medium	Lalat, Surendra, Naveen, Konark, Gajapati, Swarna, Pratikshya, Sravani
		Low	Mahanadi, Jagabandhu, Savitri, Pooja, Kanchan, Lunishree, SR 26 B, Utkal prava, Padmini, Manika, Prachi, Tulasi, Ramchandi, Upahar, Varshadhan

5.	Western Undulating, Bhawanipatna	Up	Khandagiri, Vandana, ZHU XI-26, Parijata , Annada, Heera.
		Medium	Lalat, Konark, Surendra, Naveen, Swarna, Kharavela, Pratikshya, MTU – 1001, Aromatic rice- Geetanjali
		Low	Mahanadi, Moti, Indravati Aromatic rice: Dubraj, Ketakijoha
6.	South Eastern Ghat, Kalimela	Up	Khandagiri, Aditya, Parijat, Annada, Pathara, Vandana, Ghanteswari, Kalinga-III
		Medium	Lalat, Naveen, Kharavela, Gajapati, Surendra, IR 64, Sebati, Gouri, Pusa-44 , Swarna. Aromatic rice: Dubraj, Dahan Prasad, Karpur Kranti, Geetanjali
		Low	Jagabandhu, MTU 1001, Swarna, Utkal Prava, Gayatri, Savitri, Aromatic rice: Ketakijoha
7.	Eastern Ghat High Land, Semiliguda	Up	Kalinga-III, Vandana, Heera, Khandagiri,Parijata, Jogesh, Sidhanta, Pathara.
		Medium	Konark, Sarasa, Lalat, Naveen ,Tapaswini, IR 64, Swarna, Pratikashya, Gajapati, . Aromatic rice: Geetanjali.
		Low	Indravati, Jagabandhu, Ramachandi, Utkal Prava. Aromatic rice: Dubraj, Ketakijoha
8.	North Eastern Ghat, G.Udayagiri	Up	ZHU-XI-26, Vandana, RR 166-645, Khandagiri, Pathara, Heera, Kalinga-III.
		Medium	Lalat, Konark, Naveen,Surendra, Jajati,Swarna, BPT-5204, Pusa-44, MTU-1001.
		Low	Mahanadi, Prachi
9.	East & South Eastern Coastal Plain, Bhubaneswar	Up	Heera, Kalyani II, Kalinga-III, Parijat, Khandagiri, Pathara, Jogesh, Sidhanta, Anjali, Vandana.
		Medium	Lalat, Konark, Naveen, Surendra, Birupa, MTU-1001, Swarna, Gitanjali, Pratikshya Aromatic rice: Geetanjali.
		Low	Swarna, Jajati, Kanchan, Jagabandhu, Padmini, CR-1018, T- 141, Sarala, Pooja, Mahanadi, Indravati, Utkal Prava, Dharitri, Moti, CR-1014, Sonamani, Ramchandi, Upahar, Varshadhan Aromatic rice: Magura, Kalajira, Karpur Kranti, Kalakrushna, Ketakijoha.
10	West Central Table Land, Chiplima	Up land	Heera, Kalinga-III
		Rainfed (Unbunded)	
		Rainfed (Bunded)	Annapurna, Heera, Badami, Ghanteswari, Khandagiri, Keshari. Kalinga-III.
		Irrigated (Bunded)	Parijat, Pathara, Ghanteswari, Annapurna
		Medium (Berna)	Ananga, IR 36, Lalat, Naveen, MTU- 1010, Swarna, Bhuban, Jajati, Gouri, Pratikshya, Meher, Konark, Surendra, Moti, Bhanja, Samanta, Aromatic rice: Pusa Basamati-1, Basmati-370, Kasturi, Geetanjali, Ketakijoha
Low (Bahal)	Mahanadi, Prachi, Ramachandi, Indravati, Kanchan, Jagabandhu, Savitri, Gangotri, Utkal Prava.		

UPLAND RICE

Field preparation

Cultivate the land after harvest of the previous crop preferably with a MB plough. Summer ploughing should be done after summer showers. It (i) reduces weed population, (ii) helps in fixation of atmospheric nitrogen, (iii) reduces pest and diseases, (iv) makes land preparation easier before sowing, and (v) makes soil nutrients available to the crop. Final land preparation may be done with pre-monsoon showers for sowing.

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

Seed treatment & Plant protection

Refer Annexure-III, IV & V.

Sowing

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

Test the germination percentage before sowing. Sow the seeds in line preferably with seed drill or three tyne cultivator-cum-seed drill or by opening lines at 15 cm apart. It has the following advantages: (i) less seed is required (ii) the germination is synchronous with uniform crop stand and desired plant population (iii) weeding is easier by hoeing or using rake weeder and (iv) uniform growth of the crop. Seed should be placed at a depth of 4-6 cm. Use 60-80 kg/ha of good quality seeds depending on the test weight of the seed.

Interculture

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

Manuring

Apply well decomposed FYM or compost @ 5 t /ha with chemical fertilizers. It is better to apply fertilizer on the basis of soil test recommendation. N:P:K

@ 40:20:20, 30:20:20 and 60:30:30 kg/ha for improved, local and HYV, respectively be applied depending on the initial fertility of the soil and the yield potential of the variety. Full P & K be applied as basal by broadcasting and mixing at final ploughing. Wherever possible, these should be preferably placed below the seed with a seed-cum-fertilizer drill. In case of placement, 25% of N should be supplied as basal application to have early vigour of the seedlings where line sowing has been done. When no basal application is possible, 75% N be applied as first top dressing at the time of interculture (hoeing and weeding) in the third week from germination and the rest 25% at the panicle initiation (PI) stage (18-20 days before panicle emergence). In well drained sandy soil, apply full P as basal and N & K in split. In other soils, apply full P & K as basal and N in splits.

Water management

The crop is most sensitive to water stress in the reproductive stage. Wherever water is available, irrigate the crop at this stage if rain fails. Collect all rain water after 45 days by strengthening the bunds (refer the topic on dry land agriculture).

Harvesting

Harvest the crop when the grains in the panicle are grey in colour. Delayed harvesting causes considerable loss by shattering and due to damage by rats and birds. However, early varieties should be harvested 25 days after 50% flowering. Improved sickle should be used for harvesting the crop as it reduces drudgery of the worker and gives 20% more coverage than local sickle. The improved sickles are GAIC sickle (Gujarat Agro Industries Corporation, Ahmedabad), Naveen sickle (CIAE, Bhopal), Dev sickle (Dev industries, Bangalore). For hard soil and non-lodged crop, power tiller or tractor front mounted vertical conveyor reaper should be used.

Post-harvest technology

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

IMPACT POINTS

- i) Early sowing to avoid moisture stress at later stage and accommodate second crop
- ii) Line sowing and early weeding
- iii) Seed treatment
- iv) Application of moderate dose of fertilizer
- v) Pest management especially against gundhi bug and termites

MEDIUM AND LOW LAND RICE

DIRECT SEEDING

Field preparation

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

Seed treatment & Plant protection

Refer Annexure-III, IV & V.

Dry sowing should be done from second half of May to first half of June till the onset of monsoon.

Sowing should be done preferably in lines 20 cm apart to ensure better plant population. Line sowing will eliminate '*Beusan*' operation which reduces plant population. If sowing is delayed due to unavoidable circumstances, pregerminated seeds can be directly sown on the puddled field in lines after providing proper drainage. Wet seeding in line can give as much yield as the transplanted crop. Use a seed rate of 60-80 kg/ha depending upon the test weight and tillering habit of the variety. Line sowing behind the plough or seed drill may be taken under suitable field condition. Three row pre-germinated seeder should be used to sow germinated seed. The field should be puddled, levelled and well drained at the time of using seeder. Seeds with 2 mm sprout are most suitable for the pre-germinated seeder.

Interculture

In the line sown crop the interspace can be worked out with a narrow plough or rotary weeder or rake weeder after 3 to 4 weeks of germination. In broadcast crop, *Beusan* is the common practice for killing weeds. This operation is followed by proper "*Khelua*" to maintain adequate plant population. Do not *Beusan* the crop, if it is delayed beyond 45-50 days after sowing due to want of standing water. Weed out the field and apply fertilizer.

Control weeds with pre-emergence application of butachlor @ 1.25 kg/ha or pretilachlor @ 1.00 kg/ha or pendimethalin @ 1.00 kg/ha or arozin @ 0.4 kg/ha or oxyfluorfen @ 0.04 kg/ha. Herbicides should be sprayed in moist soil one day after sowing or after first shower in case of dry sown crop.

Manuring

Apply FYM @ 5 t/ha at the time of final ploughing for sowing. Besides, adequate amount of N:P:K in form of chemical fertilizer be applied in splits as indicated in *Annexure-II*. Use fertilizer as per soil test report. Meet 50% N

requirement of rice from organic sources and rest 50% N through inorganic fertilizer for sustenance of soil fertility.

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

Fertilization for *beusan* rice

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

Water management

Whereever possible, maintain soil moisture at saturation for 20-25 days to induce tillering and about 3 cm standing water till primodia initiation. This will prevent weed growth and will not interfere in tillering. Thereafter, maintain 5 cm depth of water in the field. Drain out water about a week before harvest. Where cutworms are likely to appear, water should not be drained out till harvest. There is no extra benefit if depth of water is maintained at more than 5 cm. Cyclic submergence (5±2 cm) 3 days after disappearance of ponded water saves water without reduction in yield.

Harvesting and post-harvest technology

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

TRANSPLANTED RICE

Field preparation

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

Seed treatment & Plant protection

Refer Annexure-III, IV & V.

Nursery raising

Raise the nursery during the first week of June with water available from wells, tanks, ponds, katas, nallas, dugwells, reservoirs, canals etc for planting early in July. Dry seed bed is better than wet seed bed. Apply 6-3-3 g of N-P₂O₅-K₂O/m² in less fertile soil. Raising of seedlings with sufficient farm yard manure may not require fertilizer during the Kharif season. Precautions necessary in raising nursery are (i) addition of compost/farm yard manure and phosphatic fertilizer at sowing (ii) top dress nitrogen and potash after weeding at 15 days of germination (iii) application of granular insecticides a week before uprooting and (iv) keeping standing water of 1-2 cm depth on the bed a day before uprooting. If monsoon or canal water supply is delayed, 40 days old seedlings of short duration varieties (110-120 days) and 60 days old of medium and late duration varieties (120-150 days) can be planted with no appreciable loss of yield.

Early planting has many advantages

- i. It encourages good tillering while delayed planting affects tillering.
- ii. Likely to escape gallmidge, stem borer and blast attack.
- iii. Photo-insensitive varieties if planted early will be harvested early which will permit a second crop in rainfed lands and third crop in irrigated lands.

Planting

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

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

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

Interculture

Weeding of the crop should be done within 3 weeks of transplanting, Weed can be controlled with herbicides recommended for direct sown medium land rice

applied 3 days after transplanting. Herbicides can be applied mixed with clean and dry sand @ 50 kg/ha.

Fertiliser use

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

Water management

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

Harvesting and post harvest technology

Same as under direct sown crop

IMPACT POINTS

- i) Line sowing of the direct seeded crop and early weeding
- ii) Early nursery
- iii) Growing short duration high yielding varieties to avoid moisture stress and to accommodate the second crop
- iv) Shallow, erect and close planting
- v) Use of herbicides to reduce weeding cost
- vi) Timely *khelua*/gap filling
- vii) Ensure 400-500 earheads per square meter
- viii) Apply fertiliser at *Beusaning*
- ix) Manage water properly
- x) Timely pest management

SYSTEM OF RICE INTENSIFICATION (SRI)

In our country, the agricultural land is decreasing but population is increasing, creating additional demand for food crops. Our farmers are using more of chemical fertilizers, irrigation and pesticides that have adverse impact on soil health/quality and on its productivity. The resource poor farmers are losing interest in rice cultivation as its profitability is declining with rise in input cost. There is need for a viable alternative method of rice cultivation that saves the expensive inputs, improves soil health/ quality and protects the environment substantially apart from ensuring higher yield. At this critical juncture SRI appears as a ray of hope for rice farmers.

1. WHAT IS SRI ?

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

2. ATTRIBUTES OF HIGHER PRODUCTIVITY

- ❖ Less seed rate
- ❖ Transplanting young seedlings
- ❖ Transplanting single seedling
- ❖ Wider spacing
- ❖ Maintaining field saturation
- ❖ Incorporation of weeds through operation of weeder
- ❖ Use of preferably organic manures as source of nutrition

2.1 Less seed rate

The recommended seed rate for SRI is 5kg/ha. Thus the cost of seed in rice production can be minimized and use of quality seeds (Foundation Seeds) can be ensured. Higher seed replacement ratio can be achieved.

2.2 Transplanting young seedlings

Seedlings are transplanted at 2-leaf stage (10-12 days old). At the time of transplanting the endosperm still remains in tact. So the transplanting shock is less. During planting root system remains vertical or takes “L” shape. The seedlings get established very quickly and grow healthily. Due to early transplanting the production of tillers is continuous and uninterrupted. Therefore more tillers are produced giving rise to higher yields.

2.3 Single seedlings are planted at wider spacing

Instead of 2-3 seedlings, only one seedling is planted at a spacing of 25cmX25cm. Each plant gets more space, air and sunlight, produces healthy and extensive root system and there is more nutrient absorption. There is profuse tillering in plants, longer panicles. More no of grains are produced. The grain weight is also more.

2.4 Maintaining field saturation

In conventional rice production system, standing water creates anaerobic condition. The roots become brown/rusty and dead under hypoxic situation. By P.I. stage, as many as 75% rice roots degenerate and become defunct. On the contrary, intermittent irrigation to maintain the soil at saturation makes the rhizosphere aerated and promotes healthy growth of roots. Soil aeration prolongs the functional life of root and enhances nutrient absorption.

2.5 Incorporation of weeds through operation of weeder

Weeding is done mechanically by weeder. Weeds are incorporated in to soil and add organic matter. The soils get aerated. Better root growth is achieved and higher yield is obtained.

2.6 Use of organic manure as source of nutrition

Soil physico-chemical and biological properties are improved. Microbial population and activity of microorganisms increase. Mineralization of nutrients increases. Enzymatic and hormonal activities increase. Healthy and better plant growth takes place leading to higher yield.

3.SRI- PRACTICES

- 3.1. Selection of suitable site
- 3.2. Nutritional management
- 3.3. Nursery raising
- 3.4. Main field preparation
- 3.5. Transplanting
- 3.6. Weed management
- 3.7. Water management
- 3.8. Pest management
- 3.9. Harvesting

3.1 Selection of suitable site

Leveled lands having good water control with fertile soil are suitable for SRI. Leveled lands facilitate uniform spread and drainage of water. Saline soils are not suitable, as they need flooding to decrease salinity level. But in SRI method, flooding with water is not allowed. Further, in saline soils draining and drying of soil leads to accumulation of salts on soil surface, which harms the plants.

3.2 Nutritional management

SRI method aims at fully realizing the yield potential of rice plants. Hence it responds better to a natural growing environment with organic sources of nutrition, rather than chemicals. Organic matter encourages microbial population and activity of microorganisms. Nutrients are found in readily available form. Plants are healthy and possess resistance to insect pests and diseases.

Organic manure sources: The various organic sources are tank silt or FYM or compost @ 15-20 t/ha. Besides, green manuring crop like Dhaincha can be grown and incorporated at preflowering (45 days) stage to add approximately 15-20 t/ha fresh biomass (2.7-3.5 t dry matter). Paddy nursery is sown on the day of incorporating the green manure crop, so that by the time green-manure plants are

well decomposed in soil, the seedlings are ready for transplanting. In addition to these, vermicomposts / oil cakes/ biofertilizers etc. constitute the other organic sources of nutrition. If the soil is fertile, there is yield enhancement with organic nutrition alone, else to safeguard against yield reduction, 50% of recommended fertilizer dose along with full dose of organics may be applied basally till the soil is organically enriched.

3.3. Nursery raising

In SRI method, utmost care is taken in preparation of nursery beds, as 10-12 days old seedlings (2 leaf stage) are transplanted. Nursery may be raised near the main field to overcome the problems of transportation and reduce the time lag between uprooting and planting. Nursery is grown on raised beds of 15 cm height. The beds should be 1.5 m wide and of convenient length. The bed is covered with a thick mat of powdered FYM to facilitate easy penetration of roots, uprooting of seedlings and their separation for planting. A channel is made around the bed for letting in and draining out of water. The bed is made secure on all sides with wooden planks or bamboos to prevent the wet soil dropping down.

Two kg of seeds is raised in a bed of 40 m² for transplanting one acre. Any variety can be used for SRI method. But, considering the controlled water situation and yield compensation through tillering, medium duration varieties with good tillering ability seem to be better than short duration and shy tillering varieties. Presoaked sprouted seeds are sown sparsely. Over sprouting should be discouraged as it causes root entanglement and becomes difficult to separate. Seeds are broadcasted and covered with a thin layer of FYM/dry soil and straw. This maintains temperature, protects from rain, direct sun and birds. Straw is removed on appearance of shoots. Watering by rose cane or letting in water into the channel surrounding the nursery bed also keeps the nursery bed moist. Seedling becomes ready for transplanting in 10-12 days (2 leaf stage).

3.4. Main field preparation

Field is dry ploughed, watered and puddled. Tractor puddling is avoided. The field should be leveled and standing water should not be allowed in the field. Beds and channels are prepared. A channel of 30 cm is left after every 1.5-2 m width depending upon soil type. Cleaning of bunds, leveling, markings on the beds etc are done a day before planting.

Seedlings are planted at a spacing of 25 cm X 25 cm. There are several ways by which transplanting is done at this spacing. A rope with tie knots or marker sticks at every 25 cm may be used as guide and transplanting may be done in rows one after the other. Using this rope as guide, transplanting may be done one row after the other. However, markers made of wood or iron are available for transplanting at 25 cm X 25 cm. There are bar markers, which have to be drawn either way to form a grid, but roller markers form grids at one go.

3.5. Transplanting

Young seedlings of 10-12 days old are transplanted. Seedlings are lifted carefully with the endosperm in tact. A metal sheet is pushed 4-5" below the soil to lift the seedlings along with the soil. Single seedling is transplanted within half an

hour of lifting to minimize trauma of seedling. In conventional method of transplanting, the root takes “U” turn and takes time to turn downward but in SRI the root takes “L” shape. It requires about 20-22 persons to transplant 1 ac. In case of casualty, the gaps should be replanted immediately.

3.6. Weed management

In SRI method, water is not allowed to stand in the field. This encourages more weed growth. Weeders are used at every 10-12 days interval to turn the weed in to the soil. It requires a run of 16 km per acre to complete one weeding, for which 2-3 persons are required. The weeds are controlled and incorporated in to the soil to add organic matter. The soil becomes aerated, surface layer roots are exposed to air and profuse growth of roots as well as diverse soil microbes take place. Nutrients, enzymes and hormones secreted by microbes promote plant growth. Chemical herbicides should not be used.

3.7. Water management

Rice plant tolerates standing water but responds better to aerobic condition like other plants. Roots die under flooded condition due to lack of oxygen (hypoxic situation). In SRI, water is provided only to wet the soil. Irrigation is given before the soil develops hairline cracks. The roots grow healthily, deeply and in all directions. The condition favors microbial activity. A day before using weeder, the field should be lightly irrigated. After weeding water should not be allowed to drain. From P.I. to maturity one inch of water should be maintained in the field. The water is removed after 70 % grains get hardened.

3.8. Pest management

Chemical pesticides and herbicides are not used. Wider spacing and organic manures result in healthy growth. Incidence of pest and diseases is naturally low. Pest can be managed by use of organic concoctions. *Pot manure/ Amrit pani/ etc* are few such preparations, which are quite effective in controlling insect pests.

Preparation of *Pot manure*: Cow urine 1 Litre + Cow dung 1 Kg + *Jaggery* 50 g + *Neem* leaves 1 kg + *Callotropis (Arakha patra)* leaves 1 kg + *Pongamia* leaves (*Karanja patra*) 1 kg . In an earthen pot make a slurry of cow urine, cow dung and jaggery. To this slurry chopped leaves of *Neem*, *Callotropis (Arakha patra)* and *Pongamia* are added. The pot is covered with a cloth and kept for 7-8 days to ferment. After 8 days it is diluted with water 50 times, filtered and sprayed. This provides N and repels insects and microorganisms.

Preparation of *Amrit pani*: Cow urine one Litre + Cow dung 1Kg + *Jaggery* 250 g + Water 10 Litre. All these materials are mixed in an earthen pot. Allowed to ferment for 24 hrs. Diluted with water in 1:10 ratio, then filtered and sprayed. This also provides N and repels insects and microorganisms.

3.9. Harvesting

The grain matures even while the crop is green in colour. Farmers should be ready to take up timely harvesting at this stage. Harvesting is advanced by 7-10 days in SRI.

BENEFITS ASSOCIATED WITH SRI

- Water savings up to 25 - 50 %
- Saving in cost of seed
- Stronger tillers, large root system and less lodging
- Reduced pest and disease attack
- Low cost of production
- Increased factor productivity
- Seed multiplication with less quantity of parent seed
- Environmental benefits

CONSTRAINTS

- Lack of good water control. Generally field-to-field irrigation is in practice.
- Lifting tiny seedlings and transplanting them is seems to be difficult and time consuming
- Seedling mortality
- More weed growth
- Difficulty in workability of the weeder in varied soil type
- Inadequate organic manure availability

OPPORTUNITIES

In spite of the limitations, the potentiality of the SRI method can be best exploited for the following programs in rice production.

- Seed production and multiplication
- Aromatic rice production
- Organic rice production
- Rice production in small farm holdings

CONCLUSION

Rice yields all over the world have leveled out under the present system of flooded cultivation. Submergence of crop fields under rice-rice cropping system has led to development of soil sickness and environmental problems. Since agriculture in Orissa to a large extent means growing of rice and Orissa farmers cannot afford to go for agriculture without growing rice, there is need for an alternative method of rice cultivation. We are looking for alternatives in open mind. SRI is a type of method diversification. SRI is still evolving. Scientists –Extensionists- Farmers linkage will further refine it to suit to our situation for higher productivity.

IMPACT POINTS

- Planting at 2 leaf stage
- Planting seedlings with endosperm intact
- Planting on leveled beds
- Proper water management
- Weed incorporation by mechanical weeder

DEEP WATER RICE

The waterlogged rice lands which accumulate water to a depth of 51-100 cm for a prolonged period (2-5 months) during the crop season and the rice grown in these lands designated as deep water rice. These lands also tend to experience frequent, short term submergence, which is much more damaging to crops than the effects of standing medium deep water.

This combination of factors results in three major stresses.

- Water levels are deeper than those to which rice is optimally adopted.
- The standing water stagnates, creating imbalances in oxygen and other chemicals.
- The crop is frequently submerged.

Under this situation the crop is dry seeded before the onset of monsoon and in this sub-ecosystem the rice crop is usually harvested after the surface water has receded. Most farmers adopt varieties that are tall and photo-period sensitive and that have field duration exceeding 5-6 months. Photo-period insensitive cultivars with intermediate height (120 cm) and long growth duration are suitable for some of the area, but photo-period sensitivity is a great advantage under such waterlogged conditions. However, any cultivar grown in this ecosystem must be able to tolerate stagnant water.

These deep water direct-seeded crops often suffer from a number of field problems like

- Poor seedling establishment in the early phase and suppressed tillering in the later phase of crop growth.
- Prolonged water logging creates adverse soil conditions of nutrient deficiencies and / or mineral toxicity, thereby affecting crop growth.
- General wet conditions and reduced light intensity normally prevailing in monsoon season favour pre-mature lodging.
- Rice crop is damaged by intermittent flood water submergence caused by heavy and prolonged rainfall and impeded drainage.
- Problem of salinity caused by tidal inundation is common in deep water areas near the sea coast.
- Atmospheric and soil conditions during monsoon usually favour crop damage due to diseases and insect pests.

Photosensitive traditional tall varieties with a wide range of maturity duration from 150 to more than 180 days cover more than 90 percent area under deep water rice. Being photosensitive, the tall varieties have flowering and ripening phases after complete cessation of monsoon and become ready for harvest after recession of water from the field. Further, conditions of sunshine and temperature after cessation of monsoon favour better pollination, fertilization and grain filling and thus plants do not suffer much from the problems of spikelet sterility and show higher number of grains per panicle within the limits of genetic potential.

The modern low land high yielding varieties like Rambha, Tulsi, Kanchan, Durga, Sarala, Kalashree, Panidhan and tall varieties like CR-1014, BAM-6, T-1242 etc. are commonly grown in semi-deep water lands while farmers grow their own varieties in deep water lands. Thus, the lack of suitable rice varieties with high yield and resistance to stem borer, leaf-folder, and bacterial leaf blight and submergence

or elongation ability is the major constraint to high productivity in this ecologically handicapped deep water lands of the state. Some of the base characteristics needed for the development of deep water rice are

- Moderately high yield potential
- Intermediate height
- Sturdy culms
- Moderately long and erect leaves
- Moderate to high tillering
- Large panicles with high grain numbers
- Complete panicle exertion
- Low tiller mortality
- High seedling vigour
- Tolerance to submergence due to intermittent flood
- Tolerance to standing water with internode elongation ability

Some of the released varieties like Suresh, Biraj, Jalamagna, Jogen, Sabita, Bhudev and Hanseswari were found to exhibit better performance under stagnant water situation in deep water ecosystems.

Production Technology Recommendations

1) Land Preparation & Sowing of Seeds

- Open the land immediately after harvest with mould board plough with optimum moisture in the field, which facilitates sowing before the onset of monsoon.
- One or two summer ploughings after pre-monsoon showers disintegrate the clods formed at post-harvest ploughing and makes the land ready for early and timely sowing.
- Sow the seeds, when the land is dry well in advance of the monsoon showers. Sowing around late May to early June, ensures a good crop stand and grain yield.
- Dibble 8-10 seeds per hill, in rows 20 cm apart, with a seed drill or at least behind a country plough . This reduces the seed rate, places the seeds 3-5 cm deep and makes subsequent operations like weed control, interculture and fertilizer application easier and economical.
- In the traditional broadcast method of seed sowing, a major portion of seed is left on the soil surface and in the event of rain, the sprouted seeds die due drought injury. However, rain in late June or early July does not affect deep sown seeds as the roots are able to draw moisture stored in the soil profile.
- Depending upon the grain size, use seed rate of 60-80 Kg / ha.
- Transplanting may not be possible or considered as a suitable substitute of line sowing or dibbling of seeds in typical deep water situation, due to rapid stagnation of rain water in the event of monsoon rains in the month of June-July.
- A crop direct sown in late May to early June attains sufficient height by the end of July to Mid August to withstand prolonged water logging and flash flood situations.

2) Fertilizer application

- Application of phosphorus promotes root growth and provides anchorage to the plant. This helps the crop to withstand submergence and flood water inundation. Therefore, it is desirable to apply 20-30 Kg P₂O₅/ha during land preparation.
- It is neither feasible nor profitable to apply nitrogen fertilizer to these land situations between late July to mid October because of adverse soil water hydrology. Therefore, it is desirable to apply nitrogen fertilizer in one or two doses before water accumulates up to depth of 5-10 cms in the field. Usually fertilizer is placed in bands at sowing with seed-cum-fertilizer drill, hand plough or behind the country plough.
- For all practical purposes it is desirable to apply N:P:K @ 40-60 Kg, 20-30 kg and 20-30 Kg/ha at the time land preparation and sowing.

3) Crop Protection

- The deep water rice crop is usually infested with stemborer and leaf folder and diseases like neck-blast and BLB are major problems in reducing crop productivity. Therefore, the following prophylactic and control measures are suggested to protect the crop from attack of pests and diseases.
- Mix the seeds thoroughly with 2g Carbendazim and 25 ml chloropyriphos per kg of seeds and use this treated seed for sowing.
- Spray the crop with a solution containing 1g Carbendazim / litre of water at seedling or early growth stage to protect the crop from blast or sheath blight.

AROMATIC RICE

Aromatic rice is grown in our state only in the *Kharif* season. It can be grown in most of the soils except poor and alkaline soils. Optimum atmospheric temperature is 25-35°C. The day temperature from flowering to maturity should not exceed 25°C and night temperature should be around 21°C for better development of aroma.

Varieties	Duration (days)	Average yield (t/ha)
Tall		
Basmati -370 (Punjab basmati)	130	3.0
Taraori basmati (Karnal local)	140	3.0
Type-3 (Dehradun local)	130	2.1
Semi dwarf		
Pusa Basmati-1	125	4.0
Kasturi	125	3.6
HKR-228	135	3.5
Vasumati	125	4.0
Geetanjali (CRM 2007-1)	135	4.5
Ketakijoha (IET 18669)	150	4.0

Besides, the local scented rice varieties grown in different pockets of Orissa are *Kalajeera*, *Basuabhog*, *Sitabhog*, *Karpurakranti*, *Gopalbhog*, *Pimpudibasa* and *Dubraj*.

Seed rate, seed treatment and planting

Use 30 kg seeds/ha. Treat the seeds with a mixture of carbendazim 0.2% + thiram 0.3%. Raise nursery in an area of 1000 sq m to transplant one hectare of main field. Transplant 20-25 days old seedlings around mid July with a spacing of 20 cm x 15 cm. For delayed planting, transplant 5-6 seedlings/hill at a spacing of 15 cm x 15 cm to obtain 45 hills/sq m. Take up gap filling within a week of planting.

Fertilizer

Apply 5 ton FYM/ha at last ploughing. Adopt the recommended fertilizer dose

Improved tall : 60-30-30 kg N-P₂O₅-K₂O/ha

Semi dwarf : 80-30-30 kg N-P₂O₅-K₂O/ha

Local : 40-20-20 kg N-P₂O₅-K₂O/ha

Apply full P, K and 25% of N as basal. Top dress 50% N at 15 days after planting and 25% of N at panicle initiation stage.

Interculture, water management and plant protection

As suggested in transplanted rice.

Harvesting

Harvest the crop when 80% of the grains mature and the straw still remains green to avoid grain shedding. Dry the grains till the moisture content comes to 12-14%. Rubber sheller should be used for better head rice recovery.

HYBRID RICE

- Important hybrids are KRH 2, PA-620, PHB 71, Rajalaxmi and Ajaya.

Hybrid	Duration (days)	Yield (t/ha)
KRH 2	125	7.0
PA 6201	125-135	8.0
PHB 71	125-135	8.0
Rajalaxmi (CRHR 5)	135	7.0
Ajaya (CRHR 7)	135	7.5

- Seed rate : 15 kg/ha
- Seeding density in nursery : 10-20 g/m²
- Time of planting : Mid July
- Spacing : 20 cm x 15 cm
- Seedlings/hill : One or two
- Fertilizer dose : 120-60-60 kg of N-P₂O₅ -K₂O/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±2 cm) 3 days after disappearance of ponded water.

Follow other package of practices as under transplanted rice.

MAIZE AND JOWAR

Varieties

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

Crop	Variety	Maturity (days)	Potential yield (q/ha)	Special features
MAIZE	Composites			
	Novjot	90-95	45.00	Orange yellow, semiflint, tolerant to PFSR
	Megha	85-90	45.00	Orange yellow, semiflint, resistant to MLB
	Partap	85-90	45.00	Orange yellow, semiflint type
	Shakti 1	85-90	50.00	Orange flint, high quality protein maize, tryptophan in protein 0.92%
	Pragati	85-90	50.00	Orange yellow, semi flint
	Hybrids			
	Deccan 103	100	60.00	Orange yellow, semiflint, resistant to TLB, MLB and PFSR
	Deccan 107	90-100	70.00	Yellow, semiflint, fairly resistant to MLB, TLB
	Deccan 109	85-90	50.00	Yellow, semi-flint
	Deccan 115	85-90	60.00	Orange yellow, flint
	Ganga-II	100	60.00	Orange yellow, semi flint, resistant to DM and MLB
	Pro 311	100-110	77.00	Yellow, flint type with high yield potential
	Bio 9681	100-110	71.00	Yellow, semi flint with high yield potential
	X 3342	85-90	61.00	Yellow, semi flint with high yield potential
	Cargil 900M	115	65.00	
	Cargil 633	115	60.00	
	Sartaj	110	55.00	A double cross hybrid with yellow orange flint grains
	Hyb. 2784	85-90	60.00	Orange, semi flint
	JOWAR	Swarna (CSV 1)	115	30-35
CSH-1 (hybrid)		95-100	30-35	Dwarf in height, grains are white pearly in colour
CSH-2 (hybrid)		115-120	30-35	Medium late, 150 to 200 cm in height
CSH-9 (hybrid)		105-115	35-40	140-150 cm in height, white pearly grain
CSV-15		110	35-38	Dual purpose, tall (220-230 cm)
CSV 216		110	35-40	Medium duration
CSH 17 (Hybrid)		105	35-45	Early, white grain, tannin free, tolerant to moisture stress and green molds, resistance to leaf diseases
ASH 1 (Hybrid)		110	30-40	Medium duration
SPH 837 (Hybrid)		110	30-40	

PFSR: Post flowering stalk rot, MLB: Maydis leaf blight, TLB: Turicum leaf blight and DM: Downy mildew

Field preparation

Select well drained soil for maize and jowar. Prepare the land well before sowing and incorporate FYM or compost @ 5 t/ha at final land preparation. In termite infested areas, treat the soil with insecticide as per recommendation given in *Annexure-III*. For a good seed bed, rocket plough, borse plough, Implement Factory MB plough, power tiller operated rotavator or tractor operated cultivator can be suitably used.

Seed treatment & Plant protection

Refer Annexure-III, IV & V.

Early sowing

Early sowing 10-15 days before onset of monsoon increases yield by about 15% and eliminates shoot fly attack in jowar. It also increases the maize yield.

Plant population

Maintenance of adequate plant population is very important to obtain good yield. Over population should be avoided. Both maize and jowar should be planted in lines to facilitate intercultivation between rows. Maize should be sown in rows 60 cm x 25 cm and an optimum plant population of 55,000 to 60,000 per ha should be maintained. There should be only one plant per hill. Thin the plants at 3 leaf stage without delay. Jowar should be planted in rows 45 cm apart and thinned to maintain a spacing of 12 to 15 cm between plants which will give about 1,80,000 plants per ha.

A seed rate of 15 kg/ha for maize and 10-12 kg/ha for jowar is adequate to maintain optimum population.

Interculture

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

Fertilizer

Supplement organic manures with chemical fertilisers. Fertiliser requirement of maize crop is high. Jowar also responds favourably to fertiliser application. Apply the following doses of fertilizer.

Hybrid & composite maize	:	80-40-40 kg N-P ₂ O ₅ -K ₂ O/ha
Jowar	:	60-30-30 kg N-P ₂ O ₅ -K ₂ O/ha

Apply full P and K as basal. Nitrogen should be applied in 3 splits, 25% as basal, 50% at 3 weeks stage at first hoeing and earthing up and 25% at 6-7 weeks

stage at second hoeing and earthing up. Top dressing of fertilizers should coincide with hoeing/interculture and earthing operations to incorporate fertilizer into the soil. Placement of manures and fertilisers in the furrows before sowing and thorough mixing with soil gives better result. Point placement of 10 kg N/ha at silking stage increases yield by 10-12%.

Water management

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

Harvesting

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

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.

IMPACT POINTS

- i. Popularise high yielding composites and hybrids
- ii. Maintain optimum plant population
- iii. Early sowing in lines and early interculture
- iv. Use moderate dose of fertilizer

SWEETCORN

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-P₂O₅ -K₂O/ha (Nitrogen to be applied in 3 splits as in maize)

Harvesting: At green cob stage

Yield : 1.5 t/ha

BABYCORN

Baby corn is used for culinary purposes for making curry, pakoda and other food items.

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-P₂O₅ -K₂O/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

RAGI

Ragi can be cultivated throughout the year if irrigation is available.

Varieties: Select short-duration varieties to overcome moisture stress.

Variety	Maturity (days)	Average yield (q/ha)	Special features
Early varieties			
Dibyasinha	85-90	20.0	Earhead incurved, brown grains, moderate tolerance to blast and stem borer, show good performance under poor environment
VL 149	90-95	25.0	Open fistled larger spike with more number of fingers/spike
Champavati (VR 708)	90-95	22.0	Earheads are incurved, more fingers/spike seeds are brown coloured and tolerant to blast.
Medium varieties			
Godavari (PR 202)	115-120	30.0	Top incurved earheads
Suvra (OUAT-2)	100-105	22.0	Plant height 85-95 cm, grain white in colour, flour creamy white, protein content 10.3%, resistant to sheath blight, ash weevil, earworm.
Bhairabi (BM 9-1)	102-108	27.0	Plant height 85-100 cm, grain brown in colour, protein content 8.1%, moderately resistant to leaf, neck and finger blast.
Chilika (OEB 10)	110-115	26.0	Plant height 90-105 cm, grain brown in colour, protein content 8.2%, moderately resistant to leaf, neck and finger blast
RAU 8	105-110	25.0	
HR 376	100-108	25.0	
Neelachal	100-110	28.0	Earheads semi compact, incurved, grain light brown in colour, medium bold.

Field preparation and sowing

Prepare a well pulverized seed bed for direct seeded ragi. Bose plough, rocket plough, mould board plough, power tiller, rotavator or tractor operated cultivator may be used to prepare the seed bed. Apply FYM or compost @ 5 t/ha and incorporate well into the soil alongwith fertilizers before sowing. Use 10 kg seed/ha. Sow the seeds in line at 20 cm apart in the last week of June or first week of July. Ragi seeder is used for line sowing of direct seeded crop.

Seed hardening improves germination, imparts early vigour, tolerance to drought and helps in maintenance of subsequent plant stand. It includes (i) soaking of seeds in water for 6 hours (use one litre of water for every one kg of seeds for soaking), (ii) drain the water and keep the seeds in wet cloth bag tightly tied for two days till the seeds show initial sign of germination, and (iii) remove the seeds from wet cloth bag and dry them in shade on a dry cloth for two days before sowing.

Treat the seeds with biofertilizers like *Azospirillum brasilense* (N fixing bacterium) and *Aspergillus awamori* (P solubilising fungus) @ 25 g/kg seed before sowing.

Nursery

Use a seed rate of 6 kg/ha. A nursery area of 600-800 sq m is required for one hectare main field. Application of well decomposed FYM or compost

(20-25 baskets) and small doses of fertilisers (4 g each of N and P₂O₅ per sq m of the nursery area) helps rapid growth of the seedlings. Sow the seeds evenly in the nursery early in the month of June and irrigate the nursery, if necessary. The seedlings will be ready within 25 days.

Transplanting

Apply manures and fertilizers after final land preparation. Early varieties should be transplanted at 15 cm x 10 cm apart and medium and late varieties at 20 cm x 10 cm apart. It is, economical to transplant seedlings in plough furrows drawn 20 cm apart. Two seedlings may be placed 10 cm apart in the furrow at each hill. The base of the seedlings will be covered by soil when the next furrow is opened. Shallow planting within 5 cm depth encourages quicker and better tillering.

Fertilizer

Apply fertilizers on soil test recommendation. Where soil test has not been done, the following fertilizer schedule should be adopted. For transplanted crop N is to be applied in two equal splits 50% as basal and the rest at first weeding and hoeing 20 days after transplanting. For direct sown crop N is to be applied in three splits i.e., 25% basal, 50% at 20 days after sowing and 25% at 35-40 days after sowing.

Sl. No.	Situation	Variety	Method of sowing	N-P ₂ O ₅ -K ₂ O (kg/ha)
1.	Rainfed	Early (<100 days)	Direct sown	40-30-20
			Transplanted	50-40-25
		Medium (>100 days)	Direct sown	50-40-25
			Transplanted	50-40-25
2.	Irrigated	Early/medium	Transplanted	60-40-30

Interculture

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

Water management

Ragi cannot withstand waterlogging. Drain the field in the rainy season, if necessary.

IMPACT POINTS

- i) Sow the crop in line.
- ii) Timely thinning and weeding.
- iii) Use of moderate dose of fertilizer.

MINOR MILLETS

These are warm weather small grain cereals and include suan/gulji or little millet (*Panicum sumatrense*), cheena or proso millet (*Panicum miliaceum*), bila suan or barnyard millet (*Echinochloa frumentacea*), kodo millet (*Paspalum scrobiculatum*) and kangu or foxtail millet (*Setaria italica*). These are short duration, hardy and drought tolerant crops and generally cultivated in marginal and sloppy lands during *Kharif* season.

Minor millet	Botanical name	Variety	Duration (days)	Average yield(q/ha)	Seed rate (kg/ha)	Fertilizer N:P ₂ O ₅ :K ₂ O (kg/ha)
Suan/gulji (little millet)	<i>Panicum sumatrense</i>	Tarini (OLM 203)	110	12.50	10-12	25:10:10
		Kolab (OLM 36)	80	12.00	10-12	25:10:10
		Sabara (OLM 20)	75	12.50	10-12	25:10:10
		TNAU 91	90	10.00	10-12	25:10:10
Cheena (Proso millet)	<i>Panicum miliaceum</i>	PEO 3 K 1 CO 4	70-75	6.00	10-12	25:10:10
Kodo millet	<i>Paspalum scrobiculatum</i>	Phulbani local, VL 129 VLV 184	80-85	9.00	8-10	25:10:10
Kangu (Foxtail millet)	<i>Setaria italica</i>	TNAU 196 SIA 2876	90-100	10.00	8-10	30:15:15

Field preparation and sowing

Field should be ploughed with pre-monsoon rains to get good tilth and to retain moisture. Apply FYM @ 2 t/ha. Sow the seeds with onset of monsoon in line across the slope at a spacing of 20 cm between the lines.

Fertilizers

Apply fertilizers on soil test recommendation. Where soil testing has not been done, apply 25 kg N, 10 kg each of P₂O₅ and K₂O/ha. Nitrogen is to be applied in two splits, i.e., 25% as basal and the remaining 75% top dressed at first hoeing and weeding 21 days after sowing. Seed treatment with bio-fertilizers like PSB and *Azospirillum sp.* benefits the crop.

Interculture

Early weeding is essential for getting good yields. The first hoeing and weeding should be done within 3 weeks of sowing and a second weeding may be done if needed. Weeds can be chemically controlled by isoproturon @ 0.5 kg/ha as pre-emergence application.

IMPACT POINTS

- i. Line sowing and timely weeding
- ii. Apply low dose of fertilizer

PULSES

Importance of pulses

Pulses are rich sources of protein and play a vital role in the vegetarian diet. These build up soil fertility and increase the production of the succeeding crop and can withstand moisture stress. Pulses have low growth habit and are shorter in duration. These can be grown as catch crops between two main crops, as pure crops in double crop patterns in the rainfed land, as mixed crops with tall growing crops like arhar, cotton, sugarcane and castor and as intercrops in young orchards and coconut plantation. Expansion of area and raising the productivity through adoption of sound package of practice are considered vital for increasing the total production of pulses.

Varieties

The major *Kharif* pulse crops grown in Orissa are greengram, blackgram, arhar, cowpea and rice bean. Select the appropriate variety for the season and cropping sequence.

Crop	Variety	Duration (days)		Remarks
		<i>Kharif</i>	<i>Pre-rabi</i>	
GREENGRAM	PDM-54	65	70	Resistant to YMV
	HUM 1	70	-	Resistant to YMV
	Dhauli (TT 9E)	65	70	Resistant to PM
	OUM 11-5	55	60	Resistant to YMV
	OBBG 52	65	70	Resistant to YMV, long pods
	Jyoti(Hyb 4-3)	-	65	Moderately resistant to YMV, PM, black seeded.
	Sujata(Hyb 12-4)	65	70	Suitable for all seasons
	K 851	70	-	Seeds shining green, bold
	ML-5	65	-	Resistant to leaf spot
	ML 131	65	-	Tolerant to YMV, resistant to leaf spot
	Pusa 9072	-	70	Resistant to PM
	TARM 1	-	60-65	Tolerant to PM, YMV
	TARM 2	-	60-65	Tolerant to PM, YMV
	Samrat (PDM 84-139)	65-70	65-75	Tolerant to YMV
MGG 347	65-70	-		
BLACKGRAM	Sarala (B 12-4)	75	85	Resistant to YMV and PM
	T 9	75	80	Susceptible to YMV
	Pant U 30	65-70	65-75	Resistant to YMV, PM, leaf spot
	Pant U 19	65-70	70-75	Resistant to YMV, leaf spot
	Pant U 35	65-70	65-75	Resistant to YMV, leaf spot
	KU 301	65-70	65-75	Resistant to YMV, leaf spot
	KU 300	65-70	65-70	Resistant to YMV, leaf spot
ARHAR	Mahak	120-130	-	Indeterminate
	UPAS 120	135	-	Indeterminate
	CO 5	110-115	-	Semispreading, resistant to sterility mosaic
	Jagruti(ICPL-151)	120-140	-	Determinate

Crop	Variety	Duration (days)		Remarks
		Kharif	Pre-rabi	
	ICPH 8 (Hyb)	120-130	-	Indeterminate
	Asha (ICPL-87119)	165	-	Indeterminate, resistant to wilt and sterility mosaic.
	Durga (ICPL-84031)	130	-	Determinate
	Laxmi (ICPL-85063)	175	-	Semi spreading
	Maruti(ICP 8863)	170	-	Semi spreading type
COWPEA	SEB 2	90	90	Vegetable type
	FS 68	65	70	Bushy
	Swarna(C 152)	115	80	
	SGL 1	70	-	Suitable for intercropping
RICE BEAN	RBL 6	90	75	Yellow green seeds, average seed yield 10.0 q/ha
	BRB 1	95	75	Light green seed, average seed yield 8.0 q/ha.

YMV = yellow vein mosaic, PM = powdery mildew

Field preparation

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

Seed treatment & Plant protection

Refer Annexure-III, IV & V.

Sowing

Early and dry sowing of pulse crops with pre-monsoon showers or before the onset of monsoon helps better establishment, growth and production. Line sowing facilitates interculture and early weeding. Early control of weeds prevents competition for nutrients and water. The following table provides specification for spacing and seed rate for different pulses. Use pulse seed drill for line sowing.

Crop	Spacing between lines (cm)	Spacing between plants (cm)	Seed rate (kg/ha)
Greengram	30	10	25
Blackgram	30	15	20
Arhar (Early var.)	45	20	20
Arhar (Late var.)	60	20	15
Arhar (Sept-sown)	30	15	30
Cowpea	45	15	20
Rice bean	30	10	25

Fertilizer

Apply 20 kg N, 40 kg P₂O₅ and 20 kg K₂O/ha at sowing except cowpea. For cowpea, a fertilizer dose of 25 kg of N, 50 kg of P₂O₅ and 25 kg of K₂O/ha should be applied. Basal application of 250 kg gypsum/ha is beneficial where SSP has not been used to meet the requirement of phosphorus.

Interculture

Weed is the major problem of the *Kharif* pulses. It is more acute in areas adjacent to hills and forests. Control of weeds within 15 to 20 days after sowing is necessary. Line sowing facilitates early weeding which should be popularized. Pre-emergence application of alachlor/ butachlor/ benthocarb/ pendimethalin/ metolachlor @ 1 kg/ha or oxadiazon @ 0.75 kg/ha with 500 litres of water the day following sowing followed by a hand weeding at 50 days after sowing (DAS) in arhar and 35 days after sowing for other pulses controls most of the weeds. Post-emergence spray of quizalofop ethyl 5 EC 10-30 days after sowing @ 2ml/litre controls the grasses effectively. For arhar, which stands in the field for much longer period, a second weeding 4 weeks after the first one is necessary. Rotary peg /wheel finger weeder should be used for weeding and interculture.

Harvesting

When improved varieties of mung and biri are sown with the onset of monsoon, harvesting coincides with the peak period of rain which damage the ripened pods. To counteract this problem, matured pods should be plucked and dried in bright weather. The additional cost of hand picking will be amply compensated by the total return from the crop. Arhar is harvested by cutting the matured fruiting branches.

IMPACT POINTS

- i. Line sowing and weeding within 2-3 weeks
- ii. Liming in acid soils
- iii. Adequate use of phosphatic fertilizer
- iv. Seed treatment with rhizobium culture and molybdenum

OILSEED CROPS

SOYBEAN

Introduction

Soybean crop gives us both protein (38-42%) and oil (17-22%) with high amount of essential amino acid, lysine (5%). It can be used to prepare meal maker, nutrinugget, soy meat, soy milk, cheese, sweets and baby foods. It improves the soil fertility by biological nitrogen fixation. Soybean is mainly grown as a *Kharif* crop. It can substitute mung, biri and upland paddy in the undulating areas.

Selection of land and field preparation

It grows in well drained light sandy soils to black soils where waterlogging is not a problem. It performs best in fertile, well drained loamy soils with pH 6.0 to 7.0. Prepare the land to a fine tilth by two ploughings and two cross ploughings after the early monsoon showers. Apply FYM or compost @ 5 t/ha during the final land preparation. In acid soils application of lime or paper mill sludge @ 2.5 t/ha is desirable every third year. This should be incorporated well into the soil one month ahead of sowing.

Seed treatment & Plant protection

Refer Annexure-III, IV & V.

Improved varieties and seed rate

Variety	Duration (days)	Seed colour	Remarks	Seed rate (kg/ha)
JS-72-44 (Gaurav)	110	Yellow	Determinate growth, 18-20% Oil	75
PK-73-163	110	Yellow	Determinate growth, 18-20% Oil	75
T-49	120	Yellow	Indeterminate growth, 18-20% Oil	65
Ankur	115-120	Yellow	Tall Yellow flat seed, 19-20% oil	75

Sowing

Sow the crop with pre-monsoon showers in early June. Delayed sowing results in poor plant establishment. At sowing time optimum moisture in the field is essential as soybean is very sensitive to moisture stress during germination. Sow the seeds in line at 30 cm x 10 cm spacing at a depth of 3 to 5 cm.

Fertilizer dose

Fertilizer should be applied on the basis of soil test report. In its absence, apply 40:30:30 kg N:P₂O₅:K₂O/ha. Entire quantity of fertilizer is applied

as basal in furrows of 5.0 to 7.5 cm depth and then covered with the soil. Treat the seeds with specific Rhizobium culture.

Interculture

First hoeing and weeding is done at the end of second week and the second one at the fifth week stage of the crop to check weed growth.

Harvesting

Harvest the crop when 90% of the pods turned brown and majority of the leaves dropped off. Grain shattering is a problem with soybean. Use shattering resistant/ tolerant varieties and harvest the crop at physiological maturity. Reduce the moisture content to 12% through drying before storing.

IMPACT POINTS

1. Early sowing and early weeding
2. Seed inoculation with rhizobium culture
3. Use of moderate dose of fertilizer
4. Pest management

GROUNDNUT

Varieties

Three distinct plant types in groundnut are (a) Erect, (b) Semi erect, and (c) Spreading. Erect types are shorter in duration and non-dormant, spreading types are longer in duration and have dormancy and semi-erect types come in between these two types. The erect and semi-erect types are suitable for all the seasons. The following varieties are recommended for cultivation in the State.

Variety	Habit	Duration (days)	Av. Yield (q/ha)	Shelling (%)	Oil content (%)	Special characters
AK 12-24	Bunchy	95	10.00	70	48	Resistant to leaf spot and rust, seeds having no dormancy
Kissan (OG 13-3)	Bunchy	100	10.00	71	50	15 days dormancy
Jawan (OG 71-3)	Bunchy	95	10.00	70	47	Resistant to tikka disease
Smruti (OG 52-1)	Bunchy	100	13.00	71	51	Kernel bold, red in colour, resistant to collar rot and stem rot, no dormancy
Phule Pragati (JL-24)	Bunchy	105	12.00	75	51	Resistant to drought, no dormancy
ICGS-44	Semi-spreading	105	13.00	70	49	Bold seeded, resistant to bud necrosis
TAG 24	Bunchy	100	15.00	70	51	Resistant to bud necrosis, leaf spot
Kadiri 3	Spreading	110	12.00	75	49	Resistant to bud necrosis
TG 3	Bunchy	100	12.00	70	49	Drought resistant
ICGS-11	Bunchy	105	13.00	70	49	Plants are dwarf with dark green leaves.

Field preparation

Plough the land to get a fine tilth. Fine tilth and loose soil allow easy root penetration and better pod formation. For good seedbed preparation, improved plough (Implement Factory MB, Bose or rocket plough) and power tiller with rotavator or tractor with cultivator should be used. Provide a gentle slope to remove excess water. Apply FYM or compost @ 5 t/ha before final land preparation. Adopt, ridge and furrow method to drain out the excess water in rainy season.

Decorticator

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 & Plant protection

Refer Annexure-III, IV & V.

Sowing

Sow the crop before onset of monsoon at a spacing of 30 cm x 10 cm for erect and semi erect varieties and 30 cm x 15 cm for spreading types. The seed rate per hectare is 125 kg kernels for erect and semi-erect type and 75 kg kernels for spreading types. Depth of sowing is 5 cm. Groundnut planter should be used for line sowing of seeds. Take up gap filling at 7-10 days of sowing. Treat the seeds with Rhizobium culture before sowing.

Fertilizer use

Lime application is essential to grow groundnut in acid soils. Apply lime @ 0.25 LK or 5 quintals per hectare alongwith FYM in furrows at the time of sowing for correction of soil acidity in light to medium textured acid soil. Lime application increases phosphate availability and supplies calcium, which is essential for pod filling and higher yield. Supplement organic manures with chemical fertilizers @ 20 kg N, 40 kg P₂O₅ and 40 kg K₂O/ha. Apply full dose of fertilizer in the furrow. Seed should not come in contact with fertilizer. Phosphorus should be applied in form of single super phosphate which also meets the sulphur requirement.

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. Besides 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 AS is used as it also supplies sulphur.

Interculture

First flowering comes 16-18 days after germination. Give first hoeing and weeding within 2-3 week stage. Earth up erect and semi-erect types, which will help pegging. Second weeding in spreading types may be given within one month, if

necessary. Rotary peg weeder/wheel finger weeder should be used. Pod formation starts after 35 days of germination in erect varieties. Do not disturb the soil after flowering commences. Destroy collar rot and bud necrosis affected plants, no sooner than are observed.

Pre-emergence application of pendimethalin/metolachlor @ 0.75 kg/ha or alachlor @ 1.0 kg/ha or pre-planting incorporation of fluchloralin @ 0.75 kg/ha controls weeds effectively. Post emergence spray of quizalofop ethyl 5 EC @ 0.05 kg or fluazifop-p-butyl 28 EC @ 0.25 kg/ha at 20 days after sowing takes care of later flush of weeds.

Harvesting

Harvest the crop when plants turn yellow and leaves start drying, original seed colour develops on the kernel and the pods develop blackish streaks inside the shell. If soil is moist harvest erect types immediately after maturity as otherwise the pods may germinate in the field. Dry the pods to reduce the moisture percentage to 9-10 before storing to avoid the aflatoxin formation. Bullock drawn groundnut digger should be used for harvesting the crop. Pedal operated or power operated Groundnut thresher should be used to remove the pods from the plants.

IMPACT POINTS

- i) Soil amendment to correct acidity
- ii) Seed treatment with bacterial culture and molybdenum
- iii) Use seed-drill/high seed rate for erect type
- iv) Maintain optimum plant population and timely control weeds.
- v) Apply gypsum in sulphur and calcium deficient soils when SSP is not applied
- vi) Use groundnut digger and thresher for economical harvest and post harvest operation.

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	70-75	53	Pale white	10.00	Capsules compactly arranged, escape shattering
Usha	80-85	49	Bright biscuit	12.00	Resistant to diseases and pests
Nirmala	75-80	50	White	10.00	Resistant to bacterial diseases
Prachi	80-85	48	Black	12.00	Resistant to major pest & diseases
Vinayak	85-90	48	Reddish	6.00	Glabrous, resistant to stem rot
Kanaka	80-85	47	Biscuit	8.00	Pods pubescent
Kalika	80-85	49	Brown	8.00	Resistant to leaf spot

Land preparation

Sesame is grown as a rainfed crop on high lands and as a pre-*rabi* crop after early rice/jute/pulses. Well drained soils are suitable for growing sesame. Prepare the land to fine tilth. Apply compost or FYM @ 5 t/ha at final land preparation.

Seed treatment & Plant protection

Refer Annexure-III, IV & V.

Sowing

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. 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 sown crop the plants come up uniformly. Sow the kharif crop with the onset of monsoon and pre rabi crop in September.

Fertiliser use

Sesame is an exhaustive crop and responds to fertilizers. Recommended fertilizer dose is 30-20-20 kg N-P₂O₅-K₂O/ha. Apply full P₂O₅ and K₂O and half of nitrogen as basal and the remaining nitrogen at first hoeing and weeding.

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.

Harvesting

Harvest the crop when the plants start yellowing and drying of capsules commence. Harvest the plants and stack them for a week to allow the seeds in the upper capsules to ripen. 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

CASTOR

Castor is an important drought tolerant crop which comes up well in rainfed uplands. It is a non-edible oilseed that has immense industrial and medicinal value. Castor oil is used for making detergents, plastics, printing ink, ointment, paints, adhesives and lubricants. Castor oilcake is used mainly as manure. It has anti-termite properties. The green leaves are fed to eri-silk worms. Apart from these, castor is grown as a shade crop in turmeric plantations, as a wind break/border plant in sugarcane and as a trap crop in tobacco. This is a high foreign exchange earner crop.

Varieties/Hybrids

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

Plough the soil immediately after the receipt of premonsoon showers for proper tith and good seed bed preparation. In shallow soils deep summer ploughing helps to break the hard soil pan and facilitates easy root penetration and good crop growth apart from controlling weeds, pests and diseases.

Seeding time

The most ideal time to sow *Kharif* castor is immediately after the receipt of at least two showers of monsoon rain. The optimum seeding time for rainfed castor is second fortnight of June.

Seed rate

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

Spacing

Variety - 90 cm x 45 cm
Hybrid -120 cm x 60 cm

Fertiliser application

For rainfed castor, apply 20 kg N and 40 kg each of P₂O₅ and K₂O/ha as basal followed by top dressing with an additional 20 kg N/ha each at 35-40 and

65-70 days after sowing. In sulphur deficient soils, apply sulphur @ 20 kg/ha through gypsum.

Weeding & interculture

Castor is very sensitive to weeds. In rainfed areas 2-3 intercultures with the help of bullock drawn blade harrow starting from 25-30 days after sowing combined with one manual intra row weeding after first interculture effectively checks weed growth. Hoeing and earthing up operation is taken up after weeding.

Plant protection

Refer Annexure-III, IV & V.

Harvesting and threshing

Castor is an indeterminate plant with perenniating 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 turn 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. Timely sowing
2. Timely weed control
3. Control of capsule borer
4. Timely picking

NIGER

It is a highly drought tolerant crop with no nagging disease pest problems. It has the ability to suppress weeds to a fair extent. A copious leaf fall helps in soil recuperation. It is also not grazed by the cattle. It is because of these factors that marginal and sub-marginal farmers who are unable to invest in cash inputs, favour this crop.

Varieties

Sl. No	Name of the variety	Duration (days)	Remarks
1.	GA-10 (Deomali)	110-120	Purple stem, longer yellow ray florets, black shiny seeds
2.	IGP-76 (Sahayadri)	100-105	Greenish purple stem, smaller yellow ray florets, black seeds

Land preparation

Prepare the land to a fine tilth for sowing niger. The field should be completely free of weeds. The land where niger is to be sown should be perfectly well drained.

Sowing

Niger can be sown in July as a border crop around upland *Kharif* crops as cattle do not relish this crop. The main crop is sown from middle of August to early September. Sow the crop in lines 25-30 cm apart with a seed rate of 10 kg/ha.

Fertilizer

Apply FYM @ 5t/ha and a fertilizer dose of 40-20-20 kg N-P₂O₅-K₂O/ha . Apply full P₂O₅ and K₂O and half nitrogen as basal and rest half nitrogen three weeks after sowing.

Interculture

Early control of weeds is essential for higher yield. Take up interculture of crop within 3 weeks of sowing. A second weeding may be taken up wherever necessary.

Parasite control

Cuscuta parasite is a major problem in Koraput district and also to some extent in Keonjhar and Mayurbhanj. Use of clean seed and crop rotation will reduce the cuscuta parasite. Avoid growing niger in the same plot every year. Pre-plant incorporation of trifluralin @ 2.5 kg/ha or pre-emergence application of pendimethalin @ 1.5 kg/ha will control the parasite.

Harvesting

Harvest the crop when the leaves and flower petals dry up and heads turn blackish. Keep the harvested bundles in stacks for 5-7 days to enable the seeds to reach full maturity. Thereafter dry the bundles and beat the heads with a stick to separate out the seeds.

IMPACT POINTS

- i) Collect seeds from cuscuta free fields
- ii) Use 100 mesh sieve to separate cuscuta seeds from niger
- iii) Line sowing at 25-30 cm apart and early weed control
- iv) Moderate dose of fertilizer

FIBRE CROPS

JUTE

Varieties

Following *Capsularis* and *Olitorius* varieties are recommended for Orissa. The characteristics of the varieties are given below.

Type	Variety	Remarks
<i>Olitorius</i>	JRO-524 (Naveen)	Plant green, suitable for early sowing in March, flowers in 120-130 days, yield 30-40 q/ha.
	KOM 62 (Rebati)	Mutant of JRO 878, suitable for medium & upland, recommended for sowing in the 1 st week of April. The plants are green at early stage and slowly turn purple at later stage of growth. Matures in 130 days attaining plant height of 3.0 to 4.0 m, yields 30-42 q/ha with better quality fibres.
	S 9 (Subala)	Stem is red, non-branching, pod elongated, non-shattering, matures in 125-135 days, yield 35-40 q/ha.
	JRO 8432 (Shakti tossa)	Stem is deep green, non-branching with rudimentary axillary buds on leaf axils, pod elongated, non-shattering, seed steel grey in colour, suitable for sowing from mid March to end of April in medium land, yield 35-40 q/ha.
	TJ 40 (Mahadev)	Plants are 3.5 m tall with 1.5 cm basal diameter, moderately resistant to stem rot, root rot, less occurrence of green hoppers, stem weevil and semilooper. Potential yield 40.0 q/ha and average yield 28.0 q/ha.
<i>Capsularis</i>	JRC 212 (Sabuja sona)	Entire plant is green, medium duration, takes 140 days to flower, suitable for medium land, yield 25-30 q/ha.
	KC 1 (Jayadev)	Mutant of JRC 4444 having faster vegetative growth at early stage to suppress weed growth, green plant with average height of 3.1 m and 2.0-2.2 cm basal diameter, matures in 125 days, yields 30-38 q/ha with better quality fibres.
	JRC 4444 (Baladev)	The plant grows to a height of 3.3 m with 2-3 cm basal diameter and takes 135 days. It is less susceptible to diseases and insect pests compared to JRC 212, moderately susceptible to semilooper and stem weevil, yield potential 33.0 q/ha and average fibre yield 24.0 q/ha.

Field preparation

Well drained loamy and alluvial soils are most suitable for jute. Prepare the land to a fine tilth. Fine tilth helps easier operation of seed drill and early establishment of the crop. Apply well decomposed compost or FYM @ 5 t /ha before sowing.

Seed treatment & Plant protection

Refer Annexure-III, IV & V.

Sowing

Sow the crop in time to get good yield. Early April sowing gives the best results. For *Capsularis*, use 6 kg seed/ha for line sowing and 8 kg/ha for broadcasting. For *Olitorius* 5 kg/ha is required for line sowing and 7 kg/ha for broadcasting.

Sow the seeds in lines 30 cm apart for *Capsularis* and 25 cm for *Olitorius*. Line sowing has many advantages. These are (i) less seed is required, (ii) thinning and interculture become easier at less cost, (iii) uniform stand and plant population can be maintained. These contribute to high yields. Sow the seeds at 3 cm depth. Deep sowing affects germination as the seed is very small and delicate. Adequate moisture is necessary for quick germination. Maintain 5 lakh population in both the varieties. Use seed-cum-fertiliser drill.

Interculture

Early and timely interculture is necessary. First weeding, hoeing and partial thinning should be done within 21 days of germination. Repeat the operation fifteen days later and do the final thinning to maintain a spacing of 5-7 cm between plants in the line. In broadcast crop a rake is to be drawn 15-20 days after sowing to thin out the plants and loosen the soil slightly. This is to be followed by weeding and thinning to maintain a spacing of 8-10 cm between plants. Early interculture and partial thinning has many advantages as weeds are destroyed early and they do not compete with the crop for nutrient and water, helps early root growth and development, prevents evaporation losses from the soil and partial thinning helps in better growth of the crop.

Fluchloralin (basalin) 45 EC @ 1.0 kg/ha or Trifluralin 45 EC @ 0.5 Kg/ ha. mixed thoroughly with soil by laddering one day before sowing controls the weeds under irrigated condition. Post emergence spray of quizalofop-ethyl 5 EC @ 0.05 kg/ha at 15-20 days after sowing effectively controls the grasses.

Fertilizer

Apply fertilizers as per soil test recommendation. If the soil has not been tested, apply 60 kg N, 30 kg P₂O₅ and 30 kg K₂O for capuslaris and 40 kg N, 20 kg P₂O₅ and 20 kg K₂O for olitorius per hectare to get good yields. Phosphorus and potash are to be applied as basal before sowing, besides FYM @ 5 t/ha. Apply 50% N between 20-25 days after sowing at the time of hoeing, weeding and thinning and the rest 50% after two weeks. Apply urea (2%) as foliar spray twice at 50 and 60 days of sowing if second top dressing is not feasible.

Harvesting

Right stage for harvest is flowering stage (120 -125 days). Bundle the thick and thin plants separately for uniform retting. Leave the bundles in the field for 2 to 3 days to allow the leaves to shed in the field and then ret. The colour of the fibre is darkened if the leaves are allowed to stick to the plants during the process of retting. Steeping of plants before retting also facilitates separation of the fibre.

Retting

Add two or three sunhemp or dhanicha plants to each bundle before retting. The bark of these plants is soft and are quickly decomposed. Thus microbial action would be initiated quickly by adding these plants to each bundle. Gentle flowing clear water is good for retting. Keep the bundles in vertical position in 2 to 3 feet water for three days. This will help the thick bottom portion to ret uniformly alongwith top portions. Submerge the bundles in horizontal position. Press the jacks below 30 cm from water surface and keep them 30 cm above the bottom of the retting tank. Use covering materials like water hyacinth, dry wooden logs or stone slabs to press down

the bundles. The bundles should be arranged in not more than three layers otherwise it will result in un-uniform retting. Do not use materials like mud and banana stems to cover and press the jacks as these will impart black colour to the fibre and affect the quality.

Extraction

Extract the fibre when it comes out easily. Over retting leads to weak fibre. Single plant extraction gives good quality fibre. Wash the fibre thoroughly in clean water to remove dirt and other foreign matters like jute leaves etc. Beating the stalk against wooden pole or wooden mallet is avoided as it spoils the fibre quality. The fibre loses strength and gets tangled. Squeeze (wring) out water from the bundles and dry on bamboo racks under partial shade for 4 to 5 days. If the fibres are dried in bright sun, they become brittle. Grade the fibre and bundle separately for sale. Grading helps in fetching better price.

IMPACT POINTS

- i) Line sowing
- ii) Early interculture, weed control and thinning.
- iii) Fertilizer application in moderate dose
- iv) Apply nitrogen in two splits at 3 and 6 weeks
- v) Foliar spray with urea
- vi) Retting in running water and grading

MESTA

Varieties

Three varieties of mesta have been tested and recommended for growing in Orissa. The features of these varieties are given below.

Type	Variety	Remarks
<i>Cannabinus</i> type	H C 583 AMC 108	Smooth stem, early maturing (130 days), have glands at the leaf base
<i>Sabdariffa</i> type	AMV -1 AMV-2 AMV-3 AMV-4 H S 4288	Bristles on the stem (hairy), late maturing (160 days), no glands at leaf base
	Madhury (GR 27)	Green stems with red patch only on the nodes, other characters resemblance with HS 4288

Field preparation

Well drained conditions particularly in the early stages are necessary. Mesta comes up on all types of soils except stiff clays. Plough the land to get good tilth. Good tilth helps quick establishment of crop, better stand and growth. Apply organic manure @ 5t/ha before sowing.

Sowing

Pre paddy mesta crop is sown in March-April in low lands with supplemental irrigation. The main crop is sown in May-June. Sow the crop early. Early sowing helps in quick establishment of crop and facilitates vigorous growth with good pre-monsoon showers or monsoon rain. Adequate moisture is necessary at sowing to facilitate germination of seeds. Use a seed rate of 15 kg/ha for broadcast crop and 12 kg/ha for line sown crop to get the recommended plant population.

Sow the crop in lines 30 cm apart and maintain a distance of 8 or 10 cm between plants. Line sowing ensures uniform growth, easy interculture, efficient weed control, requires less seed and yields higher.

Interculture

As in jute, the first weeding, hoeing and thinning should be done when the crop is 15-20 cm (21-30 days age). Repeat the operation a fortnight later (35-45 days age). Early hoeing, weeding and thinning within 4 weeks is essential for good growth.

The advantages are

- a. weeds, which compete for nutrient and water are destroyed early,
- b. top soil is loosened which reduces evaporation losses in water stress condition,
- c. plant population is not affected, and
- d. root growth is hastened.

Fertilizers

Apply fertilizers on soil test recommendation. Alternatively, apply 20 kg N and 20 kg each of P_2O_5 and K_2O /ha as basal dose before sowing. Top dress an additional dose of 20 kg N/ha at 21-30 days stage just before hoeing and weeding. Application of chemical fertilizers, in addition to organic manures @ 5 t/ha greatly increases yields.

The crop responds immediately to foliar spray of 2% urea solution @ 20-25 kg N/ha twice between 45-60 days of the crop at 10 days interval. During drought spell, foliar spray with 2% urea solution can revive the crop. During rainy season when soil application of nitrogen is not possible, urea spray can be done if 3-4 hours of clear weather is available.

Harvesting

Harvest at 50% flowering stage. In cannabinus type it will take 140 days to reach this stage. In sabdariffa type, the stage is reached at about 150 days. The plants are harvested by uprooting, when there is adequate moisture in the soil. Leave the plants in the field for 3 days. During this period the leaves shed and then stems are bundled. Thick and thin plants are bundled separately and put under water for uniform retting.

Retting

As in jute, keep the bundles in 2-3 feet of water in an upright position for 3 days. Thereafter, steep the bundles completely under water arranging them in jacks and put load to the jacks with stone slabs or dried wooden logs. The jacks should be

about 30 cm below water surface and 30 cm above ground level. Contact with soil affects quality of fibre. Gentle flowing clear water improves fibre quality. Do not use banana stems and mud as covering material as the fibre quality will be affected.

Extraction

Retting is complete when the fibre tissues come off the stem as a continuous ribbon with least effort. Depending on the water temperature, it may take 15 to 30 days. After extraction, wash the fibre in clean water and dry for 4-5 days in mild sun over bamboo racks. Bundle the fibre grade wise before sending to market for sale.

IMPACT POINTS

- i) Sow in line
- ii) Timely interculture, weeding and thinning.
- iii) Urea spray at 45 days stage to increase yield

COTTON

Varieties

Cotton is grown as a sole or intercrop in rainfed high lands during *Kharif* season. The recommended varieties and hybrids with their characteristics are given below.

Sl. No.	Variety	Duration (days)	Seed cotton yield (q/ha)	Fibre length (mm)	Fibre fineness (mic)	Fibre strength (g/tex)
1.	MCU 5	175-180	14.00	36.4	4.5	25.0
2.	Bunny	160-165	19.00	32.4	4.1	23.5
3.	Savitha	165-170	17.00	30.5	4.1	23.1

Other promising hybrids are Sri Tulasi (TCHH 4), Bhaskar (TCHH 9) and Atal.

Field selection and land preparation

Both light and heavy soils are suitable for growing cotton. But moisture in the soil at boll bursting is essential. Therefore, in the drought prone areas grow cotton in heavy soils. Cotton requires well drained soil. Waterlogging at early stages damage the young plant. Therefore, select only well drained lands for growing the crop. Prepare a clean and friable seed bed.

Seed treatment & Plant protection

Refer Annexure-III, IV & V.

Sowing

Early sowing is conducive to get good yield. Complete sowing latest by end of June and if necessary resort to dry sowing. Use a seed rate of 3.75 kg/ha for improved varieties and 2.0 kg/ha for hybrids. Sow 2 seeds per pit at a depth of 4-5

cm and thin the weaker one later to maintain optimum plant population. Cotton can accommodate intercrops like very short duration varieties of blackgram and greengram.

Plant population

Sow the crop in lines. The recommended spacing is as follows

MCU-5 : 90 cm x 60 cm

Bunny/Savitha/JK Hyb.1 : 90 cm x 90 cm

The skip row or paired row technique is advantageous over the single row method of sowing. The skip row method has the following advantages

- i) Water economy
- ii) Intercultural operations are easier
- iii) Spraying operation becomes easier
- iv) Plants get exposed to adequate sunlight which encourages sympodial (fruiting) branching and development of bigger bolls.

Thinning and weeding

Thin cotton field at 10-12 days after germination. Gap filling is done with planting of seedlings raised in leaf bag. It is also advantageous to do the first hoeing and thinning at this stage. Second and third hoeing, weeding and earthing should be done at 3 and 6 weeks stage, respectively. Clean cultivation in the early stages not only helps initial growth and development of crop but also eliminates weeds which harbour insects.

Pre-emergence application of pendimethalin/alachlor @ 1.0 kg/ha or oxyfluorfen @ 0.025 kg/ha or pre-planting incorporation of fluchloralin 1.0 kg/ha in 500 litre of water effectively controls most of the weeds. In severely weed infested fields post-emergence directed spray of paraquat @ 0.4 kg/ ha or glyphosate @ 1.0 kg/ha can be done.

Topping

The apical portion of the plant is removed when the plant will attain the height of 1m to induce the formation of more reproductive branches.

Fertiliser use

Fertiliser application should be made on the basis of soil test recommendation. Otherwise, apply 80, 40 and 40 kg of N, P₂O₅ and K₂O/ha for the varieties and 120-60-60 kg N-P₂O₅-K₂O/ha for hybrids with 5 t FYM/ha. Full P & K should be applied at sowing. Apply nitrogen in 3 to 4 splits. In soils of high fertility, basal application of nitrogen is not necessary. In such soils 25% of nitrogen may be applied at 3 weeks stage, 50% at 45 days stage and the rest by 2 to 3 urea sprays, commencing from 55 to 60 days at 10 days interval. In poor soils 25% of the nitrogen may be applied at sowing and the rest in 3 equal splits at stages indicated above. Top dressing just before hoeing and earthing helps in incorporating the fertilizer into the soil and improves efficiency. Spray Cycocel or Planofix or Celmone 10 ppm at 45 days and 20 ppm 15 days later to prevent boll shedding. Spraying of 1.5% DAP at 75 and 90 DAS & 0.75% DAP+ 0.75% M.O.P at 105 DAS help in better retention.

Harvesting

Fifty percent bursting of bolls start from 115 to 130 days and 4 to 5 pickings are taken within 50 days. Picking should be done only when the bolls are fully burst open and in the cool hours of the morning. The mixture of dry leaves should be avoided to maintain quality.

Yield

Under rainfed condition with good management it gives a seed cotton yield of 20-25 q/ha.

Growth habit of the plants

The basic vegetative phase is about 45 to 50 days when square formation commences. The flowering starts at 55 to 65 days and boll formation and development takes 50 days. The bolls formed during the first 3 weeks contribute to about 80% of the total yield. The management practices of cotton indicated above and plant protection measures are timed to encourage development of bolls during the first 3 weeks of boll formation and protection of these bolls from insect damage. The plants should be topped when they are 90 days old or when plant attains a height of 100 cm to check further growth in height and divert food materials to branches and to destroy the *Heliothis* egg.

IMPACT POINTS

- i) Seed treatment with imidacloprid
- ii) Early sowing in June
- iii) Early thinning and weeding and first earthing at 20 days
- iv) Use of herbicides
- v) Appropriate pest management
- vi) Topping at 90 days of germination or when plants attain a height of 100 cm.

OTHER IMPORTANT CROPS

SUGARCANE

Varieties

A number of improved varieties of cane 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 claspings	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 (100t/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 (103t/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 (90t/ha), high sugar, suitable for irrigated uplands
4	CoC 85036	Light green	Medium thick	Moderate	S	-do-	High yield (110t/ha) with

Sl. No.	Variety	Colour (exposed cane)	Stem girth	Leaf clasping	Reaction to red rot	Identifying character	Special agronomic character
							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 (95t/ha) and high sugar, resistant to all the 3 tropical races of red rot.
7	Co 90017	Green	Thick cane	Moderate	MR	Ivory marks present, medium waxiness with hard spines on sheath.	Moderately high yield (90t/ha), high sucrose, suitable for irrigated ecosystem
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 (92t/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 (99t/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 (104t/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	High yield (107t/ha) and high sucrose, suitable for

Sl. No.	Variety	Colour (exposed cane)	Stem girth	Leaf clasping	Reaction to red rot	Identifying character	Special agronomic character
						present	irrigated ecosystem and rice land.
4.	Co 62175	Yellowish green, turns dark on exposure	Very thick	Loose	S	Sheath spine absent	High yield (105t/ha) with good sucrose, suitable for late crushing, good jaggery type, good ratooner
5.	Co 86032 (Nayana)	Reddish pink	Medium thick	Loose	MS	Prominent ivory marks, waxiness medium, spines few and hard deciduous	High yield (100t/ha) and high sucrose. Not suitable for water logging situations +
6.	Co 740	Green	Medium to thick	Very loose	MR	Sparse spines on leaf sheath	Profuse tillering, high yield (100t/ha), good ratooner, resistant to drought, prone to lodging
7.	Co 8021	Purplish green, turns darkgreen/purple in exposure	Medium thick	Loose	MR	Root zone maize yellow colour, growth ring light green	High yield (100t/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 90 cm apart from centre of one trench to the other. Drainage should be provided wherever necessary. For early maturing varieties spacing between trenches may be reduced to 75 cm. Reduce spacing to 60-75 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) : 8-10 t/ha
 - Medium/mid-late varieties (40-45 thousand 3 budded setts) : 8 t/ha
- Ensure planting of 12 buds per metre row length.

Sett cutting

A mechanical sugarcane sett cutter should be used for economical sett cutting and to obtain more viable setts. Care should be taken while detrashing canes before sett cutting to prevent damage to eye buds.

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 1/3rd of cane if seeds 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 chlorpyrifos (Do not add chlorpyrifos if soil drenching is adopted) and 1 kg urea. If possible pass the setts through Aerated steam treatment (AST) at 50°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 @ 10 t/ha along with 250 kg of N, 100 kg of P₂O₅ and 60 kg K₂O/ha.

Apply full P₂O₅ and 50% K₂O at the time of planting in trenches. Top dress nitrogen in three equal splits at 45, 75 and 105 days after planting. Apply the rest amount of K₂O at the time of the third top dressing of N. Do not top dress N after 120 days after planting as late application delayed maturity, reduces sucrose content and the total cane yield. Delay the N top dressing in February planted crop if irrigation is not available. Apply 10 kg each of Azospirillum and PSB mixed with 1.0 t of FYM in two equal split doses at 30 and 60 DAP at the base of the clumps after irrigation.

Intercultural operation

Use pre-emergence herbicides Atrazine 50 WP or Ametryn 80 WP @ 2.0 kg a.i./ha or Metribuzin 70 WP 1.0 kg a.i./ha within 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, 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.

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. They 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.

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.

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.

Monsoon planting of sugarcane

Upland rice may be substituted by monsoon sugarcane crop for production of quality planting materials. June planted sugarcane crop may be harvested in January-February (7-8 months crop) and the whole canes can be utilized for seed in the commercial planting. Package of practices are similar to that of the commercial crop usually planted in January-February.

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 short borer
- Removal of late tillers and water shoots.
- Trash mulching

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.

1. Harvesting of canes at ground level or below it to avoid upper buds to sprout.
2. 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.
3. Necessary gap filling where there is a gap of more than 45 cm within the row with poly bag settlings or sprouted single budded setts of equal age as that of ratoon.
4. Trash mulching to help quick germination of buds, conservation of soil moisture, suppression of weeds and reduction of incidence of early shoot borer.
5. Hoeing of the land for suppression of weeds and better aeration.
6. Use of recommended manures and fertilizer. Ratoon crop requires 25% more nitrogenous fertilizer than plant crop. Apply 312 kg of N, 100 kg of P₂O₅ and 60 kg of K₂O/ha as per schedule in the plant crop.
7. Irrigate immediately after fertilization and subsequently at an interval of 10-15 days depending on the type of soil
8. Detrash the leaves as required.
9. Wrapping and propping operations to keep the canes erect.
10. Harvesting of canes on the basis of hand refractometer reading (more than 18).

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 of Phulbani, Bolangir and Sambalpur districts. 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 *Andropogon 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 *Leococaphala glauca* are grown to provide natural shade by their top canopy of foliage. 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 seacoast 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 'Kapoori', 'Meetha', 'Sanchi', and 'Alupatria'. This variety exclusively grown in the interior districts is named as 'Kala Mahata' and 'Dhoba 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 m to 1.5 m to provide sufficient shade to the seedvine. Before planting, ridge, (Mandi) of 15 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 15cm-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 instead of 100 kg P₂O₅ may also 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 earth 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 disinfections with commercial bleaching powder.

Plant protection

See Annexure III, IV and V.

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 tied on the supporting 'Agasti' plants. On an average condition 48 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

BRINJAL

Varieties	:	Utkal Madhuri,Utkal Tarini,Utkal Keshari, Utkal Jyoti, Utkal Anushree, Pusa Kranti, Muktakeshi
Soil	:	Well drained sandy loam
Seed treatment	:	Treat the seeds with Thiram @ 3g/kg or Carbendazim @ 1.5 g/kg of seed.
Time of planting	:	Nursery : First week of June Planting: End of June and first week of July
Seed rate	:	500 g/ha
Spacing	:	60 cm x 45 cm
Manure and fertilizer	:	20 tonnes FYM/ ha 125 :75:125 kg N: P ₂ O ₅ : K ₂ O/ha
Basal	:	Full P ₂ O ₅ + 20% each of N and K ₂ O
First top dressing	:	40% each of N and K ₂ O at 3 weeks after planting
Second top dressing	:	40% each of N and K ₂ O at 5-6 weeks after planting
Interculture	:	Hoeing, weeding and earthing up twice
Use of growth substances	:	Apply 2,4-D (2 ppm) at flowering to increase parthenocarpy, fruit-set and total fruit yield.
Plant Protection	:	<i>Annexure-III, IV and V</i>
Average Yield	:	30 tonnes/ha

CHILLI

Varieties	:	Utkal Rashmi, Utkal Ava, Utkal Ragini, NP 46A, Pusa Jwala, Pant C 1, Pusa Sadabahar. <u>Hybrid</u> : Sungrow, Tejaswini
Soil	:	Well drained loam soil
Seed rate	:	750 g/ha
Seed treatment	:	Treat the seeds with Thiram 3 g/kg of seed
Time of planting	:	Nursery : First week of June Planting: End of June and second week of July
Spacing	:	50 cm X 30 cm
Manuring	:	FYM 20 t/ha 125:50:100 kg N:P ₂ O ₅ :K ₂ O/ha
Basal	:	Full P ₂ O ₅ + 20% each of N and K ₂ O
First top dressing	:	40% each of N and K ₂ O at 2-3 weeks after planting
Second top dressing	:	40% each of N and K ₂ O at 4-5 weeks after planting
Interculture	:	Hoeing, weeding and earthing up twice
Plant bio-regulators	:	Spray Planofix @ 10 ppm at flowering and three weeks later to increase yield.
Plant Protection	:	<i>Annexure-III, IV and V</i>
Average Yield	:	10-12 tonne/ha (green chilli) 1.5-2.0 tonne/ha (dry chilli)

TOMATO (kharif)

Varieties	:	Utkal Pallavi, Utkal Deepti, Utkal Kumari, Utkal Urbashi, Shakti, Utkal Shravani, Punjab Chhuara, <u>Hybrid</u> : Rajni, Jyoti and Rahul, Surakha, Avinash, Pusa Hyb-1, Arjun, Payal, Rashmi.
Soil	:	Well drained high land
Adaptation	:	Hilly areas of Koraput, Phulbani and Keonjhar districts
Land preparation	:	Plough the land three to four times
Time of sowing	:	2 nd week of May to 1 st week of June
Planting	:	Transplant 21 days old seedlings.
Seed rate	:	500 g/ha
Seed treatment	:	Treat the seeds with Thiram 3 g or Captan 3 g or Mancozeb 2.5 g/kg of seeds
Spacing	:	60 x 45 cm
Method of planting	:	Planting on ridges of 30 cm width
Manure	:	FYM @ 20 t/ha
Fertilizer	:	120:50:100 kg N: P ₂ O ₅ :K ₂ O/ha
Basal	:	Full P ₂ O ₅ + 20% each of N and K ₂ O Apply Borax @ 15 kg/ha in alternate years at final land preparation.
First top dressing	:	40% each of N and K ₂ O at 3 weeks after planting
Second top dressing	:	40% each of N and K ₂ O at 5 weeks after planting
Interculture	:	Two hoeing, weeding, topdressing and earthing up
Plant Protection	:	<i>Annexure-III, IV and V</i>
Harvesting	:	Harvest the fruits at the turning stage for better storage and marketing.
Average Yield	:	20 tonnes/ha

ONION (kharif)

Varieties	:	<u>Bulb onion</u> : N 53, Arka Kalyan, Agrifound dark red, Arka Pragati, Agrifound light red. <u>Multiplier onion</u> : CO 1, CO 2, good genotype of locally available.
Soil	:	Well drained sandy loam soil rich in humus pH 5.8 to 6.5
Adaptation	:	Hilly areas of Koraput, Phulbani and Keonjhar districts
Propagation	:	The common method of propagation is by seeds. However, the multiplier onion is propagated by bulblets (Sets)
Seed rate	:	8-10 kg seeds/ha (bulb onion) 1.0-1.2 t/ha (multiplier onion)
Seed treatment	:	Thiram 2-3 g/kg of seeds
Nursery	:	Raise seedlings in 3 m x 1.5 m nursery bed and incorporate 200 kg well decomposed FYM. Nursery of 0.05 ha is needed for raising seedling for 1 ha of land.
Sowing time	:	Kharif : May-June

		Late Kharif : August-September
		Sow the seeds in raised nursery bed in line spaced at 5-7 cm distance. Seedlings of 6-7 weeks old are suitable for planting. Best time of transplanting of kharif onion is July-August
Spacing	:	15 cm x 10 cm (Bulb onion) 20 cm x 10 cm (Multiplier onion)
Manuring	:	20 tonnes FYM/ha 125:60:90 kg N:P ₂ O ₅ :K ₂ O/ha Full quantity of P ₂ O ₅ , K ₂ O and half N should be applied as basal and other half N in two equal splits at 30 and 45 DAT
Interculture	:	Pre-emergence application of Pendimethalin @ 3.35 litre/ha to manage the weeds during rainy season.
Plant protection	:	<i>Annexure-III and IV</i>
Average Yield	:	10-12 tonne/ha (Bulb onion) 10-12 tonne/ha (multiplier onion)

RADISH

Varieties	:	Pusa Chetki, Pusa Rasmi, Pusa Deshi, Japanese white
Soil	:	Sandy loam
Adaptation	:	Inland districts
Seed rate	:	10 kg/ha
Seed treatment	:	Treat the seeds with Thiram @ 3 g/kg seeds
Sowing time	:	Onset of monsoon
Spacing	:	30 cm x 10 cm
Manuring and fertilizer	:	FYM @ 10 t/ha 60-50-100 kg N-P ₂ O ₅ -K ₂ O/ha Apply full P ₂ O ₅ , K ₂ O and 50% N + borax 15 kg/ha (wherever needed) as basal. Top dressed rest 50% N after two weeks after sowing. Spray 0.1% Boron if brown heart symptoms appear.
Interculture	:	Thining 7-10 days after sowing, hoeing and weeding twice.
Average Yield	:	18-20 tonne/ha

RUNNER BEAN

Varieties	:	Black and brown seeded type (local)
Soil	:	Well drained sandy loam
Adaptation	:	Hilly areas of Koraput, Keonjhar and Phulbani district
Seed rate	:	15-20 kg/ha
Seed treatment	:	Thiram 3 g/kg seed
Sowing time	:	Before onset of monsoon (Mid June)

Spacing	:	1.0 m x 0.3 m
Manuring	:	FYM @ 25 t/ha, 50-75-75 kg N-P ₂ O ₅ -K ₂ O/ha
Basal	:	Full P ₂ O ₅ + 20% each of N and K ₂ O
First top dressing	:	40% each of N and K ₂ O at 2-3 weeks after planting
Second top dressing	:	40% each of N and K ₂ O at 4-5 weeks after planting
Interculture	:	Two hoeing, weeding, topdressing and earthing up, provide staking when plants start vining.
Plant protection	:	<i>Annexure-IV</i>
Average Yield	:	10-12 tonne/ha (green pod), 4-5 pickings

YAM

Varieties	:	Sree Keerthi, Sree Roopa, Sree Shilpa, Sree Latha, Sree Subhra, Sree Priya
Spacing	:	90 cm X 90 cm
Seed rate	:	12.5 q/ha
Tuber treatment	:	Treat the tuber with 0.05% Monocrotophos for 10 minutes to control scale insects
Manure	:	FYM @ 10 tonnes/ha
Fertilizer	:	80:60:60 kg N:P ₂ O ₅ :K ₂ O/ha Apply full dose of P ₂ O ₅ and K ₂ O and 50% N at planting and rest 50% N after 7-8 weeks after planting
Planting	:	Plant the sprouted tubers in the mounds below 5 cm depth
Interculture	:	Give staking to crop immediately after planting. Two weedings and earthing up after 45 and 90 days after planting.
Plant Protection	:	<i>Annexure-III and IV</i>
Harvesting	:	8-9 months after planting.
Average Yield	:	25-30 tonne/ha

COWPEA

Variety	:	Pusa Barsati, Pusa Do-fasali, Pusa Komal, Arka Garima, Utkal Manik
Seed treatment	:	Treat the seeds with Thiram or Captan @ 3 g/kg of seeds or Carbendazim 1.5 g/kg of seeds.
Seed rate	:	25 kg/ha
Sowing time	:	June-July
Spacing	:	45 cm x 15 cm
Manure	:	15 tonnes FYM/ha
Fertilizer	:	25:50:25 kg N:P ₂ O ₅ :K ₂ O/ha
Basal	:	Full P ₂ O ₅ + 20% of N + 50% K ₂ O
First top dressing	:	40% of N at 15 days after sowing

Second top dressing	:	40% of N + 50% K ₂ O 30 days after sowing
Plant protection	:	<i>Annexure-III, IV and V</i>
Harvesting	:	55 days after sowing
Average Yield	:	11 tonne/ha (green pod)

BHINDI

Variety	:	Arka Anamika, Utkal Gourav, Parvani Kranti
Seed rate	:	8-10 kg/ha
Seed treatment	:	Treat the seeds with Thiram @ 3g/kg of seeds
Spacing	:	50 cm x 30 cm
Manure	:	FYM @ 20 t/ha
Fertilizer	:	80:40:40 kg N:P ₂ O ₅ :K ₂ O/ha
Basal	:	Full P ₂ O ₅ + 20% each of N and 50% K ₂ O
First top dressing	:	40% each of N and K ₂ O at 15 days after sowing
Second top dressing	:	40% each of N and K ₂ O at 30 days after sowing
Interculture	:	Hoeing, weeding and earthing up twice
Weeding	:	Pre-planting, soil incorporation of Fluchloralin (48 EC) @ 1.5 kg a.i./ha or Alachlor (50 EC) @ 2.0 kg/ha as pre-emergence application gives initial control of weeds.
Interculture	:	Hoeing, weeding and top dressing twice
Plant Protection	:	<i>Annexure-III, IV and V</i>
Average Yield	:	12.5 tonnes green fruit /ha

SWEET POTATO

Variety	:	Sree Vardhini, Sree Bhadra, Gouri, Sree Nandini, Kalmegh, Sankar, CO 1, CO 2
Seed rate	:	80,000 vine cuttings of 25 cm long having 3-4 nodes /ha
Seed treatment	:	Treat the vine cuttings for 10 minutes in Fenitrothion 0.05% before planting.
Spacing	:	60 cm x 25 cm
Manuring	:	FYM 10 tonnes/ha 80:60:80 kg N:P ₂ O ₅ :K ₂ O/ha
Basal	:	Full P ₂ O ₅ , K ₂ O and 50% N
Top dressing	:	50% N one month after planting
Interculture	:	Hoeing, weeding and earthing up twice
Average Yield	:	15 tonnes/ha

DRUMSTICK

Variety	:	Pal and puna Murungai, Kodikkal Murungai, PKM 1, PKM 2
Soil	:	Well drained sandy loam soil
Propagation	:	Limb cutting 1-1.5 m length Annual types by seed
Spacing	:	3-5 m x 3-5
Pit size	:	0.5m x 0.5 m x 0.5m

Planting time	:	Limb cutting (Pole planting)- early monsoon Seedling- throughout the season
Manure and fertilizer	:	7-8 kg FYM + 150 g Urea + 100 g Single Super Phosphate + 200 g Muriate of Potash/ pit during July
Irrigation	:	Watering till the plants are established
Interculture	:	First pinching of seedling at a height of 1.0 m and second one after 30 days of the first pinching.
Average yield	:	Annual- 200-250 fruits/tree Perennial – 80-90 fruits/tree in the initial years and increases up to 500-600 fruits/tree/year during 5 th & 6 th year.

CUCURBITS

S I. N o .	Name of the crop	Variety	Seed rate/ ha	Sowing time	Spacing	Manures and fertilizer		Interculture	Yield
						FY M t/ ha	N: P ₂ O ₅ K ₂ O (kg/ha)		
1	Pumpkin	Arka Suryamukhi, Arka Chandan, Pusa Viswas, Pusa Vikas, Guamal, Baidabati, COI	6-8 Kg/ha	May – June & Feb-March	150cm x 150cm Pit size 60 x 60 x 60 cm 4-5 seeds/pit but later thinned to 3 plants/pit	15	50:30::75 Full P ₂ O ₅ , K ₂ O and ½ N at planting time rest ½ at one month stage	Twice one at 30 days and another at 45 days stage . Spray Ethrel 2ml/10 litre of water to be sprayed once at two true leaf stage and another at four true leaf stage. Operate hand pollination	20-30 t/ha
2	Cucumber	Pusa Sanjog (Hybrid) Himangi, Phule Subhangi, Sheetal, Poinsette	3-4 kg/ha	June-July	150cm x 60-90cm Pit size: 30 x 30 x 30 cm	15-20	50:30:75 150:90:90 (Hyb)	Twice	15-20 t/ha 30-40 t/ha (Hyb)
3	Bitter gourd	Akra Harit, Pusa Domausami, Pusa	4-5kg	June-July	150cmx100cm Pit size: 30 x 30 x 30 cm	20-25	60:30:30	Twice	10-15 t/ha

S I. N o.	Name of the crop	Variety	Seed rate/ ha	Sowin g time	Spacing	Manures and fertilizer		Intercultu re	Yield
						FY M t/ ha	N: P ₂ O ₅ K ₂ O (kg/ha)		
		Vishesh, Priya, Coimbatore long green, Improved Nakhara							
4	Ridge gourd	CO 1,CO 2, PKM 1, Pusa Nasdar, Satputia	4kg	June- July	150cmx 100cm Pit size: 30 x 30 x30 cm	10	50:30:30	Twice	15- 20 t/ha
5	Spine gourd	Local type, Cochinchine nsis,	Tubero us root (Male: female: 1:10) 18,000- 20,000 roots /ha	June	150cmx 100cm Pit size: 30 x 30 x30 cm	2kg /pit	60:40:40 N in 3 splits at 15,30 and 45 DAP	2-3	2kg/p lant
6	Small gourd (Kund uri)	Local type	16,000- 18,000 Stem cutting of 12- 15 cm long	June- July	150cm x 120cm	10- 12	60:40:40 N:P ₂ O ₅ :K ₂ O g/ha in 2 equal splits, top dressing after 2 months	Twice (30 & 60 DAP)	8-10 kg fruits/ vine
7	Snake gourd	Co1,Co2, Co4, Konkan sweta	5-6 kg seeds	June- July	150-250 cm x 60-120 cm	10- 15 t/h a	60:40:40 kg/ ha.½ N and full P and K as basal and rest ½ N top dressed during bearing stage	Twice (30 & 50 DAP)	8-10 t/ha
8	Point ed gourd	Swarna Alaukik, Local type	6,000- 7,000 root tuber/ ha	Nove mber	150cmx15 0cm	20 t/h a	120:80:80 kg N:P ₂ O ₅ :K ₂ O/ha, N in 5 splits after 15,45,75,1 05 and 135 DAP	Staking after 30 DAP	10 t/ha

Note : For spine gourd, small gourd & pointed gourd, maintain female & male population in 10: 1 ratio for better fruit set.

OFF SEASON VEGETABLE CULTIVATION

Orissa produces 90 lakh tonnes of vegetables from an area of 7.88 lakh ha with a productivity of 11.54 t/ha. To enhance the production, productivity and net return from vegetables, the most important and feasible approach is to adopt suitable varieties and hybrids for off season vegetable cultivation in the state. For off season vegetable cultivation detail survey should be made and past experience if any may be taken as a guideline. Area specific crops should be selected and multilocational evaluation should be made to know the performance of suitable varieties both from public and private sector. Further, growing of high value vegetables under protected conditions in coastal and inland districts of Orissa should be tried to develop the standard cultural practices. In off season vegetable cultivation for better flowering and fruiting the use of plant growth regulator should be standardized as per crops. In case of tomato application of PCPA (Para Chloro Phenoxy Acetic Acid) @ 50 ppm increases fruit set in kharif and summer season.

In Orissa, commercial cultivation of off season vegetables like cabbage, cauliflower, pea, runner bean, french bean, tomato, radish, carrot, beet, coriander, onion etc. can be tried in the suitable areas like Keonjhar, Semiliguda, Pottangi, Koraput, Laxmipur, G.Udayagiri, Raikia, Daringbadi, Phulbani etc. where off season vegetable cultivation are in practice in small scale. Off season vegetable cultivation, sometimes involves risk from climatic condition and also from insect, pest and diseases for which technical support and incentives should be provided for commercialization. As per the information gathered from different Horticulturists, scientists and farmers following varieties/ hybrids of different crops may be grown for off season cultivation.

Month	Crop	Varieties
June-October	Potato	Kufri Chandramukhi, Kufri Ashoka
June-October and February-April	Tomato	Utkal Pallavi, Utkal Deepti, Utkal Kumari, Utkal Urbasi, Shakti, Hyb-Suraksha*, Avinash*, Pusa Hybrid 1, Rajni*, Jyoti*, Rahul*
July-September	Cauliflower	Pusa Early Synthetic 1, Pusa Deepali, Pusa Kunwari, Hybrid: Himlata*, Himjyoti*
June-September	Cabbage	Pusa Ageti, Pride of India, Golden Acre, Konark, Disha, Deepa, Improved Savitri
April-September	Raddish	Pusa Chetki
June-September	Onion	N 53, Agrifound Dark Red, Arka Kalyan
June-September	Runner Bean	Jampa (Black Seeded), Keonjhar Local, Pottangi Local, Udayagiri Local

* Private sector hybrids

TURMERIC

Variety	: Roma, Surama, Ranga, Rashmi
Soil	: Can be grown in a variety of soils but sandy loam is always best.
Seed rate	: Disease free rhizome 2.0 t/ha
Manure and Fertilizer	: 22 tonnes FYM + 2 tonnes neem cake, 60:30:90 kg N:P ₂ O ₅ :K ₂ O/ha.
Biofertilizer	: Azospirillum 10 kg/ha mixed with 40 times FYM
Basal dose	: Full P ₂ O ₅ and 50% K ₂ O at planting.
Top dressing	: 50% N 45 days after planting and rest 50% N + 50% K ₂ O - 90 days after planting.
Mulching	: 22 tonnes/ha, 15 tonnes just after planting, 3.5 tonnes each at 45 and 90 days after planting
Planting	: May or June 1st week. (Seed treatment as in ginger)
Spacing	: 30 x 25 cm, Plant well sprouted bits (20-25 g) with bud upwards and at 7.5 cm depth.
Interculture	: Keep the field free from weeds wherever rhizome rot is seen. Grow the crop on raised beds.
Plant protection	: Annexure-III, IV
Yield	: 20.0 t/ha (fresh rhizome)
Storage	: As under ginger
Processing	: <u>Dry turmeric</u> : Select the rhizome after harvest, clean it by washing in running water. Then boil the clean rhizome in a water container for one hour. Dry the boiled rhizome for 10-15 days till the moisture content decreases to 10%. Polish the turmeric by rubbing in a rough surface and colour it with mixing in turmeric powder. From 10 kg fresh turmeric 2 kg dried turmeric is obtained.

ORNAMENTALS

MARIGOLD

Varieties	:	African Marigold: Giant Double African Yellow, Giant Double African Orange, Golden Age, Sirakole Spun Gold, Spun Yellow, Pusa Basanti, Pusa Narangi,
Soil	:	Fertile sandy loam
Propagation	:	2.0-2.5 kg seeds /ha or cuttings (apical cuttings preferred during kharif)
Spacing	:	40 cm x 30 cm
Time of planting	:	Seedling raising from June-July, Planting during July - August
Manure and fertilizer	:	FYM 50 t/ha, N-P ₂ O ₅ - K ₂ O @ 200-200-200 kg/ha
Basal	:	Full P ₂ O ₅ , K ₂ O and 50% N at planting
Top dressing	:	50% N after 1 month of planting
Interculture	:	Pinch the apical buds at 40 days after planting to enhance branching
Plant Protection	:	<i>Annexure-III and IV</i>
Average yield	:	100-125 q/ha

TUBE ROSE

Varieties	:	<u>Single</u> : Calcutta Single, Coimbatore Single, Bangalore Single, Shringar, Prajwal <u>Double</u> : Hyb-Suvasini, Vaibhav, Pearl double
Soil	:	Fertile well drained clay loam soil
Propagation	:	Bulbs (1,00,000 bulbs/ha) planted in 10m x 1.5m beds. For 1 year crop- 2-3 bulbs/hill, for 3 year crop-1 bulb/hill
Spacing	:	30 cm x 20 cm
Time of planting	:	Provided irrigation on need basis.
Manure and fertilizer	:	FYM 50 t/ha, Neem cake-4.0 q/ha N 300 kg/ha P ₂ O ₅ 200 kg/ha K ₂ O 200 kg/ha
Basal	:	Full P ₂ O ₅ , K ₂ O and 1/3 rd N
Top dressing	:	1/3 rd N after 30 DAP 1/3 rd N after 60-90 DAP
Interculture	:	Weeding at monthly interval and light earthing up at two month stage.
Plant Protection	:	<i>Annexure-III and IV</i>
Yield	:	50q loose flowers/ha or 2.5 lakh spikes/ha

JASMINE

Varieties	:	<u><i>Jasminum sambac</i></u> (<i>Malli</i>) – Gundumalli, Rambanam, Madanabanam, Kasturi Malli, Khoya, Motia, Single Mohra, Double Mohra, Sujimali. <u><i>Jasminum auriculatum</i></u> (<i>Jooee</i>) – Pari Mullai, Co1 Mullai, Co2 Mullai <u><i>J. grandiflorum</i></u> (<i>Jai/Chameli</i>)-Thrum type, Pin type, Surabhi, Co1 Pitchi, Co2 Pitchi.
Soil	:	Well drained sandy loam to clay loam but sandy loam is best.
Propagation	:	Hard wood cuttings
Spacing	:	Bush type (<u><i>J.sambac</i></u> , <u><i>J. auriculatum</i></u>) 1.2 m x 1.2m Vine type (<u><i>J. grandiflorum</i></u>)- 2.0 m X 1.5 m
Time of planting	:	July-August
Manure and fertilizer (pit/year)	:	FYM 10-15 kg Apply fertilizer in two equal splits-once in Dec.-Jan. and again in June-July for <i>J. auriculatum</i> & <i>J. grandiflorum</i> . For <i>J.sambac</i> , it is Dec-Jan.
		N 100g
		P ₂ O ₅ 150 g
		K ₂ O 10 g
Interculture	:	Pruning during December – January A Second Pruning during July for <i>J.sambac</i>
Plant Protection	:	<i>Annexure-III and IV</i>
Yield	:	1 st year – 0.5 t/ha 2 nd year – 4t/ha 3 rd year onwards- 6-8 t/ha

CROSSANDRA

Varieties	:	Orange, Delhi, Lutea Yellow, Sebaculis Red.
Soil	:	Well drained sandy loam
Propagation	:	5 kg seeds/ha. Use freshly harvested seeds. 60 days old seedlings are transplanted in the field.
Spacing	:	60 cm x 30 cm
Time of planting	:	July-September, Replanting at every 3 years
Manure and fertilizer	:	FYM - 50 tonnes/ha N 150 kg/ha/year P ₂ O ₅ 120 kg/ha/year K ₂ O 250 kg/ha/year Apply full P ₂ O ₅ and K ₂ O and 50% N as basal and top dress rest 50% N six month after planting
Interculture	:	Hoeing, weeding and earthing up at 1,6 and 12 months after planting.
Plant Protection	:	<i>Annexure-III and IV</i>
Yield	:	Flower yield 7.5 – 8.0 tonnes/ ha.

**GENERAL INFORMATION ON
SOME MEDICINAL PLANTS SUITABLE FOR ORISSA**

Sl	Common name	Scientific name (family)	Propagation	Planting time	Economic plant parts used	Uses
1	Aswagandha	<i>Withania somnifera</i> Dunal (<i>Solanaceae</i>)	Seed	15 th Aug. to 15 th Sept.	Roots	Tonic for general weakness, fever, sexual debility, anemia, acidity etc.
2	Sarpagandha	<i>Rauvolfia serpentina</i> (<i>Apocynaceae</i>)	Seed, root cutting, stem cutting and stumps	June-July	Root, barks	Blood pressure, asthma, neurotic, psychiatry, sleeplessness
3	Kalmegh (Bhuinimba)	<i>Andrographis paniculata</i>	Seeds, stem cuttings	June-July	Stems, leaves	Fever, dysentery, gas, worms, liver, antibiotic, leprosy, diabetics
4	Satabari	<i>Asparagus racemosus</i> (<i>Liliaceae</i>)	Seeds, division of roots with a portion of crown	June-July	Root	Gonorrhoea, piles, peptic ulcer, neurotic, health tonic, arthritis, vitality etc.
5	Senna	<i>Cassia angustifolia</i>	Seeds	Sept-Oct	Leaves, fruits	Habitual constipation, purgative
6	Gudamari	<i>Gymnema sylvestre</i>	Seeds and rooted cuttings	June-July	Leaves	Diabetes, hydrocele
7	Safed Musli	<i>Chlorophytum borivilianum</i> (<i>Liliaceae</i>)	Division of roots with a portion of crown and seeds	June-July	Roots	Tonic, aphrodisiac, importance, weakness
8	Brahmi	<i>Bacopa monnieri</i>	Stem cuttings	June-July	Herbs	Nerve & hair tonic, bronchitis blood purifier, mental diseases
9	Ghee kumari	<i>Aloe vera</i> (<i>Liliaceae</i>) <i>A. Barbadosensis</i>	Suckers and rhizome cuttings	March-July	Leaves	Stomach trouble, constipation, fever, colic, cough, menstruation disorders, hair tonic, burns, acidity
10	Tulsi	<i>Ocimum sanctum</i> (<i>Lamiaceae</i>)	Seeds	June-July	Leaves	Oil is used for drugs, perfumery, cold, cough

FODDER CROPS

Green fodder is required for maintaining better health of livestock and higher returns. The package of practices of major Kharif fodder crops of the state is presented below.

PACKAGE OF PRACTICES OF DIFFERENT KHARIF 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)	Utilization	Remarks
Annual cereal										
1.Maize	African Tall, J-1006, Jawahar, Vijay Composite, Moti Composite	June	30 x 10 or broadcast	4	40-50	10	80:40:40	350	Green, Silage & Hay	Harvest at tasseling to cob formation for green fodder & at dough stage for silage.
2.Sorghum	a) Single cut: M.P.Chari, Pant Chari-5, Sudex Chari & U.P.Chari b) Multicut: Meethi Sudan (SSG-59-3) & Harasona (Hyb)	June to Aug	30 x 10 or broadcast	4	30-35	10	60:30:30	300	Green, Silage & Hay	Harvest at 50% flowering as prior to this the plants contain a poisonous substance Hydro cyanic Acid which is reduced after flowering
3.Teosinte	Teosinte improved, TL-1	June	30x10	4	40	10	80:40:40	300	Green, Silage & Hay	Harvest at 50% flowering
4.Bajra	a) Single cut: Raj bajra Chari-2, L-74 b) Multicut: Giant bajra	June to Aug	30 Solid row	4	10	10	40:20:20	250 (SC) 350 (MC)	Green, Silage & Hay	Harvest at 50% flowering
Annual Legume										
5.Cowpea	EC-4216, Russian Giant,	June to Sept.	30 x 15 or broadcast	4	30-35	5	20:40:20	250	Green & Hay	Harvest at 50% flowering

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)	Utilization	Remarks
	UPC-4200, UPC-5286 & Bundel Lobia-1									stage or 60 days after sowing.
6. Rice bean	Bidhan -1, KRB-1, RBL- 6	June to Sept.	30 x 15	4	30	5	20:40:20	200	Green & Hay	Harvest at 50% flowering stage (70-80 days after sowing). One irrigation is required in post rainy season.
Pasture Legume										
7. Centro	Common belalto	June	30 x 15 & Broadcast	3	15-20	5	20:60:20	200	Green & Hay	Harvest at 50% flowering stage. Once established it will continue to grow for a period up to 10 years
8. Siratro	Local	June	30 x 15 & Broadcast	3	15-20	5	20:60:20	200	Green & Hay	It can tolerate shade and is a potential green fodder under both irrigated and rainfed condition and can be grown as a mixed crop with Guinea, Para and NB Hybrid
9. Stylo	<i>S. hamata</i> <i>S. scabra</i> <i>S. guyanensis</i>	June to Sept.	30 x 15 & broadcast	3	6(Line sowing) 10(Broadcasting)	5	20:60:20	200	Green & Hay	First cut at 70-80 days after sowing & subsequent cuts after 60-70 days

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)	Utilization	Remarks
Cultivated Perennial Grasses										
10. Napier bajra hybrid	NB-21, CO-1, CO-3, IGFR1-7	Year round except cold months	50 x 50 (Sole crop)	-	40,000 slips	5	50:40:40 as basal. 40kg N/ha as top dress after each cut	300 per cut	Green, Silage & Hay	First cut at 70-80 DAP & subsequent cuts at 45 days interval. If inter crops like Cowpea, or Rice Bean are to be taken the row spacing is increased to 100 cm to accommodate 3 rows of inter crops.
11. Guinea grass	PGG-9, PGG-14, Hamil, Macuini, Riversedale Green Panic	June	50 x 50	-	2.5Kg/ha (40,000 slips)	5	50:40:40 as basal. 40kg N/ha as top dress after each cut	200 per cut	Green, Silage & Hay	First cut at 70-80 DAP & subsequent cuts at 45 days interval
12. Para grass	Local	June	50 x 50	-	40,000 slips	5	50:40:40 as basal. 40kg N/ha as top dress after each cut	150 per cut	Green, Silage & Hay	First cut at 70-80 DAP & subsequent cuts at 45 days interval
Pasture Grasses										
13. Signal	Basilisk	July - August	30 x 30	-	10kg seed or 100,000 slips	5	50:40:40 as basal. 15 kg N/ha as top dress after each cut	100 per cut	Green, Silage & Hay	First cut at 70-80 DAP & subsequent cuts at 45 days interval
14. Congo Signal	Local	July - August	30 x 30	-	-do-	5	-do-	100 per cut	Green, Silage & Hay	-do-

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)	Utilization	Remarks
15. Humidicola	Local	June	30x30	-	10kg seed or 100,000 slips	5	50:40:40 as basal. 15 kg N/ha as top dress after each cut	100 per cut	Green, Silage & Hay	Suitable for both dry and wet condition. First cut at 70-80 days after planting and subsequent cuts at 45 days interval. It can also be grown on sandy soil and in watershed.
16. Rhodes	Katambora, Collide	June	30x30	-	10kg seed or 100,000 slips	5	50:40:40 as basal. 15 kg N/ha as top dress after each cut	100 per cut	Green, Silage & Hay	Can tolerate salinity and suitable for dry condition

MANAGEMENT OF PROBLEMATIC SOILS OF ORISSA

I. Acid Soils

More than 70% of the cultivated area in Orissa is occupied by acid soils belonging to Alfisols, Inceptisols and Entisols. These soils have been developed from intensely weathered parent materials of varying compositions of sandstone, quartzite, granite-gneiss, charnockite, khondalites either in-situ or over transported materials. These soils are dominated by low active clays like kaolinite and oxides of iron and aluminium. Due to high precipitation, basic cations like Na^+ , K^+ , Ca^{++} , Mg^{++} are lost by leaching and their positions on the exchange surface are occupied by H^+ . This decreases percent of base saturation and increases acid saturation in soil making the soil reaction acidic. Below pH 5.2, Al^{+++} is released due to lattice break down of the silicate clays increasing Al^{+++} saturation in soil. Hydrogen directly contributes to soil acidity, where as aluminium indirectly but strongly contributes to soil acidity by inactivating the OH^- as $\text{Al}(\text{OH})^{++}$, $\text{Al}(\text{OH})^{2+}$, $\text{Al}(\text{OH})_3^0$ and $\text{Al}(\text{OH})_4^-$ species. The Al^{+++} rapidly polymerizes in presence of the surfaces of inorganic soil colloids. These multicharged Al hydroxy polymers are held on the colloidal surface with high adsorption energy causing a significant reduction in CEC of soil. This promotes the leaching of nutrients like calcium, magnesium and potassium from soil.

Constraints

Upland acid soils are mostly coarse textured with low organic matter content, low water holding capacity and high infiltration rate, permeability and bulk density. Soil crusting is a major problem which hampers germination of seeds. These soils are deficient in nitrogen, phosphorus, sulphur, boron and molybdenum. The light textured acid soils are deficient in calcium, magnesium zinc and copper. Iron toxicity is a severe problem in wet land rice soils causing drastic reduction in yield.

Management

Management of acid soils is primarily aimed at raising the pH ranging between 6.0 and 6.5 by neutralizing the soil acidity since availability of most of the nutrients is adequate at this pH range. Lime is the most effective soil ameliorant to neutralize the soil acidity and to enhance the yield. Before application the lime requirement of the soil is to be determined by Woodruff's buffer method and liming materials equivalent to 10 to 20% of the LR is to be applied.

Sources of Liming Materials

Among the naturally occurring lime sources, calcite, dolomite and stromatolitic lime stones are important. To reduce the cost of lime various industrial wastes like paper mill sludge (PMS), pressmud from sugar mills and blast furnace slags can be used as liming materials. The neutralizing value and Ca content of different liming materials available in Orissa are given in the following table.

SI No.	Name of the liming material	NV (%)	Ca (%)
1	Emami PMS, Balasore	37	12
2	Choudwar PMS	60-84	20-29
3	Rayagada PMS	55-91	21-46
4	JK PMS	56-90	23-46.56
5	Brajarajnar PMS	67-84	27-50
6	Jeypore PMS	52-87	21-33
7	Basic slag from steel industry of Rourkela & Tata (should be ground to the fineness of 10 to 60 mesh before application)	60*	-
8	Stromatolitic lime stones	84	-

Note : NV = Neutralising value or CaCO₃ equivalent of the liming material,
* = Average value

The amount of liming material to be applied is calculated as follows

$$L' = (L \times 100) / NV$$

Where, L' = Quantity of liming material to be applied in kg/ha.
L = Quantity of pure CaCO₃ required in kg/ha.
NV = Neutralising value of liming material

Time and method of application of lime

Only 10 to 20% of the liming material calculated as above is to be applied in furrows along with organic matter before sowing or planting and is thoroughly mixed with soil. Required quantities of fertilizers are then added in the same furrows and mixed with soil followed by sowing of seeds or planting of seedlings in the furrows. For close spaced crops, the required quantities of lime should be broadcast on the soil and thoroughly mixed by ploughing before sowing or planting.

Frequency of lime application

Since the effect of lime does not persist for a longer period, due to high precipitation, it should be applied in every year on soil test basis. Balanced application of fertilizers, integrated nutrient management practices should also be followed to increase the productivity of acid soils.

Crops response to liming

High response crops	pigeonpea, soyabean, cotton
Medium response crops	gram, groundnut, maize, wheat, pea, mustard, blackgram, greengram
Low response crops	Millet, paddy

Application of Rock phosphate

Availability of phosphorus in acid soil is low due to its fixation under acidic pH range. To reduce the cost of phosphatic fertilizers, the required quantity of phosphorus may be applied as mixture of rock phosphate and SSP in 3:1 ratio for strongly acid soils and 1:1 ratio for mild acidic soils.

Management of iron toxic soils

Iron toxicity in rice causes a drastic reduction in yield. It occurs in lowland rice soils due to reduction of Fe^{+++} to Fe^{++} under submergence. The intensity of this reduction increases with increase in Fe_2O_3 content and increase in undecomposed organic matter content in soil. The undecomposed organic matter in the soil acts as electron supplier to reduce Fe^{+++} to Fe^{++} . The intensity of iron toxicity increases in low lying areas due to interflow of Fe^{++} rich water from the adjacent areas of higher elevations. In Orissa about 0.75 lakh hectare of wetland rice suffers from iron toxicity.

Symptoms of iron toxicity

Iron toxicity symptoms in rice appear at 25 to 30 days after transplanting. It starts with reddish brown spots on the tips of older leaves with bronzing and later spreads over the entire leaf. The brown spots coalesce on the intervening of the leaves. With progress of iron toxicity, the entire leaf looks purplish brown followed by drying of the leaves. The roots of the iron toxicity affected plants becomes scanty, coarse, blunted and dark brown in colour. White roots are few.

Control of iron toxicity

To control Fe-toxicity, liming material equivalent to 0.2 LR should be applied before transplanting. Lime increases the soil pH and reduces the intensity of reduction of Fe^{+++} to Fe^{++} to prevent the toxic effect of iron. Iron toxicity can also be reduced by increasing the dose of potassium to 80 kg K_2O per hectare. Half of this quantity should be applied as basal and the other half after 4 weeks of transplanting. Soil application of Zn @ 5 kg /ha at the time of transplanting also reduces iron toxicity. Application of flyash @ 10 t/ha is also effective in reducing iron toxicity. Following rice cultivars tolerant to iron toxicity may be grown.

Highly tolerant varieties	: Udayagiri, Panidhan, Tulasi
Tolerant varieties	: IR36, Konark, BirupaGajapati, Samalai, Swarna, Indrabati, Seema, Kalashree, Mahalaxmi, Sabita, Mahsuri, Kanchan, Basuabhog

II. Coastal Saline Soils

Out of 10 million ha of salt affected soils of India, coastal saline soil occupies 7.5 mha. Coastal saline soils of Orissa have been formed by marine, estuarine and lacustrine deposits and their interactions in the coastal belts of undivided Balasore, Cuttack, Puri and Ganjam districts. From interpretation of satellite imagery in conjunction with aerial photography it has been found that there are 2,54,100 ha of saline soils in Orissa. Out of this 24,160 ha are under mangrove vegetation, 32,522 ha bare and 1,93,410 ha under agriculture. Salt affected soils in Orissa occur within a narrow strip of land adjacent to the coast of Bay of Bengal which runs about 375 km long and ranges in width from 2 to 15 km. These areas generally have an elevation of less than 10 m above the mean sea level and include the lowing lands of river deltas, estuaries and depressions close to the coast.

Formation

The causes of the salinity of coastal belt is mainly due to sea water along estuaries, creeks, drains and rivers and due to frequent inundation of the land with

sea water during high tides. The ground water table with high salt content is shallow and contributes significantly to soil salinisation during dry periods. The effect of tides in the Bay of Bengal regularly causes rise and fall of the water level of the rivers and creeks. The tidal flow repeatedly inundates the soils and impregnates them with salts. The occurrence of tides has a direct effect on the formation of coastal saline soils.

Soils

The soils of this zone is mostly lowlying having high percentage of clay. water retention capacity is very high, drainage capacity is very low. The pH of the soil varies from 6.0 to 8.0 with a conductivity of 10 to 40 dS/m in the summer. The exchangeable sodium percentage ranges from 18 to 27 per cent. The salts are mainly composed of chloride and sulphates of Na and Mg and to a lesser extent of Ca and K. Soils on the lacustrine sediments of Chilka lake are affected by salts due to flooding of brackish lake water during monsoon and a build up of sub-soil salinity due to high ground water table under low lying situations. Deterioration of crop yield in these soils is mainly due to:

- ❖ Plasmolysis of germinating seeds and roots;
- ❖ Failure of germination and death of seedlings;
- ❖ Reduced uptake of K, Ca, Mg due to presence of excess Na;
- ❖ Deficiency or toxicity of some micronutrients.

However, the salt content of these soils is low (2 – 3 dS/m) during rainy season due to dilution and flushing of salts by heavy rains. In general, the entire coastal belt of Orissa is mono-cropped with traditional indica rice varieties. Hardly any rabi or summer crop is grown due to increase in salinity.

Management

The inherent fertility of saline soils is high but the productivity is low. The management includes removal of salts, adoption of suitable agronomic measures, use of amendments and growing salt resistant crop varieties.

Preventive measures such as construction of salt embankments, improving the drainage to flush out soluble salts and checking the inflow of tidal water through construction of sluices across the creeks have yielded good result. Since the saline soils of Orissa have finer texture with poor hydraulic conductivity, leaching of salt below root zone is not possible. Reclamation of salt is possible by addition of FYM, paddy straw or rice husk. Insitu green manuring with Dhaincha was found most promising. Application of chemical amendments like gypsum or paper mill sludge has tremendous effect on rice yield.

After harvest of kharif rice, the entire coastal saline belt remain fallow because of high soil salinity and lack of suitable irrigation water. During rabi season bengal gram, khesari, safflower and linseed can be grown with residual moisture where limited irrigation water is available, wheat, maize and barley is recommended. The vegetables like sugarbeet, poi, knolkhol, onion, carrot, tomato, chilli, bitter gourd etc. are recommended where good quality irrigation water is available. Suitable cultural practices like cropping on the sides of alternate ridges of irrigated furrows with the intermediate furrow left as fallow and frequent light irrigation are also recommended. Raising of shelter belts over and near the saline track is advocated to save the adjoining land from “Salt cycling”.

III Management of Waterlogged Areas in Canal Commands

In many canal commands, the excess of inflow over outflow from the ground water basin has caused the degradation of basic soil resources in terms of water logging and soil salinisation. If inflow due to recharge to ground water basin is more than the outflow, then water table rises and over time reaches the root zone, thereby causing water logging, secondary salinisation and accumulation of iron. Reclamation of water logged areas is costly and time consuming. In some of the cases, it is not possible to reclaim the chronically waterlogged areas; consequently leaving them uncultivable, or in some cases leaving the only option to grow a tall rice variety of long duration. Crop diversification becomes difficult in these areas. Water logged areas may have two distinct situations – high ground water table and surface ponding. Some possible management strategies for water logged areas are:

I. High Ground water table situation

- * Improving the drainage congestion network both in canal distribution systems and deltaic region
- * Increasing the canal conveyance efficiency by lining the canal networks, repairing the damaged canal networks and removal of aquatic weeds
- * Irrigating the crop fields through field channels rather than following field to field irrigation.
- * Mechanized farming especially land leveling and grading for equitable distribution of irrigation water.
- * Adopting intermittent irrigation scheduling in rice instead of maintaining deep or medium submergence.
- * Adopting crop diversification in canal commands to replace rice-rice system.
- * Adopting scientific water management practices in irrigated dry crops.
- * Decreasing the ground water table position by enhancing surface as well as sub surface drainage systems. Parallel field surface drains with a spacing of 10m in sandy loam soil constructed with the depth of 60 cm can quickly evacuate the excess surface ponding .
- * Reuse of drainage water
- * Encouraging conjunctive use of surface and ground water.
- * Raised and sunken bed system of crop raising

- * Growing of rice variety like Birupa, Bhoi, Swarna, Mahanadi, Panidhan
etc in areas having problems of excess iron
- * Growing Rice varieties like Lunishree and Sonamani are suitable for coastal salinity
- * Tree plantation using *Terminalia arjuna*, *T. belerica*, *T. asana*, bamboo, *Acacia nilotica*(on mounds) and growing pasture species helps in lowering the ground water table.

II. Surface ponding

- * Raising field bunds
- * Providing deep drain outlet
- * Pumping of excess water
- * Rice- fish farming
- * Growing of alternate plants like water chestnut (*Trapa natans*), lotus (*Nelumba nucifera*), Bena (*Andropogon squarrosus*), Santara(*Typha angusta*) and makhana etc
- * Bio-drainage – plant species like Eucalyptus (about 4012 mm water use per year) can be used in water logged area as biodrain.
- * Some perennial fruit crops like Guava, Jamun and Banana planted on heaps are also suitable for water logged areas.
- * Emphasis on participatory approach involving farmers

DRYLAND AGRICULTURE

Out of a total cropped area of 6.1 million hectares in Orissa during *kharif*, about 72% is rainfed. In spite of the contemplated increase and thrust in irrigation potential, more than 50% of this area would still remain exposed to the vagaries of monsoon. As the economy of the state is mostly agriculture-oriented, the importance of dryland farming is too obvious. The sustainable technology that can bring about resilience in productivity in dryland areas are discussed below :

Crop substitution (Alternate crops)

Rice is the main crop in Orissa and is the staple food of the people. The farmers prefer to grow rice in all sorts of situations in spite of considerable risk and low yield. In respect of upland rice it has been observed that only the varieties of extra early group (85 days or less) have reasonable chance of success in the light textured red-lateritic soils. Even those varieties face the risk of failure in drought affected years. As against this experience other upland *kharif* crops such as maize and ragi, pulses like greengram, blackgram, cowpea and redgram and oilseeds like groundnut, sesame and niger show a stable performance with much less yield fluctuations over years. Ginger and turmeric can also be grown profitably. Hence, for stabilizing production in rainfed areas, farmers should divert a considerable portion of their uplands to these crops in stead of covering the field entirely with traditional rice varieties.

Intercropping

Intercropping is a commendable practice in dryland agriculture, since it offers a kind of insurance against total crop failure in unfavourable years. This practice also ensures proper utilization of soil moisture as well as plant nutrients. The land equivalent ratio (LER) in certain intercropping systems has been found to be invariably higher than in the sole crops. Yield advantages of 31 to 48% have been recorded in intercrops over those obtained in sole crops. The most promising intercropping systems are as follows :

Sl. No.	Intercropping	Row ratio	Set specification (cm)	Row distance of intercrop (cm)
	ARHAR BASED			
1.	Arhar + groundnut	2:6	30-210-30	30
2.	Arhar + sesame/niger	2:4	30-150-30	30
3.	Arhar + greengram/blackgram	2:3	30-120-30	30
4.	Arhar + ragi	2:4	30-100-30	20
5.	Arhar + rice	2:5	30-120-30	20
6.	Arhar + rice (mixed broadcast)	40:60	Seed rate ratio of individual crop for broadcasting	
7.	Arhar + radish*	2:2	30-90-30	30
8.	Arhar + okra*	2:2	30-90-30	30

MAIZE BASED				
9.	Maize + arhar	2:2	30-90-30	30
10.	Maize + cowpea	2:2	30-90-30	30
11.	Maize + cowpea (fodder)	2:1	30 cm uniform row	30
12.	Maize + runner bean*	2:2	30-120-30	40
13.	Maize + yam*	Two rows of maize grown in both sides of yam planted in mounds at 90 cm x 90 cm to act as live staking		
RICE BASED				
14.	Rice + greengram/blackgram	3-4:1	Uniform row	15
15.	Rice + greengram/blackgram	2:1	In drought year, if rice fails, pulse crop is maintained and in a normal year pulse is cut for fodder and rice is maintained	
16.	Groundnut + rice	1:4	Uniform row	15
17.	Okra + rice	2:4	30-75-30	15
18.	Radish + rice *	2:4	30-75-30	15

* For north eastern ghat and north central plateau zone

Sequence cropping

- ❖ Prepare the land availing the summer rain
- ❖ Select short duration crop varieties
- ❖ Arrange inputs
- ❖ Sow the kharif crop with the early onset of monsoon
- ❖ Select short duration and drought tolerant crops like horsegram, blackgram and castor to follow the kharif crop in rainfed upland.

Details on the cropping pattern for rainfed condition in different agroclimatic zones are given in *Annexure-VII*.

Use of soil amendment

About 70% of the cultivated area in Orissa is acidic. The acid soil is a major impediment to increase in yield of crop because of the abnormality in nutrient behaviour as follows:

1. Deficiencies of calcium and magnesium in light textured acidic soils
2. Low availability of phosphorus and molybdenum and fixation of applied phosphate
3. Low nitrogen fixation by symbiotic and non-symbiotic bacteria
4. Aluminium and manganese toxicity in upland situation and iron toxicity in submerged condition as a result there is very poor response to NPK

Use any one of the following locally available liming materials for reclaiming acid soil.

Liming materials

Sl. No.	Name of the material	Neutralising value (NV)	Place of availability
1.	Paper mill sludge	75%	Choudwar, Rayagada and Brajarajnar paper mills
2.	Low grade lime stone or stromatolytic lime stone powder	100%	Sundergarh, Koraput, Kalahandi and Sambalpur district
3.	Basic slag powder from steel factory	60%	Tata and Rourkela steel plant

Quantity of lime recommended

Apply lime to raise the pH to a desired level, usually 6.0 to 6.5. Test the soil samples in laboratory by modified Woodruff's method to know the lime requirement. Approximate lime requirement can be judged from the following table.

Sl. No.	Textural class of the soil	Quantity of lime (kg/ha) to raise the pH from 5.0 to 6.0 (LR)
1.	Sandy and loamy sand	875
2.	Sandy loam	1500
3.	Loam	2250
4.	Silt loam	3250
5.	Clay loam	4375

Quantity of particular liming material required = (LR X 100)/NV of the material.

Time and method of application

- ❖ Apply lime (0.1 -0.2 LR) mixed with FYM in furrows at the time of sowing.
- ❖ Apply lime to the responsive crop in the cropping system

Responsiveness of crops to liming

- High responsive : Arhar, soybean, cotton, maize and rice under iron toxic condition
- Moderate responsive : Gram, lentil, groundnut, wheat, greengram, peas, cowpea
- Low responsive : Sugarcane, mustard, rice

Use rock phosphate and single super phosphate in the following ratio to meet the recommended phosphorus dose of the crop.

	Acidity (pH)	Rock Phosphate		SSP
a.	4.5 to 5.0	90%	+	10%
b.	5.1 to 6.0	80%	+	20%
c.	6.1 to 7.0	50%	+	50%

Land treatment / preparation

- ❖ Plough the field across the slope with the receipt of summer rain to increase infiltration.
- ❖ Make field bunds and level the field wherever necessary
- ❖ Plant Vetiver grass (*V. zizanoides*) at 0.4 m vertical interval to stabilize bunds in terraced land.
- ❖ Grow close spaced sole crops viz; rice, ragi, cowpea or strip/intercropping of pigeonpea with rice, groundnut to reduce runoff and soil loss.
- ❖ Practise contour cultivation.
- ❖ Construct miniature earthen bunds turfed with *Cynodon dactylon* between 2 terraces.

Time of sowing and method of seeding

- ❖ Sow the crop with the onset or just before the monsoon rains
- ❖ Follow line sowing
- ❖ Provide adequate drainage in non-paddy crops
- ❖ Use seed-cum-fertilizer drill for better stand establishment

Fertilizer use and management

It is well known that dryland is not only thirsty, but is equally or even more hungry. The soils are infertile and generally deficient in macro and micro-nutrients. In certain situations high amounts of P_2O_5 remain fixed in the acid soils and little is actually available to the plants.

The following moderate levels of fertilizers are recommended for economic returns.

Fertilizer schedule for some important dryland crops

Sl. No.	Crop	Fertilizer dose (kg/ha)		
		N	P_2O_5	K_2O
1.	Rice	40	20	20
2.	Ragi	40	30	20
3.	Maize	80	40	40
4.	Greengram/blackgram	20	40	20
5.	Arhar	20	40	20
6.	Horsegram	10	20	0
7.	Groundnut	20	40	40
8.	Sesame	30	20	20
9.	Toria	30	20	20
10.	Niger	10	20	0
11.	Turmeric	60	30	90
12.	Ginger	125	100	100
13.	Yam	80	60	80

Besides, the chemical fertilizers add some quantity of organic manures to improve the physical condition of the soil. For growing pulses and groundnut, the acid soil should be properly limed as outlined before. Apply fertilizer in the furrows/lines thoroughly mixed with the soil for better availability of the nutrients to the crops. Popularise placement of fertilizer 6 cm below the surface by seed-cum-fertilizer drill. Organic manure is to be applied in the field at the time of summer ploughing thereby enriching the soil structures for better conservation of soil moisture. Integrated nutrient management to supply 50% N through organics gives higher and stabilized yield besides improving physico-chemical properties of the soil.

Weed control

Weeding and hoeing are the most important interculture operations under dryland agriculture. This must be done within 3 weeks of germination of seeds to check the competition between weeds and crops for the soil moisture as well as plant nutrients. Use blade harrow to kill the weeds. Other weed control implements such as garden rake and 3 tyne seed drill may be used in weeding field at the appropriate time. For intercropping systems like arhar+ groundnut/blackgram apply fluchloralin @ 0.75 kg/ha as pre-sowing spray followed by light incorporation into the soil to control the weeds effectively. Pre-emergence spray of Pendimethalin 0.5 -1.0 kg/ha also effectively controls the weeds in intercropping systems. For chemical weed control in sole crop refer weed control chapter.

Water harvesting and run-off utilization

During the monsoon period torrential rains cause heavy soil erosion and wide spread damage due to floods. Much of the precious water is lost to the sea with tonnes of fertile soil. The farmers should be encouraged as a policy to construct large number of farm ponds on community or cooperative basis to impound a portion of the excess runoff which can be utilized for life-saving irrigation during intermittent drought spells for the first crop or at critical stages for the second crop. If constructed in large numbers at suitable locations, those ponds will minimize the flood hazard to some extent, provide water for human and cattle use, encourage pisciculture and recharge water level in the wells located at lower reaches. The soil moisture regime will also improve in the immediate vicinity of the ponds to make the crop grow better. The size and location of the ponds depending on the catchment, slope and intensity of rainfall should be decided by the experts for accruing maximum benefit. The seepage and percolation losses can be minimized by providing suitable lining on the soil surface.

Cropping pattern

Agroclimatic zone wise recommended cropping systems/patterns are given in the *Annexure-VII*.

Alternate land us

Land should be used according to its capability to increase the productivity. Various agroforestry models such as Agri-silvi, Silvi-pastoral and Agri-horti systems may be followed (refer Agro-forestry chapter).

Dryland horticulture

Dryland horticulture has been given importance in the drought prone areas. It can replace the upland paddy area and serve as a regular source of income for the farmers. Fruit trees such as mango, guava, jackfruit, custard apple, pomegranate, tamarind and cashewnut are suitable.

CLIMATE CHANGE AND AGRICULTURE OVER ORISSA

1. Introduction

Climate is the primary factor influencing crop choice in a region. Weather as a single factor could be responsible for as much as 50% of variation in yield which occurs from year to year, the remaining 50% being due to production factors like irrigation, manuring, plant protection. Precipitation, temperature, humidity, dew, wind and sunshine are the important weather factors that influence right from the land preparation to the harvest and post harvest processes. While the average weather values have their importance, but their range, extreme values, duration and frequency are considered more important for biological processes that influence growth and development of crop plants, animals, insect pests and micro-organisms. There is little doubt that agricultural systems in the state of Orissa have adapted to a range of weather conditions prevailed over long history of human settlement and land-use change. So far both environmental change and adaptation of plants to the environment are evolutionarily progressive. When the environmental changes are sudden and faster, it is doubtful that such resilience of the adapted species and can continue to sustain the productivity. Recent global climate change is such a stress, which is projected to have a great impact on food production, and hence, requires special agricultural measures to combat with. Knowledge on extent of climate change and its potential impact on agriculture of the state are considered useful to formulate the required adoption measures for sustained production and productivity.

2. Global climate change/variability

Significant climate changes are taking place worldwide. The major cause of climate change has been ascribed to global warming, which is unequivocal, as evident from the 11 warmest years out of 12 years between 1995 and 2006 and 0.74^oC increase between 1996 and 2005. Increased level of green house gases (GHG), such as carbon dioxide, nitrous oxide, methane and carbon monoxide, has led to the global warming.

Uncontrolled human activities, such as burning of fossil fuels, use of refrigerants, and changed land use patterns and related practices are the major sources of GHGs.

There is high confidence that recent regional changes in temperature have had discernible impacts on many physical and biological systems. Precipitation pattern has changed with decreased rainfall over south and south-east Asia. More intense and longer droughts have occurred since 1970s. Projected scenarios of global warming indicate that the global average surface temperature could rise by 1.4 to 5.8^oC by 2100. The projected rate of warming is unprecedented during last 10,000 years. Global mean sea level is projected to rise by 0.18 to 0.59 m by the end of current century. Gross per capita water availability in India will decline from 1820 m³/yr in 2001 to as low as 1140 m³/yr in 2050.

3. Climate change/variability in Orissa

Both trend analysis and projected scenario show that the annual rainfall of the state as a whole has the increasing trend. However, trend analysis does not agree to

the projected scenario of uniformly increase over the entire state. Trend analysis suggest that six coastal districts, namely Balasore, Bhadrak, Cuttack, Khurda, Puri and Nayagarh, interior districts of Mayurbhanj and Kandhamal and possibly one western district of Kalahandi are expected to receive more rainfall, while all other districts would get less rainfall.

Following are some other '*more likely*' effect of climate change.

- Late monsoon onset and more pre-monsoon rainfall.
- Reduced post monsoon and winter rainfall.
- Less rainfall in February, June and October.
- More number of cloudy days.
- Increased day and night temperatures in all the months except July.
- Maximum increase in temperature in post-monsoon followed by summer.
- Extended summer up to June.
- Increased number of hot, humid summer days in coastal areas.
- Warm and short winter with fewer cold nights in western Orissa.
- More frequent extreme weather events, such as hot extremes (maximum temperature above 45⁰C) and prolonged heat waves.
- More number of very heavy rainy days (> 125 mm per day).
- Prolonged dry spell due to most rainfall over few days.
- More number of low-intensity low pressures at the Bay of Bengal.
- More intense tropical cyclones with larger peak wind speeds and heavier rainfall.
- Increased risk of drought and flood during monsoon.
- Intense storms resulting in loss of the rain water as direct runoff resulting in reduced groundwater recharging potential.

4. Projected effect on Agriculture of the state

Future climate change is likely to adversely affect agriculture, livelihood, food security and water resource. Some effects of the climate change on agriculture are as follows.

- Reduction yields of crops due to warm days and nights.
- Decrease in grain yield of rice (9%) by 2020 due to accelerated senescence and higher chaffyness.
- Less elongation of rice grain and lower quality of rice due to warm nights during post flowering period (October).
- Direct sown rice at more risk due to extended summer and less rainfall in June
- Substantial yield losses in winter crops. For example, 0.5⁰C rise in winter temperature would reduce wheat yield by 0.45 t/ha.
- More crop loss, soil erosion, waterlogging and difficulty in cultivation due to more heavy rainfall events.
- More crop loss and land degradation due to increased drought occurrence.
- Increased risk of soil damage and erosion due to soil wetness, waterlogging and flooding.
- Increased salinisation of the coastal areas, particularly Mahanadi delta.

- Long-term loss of soil carbon stocks.
- Increased crop water requirement due accelerated evapotranspiration.
- Decreased use efficiency of nitrogenous fertilizers.
- Higher pest incidence such as increasing infestation of rice crop by swarming caterpillar, hispa, stem borer and bacterial leaf blight.
- Loss of cultivated land by inundation and coastal erosion in low-lying coastal areas.

5. Suggested agricultural measures

Climate change requires two types of measures : adaptive measures and mitigation measures. A range of adoption measures are available to reduce vulnerability to climate change by enhancing adaptive capacity and increasing resilience. Some of such suggested measures are as follows.

a) Crop diversification : Growing non-paddy crops in rainfed uplands to perform better under prolonged soil moisture stress in kharif.

b) New crop varieties : HYVs and hybrids of vegetables tolerant / resistant to alternating temperature regimes and warm winters, improved rice varieties resistant to flashflood in low lands, salinity tolerant rice varieties in coastal areas.

c) New rice culture: Cultivation techniques such as SRI method of rice cultivation during summer and in well drained medium lands during kharif under assured water supply, wet method of direct sowing.

d) Preference to rice transplanting: Going for the transplanting of rice instead of dry method of direct sowing for more assured yield.

e) Altered sowing time: Dry sowing of rice only after sufficient monsoon rainfall recharging soil profile and early sowing of rabi crops to match warming February.

f) Efficient fertilizer use: Optimum fertilizer dose, balanced fertilization, split application of nitrogenous and potassium fertilizers, deep placement, use of *neem*, *karanja* products and other such nitrification inhibitors, liming of acid soils, use of micronutrients such as zinc and boron, use of sulphur in oilseed crops, integrated nutrient management.

g) Efficient water use: Frequent but shallow irrigation, drip and sprinkler irrigation for high value crops, irrigation at critical stages.

h) Integrated pest management: Measures to control increased incidence of polyphagous insects like swarming caterpillars and accelerated life cycles of stem borer in rice.

i) Drought and flood management: Preventive measures for drought that includes on-farm reservoirs in medium lands, growing of pulses and oilseeds in steaf of rice in uplands, ridges and furrow system in cotton, growing of intercrops in place of pure crops in uplands, land grading and leveling, stabilization of field bunds by stone and grasses, graded line bunds, contour treching for runoff collection, conservation furrows, mulching and more

application of FYM. Recommended contingent measures for drought and flood are to be ready in stock for adoption depending on emerging scenario of drought, time of occurrence and land situation.

j) Land management: Contour ploughing, counter planting, terracing, close spacing crops, and other recommended practices of soil conservation in sloppylands to minimize soil erosion.

k) Catchments management: An increased risk of water shortages at times will require greater consideration to be given to the need for better catchments management planning and technical interventions on the watersheds.

A large number of technologies developed for sustainable agriculture have strong mitigation potential. The practices having mitigation potential can collectively make a significant contribution to increasing soil carbon sinks, reducing green house gases emissions, and by contributing biomass feedstock for energy use. Considering that the per capita GHG emissions in India is negligible and the nation has to feed the growing population, no mitigation measures should be adopted at present (at least up to 2012) that will hamper the agricultural production and productivity. However, following are some suggested measures having GHG mitigation potential.

a) Improved land management : These include technologies to increase soil carbon storage. Examples are mulching, minimum/zero tillage (also less GHG emission), FYM application, intensive cropping, growing of legumes as sequence or inter crop, green manuring, *in situ* application of residues instead of burning.

b) Restoration of waste and degraded lands: Reclamation followed by crop growing in waterlogged low lands, horticulture and agroforestry in cultivable uplands and saline coastal areas.

c) Improved composting : The idea is to reduce CH₄ and N₂O emissions from the conventional method compost heaps. Improved composting not only reduces the GHG emissions, but also increases nutrient value of the manure. Vermicomposting is another recommended practice.

d) Improved nitrogenous fertilizer management : The idea is to adopt techniques to reduce N₂O loss from nitrogenous fertilisers. The technologies include use of urea super granules, slow release fertilisers, nitrification inhibitors including use of *neem*, *karanja* and other such indigenous products.

e) Integrated nutrient management: The idea is to reduce the inorganic nitrogen fertilizer requirement by a crop. Generally, 50% of recommended nutrient through inorganic fertilizers and rest 50% through organic source is the thumb rule, although it differs with the crops. Green manuring and use of bio-fertilizers like Azospirillum, Azotobacter, Phospho-solubilising bacteria and Rhizobium cultures are highly beneficial.

f) Growing of energy plants: Growing of crops like Jatropha on the wastelands and marginal lands are remunerative.

g) Efficient agricultural machinery: These measures include better designs of water pumps and agricultural machinery with reduced use of fossil fuels. Use of threshers, winnowers, etc. that require alternative energy sources such as biogas and wind energy is another option.

WATERSHED MANAGEMENT

Watershed is a geo-hydrological unit or a drainage basin draining to a common point by streams / channels. A watershed area may belong to one or several land use, land cover, soil type, topography *etc.* Delineation of watersheds can be done based on drainage and ridgelines which can be very easily performed by minutely observing the flow of runoff while raining. However, it can also be carried out by means of topographical maps published by Survey of India, ariel photographs, landsat imageries and other techniques. A watershed may vary in its geographical area from a few hectare to several lakh hectares as follows

Sl. No.	Category	Size
1.	Catchment	> 1 lakh ha
2.	Sub catchment	40,000 – 1 lakh ha
3.	Watershed	4,000 – 40,000 ha
4.	Sub-watershed	2,000 – 4,000 ha
5.	Mini watershed	400 - 2,000 ha
6.	Micro watershed	< 400 ha

A watershed boundary is not limited to a village, sub-division, district, state or any administrative or political boundaries rather it may be a part of any one or may cover full/part of more than one of such units.

The people and animals are part of the watershed community. For the developmental purposes, watershed should be selected on priority basis depending upon available finance and the possibilities of developing it completely within a reasonable period of 3-5 years. In fact the main consideration while selecting a watershed for development should be on its level of degradation and expected benefits to the watershed dwellers.

Development of watershed is an activity which is carried out for improvement of the living standard and conditions of the population, control of soil erosion and soil degradation, conserve rain water within it, improve soil moisture regime to satisfy needs of the crops/vegetations and thus food-security of the human and animal population in the watershed. Increase in productivity will upgrade economic and social status of inhabitants. Besides, ground water recharge is one of the prime purpose of development. It also establishes ecological balance between man and his environment. In integrated developmental programme animal husbandry, fishery, bee keeping, rural based industries, health *etc.* must be taken into account. All developmental activities must be advocated to be done on watershed basis. Planning for watershed development has to be carried out in close consultation and cooperation between the specialists/experts in the various related disciplines and the community. Unless the programme is made as per need/desire of inhabitants and in accordance with their suggestion, there is every chance of failure. Preferably in all developmental work local manpower should be engaged to enhance their skill so that they can maintain and progress further even if the project is withdrawn. A scientist / Govt. officer / NGO should work as initiator and/or moderator.

Watershed management may be defined as the process of formulating and carrying out a course of action involving manipulation of natural, agricultural and human resources of a watershed, to provide resources that are desired by them and suitable to the watershed community without adversely affecting the soil and water resources and ecology. Watershed management practices are taken up to bring changes in land use, vegetative cover and other non-structural and structural actions to achieve watershed development objectives. Watershed management is an integrated and interdisciplinary approach. It generally requires land use adjustment measures which contribute to the reduction in soil erosion rates thus increased agricultural production, generation of rural employment and balanced growth of the national economy.

Some of the techniques of soil and water management in a watershed are:

LAND LEVELLING AND GRADING

Land levelling or grading is the process of preparing the land surface to a planned grade to provide suitable surface. Land levelling attempts to create plain by cutting high areas and raising low spots. The fields so prepared, controls the runoff water, prevents soil erosion and provides better surface irrigation/drainage. The type and nature of levelling required for a land is generally decided by depth of soil, infiltration capacity, topography, cropping pattern, method of irrigation and rainfall characteristics of the area in addition to economic factor. Prior to levelling, the land development programme should be planned, including the location of field boundaries, irrigation, water supply system, drains and farm roads.

CONTOUR TRENCHING

Contour trenching is excavation of trenches across the slope (precisely on contour) of the land and is mainly practiced in upper reaches of watershed. Bunds may be formed at lower reaches leaving a berm of about 30 cm. Soil dug out of the trenches should only be used for the bund. Care must be taken to maintain bottom of a trench and top of the bund at same elevation throughout it's length. Contour trenches decrease the length of slope into smaller sections, which retard the rate of runoff and soil erosion. Water collected in these trenches increases the soil moisture content and supports the growth of vegetation. The trenches may be continuous or interrupted i.e., staggered and intermittent type. Continuous trenches store more water but their cost is very high and requires a careful layout. "A frame" can be used for the purpose. Staggered and continuous trenches should always be constructed on the contours. Contour trenches can be taken up on varying edaphic conditions and rainfall.

V-DITCHES

V-ditches are also effective for soil and moisture conservation in low to moderate rainfall areas. Slope of V ditches is generally a reverse of tick mark. Upstream slope of the ditch must be at very mild slope so that crop cultivation can be practiced on this slope. The upstream wall of the ditch will not be subjected to erosion. These can be easily made with the help of mould board plough. Some of the important points for V-ditch are as follows:

- Depth of ditch may be 20 cm tentatively.
- Height of bund depends upon amount of earth excavated from V-ditch.
- Upstream(U/S) side slope of V-ditches may be 6-8:1 and downstream(D/S) slope may be 1-1.5 :1 (H:V) depending on type of soil.
- U/S and D/S bund slope may be 1-1.5 :1, respectively depending on type of soil.
- Horizontal interval between consecutive bunds depends upon land slopes, mechanization level of cultivation practices and nature of crops grown.
- Crop must be sown even on U/S slope of ditch.
- If used for agro-horticulture/forestry system of cultivation, planting can be done at desired spacing in the ditch in low rainfall areas and just below the bund in high rainfall area. It is advisable not to have long continues ditches thus they must be broken at suitable intervals depending upon degree of accuracy in lay out.
- Silt deposited in the ditches must be removed and may be spread on the bunds or around plants minimum once in a year. Bund should be maintained annually.

CONTOUR BUNDING

Contour bunding essentially consists of construction of small bunds across the slope of the land on a contour, breaking the long slope into a series of small ones. Each contour bund acts as a barrier to the flow of run-off thus reducing its velocity and allowing more water to percolate into the soil. This increases the moisture regime of the soil while preventing its erosion. Details of the procedure for construction of contour bunds in Orissa has been developed by the Directorate of Soil Conservation.

Size of the bund and spacing between two bunds need basic consideration in contour bunding. Rainfall pattern, percentage of slope, soil type and depth of soil are no less, the other important governing factors. In field bunding, side bunds are put along the slope usually at right angle to the contour bund at suitable intervals.

Basing on the local consideration, specification of bunds and size of the field have been prescribed by the Directorate of Soil Conservation as follows:

Size of the bunds

Type of soil	Top width (ft)	Bottom width (ft)	Side slope	Height (ft)	Cross Sectional Area (sq. ft)
Heavy soils	1.00	7.00	1.50:1	2.00	8.00
Light soils	1.00	6.00	1.25:1	2.00	7.00
Irrigated soils	1.00	5.00	1.00:1	2.00	6.00

Grade for the bund should be sufficient to remove run off at non-erosive velocity. The grade in fixing guidelines before planning bunding (terrace) system may be uniform or variable according to site conditions. A variable grade gives greater

latitude and flexibility in erosion than the uniform grade. The grade map vary from 0.1% to 0.5%. A variable grade more than 0.5 percent would sometimes necessitate massonary waste weirs at convenient points for safe disposal of run off.

Size of the fields

Percentage of slope	Horizontal distance	Size of the field recommended	Approximate area in acres
1	198'	198' X 132'	0.60
2	99'	99' X 132'	0.30
3	66'	66' X 132'	0.20
4	66'	66' X 132'	0.20
5	66'	66' X 132'	0.20

BENCH TERRACING

In slopping land having slope more than 10-25%, when less expensive measures are not effective, bench terracing is usually adopted. Bench terracing is one of the important mechanical measures in hilly areas under shifting cultivation. The bench terraces could slope inward, outward or may be levelled. Bench terracing is a costly programme and should be taken up only when pressure on land is acute and more remunerative crop like monsoon potato/off season vegetables etc. can be taken up. Detailed investigations as to the soil depth should be taken before executing bench terracing projects and preservation of top soil during the execution. Erosion of crop lands on hill slopes can also be controlled by sorting and loose random rubbles on a contour to form stone terrace.

GULLY CONTROL

Gully erosion is an advanced stage of rill erosion. Gullies are formed due to uncontrolled flow of runoff through a natural channel. This channel gets enlarged due to erosion of its bed and bank thus converting the area uncultivable. This also allows rainwater to flow out at rapid rate reducing ground water recharge. Deep gullies not only make the land uncultivable but also render valuable surrounding land gradually unsuitable for cultivation. Depending upon the nature and extent of the gully, temporary or permanent structures have to be constructed. Some of the measures are :

- **Vegetative measures:** These are only possible in initial gullies i.e., where gully formation has just started. The gully bed and surroundings are grown with thick vegetations, preferably the drought resistant, non-grazing, deep rooted and hardy grasses/shrubs. These may be planted in staggered fashion in rows across the slope, preferably on contours.
- **Temporary structures:** These are made across the gully at regular intervals out of locally available materials, like brush wood, loose stones, or even sand/ gravel filled in plastic fiber (cement bags).
 - i. Brush wood gully control structure is suitable for the area close to a forest, as a farmer can get wooden pegs and brushes free utilizing his own labour. Pegs are driven in two rows across the gully in staggered manner. With the help of locally available creepers nets both rows. In between two rows alternate brushes and soil/stones are filled in layers. Peg-wood must be of regenerating (vegetative propagation) nature.
 - ii. Loose boulder gully control structure is suitable for hilly areas where boulders

are available to the farmer at no cost. Boulders are arranged across the gully. While arranging boulders, gully bed must be scrapped to remove loose soil, minimum width equal to bottom width of structure. Structure top width minimum 30 cm and side slope according to shape and size of stone. However, U/S slope of 1:2-4 and D/S slope of 1:3-4 may be needed. This could be used for temporary water harvesting also by placing soil in upstream side to desired depth. Loose stone boulder structure has proved to be better as it is non degradable hence more durable. It needs only annual rearrangement of slip over boulders or some new boulders may have to be placed.

- iii. In the plain areas where neither wooden pegs nor boulders are locally available, sand or gravels or any non degradable and water insoluble locally available materials may be filled in fiber bags (used cement bags or similar) and arranged across the gully. It can serve better tools for gully as silt arrest is much better than structures discussed above.

STREAM BANK EROSION CONTROL

Stream bank erosion is a matter of concern to the individual farmer as it decreases the size of his holding. The land on stream banks mostly have alluvial soils that are highly productive. Loss of any part of such land therefore decreases the income of the farmer. Sometimes, however, the stream bank erosion assumes such high in magnitude that its control warrants public concern as it can not effectively and economically be handled by an individual farmer. While conservation of the land along the stream bank is a very important part of mini watershed planning, it is not only costly but also requires careful planning and designing.

An effective and comparatively cheap measure is to cover up gullied areas and bank by vegetation. Construction of check dams and spurs are the common engineering measures employed to help bank protection work. Ipomoea (*Ipomoea cornea*), Begunia (*Vitex negundo*) and *Sachharum* species are quite effective for bank consolidation. Considering the site conditions, spurs which are projections from the bank of the stream are used to protect the bank. These deflect the flow of water. Spurs may be permeable or impermeable. However, in most cases permeable spurs made of wood are used to protect the stream bank against erosion.

CONTOUR CULTIVATION

Contour cultivation refers to any tillage practices and specially ploughing across the slope or along the contour. The furrows between the ridges developed by the contour tillage operations hold the water and store the same in the soil. This not only reduces run-off and loss of soil and water but also brings about a greater uniformity in distribution of the moisture. Contour cultivation is of greater importance in the hilly areas. In many cases the cultivators are in the habit of ploughing in straight furrows whether up and down the slope or in oblique lines. Such cultivation enhances run-off resulting in greater loss of soil and water. When ploughing is done along the contour every furrow acts as a reservoir to receive and retain the water which goes to the benefit of the growing plant. The ridge and furrow method of cultivation of sloppy lands with crop like blackgram, arhar or maize on the ridge and either short duration paddy or ragi in the furrows has shown promising results.

COVER CROPPING

Bare soil favours splashing and erosion of soil by water. Soil loss has been observed to be directly proportional to the exposed soil surface. Cover crops are to

be so selected for conservation farming that besides providing good canopy they also help in enhancing organic matter content and fertility status of the soil and increase production of crop. Experiments at different places have shown cowpea to be a very good cover crop followed by greengram. Spineless mimosa is also a good cover crop for dryland areas.

STRIP CROPPING

In strip cropping the crops are grown in strips or bunds at right angles to the slope of the land. Those strips act as obstructions to the run-off. Four types of strip cropping are generally adopted. These are (i) contour strip cropping, (ii) field strip cropping, (iii) wind strip cropping, and (iv) buffer strip cropping. In contour strip cropping the strips are laid out on the contour i.e., at right angle to the natural slope of the land. In field strip cropping, which is usually practiced in very irregular topography the strips are laid across the general slope without strictly conforming to any contour. In wind strip cropping the strips are usually straight and of nearly uniform width and are laid out at right angles to the direction of the prevailing wind. Wind strip cropping could be followed where wind erosion is more important than water erosion as in coastal area of our state along the sea shore. Such strip cropping could also be followed where the land is level to nearly level. In buffer strip cropping, strips of some legume or grass are left over permanently in the field. Out of the above four types of strip cropping for Orissa condition, contour strip cropping is most effective form of conservation farming.

In deciding the width of the strips, slope of the land, type of soil, pattern of rainfall and degree of erosion are taken into consideration. Many of our principal crops are erosion permitting. In strip cropping such erosion permitting crops are grown in strips alternating with strips of erosion resisting crops. The erosion resisting crops are normally close growing ones and are usually legumes or pulses or grasses that can develop maximum foliage to withstand the impact of heavy rains.

In Orissa, many of the farmers have limited holding and small plots where strip cropping may not be advantageous. However, such conservation farming is quite beneficial for farmers having larger holdings and bigger plot sizes and particularly in areas where cultivation are being done in hill slopes.

INTERCROPPING AND MIXED CROPPING

Intercropping by growing one more crop in rows between another crop and mixed cropping by growing two or more crops in the same row or broadcasted in field have been observed to be quite helpful in conserving soil and moisture by reducing run off. In mixed cropping deep rooted and shallow rooted crops should be associated so that plant nutrient contained and moisture conserved at different soil depths are properly utilized. The important intercropping systems are given in dryland chapter.

MULCHING

Mulching is a very effective measure to conserve soil and moisture in land particularly when the same is put under row crops. Mulching of open land surface is achieved by spreading stubbles, trash or any other vegetation. Mulching minimizes splash action of rain drops on bare surface, reduces evaporation, increases infiltration, obstructs surface flow and retards erosion, reduces excessive heating and weed growth and maintains favorable soil temperature, thereby increases crop yields.

Polyethylene mulches have also been utilised for water harvesting and control of seepage. Trash farming in which crop remains are cut, chopped and partly mixed in soil and partly left on land surface is also a form of effective mulching.

WIND BREAK AND SHELTER BELT PLANTATION

Wind break and shelter belt are quite helpful to conserve soil and water besides protecting the area against wind. The former is a barrier for protection from wind commonly associated with homestead gardens, orchards etc., while the latter is usually a longer barrier consisting of combination of trees and shrubs meant for protection of field crops for the purpose of soil and moisture conservation. By controlling the wind erosion and diverting desiccating winds, evaporation loss from the cropped land is considerably reduced. For wind break and shelter belt, mixed plantations consisting of grasses, shrubs and trees adaptable in the area are planted at right angles to the direction of wind. The width of the shelter belt along sea shore is required to be very wide and continuous for very long distances and is a concern of the Government, while the wind break could be adopted by individual farmer for his land.

WATER HARVESTING, STORAGE AND RECYCLING

Water harvesting and its recycling are extremely helpful in providing life saving protective irrigation for the crop sown in the adjoining lands during *kharif* when the monsoon fails creating drought situation. Depending on the size, some of the storage tanks may also be able to provide irrigation to limited areas for growing rabi crops. In Orissa, a number of farm ponds locally called 'Munda's and 'Kata', farm ponds, head water dams/percolation tanks etc. have been constructed for such purpose. It is necessary to ensure that there is no considerable loss of the stored water through seepage. Natural clay soil of low permeability, Bentonite (Sodium bentonite), Bituminous materials and even stone or brick lining can be done for preventing seepage. For construction of water harvesting structure the territorial soil conservation staff may be consulted. They would help in selecting a suitable site, calculate the catchment area, the peak run-off and design a suitable out-let. Care should be taken to keep at least about 100 ft up stream of the reservoirs well vegetated to work as a grassed water way to check the soil transportation into the water body. Water harvesting structures or farm ponds are less costly than conventional dug-out ponds, as dug out ponds involve comparatively more earth work to create a reservoir for storage of water. Management of catchment area of farm pond is, however, essential for sedimentation control and thereby to increase the life of the farm ponds. Converting slopes into vertical drops by terracing, stabilizing soil by turfing and by plant growth and construction of check dams in the feeding (tributary) gullies lying in the upstream side of the farm pond should be taken up as a preventive measure for control of sediment to the pond.

Afforestation or plantation with suitable species in barren land provides ample protection of velocity of falling rain drops, anchorage through its root system, higher infiltration and increase in the water holding capacity of the soil through leaf decay and consequential addition of organic matter. The Department of Soil Conservation has taken up various plantations with economic species as an approved soil conservation measure for protecting barren hills and slopes as well as vast-stretches of Government waste lands devoid of any vegetation.

AGROFORESTRY

Agroforestry is an old and traditional art of growing perennial trees and agricultural crops together on the same land. The International Centre for Research in Agroforestry defines agroforestry as “A collective name for land use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc) are deliberately grown on the same land management unit with agriculture crops and/or animals, either in some form of spatial arrangement or temporal sequence. In agroforestry systems, there are both ecological and economic interactions between different components. In more intensively managed agroforestry systems, trees are not only allowed to grow during fallow periods ,but also planted, managed and harvested alongside crops and/or farm animals so as to optimize overall farm productivity in the long term.

Agroforestry systems increase species diversity within farming systems, provide materials for human needs (food, fuel, fodders, timber etc), utilize off-season precipitation, help in soil and water conservation, give extended management options (trees can be harvested for fodder/fuel/timber/pole etc), improve micro climate for crops and soil micro flora, add organic matter to soil ,recycle nutrients from lower soil horizons, improve and stabilize income of the farmer and provide scope for off season family labour utilization.

Types of Agroforestry systems :

There are four major agroforestry systems arising from combination of two or more components including trees as one of them. These systems are :

1. Agrisilviculture system (Trees + crops)
2. Silvi pastoral system (Trees + pasture/animals)
- 3 . Agrisilvipastoral system (Trees + crops + pasture/animals)
4. Other (miscellaneous) systems (Trees with other enterprises)

In all agroforestry systems, 2 types of components exist i.e. woody and non-woody component. The woody component, also called silvi component includes trees of different types like timber trees, fuel wood species, trees giving minor forest produces, fruit trees/ horticultural trees etc. The non-woody component includes crops, pasture, animal, fish, silkworm, honey bee, etc.

1. Agrisilviculture

Growing of food crops with trees is termed as agrisilviculture. Based on nature of components, this system can be grouped into various forms/sub-systems/practices such as:

- i Trees on farm boundaries and field bunds.
- ii. Alley cropping (growing crops between tree rows).
- iii. Crop combination with plantation crops.
- iv. Shelterbelts and wind breaks.
- v. Growing commercial crops with shade trees (coffee with silver oak, cocoa with rubber, betel vine with Agasthi (*Sesbania grandiflora*) etc.

(i) Trees on farm boundary and field bunds :This is the most common agroforestry system found on agricultural lands. Trees are maintained or planted on

farm boundary and field bunds to meet various needs of the farm family. This system can effectively accommodate 100 to 133 trees per hectare at a spacing of 2 to 3 m between plants. Suitable trees for field bund plantation are *Acacia mangium* (Mangium), *Acacia auriculiformis* (Sunajhari), Babul, Subabul, Eucalyptus, Teak, Gamhar, Casuarina, Phasi, Palm tree (Tal) etc. Coconut is commonly planted on field bunds and farm boundaries in the coastal plains of the state. Trees can serve as wind break, demarcate field boundary, protect crops and produce fruits, fuel wood, tree fodder, small timber and shade etc. When fast growing trees are planted on bunds they can be harvested as poles or pulp wood or fuel wood at 5 to 7 years of age and give Rs 5000/- to Rs 6500/- per hectare.

(ii) Alley cropping : It refers to cropping between rows of trees or between hedges. The former is known as 'wide row inter cropping' and the later as 'hedge row inter cropping'. In wide row inter cropping, trees are planted at a wider spacing of 8, 10 or 12m or more between lines and field crops are grown in the alleys with recommended packages. Number of trees should be maintained at 250 to 300 per hectare and should not exceed 400. The crops are grown for more than three to four seasons until the shade of the trees reduce crop yield by more than 30 to 40%. Thereafter, shade tolerant and shade loving plants (turmeric, ginger, arrowroot, pineapple, amorphophalus, etc) are grown for few more years till the felling of trees. At 300 timber trees per hectare the return from tree component will be around Rs 30,000/- after 5 to 6 years to Rs 3,00,000/- after 12 years.

Suitable trees for wide row inter cropping are *Acacia mangium*, *Acacia auriculiformis* (Sunajhari), Teak, Gamhar, *Albizia procera*, *Acacia nilotica*, Casuarina, Phasi, Palm tree (Tal) etc. Coconut is commonly planted on field bunds and farm boundaries in the coastal plains of the state.

Hedge row intercropping is recommended for hilly or sloppy lands to check erosion and soil loss, and improve soil fertility. In this practice hedge species (Gliricidia, Subabul, etc.) are closely planted in single or double rows at 50cm between paired rows and 25-50 cm between plants to develop a thick hedge of plants. The spacing between two hedges may be 10 to 15 meters or more in moderate slopes and may reduce to 5m in greater slopes. The hedges are cut back to 50 to 75 cm height to prevent them from encroaching into the alley space. There may be three to four cuts in a year to yield 5 to 6 tons of green biomass. The pruned biomass of the hedges are used as green manure or mulch to improve soil fertility and crop yield. Crops are grown in between two hedge rows with recommended package.

(iii) Crop combination with plantation crops : Perennial trees and shrubs (small tree crops) are inter cropped in various combinations and orientations. Growing coffee under silver oak (*Grievellia robusta*), cocoa under rubber plantation, Banana under coconut and black pepper in coconut gardens are few examples. The trees are often grown as shade trees.

(iv) Shelterbelts and wind breaks: Several rows of tall growing trees are planted in a belt or block across the direction of prevailing wind to check the ill effects of wind on crops. Usually trees are planted in the centre flanked by two low growing shrubs or trees on either sides. They protect the crops on lee ward side of the break and also provide fuel, fodder, timber, food, etc. Suitable species for shelterbelts are Casuarina, Dabul, Sissoo, Jamun, Polanga, *Prosopis juliflora*, *Acacia leucophloca* (Gohira), Eucalyptus, Neem, Siris, etc.

2. Silvipastoral system

It is the growing of trees and / or shrubs combined with livestock or pasture for production of forage and fuel wood on the same unit of land. The trees may be scattered on pasture land or they are planted in definite rows with the forage crops grown between tree rows. When protein rich trees (*Dalbergia sissoo*, *Samanea saman*, *Zizyphus jujuba*, *Acacia nilotica*, *Ailanthus excelsa*, *Prosopis spp.* etc.) are grown on farm land for cut and carry system, the system is termed as protein bank. When fodder trees are planted as a live fence to protect the crops and provide fodder it is termed as a "living fence of fodder trees". Suitable tree species for silvipastoral system are Subabul, Babul, Siris, Mahala (*Ailanthus excelsa*), Kanchan, Agasthi etc and the grasses are anjan, stylo, guinea and hybrid napier. Number of trees per hectare may be maintained at 400 to 500 and the spacing between tree rows may be as close as 5 m. The grasses are grown between tree rows with recommended practices. The annual green forage yield of grasses with 3 to 4 cuts in rainy season may reach 25 to 40 tons under rain fed conditions to more than 100 tons per hectare with regular cuttings in irrigated condition.

3. Agrsilvipastoral system and home gardens

These are the most intensive form of land management in which production of agricultural crops, growing of forest trees and rearing of domestic animals are integrated into a single land management unit. It involves a multi species, multi storey combination of trees, fruit trees, shrubs, herbs and animals to represent a forest type vegetation, most commonly found in homestead lands of the humid and sub-humid tropics. This is known as home gardens and is commonly found in coastal districts of the state. It is economically most productive and ecologically most sustainable system of land use. Recommended species for home gardens include Fruit trees (Coconut, arecanut, mango, jack fruit, sapota, custard apple, ber, oau, guava, citrus fruits, etc.), Timber trees (teak, sissoo, mangium, gamhar), Bamboo, Fuel wood trees (*Samanea saman*, *Acacia auriculiformis*, *Cassia siamea*, Casuarina, etc.), Understory crops (Pine apple, banana, drum stick, Annual crops- vegetables, grasses for fodder, etc.) and other species (Eucalyptus, Polanga).

4. Other systems

Many other agroforestry practices are there which do not fall under above 3 systems and grouped under other systems. Some of the systems are:

- **Apisilviculture:** In this system, honey is produced in agroforestry system. The tree species suitable for ' bee forage ' are specially included in this system.
- **Aquasilviculture :** In this system trees are grown in association with pisciculture. Various trees and shrubs preferred by fish are planted on the boundary and around fish ponds. Trees improve microclimate and stabilize bund.
- **Energy and Pulpwood plantation :** These are high density plantations of fast growing trees in wastelands and marginal lands. Nearly 2000 to 2500 trees per hectare are planted at 2m x 2m or 2.5m x 2.5m spacing and are harvested after 5 -7 years for pole, pulp wood or fuel wood. Suitable trees include *Acacia auriculiformis*, Eucalyptus, Casuarina, Subabul, *Cassia siamea* etc. Return from sale of wood may be as high as 1.0 lakh/ha after felling or Rs. 15000/- to Rs. 20000/- /ha/year.

- **Multipurpose tree lots:** In this system, special location specific multipurpose trees are grown mixed or separately planted for various purposes such as wood, fodder, soil protection, soil reclamation, food, etc.

Selection criteria of trees for Agroforestry

1. Non interference with arable crops (i.e. narrow crown, with light open branches).
2. Easy establishment.
3. Fast growth and short gestation period.
4. Non allelopathic effect on arable crops.
5. Ability to fix atmospheric nitrogen.
6. Easy decomposition of leaf litter.
7. Ability to withstand frequent loppings.
8. Multiple uses (food, fodder, fuel, timber etc.) and huge returns.
9. Good marketability.

Nursery tips for agroforestry

Tips to select best planting materials for agroforestry plantation are:

- i) Collect matured and well developed healthy seeds from promising provenance.
- ii) Grade the seeds and take only the best ones for raising seedlings.
- iii) Screen the seedlings in the nursery bed and select the best ones with high seedling vigour, high apical dominance and low branching tendency. Separate the best seedlings for plantation in main field.
- iv) Wherever possible, use saplings raised from clonal materials to ensure uniform and optimum growth in the plantation.
- v) Proper selection and screening of seedlings ensure optimum growth and uniform stand in about 80% of the population in a plantation.

Tree Management Practices for Agroforestry Systems

Employ one or more of the following tree management practices to ensure value addition to the tree products and reduce competition between tree and crops in an agroforestry combination.

- i. Thin out excess and weak plants from tree rows to maintain 250 to 2500 plant per hectare as may be found adequate for different agroforestry models and land situation.
- ii. Prun the lower branches up to 1/3rd height of trees during winter or before the start of cropping season. Pruning should start from 2nd year onwards.
- iii. Go for deep ploughing or trenching along side the tree rows to prevent lateral spread of tree roots to the inter row spaces.
- iv. Maintain a narrow or compact canopy of trees by selective pruning of outspreading branches.
- v. Leave a space of 60 to 90 cm between tree rows and crop row depending on canopy structure of trees and growth requirement of crops.

INTEGRATED FARMING SYSTEM

Research in crop science has taken Indian agriculture to a very comfortable position and so in the case of livestock production through green and white revolutions respectively. But the galloping growth of population exerting tremendous pressure on the declining land resources and unscientific management of agriculture is gradually eroding the resource base of Indian agriculture. Efforts must be made to put in place a system of agriculture to conserve the natural resource base, protect the environment, and enhance the health and safety of human population over a longer period. This can be achieved by seeking the optimal use of internal production inputs in a way that provide acceptable levels of sustainable crop productivity and livestock production resulting in economically profitable return.

The average holding of a farm in India has been declining and over 80% of operational holdings are below the size of 1.0 hectare. In Orissa 82% of the farmers are considered small and marginal with an average holding size of 0.8 hectare. There is no scope for increasing the farm size because of steady increase in population with shrinkage of cultivated land as a result of industrialization and urbanization. Only vertical expansion is possible by integrating appropriate farming components requiring lesser space and time ensuring periodic income to the farmer. Under such situations an integrated approach is necessary to develop agriculture and related sectors for maximizing productivity to ensure food security and stability. At this juncture Integrated Farming System provides opportunity to increase yield per unit area per unit time by virtue of integration and intensification of crop and allied enterprises. Time concept by crop intensification and space concept by building up of vertical dimension through crops and allied enterprises are the ways to increase productivity. The integrated farming systems, therefore, assumes greater importance for sound management of farm resources to enhance farm productivity, reduce environmental degradation, improve quality of life of resource poor farmers and to maintain sustainability of production.

'Farming' is the process of harnessing solar energy in the form of economic plant and animal products, and 'System' implies a set of inter related practices/processes organized into a functional entity, i.e. an arrangement of components or parts that interact according to some process and transforms inputs into outputs. 'Farming systems' is a decision making unit comprising farm household, cropping and livestock systems that transform land, capital and labour into products for consumption and sale.

Thus, Farming System is a complex inter-related matrix of soil, plants, animals, implements, power, labour, capital and other inputs controlled in part by farming families and influenced to varying degrees by political, economic, institutional and social forces that operate at many levels. It focuses on:

- The interdependencies between components under the control of household.
- How these components interact with the physical, biological and socio-economic factors which are not under the control of household.
- Farm household is the basic unit of interdependent farming enterprises carried out on the farm.
- Farmers are subjected to many socio-economic, bio-physical, institutional, administrative and technological constraints.

- The farm family is the owner-cum-manager-cum-beneficiary of the farming system

Goals of Integrated Farming System

- Sound management of farm resources to enhance farm productivity and reduce the degradation of environmental quality.
- To advocate a process of change to meet the changing needs of the growing population and to promote their quality of life

Core Characteristics of Integrated Farming System

- It is holistic
- It is problem solving
- It envisages location specific technology solutions
- It is farmer-participatory.
- It recognizes (Indigenous Technical Knowledge) ITK
- It adopts 'Bottom up' approach
- It is interdisciplinary
- It emphasizes extensive "On-farm" activities
- It is gender sensitive
- It recognizes interdependencies among multiple clients
- It focuses on actual adoption
- Its ultimate objective is sustainability

Advantages of Integrated Farming System:

- Increase the farm productivity by intensification of mutually beneficial crop and allied enterprises.
- Increase profitability by making use of the produce or waste material of one component as the input for the other component, thus the cost of production is decreased and the net profit will be increased.
- There will be organic supplementation of inorganic fertilizers which will maintain the potentiality of production and becomes sustainable.
- It provides balanced food producing different sources of nutrients, proteins, carbohydrate, fat and vitamins from same unit of area which removes the malnutrition condition of the Farm family.
- It prevents the environment from pollution by recycling of farm wastes and appropriate use of organic sources
- It generates employment opportunities through out the year.
- It provides income to the farm family round the year.
- It enables to adopt new advanced technology.
- It solves the energy crisis.
- It solves fodder crisis by growing of legume fodder which, not only provides well balanced feed stock but also fixes the atmospheric N in soil.
- It avoids degradation of forest because it provides fuel, fodder, timber and reduces dependence on forests.
- It provides opportunities for agro based industries.
- It increases input use efficiency and enhance benefit cost ratio.
- It improves the standard of living by providing value added products like edible mushroom, fruit, meat, egg, milk, honey, vegetable at the farm level and availability of biogas for cooking.

Components of farming system

The selection of enterprises is based on the cardinal principles of minimizing competition and maximizing complementation amongst the enterprises. The various farming enterprises that could be adopted in a farming system are food crops, vegetable, fruit trees, ornamental plants, agro forestry, plantation crops, pisciculture, dairy, duckery, piggery, sheep and goat rearing, sericulture, apiculture, mushroom, biogas plants etc.

Farming system as a concept takes into account the components of soil, water crops, livestock, labour and other resources with the farm family at the center managing agriculture and related activities (Fig.1).

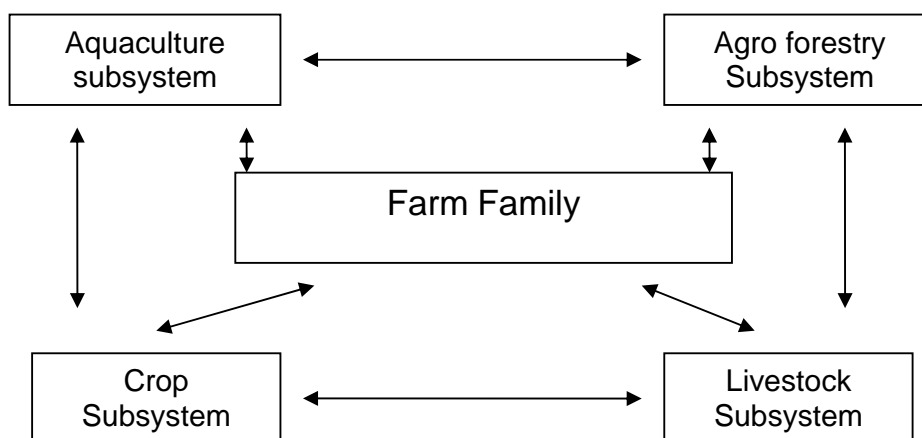


Fig. 1. Linkage of different enterprises in farming system

Case study of model Farming System for different categories of farmers for the Coastal agro ecosystem of Orissa

Sl.No	Farmers Category	Holding size (ha)	Family Size	FS modules followed	NMR (Rs)	BCR
1	Marginal (< 1 ha)	0.8	3	Field crops +Poultry + Apiculture +Mushroom	29125	2.70
2	Small (1-2 ha)	1.2	4	Field crops +Horticulture Pisciculture +Apiculture + Mushroom	68150	3.37
3	Medium Farmers (2-4 ha)	2.1	6	Field crops +Horticulture (Coconut) +Pisciculture + Dairy +Apiculture +Mushroom	69150	2.28
4	Large Farmers (> 4 ha)	7.0	4	Field crops +Horticulture Pisciculture +Dairy + Apiculture +Mushroom	214645	2.51

NMR- Net Monetary Return

BCR- Benefit Cost Ratio

The combination of enterprises which helps in recycling of the resources in a farming system, reduces cost of production, enhances profit, minimizes pollution and maintains environmental quality is shown in Fig.2

PLANT GROWTH REGULATORS AND CHEMICAL REGULATION OF GROWTH

Plant hormones are growth 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:

I. Auxin

1. Prevent pre-mature leaf and fruit drops
2. Induction of flowering and fruiting
3. Induction of parthenocarp fruit development
4. Initiate rooting in cuttings
5. Overcoming sterility
6. Sweetening of fruits
7. Prolonging dormancy period in tubers, bulbs and corms
8. Induce frost resistance in some fruit trees

II. Gibberellins

1. Increase length of internodes
2. Delay senescence
3. Increase size of fruits
4. Improve the fruit quality
5. Promote germination
6. Overcome seed dormancy
7. Increase fruit set
8. Induction of flowering in long photoperiodic plants

III Cytokinins

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

IV Ethylene

1. Induces ripening of fruits
2. Breaks dormancy of plant organ
3. Induces root initiation
4. Stimulates flowering in pineapple
5. Induces female sex in cucurbits

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
	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

	Name of growth Regulators	Concentration	Purpose of use	Type and Time of Application	Crop
	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	200 ppm	Increase fruit setting in brinjal	Spray at flowering stage	Brinjal
	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	Spray or dip seed pieces before planting	Potato

	Name of growth Regulators	Concentration	Purpose of use	Type and Time of Application	Crop
			emergence in seed potato		
	GA ₃	1000 ppm	Induces 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 femaleness in cucumber and melon	Spray at first true 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	Peanut
	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, Marygold and Zinia
	Alar or B-9	1000-5000 ppm	Promote rapid rooting in ornamental plants	Dipping of stem cuttings overnight	Ornamental Plants
	Chlormaquat (2-chloroethyl ammonium chloride)	2000-5000 ppm	Increase resistance to drought, cold and salt in vegetables	Foliar spray	Soybean, Cabbage and Tomato

	Name of growth Regulators	Concentration	Purpose of use	Type and Time of Application	Crop
	Chlormaquat (2-chloroethyl ammonium chloride)	25-50 ppm	Increase flowering, boll frequency and cotton yield	Spray 70 days after emergence	Cotton
	Daminozide	1 to 3 kg/ha In 500 – 1000 lt of water	Increase root yield and uniformity in carrot	Spray when the crop foliage is about 20 cm long	Carrot
	Chloroflurecol methyl	72-112 g/ha In 750 to 1000 lt of water	Induce seedless fruit set in all female cultivars of cucumber	Spray to foliage and flower	Cucumber
	N-Metatolylph thalamic acid	5000 ppm	Fruit setting in brinjal	Spray at flowering stage	Brinjal

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 continuous application of phosphatic fertilizers. 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 25 days interval.
	Kharif 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 first true 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 leaf 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 reduce oxides. A scum of iron having brickish red colour observed on the surface of standing water. Iron intoxicated 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, Lalat, Samalei, Parijat, CR-1009, Kalinga-III, Annada, Birupa, Bhoi, T-1242, Panidhan and Mahanadi. Providing drainage channels on the sides.
Boron	Groundnut	In groundnut apical growth severely retarded, internodes	Soil application of 10 kg borax/ha along with fertilizer at

Micro nutrient	Crop	Deficiency symptoms	Remedial measures
		condensed, water soaked areas appear in the margin	sowing.
	Kharif vegetables (brinjal, okra)	New leaves and petioles light in colour, brittle and deformed. Internodes short. In advanced stages, terminal buds die.	Soil application of 12-15 kg borax/ha or Two foliar sprays of borax (0.25%)
	Cotton	Death of terminal buds. Growth of lateral branches having short internodes. Rosette appearance. Young leaves become yellowish green in colour	Soil application of 20 kg borax/ha Or Three foliar sprays of borax @ 0.25%
	Maize	Condensation of internodes leading to altered physiology, leaf size reduced.	Soil application of 20 kg borax/ha at sowing.
	Sunflower	Brownish mottling of leaves at marginal regions, brittleness of the stems. Transverse cracking across stem, collapse and necrosis of apical growth.	Soil application of 12-15 kg borax/ha at sowing.
Molybdenum	Greengram/ Blackgram/ Groundnut	Palegreen, old leaves show interveinal chlorosis and marginal scorching.	Seed treatment of 10 g Sodium molybdate alongwith Rhizobium culture @ 25 kg seed/ha, soil amendment by liming.
Manganese	Rice	Stunted plants with normal tillers, appearance of chlorotic streaks spreading downward from tip to the base of leaf which become dark brown and necrotic. Newly emerging leaves are short narrow and light green.	Foliar spray of 0.6% manganese sulphate + 0.3% lime. Proper drainage to be assured.
	Sugarcane	Partial chlorosis occur in 3 rd to 5 th youngest leaves. Manganese deficiency leads to pahala blight of sugarcane. Middle and young leaves develop chlorotic stripes between veins, later the chlorotic areas turn necrotic with red spots which gradually elongate and coalesce to form continuous red stripes along which the leaves may split.	Soil application of Manganese Sulphate @ 15 kg/ha

INTEGRATED NUTRIENT MANAGEMENT

The integrated nutrient management or in other words the integrated plant nutrition system is the maintenance and possibly increase of soil fertility for sustaining increased crop productivity through optimizing all possible sources, organic and inorganic of plant nutrients required for crop growth and quality in an integrated manner, appropriate to each cropping system and farming situation in its ecological, social and economic possibilities. This is a long but comprehensive definition.

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) soils (ii) fertilizers (iii) organic manures and (iv) biofertilizers. Among these four sources, the soil sources need careful manipulation for not to deplete the plant nutrients by over exploitation through intensive cropping or 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 crops are less than that compensated and there is a gradual increase in soil reserve.

The second source i.e. mineral fertilizers should be used in such a way that there should be maximum use of the nutrients 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 source.

The fourth source i.e. biofertilizers or microbial inoculants supply or make available only a limited quantity of few plant nutrients which fall far short of the requirements of high yielding crop variety. However, since some of the biological sources can be produced by the farmer himself with low investment, they constitute a 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 been established that some of the components of integrated nutrient management such as organic manures and biofertilizers can be used along with appropriate doses of inorganic fertilizers to maximize yield. Such conjunctive use can also minimize the adverse effects on ecology as apprehended from long term use of fertilizers alone.

The important practices of integrated nutrient management are:

- ❖ Amelioration of soil problems on the basis of soil test results.
- ❖ Apply fertilizers on the basis of soil test results and crop requirement.

- ❖ Conserve all available bio-mass on the farm and convert them to compost/vermicompost.
- ❖ Add at least 2-3 tonnes compost/ha annually (10 t is ideal)
- ❖ Apply green manures to the field.
- ❖ Incorporate leguminous plant materials in to the soil.
- ❖ Adopt suitable crop rotation under mixed and intercropping system.
- ❖ Include legumes in crop rotation.
- ❖ Use appropriate biofertilizers.

ORGANIC MANURES

VERMICOMPOST

Vermicompost is an organic manure produced through bioconversion of organic waste materials into nutritious compost by earthworm activity. Some specific earthworms found near by the manure pit act as bioreactor 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 2-3 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 earth worm 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.
- (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 5 cm with materials like coconut coir, sugarcane trash over which 2 cm layer of FYM should be spread uniformly.
- (d) Arranging organic waste layer wise sand-witched with cow dung in the ratio of 10:3.
- (e) Covering the waste surface with layers of old gunny bags and allowing for partial decomposition of the wastes for 3 -4 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) Collection of vermi-compost in morning and heap it in the shape of pyramid under sun for 4-6 hours. The worms remaining at the bottom of the compost mass can be collected for further use of the next batch of organic waste composting.

- (i) 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. 500.00 per kilogram of earth worm.
- (j) The compost produced includes vermicasts, as a source of available form of plant nutrients alongwith vitamins and growth promoting hormones. The quality will depend on the nature of the substrate. On an average the nutrient content is N,1.2-1.8%; P₂O₅,0.4-0.6%; K₂O, 1.0-1.6% with C:N,14-18:1.

Vermicompost is used for the field crops @ 2.5 t/ha, for orchard trees or forest tree @ 1.0 kg/tree and in the potted plants and kitchen garden @ 50 g/plant.

ENRICHED COMPOST

The compost commonly prepared from the organic wastes is nutritionally poor particularly in respect of the phosphorus. To make the compost balanced 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 @ 1% and the Rock Phosphate @ 3% (Mussoorie, 100 mesh) is added to the straw material and inoculated with PSM (*Aspergillus awamori*) and the cellulose decomposing 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

- **Green Manuring *in –situ* :**

Dhaincha (*Sesbania aculeata*) and sunnhemp (*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. Sunnhemp is suitable for well drained soil condition whereas dhaincha 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 begins to flower, it is burried in the soil with the help of the plough and water is impounded for 2-3 days. Thereafter final puddling is done and paddy is transplanted. This practice adds about 12-15 t of green manure and 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.

- **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*, *Glyricidia maculata*, *Cassia tora*, *Sesbania speciosa*, *Ipomoea cornea* can be selected for green leaf manuring. Weeds like *Croton sparsiflorus*, *Leucas aspera* 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)
<i>Crotalaria juncea</i> (Sunnhemp)	16.50	73.00	3.01
<i>Sesbania cannabina</i> (Dhanicha)	14.80	78.00	2.67
<i>Vigna unguiculata</i>	10.00	85.00	2.63
<i>Cyamopsis tetragonoloba</i> (guar)	7.00	60.00	3.53
<i>Glyricidia maculata</i>	3.00	75.00	3.46
<i>Sesbania punctata</i>	3.70	73.00	2.42
<i>Cassia tora</i>	5.20	71.00	2.13

BIO-FERTILIZERS

RHIZOBIUM

Rhizobium bacteria are capable of fixing atmospheric N in association with leguminous plants. Different species of Rhizobium bacteria are used for treating different leguminous crops. Seed treatment is the common method of Rhizobium inoculation. After seed germination, the bacteria enter the roots of host plants and form nodules on the root surface. The bacteria fix N₂ and supply to the host plant. Depending on the type of host and environmental condition, about 20-100 Kg N /ha can be fixed by Rhizobia in a cropping season.

For seed treatment, a thick slurry of Rhizobium is prepared by mixing Rhizobium culture and water in 1:2 ratio. This is sprinkled over the seeds which are then thoroughly mixed and dried in shade. After drying the seeds are sown in the field. For 10 Kg seed, 200-250 g culture is used. For better efficiency of Rhizobium, 3g sodium molybdate is mixed with the wet seeds. Co-inoculation with equal amount of PSM culture also increases the efficiency of Rhizobium.

AZOTOBACTER AND AZOSPIRILLUM

These are free living aerobic bacteria capable of fixing nitrogen in different 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 of yield response have been reported in different parts of the country in a number of crops with application of *Azotobacter* and *Azospirillum* inoculants either alone or combinedly. These inoculants are used in all non legume crops.

Besides, nitrogen fixation *Azotobacter* has the ability 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 solubilising bacteria (PSB) is compatible for co-inoculation with *Azotobacter*.

Method of application

Cultures of *Azotobacter* and *Azospirillum* 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 roots of seedlings are dipped in the slurry of carrier-based inoculum for 10 to 30 minutes and then planted immediately. For sugarcane culture is applied at regular intervals in the early stages of growth by pouring the slurry near the root zone with addition of organic manure particularly at the time of weeding and earthing operation.

For Soil inoculation, One packet (500g) of carrier-based culture is mixed with about 10 kg of cattle manure/FYM four days before sowing the seeds. The mixture is moistened with water to maintain 40 to 50% moisture and then covered with gunny bags to maintain higher temperature required for rapid multiplication of bacteria. The culture inoculated FYM @ 100 kg/ha is used for band application to rice, ragi, maize, wheat, sorghum and other crops. The mixture can also be used for topdressing at the time of weeding and earthing of crops.

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 later on is added to the soil for increasing the fertility status. About 25-30 kg N/ha can be added through BGA inoculation to rice.

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 phosphorus or molybdenum, apply the recommended doses of phosphorus and the molybdenum in form of sodium or ammonium 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 or brick and mortar or 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 80 g of lime if soil is acidic. Apply 400g super phosphate.
3. Fill water (2"-6") depending upon the local conditions and rate of evaporation.
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 2-3 weeks thick algal mat will be formed on the surface of the soil and sometimes even float up. If the daily 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.
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 8-10 kg BGA per harvest and the annual production is 100-120 kg which is sufficient to inoculate 10-12 hectare of rice fields.
9. Fill the pits again and add a small amount of dry algal flakes, about a handful, 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 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 ponds, ditches and channels. The plants are branched with bilobed leaves and long suspended roots. It is found to be growing as a weed in the low land rice fields of some tropical and temperate countries like Vietnam, China, Thailand etc. Out of the several species, *Azolla pinnata* is found to be widely growing in some localities of India.

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

Low land/irrigated rice fields can be inoculated with fresh Azolla. If the desired field conditions are provided, Azolla will multiply very rapidly and can cover the whole surface of the standing water. Under favourable conditions Azolla multiplies 3 fold during a week. The optimum temperature for multiplication is 25-30°C. Upon incorporation of the Azolla biomass to 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 P₂O₅/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 dual cropping 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°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 or OUAT, Bhubaneswar.

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.

Techniques for multiplication

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 /m²).
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. Irrigate at periodic intervals, so that the water level is maintained at 10 cm.
7. Allow it for 10-15 days till a thick mat of azolla is obtained, 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.

Field inoculation

Azolla is inoculated 7 days after transplanting @ 1 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 benefit the rice crop.

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 other pests 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. The new approaches to weed management is the integrated weed management. 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. 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 alongwith other safe, effective, economical and eco-friendly control measures.

Major components of integrated weed management system (IWMS) have been identified as non-chemical methods with low cost input as follows :

1. Stale seed bed technique
2. Tillage
3. Mechanical and Manual method
4. Use of weed competitive crop and cultivars
5. Crop rotation
6. intercropping
7. Plant geometry and plant density
8. Nutrient management
9. Water management
10. Soil solarization
11. Herbicides
12. 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 plant 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 :

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

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. Dispose off the empty containers by burying them at least 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 at least 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 a.i./ha)	Manufacturer
<i>Alachlor</i>	Lasso-EC	50%	Pre*	1-3	Monsanto
	Lasso-G	10%	Pre	5-8	Monsanto
<i>Atrazine</i>	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
<i>Anilophos</i>	Anilophos-EC	30%	Pre, early post	0.3-0.4	Aventis
	Aniloguard-G	2%	Pre	0.3-0.4	Gharda Chemicals
<i>Benthiocarb/ Thiobencarb</i>	Saturn-EC	50%	Pre, early post	2-4	Pesticide India
<i>Butachlor</i>	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
<i>Dalapon</i>	Hexapon-WP	85%	Post**	2-5	BASF
	Dowpon-WP	80%	Post	5-10	Dow
	Dulapon				
<i>Diuron</i>	Karmex-WP	80%	Pre	0.5-1	Dupont
	Hexuron-WP	80%	Pre	0.5-1	B.P.M.
<i>Fluchloralin</i>	Basalin-SL	45%	PPI***	0.75-1.25	BASF
<i>Glyphosate</i>	Roundup-SL	41%	Post	0.5-2	Monsanto
	Glyfos - SL	41%	Post	0.5-2	Cheminova
	Glycel-SL	41%	Post	0.5-2	Excel Industries
	Weed off-SL	41%	Post	0.5-2	Nocil
<i>Isoproturon</i>	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
<i>Methabenz-thaizuron</i>	Tribunil-WP	70%	Post	1-3	Bayer
	Yield-70-WP	70%	Post	1-3	Bayer
<i>Metoxuron</i>	Dosanex-WP	80%	Post	0.75-1	Syngenta
<i>Metolachlor</i>	Dual-EC	50%	Pre	0.5-1	Syngenta
<i>Oxyfluorfen</i>	Oxygold EC	23.5%	Pre	0.05-0.5	Endofil
<i>Oxadiazon</i>	Ronstar-EC	25%	Pre	1-2	Aventis
<i>Paraquat</i>	Gramoxone-WSC	24%	Post	0.3-1	Syngenta
<i>Pendimethalin</i>	Stomp-EC	30%	Pre	1-2	Cynamid
<i>Pretilachlor (+safener)</i>	Sofit-EC Safener-CGA123407	30%	Pre	0.5-0.75	Syngenta
<i>Pretilachlor</i>	Rifit-EC	50%	Pre	0.75-1	Syngenta
<i>Simazine</i>	Hexazine-WP	50%	Pre	1-3	BPM
	Tefazine-WP	50%			Rallis India
<i>Triallate</i>	Avadex-EC	50%	PPI	1-2	Monsanto
<i>Terbutryn</i>	Igram-WP	50-80%	Pre	0.5-2.5	Syngenta
<i>2,4-D</i>	Atul-WSC	80%	Post	0.25-2	Herbicide India

Common name	Trade name & formulation	a.i.	Time of application	Rate (kg a.i./ha)	Manufacturer
<i>Amine salt EE</i>	Agrodore-95-WP	58%	Pre	0.5-1	Herbicide India
	Weedone-EC	18%	Pre	0.5-1	Pesticide India
	Knockweed-EC	36%	Pre	0.5-1	Rhone Poulenc
	Knockweed-G	4%			
<i>Metasulfuron + Chlorimuron</i>	Almix WP	20%	Early post	0.004	Dupont
<i>Clomazone</i>	Command-EC	50%	Pre	0.5	Rallis India
<i>Metribuzin</i>	Sencor-WP	70%	Pre	0.5-1	Bayer
<i>Oxadiargyl</i>	Topstar-WP	80%	Pre	0.07-0.1	Aventis
<i>Quizalofop-ethyl</i>	Targa Super EC	5%	Post	0.07-0.1	Dhanuka
<i>Sulfasulfuron</i>	Leader WP	75%	Post	0.025	Monsanto
<i>Imazapic</i>	Cadre AS	24%	Pre	0.12	Cynamide

* 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
Rice Upland (D.S.)	Oxadiazon	0.5	Pre	Annual grass & BLW
	Butachlor	1.00	Pre	Annual grass, BLW & Sedges
	Pendimethalin	1.00	Pre	Grasses & BLW
	Oxyfluorfen	0.03-0.04	Pre	Grasses & BLW
	Anilophos	0.30 – 0.40	Pre	Grasses & BLW
	Pyrazosulfuron ethyl (Sathi)	0.08	Post	
	Fenoxaprop ethyl	0.15	Post	
Medium land rice (D.S.)	Butachlor	1.25	Pre	Annual grass & BLW
	Pretilachlor	0.5 – 0.75	Pre	Annual grass & BLW
	Anilophos	0.40	Pre	Annual grass & BLW
	Pendimethalin	1.00	Pre	Annual grass & BLW
	Pyrazosulfuron ethyl (Sathi)	0.08	Post	
	Fenoxaprop ethyl	0.15	Post	
Transplanted rice	Pretilachlor	0.75	Pre	Grasses & BLW
	Butachlor	1.25	Pre	Annual grass & BLW
	Acetachlor	0.125	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
	Pendimethalin	1.00	Pre	Annual grass & BLW
	Cyclosulfamuron	0.03	Post	Annual grass & BLW
	Oxadiargyl	0.075	Post	Annual grass & BLW
	Almix	0.004	Post	Annual grass & BLW
	Cyhalofopbupyl	0.08-0.10	Post	

Crop	Name of the herbicide	Rate (kg a.i /ha)	Time of application	Weeds to be controlled
Maize	Pendimethalin	0.5-0.75	Pre	Annual grass & BLW
	Atrazine	0.5-1.00	Pre	Grasses & BLW
	Fluchloralin	1.00	PPI(1DBS)	Grasses & BLW
	Butachlor	1.00	Pre	Annual grass & BLW
	Alachlor	1.00	Pre	Annual grasses
	Metolachlor	1.00	Pre	Annual grass & BLW
	2,4-D-Na Salt	1.00	Post	Annual grass, Sedges & BLW
Ragi	Anilophos	0.20	Pre	Grasses & BLW
	Oxyfluorfen	0.02	4 DAT	Annual grass & BLW
	Metolachlor	0.40	4 DAT	Annual grass & BLW
	Butachlor	0.50		
Sorghum	Atrazine	1.00	Pre	Grasses & BLW
Arhar	Pendimethalin	1.00	Pre	Grasses & BLW
	Metolachlor	0.75	Pre	Annual grass & BLW
	Fluchloralin	1.00	PPI(1DBS)	Grasses & BLW
	Alachlor	1.00	Pre	Grasses & BLW
	Quizalofop-ethyl	0.05	Post	Annual and perennial grasses
Greengram & Blackgram	Alachlor	0.75	Pre	Annual grass & BLW
	Fluchloralin	0.75	Pre-plant	Grasses
	Pendimethalin	0.75	Pre	Annual grass & BLW
	Metolachlor	0.75	Pre	Annual grass & BLW
	Quizalofop-ethyl	0.05	Post	Annual and perennial grasses
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
	Metolachlor	1.00	Pre	Grasses and BLW
	Oxyfluorfen	0.02	Pre	Grasses & BLW
	Imazethapyr 24 AS	0.12	Pre	Grasses & BLW
	Quizalofop-ethyl	0.05	Post	Annual and perennial grasses
	Butachlor	1.00	Pre	Grasses & BLW
Sesame	Alachlor	1.00	Pre	Annual grass
	Butachlor	0.75	Pre	Annual grass, BLW & Sedges
	Metolachlor	0.50	Pre	Grasses & BLW
	Fluchloralin	0.50	PPI(1DBS)	Grasses & BLW
	Quizalofop-ethyl	0.05	Post	Annual and perennial grasses
Jute	Pendimethalin	0.75	Pre	Grasses & BLW
	Fluchloralin	1.00	PPI	Grasses & BLW
	Butachlor	1.20	Pre	Grasses & BLW
	Quizalofop-ethyl	0.05	Post	Grassy weeds
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
	Glyphosate	1.00-1.50	Post	Total killer
Cotton	Pendimethalin	1.00	Pre	Grasses & BLW
	Fluchloralin	1.00	PPI	Grasses & BLW
	Alachlor	1.00	Pre	Grasses
	Oxyfluorfen	0.45	Pre	Grasses & BLW
	Diuron	0.5-0.75	Pre	Grasses & BLW
	Glyphosate	1.00	Post	Total killer
	Quizalofop-ethyl	0.05	Post	Grasses

Crop	Name of the herbicide	Rate (kg a.i /ha)	Time of application	Weeds to be controlled
Brinjal	Fluchloralin	0.75	PPI	Grasses & BLW
	Alachlor	1.00	4DAT	Grasses & BLW
	Butachlor	1.00	4DAT	Grasses & BLW
	Quizalofop-ethyl	0.05	Post	Grasses
	Glyphosate	1.00-1.50	Post	Total killer
Legends :				
Pre=	Pre emergence		Post=	Post emergence
PPI=	Pre-plant incorporation		BLW=	Board-leaf weeds
DBS=	Days before sowing		DAYS AFTER SOWING=	Days after sowing
DAT=	Days after transplanting		Early post=	8-10 DAYS AFTER SOWING/DAT

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.	<i>Eichhornia crassipes</i> (Bilati dal)	Mixture of Glyphosate 0.5 + 2,4-D Na Salt 2.0	Active vegetative stage
2.	<i>Scirpus grossus</i> (Santara)	Mixture of Glyphosate 1.0 + 2,4-D Na Salt 2.0	Active vegetative stage
3.	<i>Pistia stratiotes</i> (Borjhanji)	Glyphosate 0.5-1.0	Active vegetative stage
4.	<i>Salvinia natans</i> (Kuji dala)	Glyphosate 0.5-1.0	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.	<i>Mikania micrantha</i> (Mile-a-minute/Indian hempvine)	Glyphosate 1.0 kg	Active growth stage
2.	<i>Parthenium hysterophorus</i> (congress grass)	Metribuzin 0.3 – 0.5 kg/ Glyphosate 1.5 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.
- ❖ Directed 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 at least for 5 years.

B. Chemical method

- ❖ Pre-plant incorporation of trifluralin 2.5 kg/ha or pre-emergence application of pendimethalin 1.5 kg/ha.

Striga spp.

A. Cultural method

- ❖ Eradicate the weed *Digitaria ciliaris/ 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.

FARM IMPLEMENTS AND MACHINERY

Name of the Implement	Features	Weight (Kg)	Field capacity
Mould Board Plough	<ul style="list-style-type: none"> Suitable for dry and wet land cultivation Replaceable share at nominal cost Operated by a pair of bullock and one person 	7.0	0.3 ha /day
Heavy soil plough	<ul style="list-style-type: none"> Works well in heavy soil condition Bar share ensure proper penetration Operated by a pair of bullock and one person 	8.5	0.24 ha /day
Seed – cum-fertilizer drill (Two row)	<ul style="list-style-type: none"> Line sowing of seed and fertilizer simultaneously Operated by one person Suitable for paddy and wheat crop 	15.5	0.5 ha /day
Bullock drawn seed drill (three row)	<ul style="list-style-type: none"> Used for sowing of paddy seeds in upland Seeds distribution is uniform through a cell type metering device Operated by a pair of bullock and one person 	20.5	0.80 ha /day
Tractors drawn seed drill(Nine row)	<ul style="list-style-type: none"> Used for line sowing of nine rows paddy or wheat in one pass Operated by 25-30 hp tractor 	200	3.0 ha /day
Pregerminated seeder (Six row)	<ul style="list-style-type: none"> Used for line sowing of pre germinated paddy seeds in wet land conditions 	15	0.8 ha /day
Pulse seed drill (Four row)	<ul style="list-style-type: none"> Used for line sowing of seeds of green gram, black gram, horse gram, arhar, cowpea and soybean Covers four rows in one pass Operated by a pair of bullock and one person 	26	1.0 ha /day
Interculture plough	<ul style="list-style-type: none"> Used for thinning of plants in direct seeded paddy and for weeding Operated by a pair of bullock and one person 	4.80	0.4 ha /day
Garden rake	<ul style="list-style-type: none"> Used for cleaning leaves, stones etc from garden and also suitable for interculture in ragi crop Operated by one person 	1.13	0.25 ha /day
Trench hoe	<ul style="list-style-type: none"> Used for weeding in line-sown crops Can be used either as phowrah or as pickaxe. 	1.1	0.1 ha /day

Name of the Implement	Features	Weight (Kg)	Field capacity
Gujarat hand hoe	<ul style="list-style-type: none"> Suitable for furrow making in row crops and earthing up operation in groundnut, potato, cotton and vegetables 	1.25	0.1 ha /day
Wheel finger weeder	<ul style="list-style-type: none"> Used for weeding in upland line sown crops (paddy, groundnut, mustard, pulse) Operated by one person 	7	0.12 ha /day
Cono weeder	<ul style="list-style-type: none"> 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 ha /day
Zigzag puddler	<ul style="list-style-type: none"> Suitable for puddling in light soil Operated by one pair of bullock and one person 	30	0.8 ha /day
Transplanting guide	<ul style="list-style-type: none"> Used as a marker for line transplanting of paddy seedlings as per recommended Can be prepared out of locally available materials by village artisans 	3	0.12 ha /day
Low volume sprayer	<ul style="list-style-type: none"> Used to spray pesticides in all field crops and horticultural crops Needs only 15 litre of water per hectare instead of 500 litre Operated by one person and four dry cells (6.0 volts) 	3.5	0.62 ha /day
Knap sack sprayer	<ul style="list-style-type: none"> Used to spray pesticides in all crops Provision of automatic agitation Operated by one person 	5	0.76 ha /day
Power sprayer-cum - duster	<ul style="list-style-type: none"> Ideal for quick spraying in orchards, tea, coffee, paddy and other crops Also used for economic, effective and quick application of dry pesticides (in dust form) 	6.5	1.76 ha /day
Improved sickle	<ul style="list-style-type: none"> Used for harvesting of paddy crop Replaceable serrated blade at nominal cost 	0.22	0.08 ha /day
Pedal operated paddy thresher	<ul style="list-style-type: none"> Used for threshing of paddy Threshing efficiency is 95-98 percent Operated by one person 	45	250 Kg / day
Power operated paddy thresher	<ul style="list-style-type: none"> Used for threshing of paddy Threshing efficiency is 96-99 % Operated by 1.0 hp single phase electric motor and 3 persons 	68.5	10-12 qntl./ day

Name of the Implement	Features	Weight (Kg)	Field capacity
Paddy thresher-cum-winnower (power operated)	<ul style="list-style-type: none"> • Used for threshing and clearing of paddy • Operated by 1.0 hp single phase electric motor and 4 persons. • Can be used for Groundnut threshing. 	97	10-12 qntl. per day (paddy)
Manually operated winnower	<ul style="list-style-type: none"> • Used to clean chaff and other light foreign materials from threshed paddy. • Cleaning efficiency is 90 per cent 	29	17-20 Qntl. Per day
Parboiling unit	<ul style="list-style-type: none"> • Used for parboiling of paddy • Two persons are required. 	36	75 Kg per batch
Low lift hand pump	<ul style="list-style-type: none"> • Lifts water from dug well, farm pond, canal • Most suitable for vegetable crops • Useful to give life saving irrigation for crops • Replacable diaphragm at nominal cost • Operated by one person 	30	5000 liters per hour (from a depth of 5m)
Krushak bandhu pump	<ul style="list-style-type: none"> • Used to lift water from dugwell, borewell, pond, and canal. • Most suitable for vegetable crops • Useful for giving life saving irrigation • Valves last upto 900 hour of operation and are replaceable at nominal cost. • Operated by one person 	17	3000 liters per hour (from a depth of 3.6 m)
Groundnut planter (two row)	<ul style="list-style-type: none"> • 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 	15.5	0.5 ha /day
Groundnut digger	<ul style="list-style-type: none"> • Used for digging of groundnut and also suitable for potato digging • Ploughing of the land for the subsequent crop is achieved without any extra expenditure • Operated by a pair of bullock and one person 	10	0.4 ha /day
Groundnut decorticator (Oscillating type)	<ul style="list-style-type: none"> • Used for separating groundnut kernels from the pod • Operated by one person 	14	400 Kg. Per day
Groundnut decorticator-cum-cleaner (power operated)	<ul style="list-style-type: none"> • Used for decortication of groundnut pods and cleaning of kernels • Decortication efficiency is 98% and cleaning efficiency is 96% • Operated by 1.0 hp electric motor and one person 	39	12.0 quintal per day

Name of the Implement	Features	Weight (Kg)	Field capacity
Self propelled rice transplanter (8 row)	<ul style="list-style-type: none"> • Used for line transplanting of Paddy • Row spacing of 23.8 cm and hill spacing of 12, 14 or 17 cm is maintained 	320	1.20 ha/ Day
Power tiller operated axial flow thresher	<ul style="list-style-type: none"> • 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 percent 	450	3.80 qntl per hour .
Self propelled Reaper	<ul style="list-style-type: none"> • 1.2m cutter bar which harvest cereal crops of 60 cm height & above • Operated by 4 to 5 hp diesel engine or petrol start kerosene engine 	180kg	1.6 ha /day
Tractor mounted Rotavator	<ul style="list-style-type: none"> • Suitable for seed bed preparation • Working depth of 10 to 12 cm and width of 120 cm is maintained. 	215	0.4 ha / hr

BEE KEEPING

Apiculture (Bee keeping) is an integral part of the Integrated Farming System. It contributes an appreciable share in enhancing yield of agricultural and horticultural crops with quality produce through bee pollination. It can be taken up as an agricultural practice especially in areas where oil seed crops (niger, mustard, sesame and sunflower) and horticultural crops (guava, citrus, litchi, coconut, ber etc.) are extensively grown. Further, establishment of apiculture based floriculture (calendula, cosmos, marigold, gladioli, aster, chrysanthemum, rose, dahalia, zinnia, etc.) will make bee keeping enterprise more rewarding. Bee keeping improves the socio-economic conditions of the rural people. It acts as a very good enterprise for landless farmers, SHG and income-generating avenue for the unemployed rural youth.

Orissa is very rich in its diverse bee fauna as well as ample flora to support bee keeping. All the four leading species of social bees are existing in the state. They are

Rock bee	:	<i>Apis dorsata</i>
Indian hive bee	:	<i>Apis cerana indica</i>
Little bee	:	<i>Apis florea</i>
and Sting less bee	:	<i>Trigona irridipennis.</i>

Besides, the Italian honeybee, *Apis mellifera* introduced to the state during 1990 has been domesticated successfully in the inland districts like Koraput, Kandhamal, Keonjhar and Mayurbhanj.

Successful bee keeping necessitates clear understanding about the bee behaviour and the amenable conditions the bee species requires and adopts the bee management practices accordingly.

Brood development and honey flow season in Orissa

<i>Annual Phases of Honeybees</i>	<i>Months</i>
Breeding season	October – November and December – February
Swarming Period	October – November and December – February
Major honey flow season	February to May
Minor honey flow season	October - December
Major dearth/ Lean period	June – September
Major dearth/ Lean period	January

Bee Management

- The seed yield in different oilseed crops like mustard, sesamum, niger, sunflower and safflower can be increased by placement of 3-5 bee colonies/ acre.
- Bee foraging crops can be treated with safer insecticides before onset of flowering and preferably during afternoon hour to safe-guard the crop against the pests and simultaneously to ensure adequate activity of the pollinators without having lethal contamination with insecticides.
- The sting less bees, *T. irridipennis* can be hived successfully in wooden box (25 X 15 X 13 cm) in the backyard to ensure pollination of backyard crops or kitchen garden crops.
- Fumigation with 85% Formic acid @ 5 ml/colony/ day for 21 days is suggested to achieve satisfactory control of the mite *Tropilaelaps clareae* in the Italian honeybee colonies.

- Metranidazole (Metron) an ant-amoebic drug can be fed to bees @ 5 ml/ hive with equal amount of sugar syrup or honey controls Nosema disease in *A. mellifera*.
- Removal of old combs and spraying with neem oil (2.0%) or Dipel (1.5%) on bottom board checked the incidence of wax moth during rainy and post rainy seasons.

Specific tips for successful bee management

- Maintain the colony with young and healthy queen and requeen the colony on every 1 or 1 ½ years.
- Allow the bees to construct 3-4 fresh combs every year during appropriate time.
- Cover the brood chamber with cloth while inspecting the colony.
- Use the smoke gently if at all necessary.
- Harvest honey timely when 70-80% combs in super chamber are sealed.
- Extract honey by using extractor or don't keep honeycombs and honey exposed in the apiary for long time.
- Feed the bees with sugar solution in the afternoon hour during dearth period.
- Provision should be made for well ventilation of hive with protection from extreme temperature in summer and temperature regulatory measures in winter.
- Regular inspection and cleaning of bottom board at 7-10 days interval especially in kharif season should be done.

It can be taken up as an agricultural practice especially in areas where oil seed crops (niger, mustard, sesame, and sunflower) and horticultural crops (guava, citrus, litchi, coconut, ber etc.) are extensively grown. Further, establishment of apiculture based floriculture (calendula, cosmos, marigold, gladioli, aster, chrysanthemum, rose, dahalia, zinnia, etc.) will make beekeeping enterprise more rewarding. The one time capital investment and gains there off from a medium scale apiary unit of 10 bee colonies are presented below.

CAPITAL INVESTMENT AND ESTIMATED SALES REALIZATION FROM A MEDIUM SCALE APIARY UNIT WITH 10 BEE COLONIES.

Capital investment				Estimated Sales realization during		
Item	Cost	Qty.	Total	1 st year	2 nd year	3 rd Year
Beehives	1024=00	10	10240=00	Honey: Rs15,000=00	Honey: Rs15,000=00	Honey: Rs15,000=00
Nucleus box	400=00	05	2000=00	Wax: Rs.50=00	Wax: Rs.50=00	Wax: Rs.50=00
Hive stand	200=00	10	2000=00	Colonies: Rs3000=00	Colonies: Rs3000=00	Colonies: Rs3000=00
Queen gate	6=00	10	60=00	Total receipt: Rs18050=00	Total receipt: Rs18050=00	Total receipt: Rs18050=00
Beeveil	96=00	01	96=00	Gain/Loss:	Gain/Loss:	Gain/Loss:
Smoker	156=00	01	156=00	-Rs1782=00	+Rs15448=00	+Rs17230=00
Honey extractor	510=00	01	510=00	(74% recovery of capital is ensured during first year)		
Misc.Expd.	200=00	-	200=00	Additional earnings:		
Bee colonies	300=00	10	3000=00			
Transport & establishment	-	-	250=00			
Honey storage steel drums	250=00	02	500=00			
Total			19,012=00	<ul style="list-style-type: none"> • By renting the honey extractor @ Rs.25-30/- per day. • By renting the bee colonies for crop pollination @ Rs.50/- per flowering season. • Value accrued owing to enhanced crop yield due to cross pollination. • Rendering expertised skill service. 		
Consumable items:						
Sugar	20=00	06kg	120=00			
Migrating bee colonies	-	-	500=00			
Disease/Pest control	-	-	200=00			
Total			820=00			
Grand Total			19,832=00			

PRE-COCOON MANAGEMENT IN REARING OF MULBERRY AND ERI SILKWORMS

Silk is an animal protein fiber produced by silkworm larvae for spinning of cocoon. Sericulture, being an age-old tradition of rearing of silkworms, includes plantation of the host plant, rearing of silkworms, extraction of silk yarn from cocoon, weaving of the fabrics and its marketing. It is a highly labour intensive rural based agro-industry which provides rural employment to poor people including tribal, schedule caste and women round the year. It can generate employment upto 11 persons for every kg of raw silk produced out of which more than 6 persons are women.

Sericulture in Orissa is a major source of livelihood for rural poor, mostly in the tribal dominated districts of Mayurbhanj, Keonjhar, Sundargarh, Kandhamal, Rayagada, Koraput, Gajapati, Kalahandi, Nawarangpur, Jajpur, Deogarh and Dhenkanal. In Orissa three types of silkworms such as Mulberry (*Bombyx mori*), Tasar (*Antheraea mylitta*) and Eri (*Samia ricini*) are cultivated. Tasar is cultivated in natural forest by the tribals in a traditional manner. The tropical humid forest constitutes 80% of the total forest area of the state where primary tasar food plants are abundantly available. There are about 46,828 SC / ST families practising tasar cultivation in thirteen hilly districts of the state. Massive plantation of Asan and Arjun are taken up to expand tasar cultivation. Annually 44,000 kahanas of tasar cocoons are produced and marketed in the state.

Eri culture is traditionally practised in 12 districts of the state. Besides castor, it can feed on Kessuru, Payam, Cassava, Sankru etc. which are available in plenty. At present there are about 1090 beneficiaries and 2.13 MT of cocoons are being produced annually.

Mulberry cultivation has been introduced in the recent past and practiced in 9 districts of the state. About 30,000 to 50,000 kgs of cocoon are produced annually. In Orissa, mulberry programme has been taken under poverty alleviation programme and mulberry gardens are developed mostly in rainfed situations.

In Orissa there is a great demand for raw silk. At the moment, state produces only 50 MT of silk as against demand of 250 MT. Moreover, overall climate of the state is quite congenial for sericulture with well-defined rearing seasons, and abundant natural resources. Hence there is a great scope for sericulture expansion in the state. However, lack of awareness & competitive market, non-availability of good varieties of host plants and silkworm breeds and poor adoption of viable technologies are the reasons of slow growth of sericulture industry in the state. Technologies available for efficient rearing of domesticated species of silkworms such as mulberry and eri in the state are given below.

Package of practices for mulberry silkworm rearing:

Mulberry cultivation

- Soil should be porous, loamy or sandy loam or clay loam with PH 6-7

- Ensure fine tilth up to 30-40 cm depth
- Select improved variety of mulberry –S1635/S 34
- Planting should be done in pits of 1.5'x1.5'x1.5'size at a spacing of 3' x 3'
- Add 5 Kg FYM and 5-10 gms of chlorpyrifos dust prior to planting
- Maintain 4900 plants per acre
- Transplant 3-4' high saplings in the pits during April-May
- Use bio-fertilizers such as Nitrofert @ 10 Kg/ha/yr in 2 equal split doses and Phosphofert: 40 Kg/ha once in 4 years
- Use N:P:K:@ 75:37.5:37.5 Kg/ha and vermicompost @ 5 MT /ha/yr
- Weeding should be done at 60 and 90 DAP
- In 2nd year prune the plant at 1.5-2.0' height in the month of June and at 6' height in November
- Carry out hoeing , weeding and fertilizer application after each pruning
- Green manuring may be done with Dhanicha, Sunhemp depending on water availability
- Plant Growth Regulator should be sprayed @ 0.01% after 15 days and 30 days after pruning
- Integrated pest and disease management should be practiced.
- Leaf should be harvested 10 wks of pruning during autumn and spring seasons.

Silk worm rearing

- Disinfection of rearing house and appliances with 5% bleaching powder solution
- Fumigation of air tight rearing house may also be done by using 10% formaldehyde and heat on a pan over a stove or heater
- Surface disinfection of larvae/ silkworm rearing bed by using Resom Keet Oushadh(RKO) against grasserie and muscardine / Formaline chaff / or Dithane M 45 and Kaoline mixture for controlling Muscardine disease.
- Disinfection of silk worm eggs should be done in 2% formaline for 10 minutes
- Maintain hygienic condition by proper disposal of dead and diseased larva
- Clean the floor of the rearing room with 2% bleaching powder solution every day after bed cleaning
- Dust bleaching powder-lime mixture at the entrance and around rearing building
- Wash hand and feet with formaldehyde solution before attending the rearing work.
- Use Multi x B1 hybrids in rainy and B1 x B1 in Autumn and Spring season
- Rear newly hatched larvae up to the beginning of 3rd instar for a period of 8-9 days as per standard chawki rearing technique

Incubation of DFLs

- Incubate silk worm dfls at 25 ° C and 80-86% RH for uniform hatching
- On 9th day remove paraffin paper cover from the tray and cover it with a black sheet of paper.
- On 10th day remove the black paper and suddenly expose the dfls to bright light between 8 am to 9 am to ensure uniform hatching.

- Brushing of silk worm in early hour (8 am-10 am) and after 10 min. transfer worm along with leaves into rearing tray @ 25 dfl/tray.
- Use ant wells to prevent ants attack.
- Use freshly plucked tender, dark green succulent leaves for rearing
- Maintain 27-28 °C temperature and 85-90% RH in the rearing chamber. Rear the grown up worms in one tray (3rd-5th instar) which needs 16-17 days
- Use bed disinfectants- Labex @ 3.5 Kg/ 100 dfls
- Pick the ripe worms 6-7 days after 4th moult and mount @ 1000 worms on chandrika 1.8m x 1.2m size
- Maintain 24 °C temperature and 60-65% RH and harvest the cocoon on 5th day.

Package of practice for Eri culture:

Castor cultivation

- Select highland with good drainage facility
- Plough the land 2-3 times and ensure fine tilth up to 20-30 cm depth
- Sow seeds of local variety (preferably non-blooming type) in pits of 20x25x25 cm size at 1m x 1m spacing.
- Sowing is to be done in March-April and Sept-Oct after seed treatment with Bavistin @ 2g/kg of seeds
- NPK @ 24:16:8 Kg/ha should be applied along with 1 kg FYM/pit
- 1st leaf harvest should be after 3 months and subsequently after 1.5-2 months interval

Eri silk worm rearing

- Construct well ventilated , fly proof rearing room
- Disinfection of rearing room and appliances with 5% bleaching powder solution or fumigate the rearing chamber with 5% formaldehyde solution
- Incubate dfls at 24-26 °C and 85-90% RH
- Wash hands with 2% formaline solution prior to starting handling operations
- Supply chopped tender leaves to newly hatched worms, whole tender leaves to 2nd instar, semi mature leaf to 3rd and 4th instar and mature leaves to 5th instar
- Feedings may be provided 4 times a day for larvae up to 4th instar and five times to 5th instar
- Close monitoring should be done for Pebrine disease incidence and take-up steps to destroy the whole affected lot
- Cover nylon net to prevent uzi fly attack
- Clean rearing bed once for 1st instar, twice for 2nd instar, thrice for 3rd and 4th instar and every day in 5th instar stage
- Provide adequate space in rearing tray for different instars
- Collect mature worms 5-7 days after 4th instar and put 50-60 worms per sq.ft in bamboo chandrika for pupation
- Mount 500-550 worms in chandrika of 1.8m x 1.2m
- Maintain 24-25 °C temperature and 75-80% RH
- Harvest cocoon 5th day in summer and 9th day in winter

PADDY STRAW MUSHROOM CULTIVATION

Paddy straw mushroom is also called Chinese or straw or tropical mushroom. It comprises of species belonging to the genus *Volvariella*. Of the over 25 species known, *V. volvacea*, *V. diplasia* and *V. esculenta* are edible and are well known for their table delicacy in many parts of the world. They are very delicate and must be consumed fresh. Half life is 12 hours only. If stored at 10-12 °C, this can be extended upto 3 or 4 days. These are commercially grown in China, Indonesia, Myanmar, Philippines, Taiwan, Madagascar, India and Nigeria.

Climate

Paddy straw mushroom can grow well in temperature ranging between 25 to 38°C. However, good production can be achieved in an environment of 30°C. Atmospheric humidity of 85 to 90% with sufficient light (1000 lux) and oxygen during reproductive stage are required for a good crop.

Materials

Paddy straw 15 bundles or 12 kg, spawn 300 g, pulse powder/wheat bran 250 g, polythene sheet of size 6' X 6'

Cultivation procedure

- ❖ Collect dry, hand threshed paddy straw which is not very leafy, not more than one year old and uncrumbled.
- ❖ Store the straw at a protected place where it does not get wet during rain.
- ❖ Soak the bundles in clean and cold water for 12-18 hours in small tanks, in such a way that the bundles are completely immersed in water.
- ❖ Take-out the bundles from the tanks
- ❖ Bundles can be pasteurized by steaming for one hour or mixing 100 ml of Formalin and 10 g of Bavistin in 100 litre of water at time of soaking.
- ❖ Drain out the excess water from the straw. Substrate moisture of 65% is appropriate for mushroom cultivation.
- ❖ Make square beds (2' X 2' X 2') of the soaked straw bundles placed length wise close to each other on a bamboo frame supported on bricks with the thickness of the first layer at 6".

- ❖ Make spawn bits from the spawn block and divide into four parts. Likewise divide the pulse powder into 4 parts.
- ❖ Place ¼ th of spawn bits 4” inside the margin leaving a space of 4” from each other and sprinkle ¼ th pulse powder over it.
- ❖ Make a 2nd layer by placing the bundles at right angles to the previous layers i.e. criss cross fashion with a thickness of 6” and spawn this layer too as done earlier.
- ❖ Place the 3rd layer of straw bundles over the 2nd layer opposite to it.
- ❖ Spread two parts each of spawn bits and pulse powder over the entire surface of third layer.
- ❖ Cover the inoculated layer with loose straw and press down the bed. Cover the bed with a polythene sheet after trimming.

After care and yield

Remove the polythene sheet after 7-10 days of spawning for the appearance of small buttons. Harvest the mushrooms when the volva is about to rupture or is just ruptured by gently twisting the fruiting bodies.

From one bed 1.5 kg mushroom will be harvested in two flushes. The first flush will give 90% of yield within 15 days of spawning and remaining 10% after one week.

Economics

To prepare a bed Rs.25/- to Rs.30/- will be required. Cost of the produce is Rs.75/- @ Rs.50/kg with a net return of Rs.45/- to Rs. 50/- in a crop cycle of 15 days.

POST HARVEST TECHNOLOGY AND VALUE ADDITION

Proper post harvest management is very important not only to prevent losses, but also to maintain the nutritive quality of the food product. In addition, suitable processing and value addition technologies can also generate additional employment and income. The most common post harvest operations for the food grains include the threshing, drying, handling, processing or milling, storage, marketing and distribution. The effects of all these unit operations are cumulative and decide the final quality of the product.

Processing of Cereals, Pulses and Oilseeds

Drying: Physiologically mature crop at optimum moisture content should be harvested to minimise losses due to shattering, sprouting, bad weather, and attacks by birds, rodents, insects and molds. Usually if there is a higher moisture content than that required for storage, then the grains should be dried to proper moisture level for safe storage and better milling recovery. The optimum moisture content for safe storage of paddy is 12.5 -14% for a storage upto 6 months. For prolonged storage up to 2 years, the safe storage moisture level is 10.5 -12 per cent. The oilseeds, in general, should be stored at lower moisture content than the cereal grains.

Drying can be done either under sun or with the help of mechanical dryers. Mechanical dryers, due to controlled drying conditions yield better quality product than the sun drying. The heated air dryers may be broadly classified as below.

Batch and/or bin dryers suitable for drying and storing of farm crops

Continuous flow dryers for commercial drying of paddy, oilseeds and pulses. The LSU dryer is a common continuous mixing type dryer.

Low cost dryers for batch drying can also be fabricated locally to meet the requirement of small millers and small scale drying operations. The dryer can be designed to use agricultural waste as the fuel. The basic selection of the dryer is to be done depending on the crop to be dried and the throughout capacity.

Different processing units can be established for the processing of food grains, as stated below.

- * Rice mill
- * Parboiling unit
- * Production of rice flakes, puffed rice and popped rice
- * Rice bran stabilisation unit
- * Rice bran oil extraction unit
- * Dal mill
- * Flour mill to manufacture maida, atta, besan, etc.
- * Bread, bakery and snack-food manufacturing unit
- * Breakfast cereals production

- * Extruded products
- * Oil mill
- * Oil refining and packaging unit

In all the above cases, suitable selection of equipment and process parameters are vital in obtaining a better quality product.

Rice Milling

In rural areas, rice is mostly milled by traditional hullers. As high pressure is applied in the huller for separating the husk cover and bran layers from paddy in a single stage, there is considerable breakage of rice. Therefore, modern rice mills or rubber roll sheller type rice mills should be used for milling of rice. The modern rice mill involves a set of machines for milling of rice, as follows.

Different unit operations in a modern rice mill

Operation	Purpose	Machines used
Cleaning	For obtaining better grade product and protecting subsequent machines	Sieves, Aspirators, Magnetic separators, Stoners, etc.
Dehusking	For separating husk from the paddy grain	Rubber roll sheller Centrifugal sheller
Husk aspiration	For separation of husk from the product	Husk aspirator
Paddy separation	For separation of paddy from brown rice	Compartment type paddy separator Tray type paddy separator Specific gravity paddy separator
Polishing	For removal of bran adhering to the rice	Vertical cone polishers Horizontal polishers
Grading	For separation of broken rice from head rice	Plansifter Trieur
Glazing	For luster	Glazing drums

In addition to getting higher yield of rice, the modern rice milling system also gives husk and bran separately. The husk has several uses as fuel, raw material in cardboard preparations and is a rich source of silica. The rice bran contains 20-25% oil (by weight) and can be used as a rich source of both edible and non-edible oil.

Another unit operation named parboiling is the hydrothermal treatment to paddy to improve the quality and yield of rice during milling. The process basically involves soaking of the paddy in hot water (65-85°C) for 4-6 hours, followed by steaming for 5-10 minutes and then drying. Parboiled rice gives an increase of 1-2% in total yield and 5-10% in head rice yield as compared to the raw rice. Small parboiling tanks are also available which take 6-8 hours to parboil a batch of 75 kg paddy. Such tanks can also be fabricated locally.

Storage of grains

The traditional storages structures made of straw, bamboo, mud, etc. are not rat proof, insect proof or moisture proof. These traditional storage structures can be made rat proof by constructing the structure at an elevated platform made of stone or RCC with sufficient overhang from the pillars supporting the platform, covering the lower 90 cm height of the structure with 22 gauge metal sheet, and by fixing inverted metal cones on the pillars supporting the platform. In high humidity regions, an additional polythene sheet layer may be provided on the inner side of the structure to reduce moisture ingress. Besides, suitable provisions are made to prevent entry of the rain water into the structure.

The bins, silos, RCC godowns come under the category of modern storage structures. As the silos are practically air tight, the operations such as insect proofing, fumigation and maintenance of sanitary conditions are easier as compared to traditional structures. The improved storage structures like Pusa bin stores the food grains in a better way than the traditional ones. Pusa bin is constructed of kachha bricks with a plastic film on all the inner sides for moisture proofing.

Processed Fruits and vegetables products

A wide scope exists for production of different processed fruits and vegetables products, which not only prevents loss, but also adds to income. Some such products are given below.

- * Dehydrated fruits and vegetables
- * Canned fruits and vegetables
- * Jams, jellies, Marmalades
- * Squashes and syrups, RTS beverages
- * Pickles and Chutneys
- * Fruit bars and toffees
- * Preserves and candied fruits and vegetables
- * Potato products
- * Tomato products
- * Tamarind pulp concentrate
- * Papain from papaya latex
- * Ground and processed spices
- * Processed cashewnut, etc.
- * Storage of fruits and vegetables

The fruits and vegetables are perishable and it is very essential to store them under recommended temperature and relative humidity conditions. The cold stores can be used to extend the shelf life of fresh fruits and vegetables for extended period. For short term storage in low relative humidity conditions, evaporatively cooled structures can be used. For high value products, controlled atmosphere and modified atmosphere storage can be employed.

Annexure - I

**CHARACTERISTICS OF HIGH YIELDING RICE VARIETIES
SUITABLE FOR CULTIVATION IN ORISSA**

Sl. No	Varieties	Duration (days)	Grain type	Potential yield (t/ha)	Reaction to disease and insect pests										Special features and areas of adoption
					B	S	S	B	H	S	G	G	B	P	
					B	S	S	B	H	S	G	G	B	P	
I.	Extra early														
1	Sneha	70	MS	2.00	-	-	-	-	-	-	-	-	-	-	Semi-dwarf, white kernel, drought tolerant, tolerant to gundhi bug, suitable for rainfed uplands.
2	Heera (CR 544-1-2)	70	LS	3.00	R	-	-	-	-	-	R	R	-	-	Hull red colour, white kernel, suited to drought prone uplands and also to late planting as a post flood crop.
3	Kalinga-III (CR 237-1)	80	LS	3.00	M	-	-	S	-	M	-	-	M	R	Semi-tall, cold tolerant, Susceptible to gundhi bug, suitable for drought prone uplands.
II.	Early duration														
4	Pathara (OR 83-23)	90	MB	6.50	M	-	-	M	R	M	R	M	M	R	Semi-dwarf, hull straw coloured, MB grains and suitable for uplands all over the state.
5	Parijat (OR 34-16)	95	MS	7.00	M	-	-	M	M	M	M	S	-	-	Semi-dwarf, hull straw coloured, white kernel, MS grains, grown All over the state in upper mal and coastal uplands.
6	Khandagiri (OR 811-2)	95	MS	6.00	R	M	-	-	R	R	-	M	-	-	Semi dwarf , hull straw colour, white kernel, moderately resistant to RTV, suited to uplands,
7	Ghanteswari (OR 377-85-6)	95	MB	7.00	R	M	M	-	M	R	-	R	-	-	Semi dwarf , hull straw colour, dull red kernel, suited to uplands
8	Udayagiri (OR 752-38-1)	95	MB	5.50	R	M	-	M	R	R	-	M	-	-	Semi-dwarf , hull golden colour, dull red kernel, suited

Sl. No	Varieties	Duration (days)	Grain type	Potential yield (t/ha)	Reaction to disease and insect pests										Special features and areas of adoption	
					B	S	S	B	H	S	G	G	B	P		
																to uplands,
9	Lalitagiri (OR 1045-1-3)	95	MB	6.50	M	-	R	-	R	R	-	R	M	R		Semi dwarf , hull straw colour, white kernel, moderately resistant to RTV, suited to uplands,
10	Badami (OR 164-5)	95	MB	7.5	M	-	-	M	R	M	R	-	-			Semi-dwarf, hull and kernel golden colour, suited to uplands.
11	Anjali	95	MS	3.50	-	-	-	-	-	-	-	-	-			Semi-dwarf, drought tolerant, suitable for direct seeding in favourable uplands.
12	Vandana	95	SB	3.00	-	-	-	-	-	-	-	M	R	-		Semi-tall, cold tolerant, possess tolerance to major pests and diseases, susceptible to gundhi bug, suitable for drought prone uplands
13.	Jogesh (OR 1519-2)	89	MB	5.60	M	M	-	M	-	M	-	R	M	R		Semidwarf, hull straw colour with MB white kernel, Suitable for drought prone uplands. Resistant to BS, Neck blast.
14.	Sidhant (ORS 102-4)	96	SB	7.30	-	-	M	M	-	R	-	R	M	R		Semitall, slender stem, SB golden hull and white kernel, suitable for drought prone uplands. Resistant to Leaf blast, LF and Brown spot, Moderately Resistant to Neckblast, RTV, WBPH.
III.	Medium Duration															
15	IR-36	115	MS	7.00	M	-	-	R	R	M	R	M	R	-		Possess broad spectrum of resistance to

Sl. No	Varieties	Duration (days)	Grain type	Potential yield (t/ha)	Reaction to disease and insect pests										Special features and areas of adoption	
					B	S	S	B	H	S	G	G	B	P		
																diseases and insect pests, adaptable to irrigated medium lands,
16	Naveen (CR 749-20-2)	15	B	.0		R										Semi dwarf, N-responsive, resistant to viviparous germination, suitable for medium land.
17	Navin (CR 749-20-2)	120	MB	4.50	M	M	-	-	M	-	R	-	-			White kernel, suitable for rainfed medium land
18	Sebati (OR 776-SSD-26)	125	MS	6.00	R	-	M	M	R	-	-	R	M	R		Semi dwarf , hull straw colour, white kernel, resistant to leaf folder, suited to medium lands,
19	Bhoi (OR 987-13)	125	MB	6.00	R	-	-	M	R	-	-	R	-			Semi dwarf , hull straw colour, white kernel, resistant to leaf folder and WBPH, suited to medium lands
20	Konark (OR 1143-230)	125	MS	8.50	M	-	-	M	R	R	-	R	M	R		Semi dwarf , hull straw colour, white kernel, resistant to RTV, very high yielders, suited to medium lands,
21	Kharavela (OR 815-3)	125	MS	8.00	R	-	R	-	R	R	-	R	-			Semi dwarf , hull straw colour, white kernel, resistant to RTV, LF and WBPH, suited to medium lands.
22	Radhi (CRM 40)	125	LB	4.50	S	-	-	-	-	S	-	-	-			Tall plant type, white kernel, suitable for shallow lowlands.
23	Srabani OR 367-SP-II)	125	MS	7.50	R	-	-	M	M	M	M	M	M	R		Suitable for medium land. Golden coloured hull, white kernel, Semi tall
24	Lalat (ORS 25-2014-4)	125	LS	7.50	R	-	-	R	R	M	R	R	R			Possess resistance to gall midge and BPH, Suitable for medium land.

Sl. No	Varieties	Duration (days)	Grain type	Potential yield (t/ha)	Reaction to disease and insect pests									Special features and areas of adoption
					B	S	S	B	H	S	G	G	B	
					h	h	L	M	B	L	M	P	H	
25	Gajapati (OR 820-29)	130	MS	7.00	R	-	R	-	R	R	-	R	-	Semi dwarf , hull straw colour, white kernel, suited to medium lands.
26	Cotondora sannalu (MTU-1010)	130	LS	6.00	-	-	-	R	-	-	-	-	R	Suitable for medium land
27	Surendra (OR 447-20-P)	135	MB	7.50	R	-	R	-	R	R	-	R	R	Semi dwarf , hull straw colour, white kernel, apiculus pigmented, resistant to RTV, LF and WBPH, suited to medium lands.
28	Tapaswini (CR 333-6-1)	135	MS	7.00	M	-	-	R	-	M	-	M	R	Semi-dwarf, resistant to WBPH, submergence tolerance for 7 days, susceptible to gundhi bug and brown spot, suitable for irrigated medium land,
29	Geetanjali (CRM 2007-1)	35	S	.5										Selection from Basmati 370, photo-insensitive, intermediate plant height, aromatic rice, suitable for medium land
30	Jajati (OR 47-2)	135	SS	6.00	M	-	-	M	M	S	S	R	M	Intermediate height, performs well in low fertility condition. Suited to medium land
31	Padmini (CRM 30)	140	SF	4.00	-	-	-	R	-	-	-	-	-	Suitable for irrigated medium land and also for late planting upto 1 st week of September in jute-rice system
32	Meher (ORS 26-2008)	140	MB	6.50	R	-	-	-	-	-	-	R	R	Semi dwarf, white kernel, suited to medium lands

Sl. No	Varieties	Duration (days)	Grain type	Potential yield (t/ha)	Reaction to disease and insect pests										Special features and areas of adoption
					B	S h B	S h R	B L B	H M	S B	G L H	G M	B P H		
33	RGL-2538	140	LB	5.00	R	-	-	-	-	-	-	R	-	Semi-dwarf, suitable for late planting kharif.	
34	Swarna (MTU-7029)	145	MS	7.00	-	-	R	-	-	-	-	-	-	Seed hull red in colour, white kernel suitable for rainfed low lands.	
35	Vijeta (MTU-1001)	145	MS	6.00	M R	-	-	-	-	-	-	R	R	Seed possess dormancy for 6-8 weeks, suitable for kharif and rabi. In rabi it takes 125 days. Suitable for irrigated medium land and rainfed low land.*	

* To break dormancy, sundry the seeds between 10 A.M. to 3 P.M. for 10 days during April-May or soak the seeds in 250 ppm GA₃ or 0.1 N nitric acid for 24 hours.

Sl. No	Varieties	Duration (days)	Grain type	Potential yield (t/ha)	Reaction to disease and insect pests										Special features and areas of adoption
					B	S h B	S h R	B L B	H M	S B	G L H	G M	B P H		
36	Moti	145	LS	4.50	M R	-	-	-	-	M R	M R	-	S	Tall, non-lodging responds to low N level, photosensitive, resistant to RTV, suitable for late planting in jute-rice system, adopt to shallow lands.	
37.	Pratikshya (ORS 201-5)	142	MS	7.30	M R	M R	R	-	-	R	-	R	M R	Semidwarf, stout stem, MS golden coloured hull, white kernel, suitable for medium and mid-low lands. Resistant to LF, Brown spot and Moderately resistant to WBPH.	
38	Mahsuri	145	MS	4.50	S	S	S	S	S	S	S	S	S	Tall, moderately resistant to lodging, suitable to medium/ lowlands.	

Sl. No	Varieties	Duration (days)	Grain type	Potential yield (t/ha)	Reaction to disease and insect pests									Special features and areas of adaptation	
					B	S h B	S h R	B L B	H M	S B	G L H	G M	B P H		
39	Lunishree (CRM 30)	145	LS	5.00	-	-	-	-	-	-	-	-	-	-	Tall, photosensitive, white kernel, tolerant to lodging, fertilizer responsiveness upto 60 kg/ha, possess tolerance to major pests and diseases.
IV.	Late duration														
40	Mahanadi (OR 1301-13)	150	MB	7.00	R	-	R	M R	R	M R	-	-	-	Semi dwarf, photosensitive, white kernel, panicle weight type, moderately resistant to RTV, LF and WBPH, suited to shallow low lands.	
41	Indravati (OR 1128-7-S ₁)	150	MB	7.00	R	-	R	M R	R	M R	-	-	M R	Semi dwarf, Photosensitive, white kernel, panicle weight type, moderately resistant to RTV, LF and WBPH, suited to shallow low lands.	
42	Jagabandhu (OR 1206-25-1)	150	MB	7.00	R	R	R	M R	-	M R	-	-	-	Intermediate height, photosensitive, white kernel, resistant to RTV& WM, suited to shallow low lands.	
43	Sambam-ahsuri (BPT-5204)	150	SF	5.00	S	-	-	S	-	-	-	-	S	Susceptible to major diseases, required adequate prophylactic measures, suited to medium and lowland situation.	
44	Dharitri (CR-1017)	150	SB	6.00	M R	-	-	M R	-	M R	-	M R	-	Semi-tall, white kernel, photosensitive, possess moderate resistance to major pests and	

Sl. No	Varieties	Duration (days)	Grain type	Potential yield (t/ha)	Reaction to disease and insect pests									Special features and areas of adaptation
					B	S h B	S h R	B L B	H M	S B	G L H	G M	B P H	
														diseases, suitable for shallow low land.
45	Ketaki-joha (IET 18669)	50	S	.0										Intermediate plant height, resistant to lodging, photosensitive, aromatic rice, suitable for shallow lowlands (0-15 cm)
46	Pooja (CR 629-256)	150	MS	6.00	-	-	M R	-	-	-	-	-	-	Semi dwarf, white kernel, possess tolerance to major pests and diseases, suitable for shallow low land.
47	Sonamani (CR 644)	155	SB	4.00	-	-	-	-	-	M R	-	-	-	Tall, white kernel, photosensitive, tolerant to salinity and waterlogging up to 40cm depth, suitable for semideep lowlands.
48	Manik (OR 624-46)	155	MB	6.00	M R	R	M R	M R	M R	R	-	R	-	Semi dwarf, white kernel, panicle weight type, resistant to RTV, suited to shallow low lands.
49	Prachi (OR 884-4-30)	155	MB	8.00	M R	-	-	M R	M R	-	-	-	M R	Semi dwarf, photosensitive, white kernel, panicle weight type, moderately resistant to RTV and WBPH, suited to shallow low lands.

Sl. No	Varieties	Duration (days)	Grain type	Potential yield (t/ha)	Reaction to disease and insect pests									Special features and areas of adaptation
					B	S h B	S h R	B L B	H M	S B	G L H	G M	B P H	
50	Ramachandri (OR 912-10-190)	155	MB	8.00	M R	-	R	-	R	M R	-	-	M R	Semi dwarf, photosensitive, white kernel, panicle weight type, moderately resistant to RTV, LF and WBPH , suited to shallow low lands.
51	Utkal Prava (CR-1030)	155	MS	5.00	-	-	-	-	-	-	-	-	-	Tall, photosensitive, tolerant to submergence, suited to lowlands.
52	Savitri (CR 1009)	155	MS	7.00	M R	-	-	S	R	-	S	R	S	Preferably be planted in July, early planting ensures synchronous flowering, suited to low lands.
53	Rambha (OR 143-7)	160	MB	5.50	R	M R	-	M R	R	-	R	-	M R	Tall, photosensitive, white kernel, resistant to intermediate water depth, moderately resistant to LF
54	Kanchan (OR 609-15)	160	MS	5.50	R	M R	-	R	R	-	R	-	M R	Tall, photosensitive, white kernel, Suitable for shallow and intermediate water depth. , moderately resistant to LF
55	Gayatri (CR-1018)	160	SB	6.50	M R	-	-	R	-	-	-	M R	-	Semi-tall, non-lodging, white kernel, photosensitive , tolerate slight saline condition, resistant to major pest and diseases, suitable for semi deep low lands.
56	Kalashree (CR 260-292)	160	LS	4.50	M R	-	-	S	-	S	-	M R	S	Semi-tall, white kernel, Basal leaf sheath and leaf margin are pigmented, responds to 40kg N/ha, suitable for semi deep lowlands.

Sl. No	Varieties	Duration (days)	Grain type	Potential yield (t/ha)	Reaction to disease and insect pests									Special features and areas of adaptation	
					B	S h B	S h R	B L B	H M	S B	G L H	G M	B P H		
57	Panidhan (CR 260-30)	160	MS	4.5	-	-	-	-	-	-	-	-	-	-	Tall, white kernel, tolerant to submergence as well as to major pests and diseases, suitable for semi deep lowlands.
58	Sarala (CR 260-77)	160	MS	5.00	-	-	-	S	-	-	-	-	-	-	Intermediate height, non-lodging, white kernel, photosensitive, suitable for semi deep low lands.
59	Durga (CR 683-123)	160	SB	5.00	-	-	R	R	-	-	-	-	R	Semi-tall, photo-sensitive, white kernel, suitable for late planting in jute-rice sequence, resistant to RTV, tolerate Semi-deep water conditions.	
60	RGL-2537	160	LS	4.50	R	-	-	-	-	-	-	R	-	Intermediate height with resistance to water logging and grain shedding, suitable for lowland and late planting in kharif.	
61	Varshadhan CRLC 899	60	B	.5											Tall, stiff straw, photo sensitive, grains yield quality rice, suitable for popped rice (Mudhi), adopted to lowlands, can withstand flooding up to 75 cm for short period.
62	CR-1014	160	MS	3.00	M R	-	-	-	-	-	-	-	-	-	Tall, photosensitive, non-lodging, tolerant to all disease and pest, suitable for low lands water lodged areas, tolerate late transplanting.

Sl. No	Varieties	Duration (days)	Grain type	Potential yield (t/ha)	Reaction to disease and insect pests									Special features and areas of adaptation
					B	ShB	ShR	BLB	HM	SB	GLH	GM	BPH	
63	Upahar	162	SB	6.40	-	M R	M R	M R	-	M R	-	R	-	Intermediate height, SB straw coloured hull and white kernel. Possesses tolerance to seedling submergence, suitable for shallow and semi deep low lands. Resistant to neck blast and leaf blast, moderately resistant to LF, whorl maggot, RTV.
64	Tulsi (CR 260-171)	170	MS	4.00	M R	-	-	S	M R	M R	-	M R	S	Tall, photosensitive, field tolerance to major pests and diseases. Non-lodging, panicle remains hidden by the erect flag leaf, tolerant to cyclic submergence during July-September, suitable for deep water ecology.

N.B.:

MS-	Medium slender	B-	Blast	GLH-	Green leaf hopper	R-	Resistant
MB-	Medium bold	Sh.B-	Sheath blight	BPH-	Brown plant hopper	MR-	Moderately resistant
LS-	Long slender	Sh.R-	Sheath rot	RTV-	Rice Tungro virus	S-	Susceptible
SS-	Short slender	BLB-	Bacterial leaf blight	WBPH-	White backed plant hopper	MS-	Moderately susceptible
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				

RECOMMENDED FERTILIZER DOSES FOR KHARIF RICE

Category of land	Duration of crop	Planting method	Recommended dose per ha			Time of application of N
			N	P ₂ O ₅	K ₂ O	
Medium land	High yielding varieties	Line sown	60	30	30	25% as basal in lines 50% at 1 st weeding 25% at panicle initiation stage
		Broadcast	60	30	30	50% at 1 st weeding/ <i>beushaning</i> 25% two weeks after 1 st application / <i>Khelua</i> 25% at panicle initiation stage
		Trans-planted	60	30	30	25% as basal 50% 2-3 weeks after planting at 1 st weeding 25% at panicle initiation stage
Medium /Low medium and Low land	Improved and local varieties	Line sown	40	20	20	25% as basal in lines 50% at 1 st weeding within 2-3 weeks 25% at panicle initiation stage
		Broadcast	40	20	20	50% at 1 st weeding/ <i>beushaning</i> . 25% 2-3 weeks after 1 st application / <i>Khelua</i> 25% at panicle initiation stage
		Trans-planted	40	20	20	25% as basal 50% 2-3 weeks after planting 25% at panicle initiation stage
Low medium & low land	High yielding varieties	Line sown	80	40	40	25% as basal in lines 50% at 1 st weeding 3 weeks after sowing 25% at panicle initiation stage
		Broadcast	80	40	40	50% at 1 st weeding/ <i>beushaning</i> . 25% after 3 weeks of 1 st application / <i>Khelua</i> 25% at panicle initiation stage
		Trans-planted	80	40	40	25% as basal 50% after 3 weeks of planting 25% at panicle initiation stage

N.B.:

1. The fertilizer recommendation for upland rice is mentioned in concerned section.
2. It is preferable to apply potash in 3 splits as in case of N or at least in two equal halves at planting and panicle initiation in light textured soils. This is to be adopted specially for HYV where high levels of N are used.
3. In case of low land paddy, NPK be applied as basal in lines at sowing or at *beushaning*. Then spray urea twice 25 and 10 days before panicle initiation.
4. In light textured soils 50% of N to be applied at tillering may be further splitted as 25% and 25% to be applied at 15-20 and 25-30 days after transplanting.
5. Under drought condition the timing for split application of N is to be adjusted according to receipt of rain.

Symptoms & nature of damage

Damage is caused by larvae feeding within the stem, severing the vascular system. "Dead heart" is the damage symptom of the tiller before flowering. 'Dead heart' is easily pulled out from the tiller. Symptoms of damage by larval feeding is indicated by frass in a culm, or discolouration and exit holes on the leaf sheaths and culm. When damage occurs before maximum tillering, the plant partially compensates by producing additional tillers.

"White ear head" is the damage symptom caused after flowering, resulting in chaffy earheads. It causes the entire panicle chaffy. The chaffy panicle is pulled out easily.

Control measures

1. Cut the plants close to the ground at the harvest.
2. Uproot and destroy stubbles after harvest of paddy, during summer ploughing.
3. Grow resistant/tolerant varieties like Parijat, Annapurna, IR-36, Savitri, Rambha, Samanta, Meher, Birupa and Sarathi.
4. Clip off the seedling tips while transplanting to destroy borer eggs.
5. Follow chemical control measures as suggested in case of gall midge.
6. Release *Trichogramma japonicum* parasitoid @ 20,000/acre one month after transplanting 6 times at weekly intervals.
7. Wherever possible, fix light traps to catch the adult moths.
8. Fix pheromone traps for YSB @ 8/ac. Collect the moths and kill everyday.
9. Provide cage-cum-bird percher @ 8-10/ac
10. Strict surveillance for the pests, collection and destruction of egg masses and adults is necessary.
11. Insecticide application can be kept as a last resort.

Brown plant hopper (*Nilaparvata lugens*) "Matiagundi Poka"

It occurs during July to September in Kharif paddy.

Symptoms and nature of damage

Both nymphs and adults appear in large numbers at the base of the plants above the water level. They suck the sap of the plant and plug the xylem and phloem vessels causing yellowing of leaves and drying of the plants in circular patches known as 'Hopper burn'. The feeding and ovipositional marks predispose plants to fungal and bacterial infection, and the honeydew encourages sooty mould. Hoppers transmit grassy stunt, ragged stunt and wilted stunt virus diseases.

Control measures

1. Alternate wetting and drying - drain out water from the field for 3-4 days during infestation and irrigate thereafter to reduce BPH population.
2. Grow tolerant varieties : IR-36, Annapurna, Parijata, Bhuban, Neela, Sarasa, Gouri, Krishna, Jawahar, Indrabati, Mahanadi, Prachi, Ramachandi, Jagabandhu, Durga and Sarala.
3. Maintain optimum plant population.
4. Preparing alleys (skip one row after each 10 rows) helps in reducing BPH population.
5. Do not spray resurgence causing insecticides like Chlorpyrifos, Quinalphos and synthetic pyrethroids.
6. Apply insecticides only when the nymph or adult hopper population reach ETL (5-10/hill)
7. Avoid insecticide application when pest-defender ratio is 2:1.
8. If plant hopper population is more, spray the crop with Clothianidin 50 WP @ 20 gms or Ethofenprox 10 EC @ 200 ml or Imidacloprid @ 50 ml or BPMC @ 400 ml per

acre in 200 litres of water. Direct the nozzle to the base of the plants ensuring thorough coverage of lower parts of the plant.

9. Spray neem based pesticides (300 ppm) @ 5 ml per litre at the base of the plant to conserve natural enemies and control BPH.

Green leaf hopper (*Nephotettix virescens* & *Nephotettix nigropictus*)
'Haladigundi Poka'

It occurs during July to October.

Symptoms and nature of damage

Both nymphs and adults suck the plant sap causing yellowing of leaves and affect the growth, vigour and number of tillers of the plant. They are important vectors of viruses that cause rice dwarf, transitory yellowing, tungro and yellow dwarf diseases.

Control measures

Insecticides suggested for BPH management will suppress this pest damage.

Grass hoppers (*Hieroglyphus banian*) 'Jhintika'

It occurs during July to December.

Symptoms and nature of damage

Nymphs as well as adults devour leaves from margins and tender grains in the glumes. Usually active from September to December.

Control measures

Dust the affected field with Carbaryl 4% or Malathion 5% dust @ 10-12kg per acre.

Rice case worm (*Nymphula depunctalis*) 'Nalipoka'

It occurs during August to October.

Symptoms and nature of damage

The caterpillars cut the leaves and form tubular cases. They remain in cases and feed on the green matter of the leaves leaving the upper epidermis, which is papery white. Cut leaves found at the side of the paddy plant, where they may be carried by water, appear as if snapped off. Severely attacked fields show a typical white appearance from damaged plant tips.

Control measure

Spray insecticides as recommended under gall midge/ stem borer control.

Or

Flood the field with water and have a thin layer of Kerosene oil @ 5 litre/acre on the surface of water and dislodge the cases from the plant by shaking the plants with a rope or bamboo sticks.

Leaf-folder (*Cnaphalocrocis medinalis*) 'Patramoda Poka'

It occurs during August to October.

Symptoms and nature of damage

Larvae feed on leaf tissue, rendering it white and as they become older, fold the leaf to form a tube. Larval feeding results in white and transparent streaks. Population occurs within the folded portion, severely damaged plants appear burnt.

Control measures

1. Spray insecticides as suggested in gall midge/ stem borer control.
2. Release *Trichogramma chilonis* @ 20,000/ acre.

Gundhi bug (*Leptocorisa acuta*, *L.varicornis*)'Gandhi Poka'

It occurs during September to November.

Symptoms and nature of damage

Attacks the earheads at the milky stage and sucks the sap from grains resulting in empty grains. Feeding results in grain discolouration due to infestation by various fungi.

Control measures

Dusting with Carbaryl 4% or Malathion 5% dust @ 10-12 kg per acre.

Or

Spray Carbaryl 50 WP @ 1 kg per acre or DDVP 76EC @ 200 ml/ac Or use rotten snail bait @ 10 nos/ac each containing 100g. Burn the cycle tube and tyre, if available in rice field to attract and kill the adults.

Swarming caterpillar (*Spodoptera mauritia*)'Leda poka' and

Paddy cut-worms (*Mythmna separata*)

These occur during June to August.

Symptoms and nature of damage

Caterpillars appear in large swarms in seed beds/direct seeded field and devour the plants causing heavy damage, when cold weather is suddenly followed by a heat spell. When young, the caterpillars eat the soft leaves of plant, but full-grown caterpillars are capable of devouring the entire plant. Caterpillars appear after heavy rain or after the floods recede.

Control measures

Infested fields should be first segregated by applying a heavy band of any one of the insecticide dust suggested for grass hopper control. The crop, then be treated with Chlopyriphos 1.5% dust @ 10-12 kg per acre during evening hours or spraying of Dichlorvos 76 EC @ 200 ml /ac or Chlorpyriphos 20 EC @ 400ml/Ac is very effective, during late afternoon hours.

Mealy bugs (*Ripersia oryzae*)'Dahia Poka'

It occurs during July to September,

Symptoms and nature of damage

Common in well drained rainfed environments, suck plant saps resulting in stunted growth High infestation inhibits panicle emergence, infected fields show isolate patches of stunted plants.

Control measures

Spray the crop with Phosphamidon 40 SC @ 200 ml or Monocrotophos 36 SL @ 400 ml per acre in 200 litres of water.

Surti caterpillar (*Nisaga simplex*) 'Sambalua poka'

Symptoms and nature of damage

The caterpillars feed on the leaves and defoliate the plant completely. Adults appear in between last week of June to second week of July.

Control measures

Dust the crop with Chlorpyrifos 1.5% dust @ 10-12kg per acre or spray the crop with Triazophos 40 EC @ 400 ml or Dichlorvos 76 EC @ 200 ml per acre.

MAIZE

Termites (*Odontotermes obesus*) 'Uei'

It occurs during the young stage of the crop.

Symptoms and nature of damage

The termites cut the underground plant parts and bore into the stems. The affected plants wither and die.

Control measure

Apply Chlorpyrifos 1.5% dust @ 10-12kg per acre during land preparation. If the termites attack in growth stage, drench the soil with Chlorpyrifos 20 EC @ 5ml/litre of water.

Grass hopper (*Hieroglyphus nigrorepletus*) " Jhintika"

Symptoms and nature of damage

Both nymphs and adults feed on the leaves.

Control measures

Dust the crop with Malathion 5% or Carbaryl 4% @ 10-12kg per acre.

Stem borer (*Chilo partellus*) "Kanda bindha poka"

It occurs during January to March and in rainy season.

Symptoms and nature of damage

The larvae bore into the central shoot causing dead hearts. Shot holes are seen on maize leaves due to its attack.

Control measure

1. Spray Phosphamidon 40 SC @ 200 ml per acre in 200 litres of water or apply Carbofuran 3G @ 4kg per acre into the leaf whorls when tiny holes in top whorls of the leaves are seen.
2. Release *T.Chilonis* @ 20,000/acre at 10 days intervals, six times starting from 20 days after germination.

Aphids (*Rhopalosiphum maidis*) "Jau poka"

It occurs during December to January and in rainy season.

Symptoms and nature of damage

Both adults and nymphs appear in colonies in tender parts of the leaf whorls and earheads. They suck the sap from stem and leaves

Control measure

Spray Methyl demeton 25 EC or Dimethoate 30 EC @ 400 ml/ac in 200 litres of water. If population of natural enemies like coccinellid beetles, syrphid flies and green lace wing are seen (1000/Acre) spraying should not be undertaken.

JOWAR

Shoot fly (*Atherigona varia soccata*) 'Kanda bindha machhi'

Symptoms and nature of damage

The maggots bore into the central shoot of young plants and kill the growing points causing dead heart. When attack in the reproductive stage, cause white ears.

Control measures

1. Early sowing and using high seed rate to compensate loss.
2. Removal of infested plants help in suppressing its population in the field.
3. Leaf whorl application with Carbofuran 3G @ 8 kg/ac. Spray Monocrotophos or Chlorpyrifos @ 400ml/ac.
4. Post emergence spray of Dimethoate 30 EC @ 400 ml per acre or Phosphamidon 40SC @ 200 ml/acre is quite effective in controlling this pest.

Stem borer (*Chilo partellus*) "Kanda bindha poka"

Symptoms and nature of damage

The larvae bore into the central shoot of the plant and cause dead hearts. Small tiny shot holes in the leaves indicate its presence.

Control measures

1. Follow the control measures suggested for maize stem borer.
2. Destruction of stubbles and dead hearts.
3. Use high seed rate.
4. Grow resistant / tolerant varieties.
5. Spray the crop with Chlorpyrifos 20 EC @ 400 ml or Phosphamidon 40 SC @ 200 ml /acre in 200 litres of water.
6. Release T. Chilonis as in maize.

Earhead bug (*Calocoris angustatus*)

Symptoms and nature of damage

The long slender bug (greenish yellow) sucks the juice from the grains in dough stage. The affected earheads are devoid of ripe and healthy grains.

Control measures

1. Sorghum varieties with loose ears which are less susceptible should be preferred.
2. Spray the crop with Carbaryl 50 WP @ 1kg or DDVP 76 EC @ 150ml per acre at panicle emergence stage with 200 litres of water.
Or
1. Dust the earheads with Malathion 5% or Carbaryl 4% dust @ 10-12 kg per acre.

RAGI

Termites (*Odontotermes obesus*) "Uei"

It occurs during July to September.

Symptoms and nature of damage

They attack the germinating seeds and the young plants.

Control measures

Soil treatment with Chlorpyrifos 1.5% dust @ 10-12 kg/ha during land preparation. If attacks in growth stages soil, drenching with Chlorpyrifos 20EC @ 2 ml/litre of water.

Stem borer (*Sesamia inferens*) "Kanda bindha poka"

It occurs during August to September and February to March.

Symptoms and nature of damage

The caterpillars bore into the stem and cause dead hearts in young plants and chaffy grains in mature plants.

Control measure

1. Spray the nursery at 15-20 days stage with Chlorpyrifos @ 40 ml or Monocrotophos 40 ml for 10 cent nursery.
2. Spray the crop with Monocrotophos 36 SL @ 400 ml or Phosphamidon 40 EC @ 200 ml/acre in 200 litres of water.
3. Release *T. Japonicum* as in maize.

Armyworm and cutworm

It occurs in the early stage and continues up to the harvest.

Symptoms and nature of damage

Cut the seedlings at the base which appears as if grazed by domestic animals.

Control measure

Dusting with Malathion 5% or Endosulfan 4% or Phosalone 4% @ 10 kg/acre or alternatively spray with insecticides as suggested for paddy cutworm/army worm control.

Jassids

Symptoms and nature of damage

Both nymphs and adults suck sap from the plants, leaves turn yellow and dry.

Control measure

Spray Dimethoate or Carbaryl @ 800 g/acre or Imidacloprid 200 SL @ 50 ml/ac.

PULSES

Aphids (*Aphis craccivora*) “Jau poka”

Symptoms and nature of damage

Nymphs and adults suck the sap of the plant. Heavy attack causes withering.

Control measure

- Spray the crop with Methyl demeton or Dimethoate @ 400 ml or DDVP 76EC @ 200 ml/ac or Imidacloprid 200 SL @ 50 ml/ac in 200 litres of water.
- Release *Chrysoperla carnea* @ 50,000 first instar larvae/ha 1-2 times as per need.

Leaf eating caterpillar (*Spodoptera litura*) ‘Patrakata poka’

Symptoms and nature of damage

The caterpillars eat away the leaves and defoliate the plants.

Control measure

Dusting with Carbaryl 5% dust @ 10-12 kg per acre or spray the crop with Carbaryl 50 WP @ 800 gm or Malathion 50 EC or Triazophos 40 EC @ 400 ml in 200 litres of water.

Pulse beetle (*Callosobruchus chinensis*)

Symptoms and nature of damage

The grubs bore into the pod and feed inside the pod.

Control measure

Dust the crop with Malathion 5% or Endosulfan 4% dust @ 10-12kg per acre or spray the crop with Malathion 50 EC or Cypermethrin 10 EC @ 400 ml in 200 litres of water per acre. Spray neem formulations @ 5 ml/litre of water during pod maturity stage.

Pod borer complex in arhar

Symptoms and nature of damage

Pods are infested by nine different species of borers. They bore the pods making characteristics holes and then feed on the seeds. Some of the borer species also make webbing at tender growing portions and the inflorescence.

Control measure

1. Spray the crop with Endosulfan 35 EC @ 400 ml per acre with 200 litres of water starting from flowering till pod maturity at 15 days intervals.
2. Against *Helicoverpa armigera*, Ha NPV should be sprayed @ 100 LE per acre. Spraying is most effective when sprayed in evening hours.
3. Half the dose of Endosulfan + half the dose of Ha NPV be mixed and sprayed at 15 days intervals from flowering.
4. Spray *Bacillus thuringiensis* product @ 0.4 kg/acre.

GROUNDNUT

Termites (*Odontotermes obesus*) 'Uei'

And

White grub (*Holotrichia consanguinea*) 'Dhabala bhrunga sabaka'

These occur during June to July

Symptoms and nature of damage

The termites and white grubs attack the underground plant parts such as root, stem and pods as a result of which plant wither and die.

Control measures

1. Use certified seeds having uniform ripening character. Dress seeds before sowing with Chlorpyrifos 20 EC @ 25 ml/kg of seed.
2. Soil may be treated with Chlorpyrifos 1.5% dust @ 10-12 kg per acre at the time of land preparation. If the problem persists during crop growth, drench the soil with Chlorpyrifos @ 5 ml/litre of water.

Hairy caterpillar (*Amsacta albistriga*) 'Sambalua'

It occurs during June to August.

Symptoms and nature of damage

The caterpillars feed on the leaves and completely defoliate the plants.

Control measures

1. Fix light trap on receiving first shower of rain.
2. Dust the crop with Chlorpyrifos 1.5% dust @ 10-12kg per acre.
Or
Spray the crop with Dichlorvos 76 EC @ 200 ml per acre in 200 litres of water.
3. Use of vegetative traps like Ipomoea, Jatropha around the field .

Leaf eating caterpillar (*Spodoptera litura*)

Symptoms and nature of damage

The caterpillar feed on the foliage parts. Due to attack the photosynthetic activities of the plants is reduced.

Control measures

1. Use pheromone trap with *Spodolure* @ 6-8 nos/ac.
2. Fix bird perchers @ 8-10/ac.
3. Spray SI NPV @ 100 LE/acre in the evening hours.

Thrips (*Thrips palmi*, *Caliothrips indicus*, *Frankliniella schultzei*)

Symptoms and nature of damage

Nymphs and adults feed on leaf buds and retard growth and vigour, leaves destroyed, stunting of plants.

Control measures

For control of thrips and aphids, spray Methyl demeton 25EC, Dimethoate 30 EC, @ 400 ml/ac or Imidacloprid @ 50 ml/ac.

Leaf miner (*Aproaerema modicella*)

Symptoms and nature of damage

Appears in early July and continues till late September. Caterpillars mine into the leaves producing blister like mines. Protective enclosure of webbing are formed. Drought condition favours rapid multiplication. 2 larvae/10 plant or 20-30% plant infestation is the ETL.

Control measures

Spray Monocrotophos 36 SL or Triazophos 40 EC @ 1000 ml/ha usually in late August to early September.

SESAME (Til)

Leaf webber and capsule borer (*Antigastra catalaunalis*)

Symptoms and nature of damage

Serious in July-October. Caterpillars web together leaves, flowers and pods and feeds on them from within. It also bores into shoots which results in wilting of the portion above the injury. Bores into flowers and capsules and feeds on developing seeds.

Control measures

Apply Fenvalerate 20 EC 500 ml or Carbaryl 50 WP @ 2.0 kg/ha.

CASTOR

Semilooper (*Achaea janata*)

Symptoms and nature of damage

Caterpillars feed on foliage and growing points. Heavy attack results in complete defoliation. Problem noticed between August to October.

Control measures

Apply Endosulfan 35 EC @ 1000 ml or Fenvalerate 20 EC @ 500 ml or Carbaryl 50 WP @ 2.0 kg/ha.

Shoot and capsule borer (*Conogethes punctiferalis*)

Symptoms and nature of 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 Quinalphos 25 EC 1000 ml or Monocrotophos 36 SL 1000 ml/ha can provide effective control.

JUTE

Semilooper (*Anomis sabulifera*) 'Ghoda poka'

and

Leaf eating caterpillar

They occur during June to August.

Symptoms and nature of damage

The caterpillars feed on the apical buds and the top shoots.

Control measures

1. Dust Malathion 5% @ 10-12 kg per acre.
- Or
1. Spray the crop with Monocrotophos 36 SL @ 400 ml per acre in 200 litres of water.
 2. Dragging a rope over the crop to dislodge the caterpillars to kerosenized standing water.

Cut worms (*Agrotis ipsilon*) 'Kartaka kita'

It occurs during June to August.

Symptoms and nature of damage

The caterpillars feed on the apical buds and the top shoots.

Control measures

Chemical control measures as in case of semilooper.

Bihar hairy caterpillar (*Spilosoma obliqua*) 'Sambalua'

It occurs during July to August.

Symptoms and nature of damage

The caterpillars feed on the leaves and completely defoliate the plants.

Control measures

Chemical control measures as in case of semilooper.

Jute weevil (*Apion corchorii*)

It occurs during July to August.

Symptoms and nature of damage

The grubs feed inside the bark and damage the fibre. Due to attack of the grubs, mucilaginous substances ooze out together with larval excreta.

Control measures

Chemical control measures as in case of semilooper.

Jute stem girdler (*Nupserha bicolour postbrunnea*)

Symptoms and nature of damage

Egg laying by the adults damages fibre length. The top portion of the plant breaks from the point of damage to grub feeding and tunneling inside the pith.

Control measures

As suggested in case of semilooper.

Mites

Symptoms and nature of damage

Occasionally serious if dry weather prolongs. Chlorosis and curling of leaves and stunted growth are the common symptoms.

Control measures

Spray either Dicofol 400 ml or Eithion 400 ml/ha or Micronized sulphur @1.0 kg/acre.

COTTON

Pink boll worm (*Pectinophora gossypiella*) 'Nali bindha poka'

It occurs during August to October.

Symptoms and nature of damage

The caterpillar either bores into the boll or feeds on the flower or leaf before entering into the boll and causes shedding of flower buds.

Spotted boll worm (*Earias vitella* and *E. insulana*) 'Chitra bakara kita'

It occurs during August to October.

Symptoms and nature of damage

The caterpillars bore into the growing shoots which wither and arrest the development of the plants. In later stage, they damage flower buds, flowers and finally enters the bolls of cotton.

Leaf roller (*Sylepta derogata*) 'Patramoda poka'

It occurs during July to September.

Symptoms and nature of damage

The caterpillars feed on the lower surface of the leaves and roll them and remain inside the rolled up leaves, thus eat up the whole leaf leaving only the mid rib.

Jassids (*Amrasca biguttula biguttula*) 'Patradian poka'

It occurs during July to September.

Symptoms and nature of damage

Both nymphs and adults suck the juice from the leaves which curl up and become distorted and fall down.

Red cotton bug (*Dysdercus cingulatus*) 'Lal dagara poka'

It occurs during August to October.

Symptoms and nature of damage

Both the adult and nymphs suck the sap from the leaves, flowers, bolls and seeds. Affected parts become distorted and the normal growth of the plant as well as quality of the fibre is affected.

American cotton bollworm (*Helicoverpa armigera*)

'Bakara bindha poka' or 'Bakara kita'

It occurs during January to March.

Symptoms and nature of damage

The larvae feed on the leaves, shoots, buds and bolls. Unlike other boll worms, it does not remain in a single boll, but moves from boll to boll damaging them, as it feeds on.

Aphids (*Aphis gossypii*) 'Jau poka'

It occurs during September to October.

Symptoms and nature of damage

The aphids suck the sap from the leaves, stem, flowers and bolls. The plants become stunted and leaves curl from margin.

Whitefly (*Bemisia tabaci*)

Symptoms and nature of damage

Nymphs and adults suck sap from tender leaves. Leaves turn chlorotic and shed. Damage may cause death of seedlings. The pest is a vector of several virus diseases. ETL is 5-10 adults/leaf or 20 nymphs/leaf. Transmit cotton leaf curl virus.

IPM Strategy

1. Destruction of crop remnants of the previous crop after harvest.
2. Summer ploughing
3. Seed treatment with Imidacloprid 70 WG @ 7 g/kg of seed.
4. Grow trap crops like okra and marigold around cotton field.
5. Fix light trap in cotton field during the crop growth period.
6. Release natural enemies like *Chrysoperla carnea* @ 20,000 1st instar larvae/acre at 15 days intervals twice for control of aphids and early pests. *Trichogramma chilonis* @ 60,000/acre at 10 days intervals 6 times starting from 45 DAS.
7. Use pheromone traps with lures to control *Helicoverpa*, *Spodoptera*, *Earias spp* @ 8 nos./acre.
8. Fix bird perchers @ 10 no/ac.
9. Topping of leaves at 90 days.
10. Spray Ha NPV and SI NPV on need basis @ 200 LE/acre of Btk formulation @ 0.40 kg/acre.
11. Spray neem based formulations on need basis @ 5 ml/litre or water of NSKE @ 5%.
12. In spite of the above management practices, if the pest population attain ETL, then follow chemical control measures as follows:
 - a. For sucking pests like aphids, jassids, white flies, thrips etc. spray Imidacloprid 200 SL @ 50 ml/ac or Dimethoate @ 400 ml/ac (upto 30-40 days)
 - b. Against boll worm, spray Acephate 75 SP @ 150 gm/ac or Profenophos 40 EC @ 400 ml/ac or Triazophos 40 EC @ 400 ml/ac or Indoxacarb @ 200 ml/ac. Endosulfan should not be applied after 90 days of crop growth. After 120 days of crop growth, hand collection and destruction of larvae before and after each spray is advisable.
 - c. Avoid repetition of insecticides belonging to same group.

SUGARCANE

Termites (*Odontotermes obesus*) 'Uei'

It occur during January to May

Symptoms and nature of damage

They attack planted setts and underground part of young plants. As a result, the roots are destroyed and the plant wither and die.

Control measures

Apply Chlorpyriphos 1.5%, dust @ 10 -12 kg/acre in soil at the time of land preparation or spray the setts with 0.1% Chlorpyriphos thoroughly drenching the soil around the setts.

Early shoot borer (*Chilo infuscatellus*) 'Sahala Kandabindha Poka'

It occur during March to June

Symptoms and nature of damage

The caterpillars cause deadheart in young plants, which can be pulled out easily. The affected plants dry up completely.

Control measures

1. Early planting (middle of January) and light earthing at early stage of crop growth will check the infestation.

Or

- In furrow, treat with Sevidol @ 10 kg or Carbofuran 3G @ 12 kg per acre at the time of first earthing. In ratoon crop, rake into the soil and apply Chlorpyriphos 1.5% dust @ 10 kg per acre two times.
2. Timely cutting the attacked shoot at or just below the ground level ensures destruction of most of the caterpillar.
3. Collection of egg masses and destroying them is useful
4. Irrigate frequently during hot months
5. Trash mulching at planting is advisable.
6. Release *Trichogramma chilonis* parasitoid @ 20,000/ac 30 days after planting 3-4 times at 10 days intervals.

Root borer (Pre-monsoon borer)(*Emmalocera depressella*)'Mulabindha Poka'

It occurs during April to July

Symptoms and nature of damage

The larvae bore into the underground stem parts at early stages of the crops. In severe cases, the whole clump dries up.

Control measures

Follow control schedule as recommended for early shoot borer.

Top shoot borer (*Scirpophaga nivella*) 'Aga bindha poka'

It occurs during August to October

Symptoms and nature of damage

After cane formation, the top borer attack appears in the field. In the middle growth stages of sugarcane side shoots are produced and in grown up crops its attack results in bunchy top.

Control measures

1. Destruction of egg masses and cutting of affected shoots should be carried out collectively.
2. Adequate and timely nitrogen fertilization helps the crop to withstand top shoot borer attack.
3. Use light trap to catch the adult moth.
4. Follow bio-control as per early shoot borer in September
5. Release *Trichogramma japonicum* @ 20,000/acre 3-4 times at 10 day intervals.

Pyrilla (*Pyrilla perpusilla*) 'Patra dian poka' or 'Jahaja poka'

It occurs during August to October.

Symptoms and nature of damage

Both nymphs and adults suck the sap from the underside of the leaves and cause drying of leaves.

Control measures

Release of the parasitoid, *Epiricania melanoleuca*, successfully controls the pyrilla @ 5000 cocoons or 4-5 lakh eggs per hectare.

White fly (*Aleurolobus barodensis*) ' Dhala machhi'

It occur during July to August

Symptoms and nature of damage

The nymphs desap the leaves causing it yellow. In severe cases, the leaves may be filled up with black pupal cases of the insects.

Control measures

Spray the crop with Imidacloprid 50 ml/ac or Dimethoate 400 ml/ac by availing the dry spells between rainy weather at 3-4 weeks interval. Avoid waterlogging in the field.

Red spider mites (*Tetranychus sps*)

It occurs during August to September.

Symptoms and nature of damage

Reddish pink mites are found in large numbers under the webbings made on the leaves and feed mostly on the under surface of leaf. Severely affected leaves become yellow and dry up.

Control measures

1. After harvesting the crop, dispose off the trash by burning.
2. Spray with Dicofol @ 1lt./acre.

Mealy bug (*Saccharicoccus sacchari*)

Control measures

Detrashing and spraying the crop with Malathion 400 ml/acre Dimethoate 400 ml/ac or Monocrotophos @ 400 ml/ac in 200 litres of water.

Plant protection measures (Ratoon crop)

- Clean the field after harvest of the previous plant crop.
- Spray Chlorpyrifos or Monocrotophos @ 1500 ml /ha on the standing crop to check the attack of shoot borers.

VEGETABLES:

BRINJAL

Shoot and fruit borer (*Leucinodes orbonalis*) 'Aaga O phala bindha poka'

Symptoms and nature of damage

Caterpillars bore into the shoots and fruits and cause damage.

Control measures

1. Apply Carbofuran 3G at 15 days after planting @ 30 kg/ha followed by irrigation.
2. Clipping the affected shoots and destroy the caterpillars.
3. Use Pheromone traps (25 no/ac) for fruit and shoot borer.
4. Spray when shoot damage exceeds 4% and fruit damage 14% alternatively with Diflubenzuron 25 WP @ 200 g/ac or Cartap hydrochloride 50 SP @ 400 g/ha or Carbaryl @ 1.0 kg/ac. or a single spray of any synthetic pyrethroid or Triazophos 40 EC @ 1000 ml/ha or neem products @ 4-5 ml/litre of water.
5. Spray after plucking the fruits and observe waiting period strictly.
6. Field sanitation is essential.
7. Soil application of neem cake @ 250 kg/ha.
8. Spray NSKE @ 5% or Neem pesticide (300 ppm) @ 1 litre/ac.
9. Release egg parasitoid, *Trichogramma chilonis* @ 1.00 lakh/ha.

Epilachna beetle (*Epilachna vigini toctopunctata*) 'Kankedia poka'

It occurs in July to October

Symptoms and nature of damage

The grubs and adults feed on the green portion from the leaves and tender parts of the plant often cause serious damage.

Control measures

1. Hand collection of egg mass, grub, pupa and adult and destroy them.
2. Spray the crop with Carbaryl 50 WP @ 1.0 kg/ac in 200 litres of water.
3. Dust Carbaryl 5% D @ 10-12 kg/ac.

Brinjal mite (*Tetranychus urticae*)

Control measures

Spray the crop with Sulfex 20 EC @ 1000 g/acre or Dicofol 18.5 EC @ 1000 ml/acre or Ethion 50 EC @ 400 ml/ac.

Jassid (*Amrasca biguttula biguttula*) 'Patra dian poka'

It transmits the little leaf disease of brinjal.

Control measures

Spray the crop with Dimethoate 30 EC @ 400 ml/acre or Imidacloprid 200 SL or Acetamiprid 20 SP @ 50 ml/g per acre.

CHILLI

Thrips (*Scirotothrips dorsalis*) 'Ukunia poka'

Symptoms and nature of damage

It causes "Murda" disease of chilli.

Control measures

Spray the crop with Abamectin 1.9 EC @ 400 ml/ac or Dimethoate 30 EC 400ml/acre
Ethion 50 EC @ 200 ml/acre.

TOMATO

Serpentine leaf miner (*Liriomyza trifolii*)

It mines on the leaves.

Control measures

Spray the crop with NSKE 5% or Neem Pesticide 300 ppm @ 1 litre/acre. Spray the crop with Endosulfan 35 EC @ 400 ml/acre.

Fruit borer (*Helicoverpa armigera*)

The larvae bore into the fruits and feed on the inner content.

Control measures

1. Apply neem cake @ 100 kg/acre at planting .
2. Plant African Marigold seedlings (40 days old) either as border crops or after every 10th line of tomato to attract and trap *Helicoverpa armigera* as trap crop.
3. Spray HaNPV @ 250 LE/ha or Triazophos @ 1000 ml/ha.
4. Release Trichogramma brasiliense @ 20,000 / ac. 3-4 times.
5. Spray Bt. Formulations @ 1000 ml/ha at 10 days intervals from planting. Always spray should be accomplished in the evening hours.
6. In case the infestation continues in the ripening stage, spray Carbaryl 50 WP @ 2 kg/ha and maintain a minimum waiting period 7 days for harvesting.

Sucking pests (Seedling stage)

Aphid, jassid and whitefly attack the seedlings and weaken the plants.

Control measures

Spray Methyl-oxy-demeton @ 400 ml/ac or Imidacloprid 200 SL @ 50 ml/ac or Dimethoate @ 400 ml/ac. Restrict spraying of these chemicals at fruiting stage.

ONION

Thrips (*Thrips tabaci*)

Thrips at the initial vegetative stage blotch the leaves and affect the vigour of the plants. Tips look burning with white scars.

Control measures

Spray Methyl-oxy-demeton @ 400 ml/ac or Dimethoate @ 400 ml/ac on need basis.

OKRA

Leaf hopper (*Amrasca biguttula biguttula*)

Control measures

Spray the crop with Oxydemeton methyl or Dimethoate @ 400 ml/ac or Imidacloprid 200 SL @ 50 ml/ac or Acetamiprid 20 SP @ 50 g/acre.

Fruit borer (*Earias vitella*, *E. insulana*)

1. Apply neem cake 100 kg/acre
2. Installation of yellow sticky traps @ 20 nos. /acre.
3. Spray NSKE 5% or neem pesticide 300 ppm 1ltr/acre.
4. Release Trichogramma Chilonis @ 20,000 /acre 3-4 times at 10 day intervals.
5. Release Chrysoperla carnea @ 20,000 larvae/acre.
6. Fix pheromone traps @ 8 nos/acre using Envit lure and Erin lure depending on the appearance of *E.vilella* and *E. insulana*.

Control measures

It can be controlled by spraying Cypermethrin 20 EC @ 200ml /acre or Cartap hydrochloride @ 200 g/ac on need basis.

PUMPKIN

Red pumpkin beetle (*Raphidopalpa foveicollis*)

Control measures

Spray the crop with Carbaryl 50 WP @ 1.0 kg/ac.

Fruit fly (*Bactrocera cucurbitae*)

Control measures

1. Set up pheromone traps @ 8 nos./acre
2. Apply bait against fruit fly at initial fruiting stage. Bait can be prepared with 20 ml Malathion, 200 g of Molases in 20 litre of water dispensed carefully in the field in small earthen pots, out of reach of children, pet animal and stray cattle.

Serpentine leaf miner (*Liriomyza trifolii*)

Control measures

Spray neem seed kernel extract (5%) or Triazophos @ 400 ml/ac.

SWEET POTATO

Weevil (*Cylas formicarius*) and defoliators

Control measures

1. Use pheromone trap @ 8 nos./acre.
2. Spray the crop with 400 ml/acre of Endosulfan 35 EC in 200 litres of water. Mulching and timely harvest also ensures minimum damage.

SPINE GOURD

Epilachna beetle (*Epilachna sparsa*)

Control measures

Refer control measures in brinjal.

DRUM STICK

Hairy caterpillar (*Eupterote mollifera*)

Control measures

Burning the gregarious caterpillars or spraying of any of the contact insecticides like Malathion 50 EC @ 400 ml or DDVP 76 EC @ 200 ml/acre.

AMARANTHUS

Leaf webber (*Hymenia recurvalis*)

Control measures

Destroy the larvae manually and keep surrounding clean. Spray the crop with Carbaryl 50 WP @ 0.8 kg or Dichlorvos @ 200 ml/acre on need basis.

GINGER

Stem borer and leaf eating caterpillar (*Conogethes punctiferalis*)

Control measures

Prophylactic spray of NSKE 5% or neem pesticide (300 ppm) 1 litre/acre at 10 days interval in month of July and August.

TURMERIC

Rhizome fly (*Mimegralla coeruleifrons*)

Symptoms and nature of damage

Maggots bore into rhizomes resulting in wilting and drying of the aerial parts.

Control measures

Use of healthy rhizomes for planting and early removal of dead plants and effected rhizomes reduces infestation. Spraying of Dimethoate @ 400 ml/ac is effective.

DISEASE MANAGEMENT

PADDY

Brown spot or helminthosporium spot (*Helminthosporium oryzae*, *Drechslera oryzae*) 'Chitaroga' or 'Patra chita roga'

It occurs during July to September

Symptoms and nature of damage

Circular to oval brown to dark brown spots appear on the leaves, leaf sheath and glumes. Most spots have a light yellow halo around their margins and are evenly distributed over the leaf surface. In severe cases, the grains are covered with dark velvety coloured fructification of the fungus and the grains become shrivelled and discoloured. The disease occurs more severely during long dry spells in Kharif season.

Control measures

1. Use resistant/moderately resistant varieties :-
Parijat, Keshari, Annapurna, IR-36, Jajati, Pratap, Savitri, Heera, Pathara, Ananga, Annada, Lalat and Shrabani, Lalitagiri, Udayagiri, Sebati, Bhoi, Gajapati, Indravati, Prachi, Ramachandi, Surendra, Kharavela.
2. Treat the seeds with Carboxin (37.5%)+Thiram (37.5%) @ 0.2% or Carbendazim 0.2% + Thiram 0.3%(1:1) @ 0.2%.
3. Spray the crop with 0.3% Mancozeb or 0.15% Carbendazim or 0.2% Carbendazim (12%) + Mancozeb (63%). Do not spray Copper fungicide to high yielding crop without sensibility test of the variety concerned.

Blast (*Pyricularia grisea*) 'Mahisa roga'

It occurs during July to September and during dry spell.

Symptoms and nature of damage

Small brown coloured spots appear on the leaves which later become spindle shaped with pointed ends having reddish or purplish brown margin and ashy coloured centre. In severe cases the spindle shaped spots coalesce and the leaves wither. If the infection starts earlier, the culm and nodes are also affected causing chaffy grains. In severe cases of infection, dark brown to almost black lesions appear on the rachis at panicle base, as a result of which, the grain the affected panicles may become chaffy or shriveled. The affected panicles become lighter in weight and dry up soon. This is called neck infection.

Control measures

1. Treat the seeds with Tricyclazole @ 1 g/kg of seed/ Captan or Thiram @ 3 g/kg of seeds or Carbendazim 2 g/kg of seeds or Carboxin (37.5%)+Thiram (37.5%) @ 2g/kg of seeds.
2. Spray the crop with 0.15% Ediphenophos or 0.2% Kasugamycin or 0.1% Tricyclazole or 0.15% Carbendazim or 0.2% Kasugamycin. Three sprayings one each at tillering, boot leaf and grain formation stages may be given.
3. Grow moderately resistant varieties like Parijat, Mahsuri, Kumar, Pankaja, Savitri, Shrabani, Gouri, IR-36, Ratna, Udaya, Jajati, Pratap etc. Udayagiri, Kharavela, Sebati, Bhoi, Gajapati, Surendra, Indravati.
4. Nitrogen application may be limited to 24 kg per acre.

Foot rot (*Fusarium moniliforme*)'Mulasadha roga'

It occurs during August to November.

Symptoms and nature of damage

The seedlings become thin and pale in initial stages of infection. The diseased plants become taller, affected leaves dry one after another and drying starts from lower leaves.

Control measures

1. Treat the seeds with Captan or Thiram @ 2 g/kg of seeds or Carbendazim @ 2 g/kg of seeds or Carboxin (37.5%+Thiram 37.5%) @ 2g/kg of seed.
2. Spray the basal portion of the crop with 0.15% Carbendazim or 0.2.% Carbendazim (12%) + Mancozeb (63%) after draining the water, if possible.

Udbatta disease (*Ephelis oryzae*)'Jaukhadi roga'/Agarbati roga'

It occurs during September to November.

Symptoms and nature of damage

The spike lets of the earheads are affected. The characteristic symptom of the disease is the formation of cylindrical rod or spike like structure compact axis covered by a thin membrane which look like Agarbati from the leaf sheath instead of normal earhead and no grain is formed.

Control measures

1. Grow moderately resistant varieties : Basumati, Mahsuri, CR-1014, Sabarmati, Jamuna, Kanchi, Jajati.
2. As the disease is internally seed borne, before sowing, soak the seed in water for 10-12 hours and then sun dry the seeds from 10 AM to 3 P.M. in bright sunny days in April-May or treat seed in hot water at 52-54°C for 10 minutes.
3. Drench the nursery soil with Thiram (180 g from the mixture of Carbendazim WP 120 g and Thiram WDP-80 g) dissolved in 18 litres of water and apply in 2 sq m Area.
4. Seed treatment with Benomyl /Carbendazim/ Carboxin (37.5%)+Thiram (37.5%) @ 2 g/kg of seeds.
5. Foliar spraying with Propiconazole 0.1% or Benomyl 0.1% or Thiophanate methyl 0.15%.

Bacterial leaf blight (*Xanthomonas oryzae pv.oryzae*)'Patrapoda roga'

It occurs during July to November.

Symptoms and nature of damage

Water soaked strips develop at the leaf tip and margins of a leaf blade which elongate, become yellow with wavy margin and proceed downward along one or both edges of a leaf or at any point on injured blades. Later, the yellow colour turns white and dry up. On susceptible cultivars, lesions may reach the lower end of the leaf sheath. The affected leaves dry up from top and margin. Yellowing of leaves and wilting of seedlings/young tillers are two additional symptoms seen in our region.

Control measures

1. Drain out excess water from the field.
2. Limit the level of Nitrogen application at 30 kg per acre. Encourage the application of potassic fertilizer in split doses.

3. Grow resistant/moderately resistant varieties- IR-36, Parijat, Mahsuri, Jajati, IET-2812, Udayagiri, Sebati, Konark, Surendra, Prachi and Indravati.
4. Treat the seeds by soaking in 0.015% Steptocycline (0.15 g in 1 litre) for 12 hours and sow the seed in nursery after germination.
5. Dip roots of the seedlings in solution of Streptocycline (0.01%) or Plantomycin (0.1%) for 30 minutes.
6. Spray the crop at, tillering and boot leaf stage with 0.01% streptocycline or 0.1% Plantomycin alongwith 0.2% Copper oxychloride.
7. Potash application, alternate drying & flooding the field and field sanitation help in reducing infection.

False smut (*Ustilaginoidea virens*)"Saara roga"

It occurs during October to November.

Symptoms and nature of damage

The disease is found on the earheads only. Due to development of fructification of the fungus scattered individual grains are transformed into large velvety green masses, more than twice the diameter of normal grains. The smutted grain look dark velvety green or black in colour

Control measures

1. Grow resistant varieties like Shakti, Vijaya, Mahsuri, Pankaj and Sabarmati.
2. Spray twice at 7 days interval at boot leaf stage with 0.15% Carbendazim or 0.25% Captafol or 0.2% Carbendazim (12%) + Mancozeb (63 %).
3. Draining out water from the field after grain formation reduces severity.

Sheath blight (*Rhizoctonia solani*, *Thanatephorus cucumeris*)

'Patrachhada poda roga'

It occurs during August to November.

Symptoms and nature of damage

First symptoms are greenish grey spots that develop on the leaf sheath on basal stem near the water line. The spots become elliptical or oval, about 1cm. long, subsequently enlarge and lengthen to 2 or 3 cm. They coalesce with each other and encroach the entire sheath under severe condition. The border of each lesion after coalescing gives a distinct banded appearance to the infected area. Under favourable humid conditions, leaf blades in contact with adjacent infected stems also become affected. Symptoms are usually distinct during tillering, flowering or maturing stages. Severe infection results on poor grain filling.

Control measures

1. Grow tolerant varieties : Nilagiri, Parijata and Pankaj etc. and avoid growing susceptible varieties : Swarna, Savitri and Lalat in disease endemic areas.
2. Reduce supply of Nitrogen and avoid close plant spacing.
3. Soil treatment with Kitazin granule at puddling @ 10kg /acre, if the disease had occurred there, previously.
4. Two to three sprayings with 0.15% Propiconazole or 0.15% Hexaconazol or 0.3% Validamycin or 0.15% Carbendazim or 0.1% Kitazin 48 EC at tillering stage.

Sheath rot (*Sarocladium oryae*)'Acchada pacha roga'

It occurs during August to November.

Symptoms and nature of damage

The disease can be recognized by the non emergence or partial emergence of panicles alongwith dark to chocolate coloured unfilled grains. Brown to dark chocolate brown lesions surrounded by diffused light brown halo appears on boot leaf and top most sheath which covers the panicles.

Control measures

1. Grow resistant varieties like Mahsuri, Bishnu bhog, Kala namak, Hansa raj-99, Jyoti, Jayanti, Supriya, Triveni, Lalitgiri, Kharavela, Gajapati, Surendra, Indravati, Ramachandi.
2. Spray twice at 10 days interval starting from boot leaf stage with 0.15% Benomyl or Carbendazim or 0.2% Thiophanate methyl. An insecticide can be mixed for control of insects (mites) which predispose the plants to attack of this disease.

Grain discolouration disease

This has been emerged as a serious disease of rice.

Symptoms and nature of damage

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 of the grain and association 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 seeds become black and shriveled and can easily be cracked. The disease symptoms affect seed germination and grain weight reducing its commercial value to a large extent.

Control Measure

1. Seed treatment with Carbendazim (0.2%) + Thiram (0.3%) @ 0.2% or Carboxin (37.5%) + Thiram (37.5%) @ 0.2% or Thiophanate methyl @ 0.2%
2. Spraying the crop twice at the time of tillering and before flowering with Carbendazim 0.5% or Carbendazim (12%)+ Mancozeb (63%) @ 0.2%, Mancozeb 0.3% or Carbendazim 0.2% or Propiconazole 0.15%.

MAIZE

Leaf blight (*Helminthosporium turcicum*) 'Chitta roga'

Symptoms and nature of damage

The infected leaves show greyish parallel or elongated irregular lesions with prominent colour banding. These lesions coalesce to produce blighted straw coloured patches.

Control measures

1. Treat the seeds with Captan or Thiram @ 2.5 g/kg of seed.
2. Spray the crop with 0.3% Copper oxychloride or 0.3% Mancozeb or 0.15% Difolatan/ Carbendazim (12%)+ Mancozeb (63%) @ 0.2%, 2-3 times at an interval of 10 days.

Wilt

Symptoms and nature of damage

Disease may appear in seedling stage. Water soaked lesions found on foliage, withering or damping off on grown up plants, youngest leave before opening from whorl may

be yellow, dry and die. With advance of disease, shoots may be thinned and plants look weak. If cobs develop, become poor in quality.

Control measures

1. Spraying with Carbendazim 0.15% at different stages of crop.
2. Seed treatment with Thiram 3 g or Carboxin (37.5%) + Thiram(37.5%) @ 2 g/kg of seed
3. Avoid excess soil moisture
4. Remove crop residue
5. Grass weeds should be removed from plots.

JOWAR

Leaf spot

Symptoms and nature of damage

It occurs from July to September. The spots appear on both the surface of the lamina. The spots usually coalesce at later stages and form irregular lesions of various dimensions. The colour of spots varies from brick red to blackish brown.

Control measures

Spray Carbendazim (12%)+ Mancozeb (63%) @ 0.2% or Mancozeb @ 0.3% or Copper Oxychloride (0.25%).

Grain smut

Symptoms and nature of damage

It occurs from October to November. Each grain is transformed into spore sac (sorus) which varies in shape and size.

Control measures

Seed treatment with Carboxin (37.5%)+Thiram (37.5%) @ 0.2% or Captan or Thiram @ 2.5 g/kg of seed or seed treatment with Carbendazim @ 2 g/kg of seed. Spray with Oxycarboxin 20 EC @ 0.2% .

RAGI

Ragi blast (*Pyricularia setariae*) 'Mahisa roga'

It occurs during July to November.

Symptoms and nature of damage

Spindle shaped brown spots with ashy grey centres appear on leaves, stems and nodes. Dark brown to black colour develop at the basal portion of the panicle resulting in grain sterility.

Control measures

1. Treat the seeds with Tricyclazole WP 75% @ 1g/kg of seed or Captan or Thiram @ 2g per kg of seed.
2. Grow moderately resistant varieties "AKP-2, Dibyasinha, JMR-1008, MR-1169 and PR-202', Suvra.
3. Two sprayings with 0.15% Ediphenophos or Carbendazim or 0.1% Tricyclazole first at tillering and second at boot leaf stage may be given.

Leaf spot / blight

Symptoms and nature of damage

Disease causes small brown spots first on foliage which increase in size and coalesce to form larger lesions. Ultimately leaves may dry. The lesions even spread on stem and leaf sheath. Plants may lose vigour. Infection on fingers is also common causing discoloured grains.

Control measures

Treat the seeds with Thiram (0.2%) spray with Mancozeb 75% W.D.P. @ 0.3% or Captafol 80 WP (0.25%) or copper oxychloride 2-3 times after initiation of disease.

PULSES

Powdery mildew (*Erysiphe polygoni*) "Paunsia roga"

It occurs during August to September.

Symptoms and nature of damage

White powdery growth found on the upper surface of leaves, later the white powdery growth turns into greyish white resulting drying of the affected parts.

Control measure

Spray the crop with 0.5% wettable Sulphur or 0.2% Fluzilazole 40 EC or 0.25% Benomyl or 0.15% Carbendazim or 0.05% Tridemorph 80% EC once or twice at the appearance of the disease.

Seed rot & seedling damage

Symptoms and nature of damage

When untreated seeds are sown, there is heavy pre-emergence damage to the germinating seeds causing seed rot. Rotting is caused by any fungi i.e Aspergillus, Colletotrichum, Fusarium, Sclerotium, Rhizoctonia and Pythium. There is heavy mortality in young seedlings due to these fungi. Excess soil moisture favour the seed rot.

Control measures

1. Treat the seeds with 2 g of Thiram or Captan or 2 g of Thiophanate Methyl or Carboxin (37.5%) + Thiram (37.5 %) @ 2 gm / kg of seed.
2. Drainage should be provided in the field.
3. Spraying at the basal portion of the plant with Carbendazim 0.15% or Mancozeb 0.3% or Propiconazole @ 0.2% 2-3 times at 10 days interval.

Wilt

Symptoms and nature of damage

In wilt disease, the most striking symptom is dying or wilting of the entire plant. The leaves and other green succulent parts lose their turgidity, become flaccid and drooping down. Black linear streaks can be observed under the bark. This effect is seen in some of the leaves. Later, young growing tip or the whole plant may suddenly or gradually dry up. In Bengal gram and Arhar, "fusarium wilt" is a severe and common disease.

Control measures

1. Seed treatment with Thiram (0.2%) or with Carbendazim (0.2%) or mixture of the two @ 0.2% for wet treatment, the seeds are to be dipped in the fungicidal solution for 30 minutes and air dried for 2 hours.
2. Grow resistant varieties.
3. Drench the soil around plants with 0.15% Carbendazim solution or 0.15% metalaxyl solution.

Collar rot

Symptoms and nature of damage

In collar rot, the position of the stem just above root crown is affected by soil inhabiting fungi. The affected portion rots and the whole plant show symptoms of wilting. The affected plants ultimately die.

Control measures

1. Seed treatment with a mixture of 3gm Thiram + 2gm Carbendazim @ 0.2%
2. Foliar spray with 0.15% Carbendazim or 0.3% Mancozeb or 0.15% Thiophanate methyl would prove beneficial.

Yellow mosaic virus

It occurs during August to October.

Symptoms and nature of damage

Affected leaves exhibit bright yellow and green patches. In severe cases, the whole leaf completely turns yellow. The yield is very much reduced. The disease is very common in green gram and black gram.

Control measures

1. Spray Dimethoate @ 400 ml per acre in 200 litres of water to control white fly, the insect vector.
2. Grow tolerant varieties of mung such as Hyb.12-4, Hyb 4-3 and of biri such as T-9 and K-10.

Rust (*Uromyces ciceris arietini*) "Kalanki roga"

Symptoms and nature of damage

Reddish brown elongated pustules found on the leaves. In severe cases, the leaves appear rough, wither and dry up.

Control measure

Spray wettable Sulphur @ 0.5% or Tridemorph @ 0.2% or Oxycarboxin @ 0.2 % or Chlorothalonil @ 0.2%.

Leaf spot (*Cercospora* sp.)

It occurs during August to October

Symptoms and nature of damage

Dark brown circular to irregular spots appear on the leaflets. In severe cases, lesions appear on petioles and stem. Greengram and blackgram are severely affected.

Control measure

Spray the crop with 0.3% Mancozeb or 0.15% Carbendazim or 0.3% Copper oxychloride for 3 times at an interval of 10 days commencing from 3 weeks after planting.

GROUNDNUT

Tikka disease (*Cercospora personata*) (*C.arachidicola*) 'Tikka roga'

It occurs during August to November.

Symptoms and nature of damage

Dark brown circular spots appear on the lower leaves with necrotic lesions appearing on both the surface of the leaf. Spots occur on petioles and stem also. In severe cases, the spots enlarge, coalesce, leaves become yellow and defoliate.

Control measures

1. Treat the seeds before sowing with Captan or Thiophanate methyl or Thiram DSD @ 2.5-3.0 g/kg of seed or 4 g Trichoderma per kg of seed.
2. Spray the crop with 0.3% Mancozeb or 0.15% Chlorothalonil or 0.15% Carbendazim or 0.2% Carbendazim (12%) + Mancozeb (63%) or 0.1% Difenoconazole or 0.15% Thiophonate methyl.
3. Grow moderately resistant varieties such as M-13, Punjab-1, Polachi, J-11 and improved spanish and tolerant variety OG-1-13-3 (Kissan)

Stem rot (*Macrophomina phaseoli*) 'Kanda pacha roga'

It occurs during August to October.

Symptoms and nature of damage

Water soaked spots appear on the stem at the ground level. Mustard like fruiting bodies are formed on the affected portion of the stem, subsequently the plants wilt and die in irregular patches.

Control measures

1. Control measures as in case of Tikka disease.
2. Grow resistant varieties such as J-11 and Polachi.
3. Spray the basal portion & foliage with 0.15% Carbendazim or 0.3% Mancozeb or 0.15% Chlorothalonil or 0.2% Metalaxyl (8%) + Mancozeb (64%) or 0.15% Propiconazole.

Root rot (*Rhizoctonia bataticola*) 'Chera sadha roga'

It occurs during June to July.

Symptoms and nature of damage

The affected seedlings suddenly wilt and die. Many infested seeds fail to germinate.

Control measures

1. Control measures as of Tikka disease.
2. Spray with Metalaxyl (8%) + Mancozeb (64 %) @ 0.2% or Propiconazole @ 0.15%.

Collar rot (*Aspergillus niger*) 'Sadha roga'

It occurs during June to August.

Symptoms and nature of damage

The fungus affects the plant just above the ground level, black rotting patches develop at the base of the plant initially. The affected plants wither & die.

Control measures

1. Treat the seeds with 0.3% Thiram or 0.2% Carbendazim or mixture of both @ 0.2% or 0.2% Thiophanate methyl or Carbendazim (12%) + Mancozeb (63%).
2. Drench the basal portion of the plants with 0.15% Carbendazim or 0.3% Mancozeb, if the disease is seen in later stage.
3. Restrict over irrigation of plots during seedling stage of the crop.
4. Grow resistant varieties such as Polachi and J-11.

Seedling blight

Symptoms and nature of damage

It occurs from July to August. The parasite causes rotting of the germinating seed and rotting of the hypocotyls region at a later phase resulting in death of the seedlings.

Control measures

1. Treat the kernels with Thiophanate methyl @ 0.2% or Captan @ 2.5 g/kg seed or with Carbendazim @ 2.0 g/kg of seed or Thiram @ 3 g/kg of kernel.
2. Spray the seedlings with Captafol or Ziram (0.4%) or Mancozeb 0.3% or with Carbendazim 0.15% or Metalaxyl @ 0.15%
3. Grow resistant varieties like polachi.

Bud necrosis

Symptoms and nature of damage

It occurs from August to October. The disease plants are stunted, less vigour, normal flowering is affected. Floral tissues are atrophied, become black and necrotic. In severe cases the maturing plant plants show blight. Pods are reduced in size with poor seed filling and abnormally small seeds.

Control measures

1. It is a virus disease and transmitted by Thrips. Hence, vector control by use of Dimethoate/phosphamidon @ 400 ml/ac will reduce disease spread.
2. Growing crop at high plant population and sowing the crop by mid June.
3. Highly susceptible cultivar, TMV-2, J-11 should not be grown.
4. Kadiri-3 and AK-12-24 varieties are tolerant and should be encouraged.

SESAME (Til)

Phyllody

Symptoms and nature of damage

It occurs from August to September. The disease is caused at the flowering stage when the floral parts are transformed into green leafy structures which grow profusely. The entire floral parts appear leafy and the flower becomes sterile. The portion appears bushy.

Control measures

Spray with Carbaryl 50% WP @ 400 g/ac for vector control as prophylaxis. Grow early duration varieties.

Fungal blight (*Alternaria/Cercospora*)

Symptoms and nature of damage

It occurs from August to September. On foliage brown coloured spots appears which increase in size, several spots, coalesce, leaves show blight which extends to all leaves in

severe stages. Diseased tissues break off, at the time infection on capsules and stem is also seen.

Control measures

1. Treat seed with Carbandazim @ 0.2% or with Captan (0.2%) or with Thiram (0.3%).
2. Spray at 2 week intervals with Mancozeb (0.3%) or Carbendazim (0.15%) 1st spray after 4 weeks of planting. Chlorothalonil @ 1.5 g/litre of water or 1% Bordeaux mixture or any copper compound at 0.3% concentration may also be sprayed.

CASTOR

Rust

Symptoms and nature of damage

It occurs from November to December. Orange yellow rust pustules occur on the under surface of the leaves.

Control measures

Spray with sulphur WP @ 0.5% or spray 0.05% or Tridemorph 80% EC or Chlorothalonil @ 0.2%.

Leaf spot

Symptoms and nature of damage

It occurs from August to October. The disease appears as minute water soaked lesions which enlarge into irregular shapes with deep brown margins and grayish white centres.

Control measures

Spray Bordeaux mixture (1%), Mancozeb 75% WDP or Copper Oxychloride or Blue copper or Mancozeb @ 0.3% or Captafol (0.2%) or Ziram (0.2%) twice at 10 days interval.

Phytophthora blight

Symptoms and nature of damage

It occurs from August to October. Water soaked lesions develop on the leaves which turn brown, later on leaves wither and blight.

Control measures

Spray the crop with 5:5:50 Bordeaux mixture @ 1.0% or with any Copper oxychloride (0.3%) for two times at an interval of 15 days or Metalaxyl (8 %) + Mancozeb (64%) @ 0.2% or with Mancozeb 0.3% .

JUTE

Stem rot (*Marcophomina phaseoli*) 'Kanda sadha roga'

It occurs during July to August.

Symptoms and nature of damage

Blackish brown shrunken and linear streaks appear on the collar region resulting drying of the plant. In older plants, shedding of leaves, rotting of stems and finally death of plant occurs.

Control measures

1. Treat the seed with Captan or Thiram @ 2.0 g or Carbendazim 2.0 g per kg of seed.
2. Spray the crop with 0.3% Mancozeb or 0.15% Carbendazim or 0.3% Copper oxychloride or 0.15% Propiconazole or 0.2. Metalaxyl (8%) + Mancozeb (64%).
3. Grow resistant varieties :- Capsularies : JRC-212, JRC-747, JRC-321, D-154, JRC-4444 and Olitorius : JRO-632, JRO-7835 and JRO-878.
4. Grow Jute in the soil with pH 6.0-6.8.

COTTON

Bacterial blight (*Xanthomonas axonopodis* pv. *Malvacearum*)

It occurs during August to October.

Symptoms and nature of damage

Scattered, angular water-soaked spots appear on both the sides of leaves which on drying become dark brown. The young shoots, when affected, turn black and finally dry up. Black arm, twig blight and boll rot are the other prominent symptoms of this disease.

Control measures

1. Soak acid delinted seeds in 0.15% solution of Plantomycin or 0.15% Streptocycline for a period of 2 hours followed by drying of the seeds in shade.
2. Spray the crop with 0.1% Plantomycin or 0.01% Streptocycline with Copper fungicide added @ 2 g/litre of solution. Give at least 3 (three) sprayings at 20 days intervals starting from the pre-flowering stage.

Anthracnose (*Colletotrichum indicum*)

It occurs during September to October

Symptoms and nature of damage

The disease attacks the seedlings first, causing small reddish circular spots on the cotyledon. When the lesions are on the collar region, the stem may be girdled causing seedling to wilt and die.

Control measures

1. Treat the seeds with 0.3% Thiram or Captan after delinting.
2. Spray 0.3% Copper oxychloride or 0.15% Carbendazim or 0.3% Mancozeb or 0.25% Ziram 2 to 3 times at an interval of 15 days.

Wilt

Symptoms and nature of damage

Wilting is characterized by gradual or sudden yellowing, withering and drying up of leaves and the entire plants in patches.

Control measures

1. Follow crop rotation.
2. Treat the seeds with 0.2% Thiophanate Methyl.
3. Spraying the basal portion of the plant and soil drench with Carbendazim 0.15% or Thiophanate Methyl @ 0.2%.
4. Apply Groundnut oil cake with Zinc into the soil at the time of land preparation.

SUGARCANE

Red rot (*Physalospora tucummanensis*) 'Nali sadha roga'

It occurs during August to November.

Symptoms and nature of damage

Dark reddish spot with dark brown margin appear along the midrib. Black specks appear on the rind. On splitting upon the diseased cane, red blotches with transversely elongated white centres are seen.

Control measures

1. Select healthy and disease free setts.
2. Dip the setts on 0.15% Carbendazim or Thiophanate methyl WP 70% @ 0.15% solution for 30 minutes before planting.
3. Avoid ratooning of infested crops.
4. Grow resistant/tolerant variety viz; Co 6907, Co 7219, Co 838, Co 841, Co 813, CoT 8201, CoA 601, CoA-7602, CoA 89085, Co 87044, Co 86249, Co 87263.
5. Spray with 0.15% Benomyl or Carbandazim or 0.2% Thiophanate methyl
6. Highly susceptible varieties like Co 997, Co 527, CoC 671, Co 62174, Co 740, Co 62175 should be avoided for planting in endemic areas.
7. Avoid waterlogging
8. Uprooted the infested clump and destroy.

Smut (*Ustilago scitaminae*) 'Chatta roga'

It appears during March to April and September to October

Symptoms and nature of damage

A long whip of dusty black shoots are found on the growing axis.

Control measures

1. Collect smutted whips carefully in a bag and burn them.
2. Avoid ratooning and collection of seed canes of infested crop.
3. Disinfect seed canes in 0.3% solution of Carboxin or 0.2% Carboxin (37.5%) + Thiram (37.5%) for 30 minutes. Alternatively dip the setts for 10 minutes in hot water at 54°C before planting.
4. Grow resistant/tolerant varieties like Co 6907, Co 87263, Co 7508, Co A 89085, Co 86249, Co 87044.

Plant protection measures (Ratoon crop)

- Clean the field after harvest of the previous plant crop
- Spray the stubbles with 0.2% carbendazim or Benlate immediately after harvest of crop
- Apply carbendazim (12%) + Mancozeb (63%) @ 0.2% in the standing crop as basal soil drench to check red rot and smut diseases.
- Spray 0.15% carbendazim or benlate towards mid of June to control red rot and smut diseases.

BETELVINE

Disease Symptoms :

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 laminae, surrounded by a water soaked margin followed by a bright yellowish halo. Aerial 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%) + Streptomycin (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 Streptomycin or Plantomycin (250 ppm) or Bromonitropropanediol (0.05%) 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* @ 2.0 to 2.5 kg/ha one month before and after the Bordeaux mixture.
6. Substitute neem oil 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

Bacterial wilt of solanaceous vegetables (*Ralstonia solanacearum*) ‘Jhaunla roga’

Symptoms and nature of damage

It is a soil and seed borne disease. Plants show wilting at flowering and post-flowering stages. Drooping of leaves followed by total wilting of the plants at fruiting stage is the main symptom of the disease. Infection at late growth stage of the plant result in drying of auxillary buds and small fruits, dropping of leaves and flowers, blackening of nodes etc. The disease is most predominant during most part of the year except the winter months.

Control measures

1. Soak the seed with 0.15 g of Plantomycin or 0.015 g of Streptocycline + 2 g of Copper oxychloride in 1 litre of water for 10 minutes. Dry the seeds before sowing.
2. Follow seedlings root dip for 15 minutes in a solution of 0.01% Streptocycline or 0.1% Plantomycin.
3. Soil drenching with 0.015% Streptocycline or 0.15% Plantomycin + 0.2% Copper-oxy-chloride to the base of the plant.
4. Fumigate the nursery bed @ 500 cc Formalin of 4% solution per 10 sq.m. area atleast 7 days before sowing.
5. Practise crop rotation with non-solanaceous crops for 2-3 years to eradicate the pathogen.
6. Avoid water stagnation
7. Grow resistant varieties; brinjal- Pusa purple cluster, BB-7 (Utkal Tarini), BB-44 (Utkal Madhuri)

Wilt complex in solanaceous vegetables (Brinjal, Chilli)

Wilt can be caused independently by a bacterium (*Ralstonia solanacearum*), fungi (*Sclerotium rolfsii*, *Fusarium oxysporum*) or root knot nematode (*Meloidogyne incognita*). Root knot and/or numerous other nematodes help easy entry of bacterium and fungi into the host plant and increase the intensity of wilting. Intensity of wilting due to the complex is always much more than any single causal organism. High temperature and excess soil moisture at flowering stage of the crop favour development and spread of the disease.

Control measures

1. Practise summer ploughing with a furrow turner plough twice.
2. Follow crop rotation with rice (low and medium land), marigold or sesame.
3. Avoid seedlings from private/commercial agencies. Raise your own seedlings in fine sterilized beds earthen plots.
4. Treat the seeds with 1 g Plantomycin + 1 g Carbendazim in 1000 ml water for 30 minutes before sowing to reduce disease incidence.
5. Treat the nursery with Carbofuran @ 1 kg/ha one week before uprooting.
6. Follow seedling root dip for 15 minutes with 0.15 g of Streptocycline + 1.5g of Carbendazim in one litre of water.
7. Apply neem or karanja oilcake @ 1 t/ha to the main field once in every 3 years.
8. Apply sufficient well decomposed cowdung compost or FYM.
9. Drench the base of the plant with Streptocycline 0.15 g. + Carbendazim 1 g or with 0.2% Kasugamycin in one litre of water after every intercultural operation.
10. Avoid water stagnation .
11. Grow resistant varieties like Utkal Madhuri, Utkal Anushree and Utkal Tarini of brinjal and Utkal Rashmi, Utkal Ava and Utkal Ragini of Chilli
12. Follow crop rotation with non-solanaceae crop, having a solanaceous crop atleast in every 3 years.

BRINJAL

Root rot (*Fusarium* sp.) 'Cherasadha roga'

It occurs during August to November

Symptoms and nature of damage

The leaves of affected plants become yellow. There is often premature dropping of flowers. As the rotting progress, the plant wilts and dried up.

Control measures

1. Adopt crop rotation.
2. Treat the seeds with Captan or Thiram @ 2 g/kg of seeds or Carboxin (37.5 %) + Thiram (37.5 %) @ 2g/kg.
3. Spray the crop with 0.2% of Metalaxyl (8%) + Mancozeb (64%) or 0.3% Mancozeb or 0.15% Carbendazim, especially to the basal portion.

Wilt (*Ralstonia solanacearum*) 'Jhaunla roga'

Symptoms and nature of damage

Drooping of leaves followed by sudden wilting of the plant at first fruiting stage is the main characteristic of this disease. Drying of auxillary buds and small fruits, drooping of leaves and flowers, blackening of nodes are some of the other symptoms seen in older plants.

Control measures

- ❖ Treat the seeds with 0.15% of Plantomycin or 0.015% of Streptocycline solution for 20 minutes.
- ❖ Grow resistant varieties like Utkal Tarini, Utkal Madhuri and Pusa purple cluster etc.
- ❖ Drench the soil at the base of the plant with 0.015% Steptocycline + 0.2% solution of any Copper fungicide for 2 to 3 times.
- ❖ Avoid water stagnation

Phomopsis blight of brinjal (*Phomopsis vexans*)

Symptoms and nature of damage

The disease symptoms appear as dark brown to black rotting patches on young twigs and branches during vegetative growth of the plant. The symptoms may spread at the time of development of fruits. The dark brown rotting patch with greyish centre appear on matured fruit which under severe condition make the fruit completely rotten, mummified and drop of.

Control measures

1. Treat the seeds with Carboxin (37.5%) + Thiram (37.5%) @ 0.2% or Carbendazim (12%) + Mancozeb (63%) @ 2gm /kg of seed.
2. Spray twice the crops before fruiting with Carbendazim (12%) + Mancozeb (63%) @ 0.2% and Mancozeb 0.3% after removing the affected plant parts and fruits from the plant.

CHILLI

Damping off (*Prythium aphanidermatum*) 'Talighara roga'

Symptoms and nature of damage

The seedlings are attacked just below the soil level and die gradually.

Control measures

1. Treat the seeds with Captan (0.3%).
2. Nursery bed sterilization with Formaldehyde @ 4 ml/litre of water one week before sowing.
3. Drench the nursery soil with 0.15% Carbendazim or 0.2% Metalaxyl (8%) + Mancozeb (64%).

Anthracnose and die back (*Colletotrichum capsici*) (Patra chitta & Agamara roga)

Symptoms and nature of damage

The foliage, stem and fruits are attacked. In severe cases it causes die back. High humidity favours disease development.

Control measures

Spray the crop with copper oxychloride (0.3%) or Difolatan (0.25%) or Carbendazim (0.15%) two to three times at 10 days intervals.

Bacterial wilt (*Ralstonia solanacearum*)

Symptoms and nature of damage

Sudden drooping of leaves and death of plants. Secondary infection result in gradual defoliation, flower drop, drying of auxillary buds and small fruits.

Control measures

Grow resistant varieties like Utkal Rashmi, Utkal Ava and Utkal Ragini (other measures same as under brinjal)

TOMATO/ ONION

Leaf blight

Control measures

Spray the crop with Mancozeb @ 0.3% or Carbendazim @ 0.15% or 0.2% of combination fungicides containing Carbendazim and Mancozeb at 10 days interval on need basis.

RUNNER BEAN

Web blight (*Rhizoctonia solani*)

Symptoms and nature of damage

At the initial stage of infection there is damping off of the seedlings. At later stages water soaked patches appear on the leaves and stems which coalesce to produce large bright areas.

Control measures

Spray Mancozeb @ 0.3% on need basis

Cercospora leaf spot (*Cercospora* sp.)

Symptoms and nature of damage

Small irregular brown spots appear on the leaves.

Control measures

Spray Carbendazim @ 0.15% or Mancozeb @ 0.3% .

OKRA

Yellow vein mosaic (*Sahebi roga*)

It is a very common virus disease.

Symptoms and nature of damage

In early stage of infestation the plants turn yellow and become barrern. If the infestation takes place in late, the earlier formed leaves on the main stem remain green where as the top leaves and flowering parts show clear symptoms. On such plants the fruits become yellow and fetches low price in the market.

Control measures

1. Grow tolerant varieties viz; Utkal Gaurab (BO 2), Arka Anamika
2. The disease is transmitted by the white fly (*Bemisia tabaci*). Control the white fly by spraying Confidor @ 0.25 ml or Regent @ 2 ml per litre of water.

CUCURBITS (pumpkin, cucumber and gourds)

Powdery mildew (*Erysiphe* sp) 'Paunsia roga'

Symptoms and nature of damage

White fluffy, circular spots having grayish white powdery growth appear on the surface of older leaves which increase in size and coalesce to cover both surfaces. Severely affected leaves become brown and shrivelled. The fungus attacks leaves, stem and fruits.

Control measures

Spray 0.3% Dinocap 48% EC or Tridemorph 80 EC @ 2 ml/litre of water twice at 10 days interval.

Mosaic

This is a virus disease occurring on many cucurbits including cucumber, bottle gourd, bitter gourd and water melon and pumpkin etc.

Symptoms and nature of damage

There is formation of streaks in the interveinal regions of leaves. Young leaves are usually distorted with wavy or irregular margins and wrinkled surface with green blisters. Diseased plants flower little or none and fruiting is greatly reduced in number and size.

Control measures

The disease is transmitted through the insect vectors. Take up prophylactic spray against vectors to check the disease.

SWEET POTATO

Leaf spot (*Cercospora sp.*) 'Patra daga roga'

Symptoms and nature of damage

The disease appears at all the stages of crop growth. Minute circular to irregular dark brown spots appear on the leaves. In severe case defoliation occurs.

Control measures

Spray the crop with Carbendazim (0.15%) or Copper fungicide (0.3%) or Mancozeb (0.3%) twice at 10 days intervals.

White rust (*Albugo candida*)

Symptoms and nature of damage

White blister like circular or irregular pustules appear on the lower surface of the leaf and opposite to each pustule on the upper surface a yellow patch develop. Heavy infection causes leaves to turn brown and give the field a blighted look.

Control measures

Keep the field and the surroundings clean. Spray the crop with Metalaxil (8%)+ Mancozeb (64%) @ 0.2% or Carbendazim (0.15%) or Zineb (0.3%) thrice at 15 days interval.

GINGER

Phyllosticta leaf spot

It occurs in August and September.

Control measures

Spray the crop in July-August with Copper oxychloride (0.3%) twice at 12 days interval.

Rhizome rot and wilt

Control measures

1. Select disease free rhizome from healthy plot
2. Follow rhizome treatment.
3. Adopt two year crop rotation
4. Removal the rotted plants from the field
5. Take up prophylatic spray with Mancozeb (0.3%) or Carbendazim (0.15%) or Copper oxychloride (0.3%) at 50, 80 and 100 days after planting.
6. Rhizome treatment with streptomycin 0.015% + Carbendazim 0.1% before planting.
7. Soil drench at the basal portion with the same chemicals.

TURMERIC

Leaf spot

Symptoms and nature of damage

Two types of leaf spots are seen. Numerous circular blackish or reddish spots are seen in the leaves. In another type blighting is seen from leaf tip which proceed inwards forming larger blighted area.

control measures

Spray the crops with Mancozeb (0.3%) or Carbendazim (12%) + Mancozeb (63%) @ 0.2% twice at 12 days interval.

Rhizome rot

Symptoms and nature of damage

Rotting of the rhizome below the soil level followed by yellowing and death of the plants.

Control measures

1. Growing of resistant varieties like Roma, Ranga, Rashmi and Surama.
2. Spray the crop with Carbendazim 0.15% or Mancozeb 0.3% or Metalaxyl (8%) + Mancozeb(64%) @ 0.2% twice at 12 days interval starting from 45 days after planting.
3. Drench the soil with Streptocycline 0.015% + Copper Oxychloride 0.2%

ORNAMENTAL CROPS

TUBER ROSE

Alternaria leaf spot (*Alternaria alternata*)

Symptoms and nature of damage

The symptoms initiate from the leaf tip and gradually progress inward with wavy margins.

Control measures

Spray the crop with Mancozeb (0.3%) or Carbendazim (0.15%) or Carbendazim (12%) + Mancozeb (63%) @ 0.2% twice at 10 days interval.

MARIGOLD

Leaf spot (*Alternaria taeticola*)

Symptoms and nature of damage

Dark brown irregular spots appear which coalesce to give blighted appearance.

Control measures

Spray the crop with Carbendazim (0.15%) or Mancozeb (0.3%) or Carbendazim (12%) + Mancozeb(63%) @ 0.2% twice at 10 days interval.

Powdery mildew (*Erysiphe cichoracearum*)

Symptoms and nature of damage

Whitish patches appear on leaves. In severe cases the stem and flower buds are affected. Diseased leaves turn yellow, curl and dry up.

Control measures

Spray with Dinocap 48% EC (0.25%) or wettable sulphur (0.5%) or 0.2% fluzilazole 40 EC.

Flower blight (*Alternaria sp.*)

Symptoms and nature of damage

The pathogen attacks ray florets and peduncles, resulting in dark brown spots or lesions which later turn greyish. The flower heads dry. The infection is carried through seed and diseased debris.

Control measures

Maintain crop sanitation. Spray Carbendazim (0.15%) or Mancozeb (0.3%) to control the disease

JASMINE

Anthracoze (*Colletotrichum sp*)

Symptoms and nature of damage

The spots on leaves are scattered, numerous and often coalesce to form large patches. On young shoots, the spots are many, closely grouped, elongated, raised and form crusts.

Control measures

Spray the crop with Carbendazim (0.15%) or Mancozeb (0.3%) or Carbendazim (12%) + Mancozeb (63%) @ 0.2% or Copper oxychloride (0.3%) twice at 10 days interval.

NEMATODE MANAGEMENT

RICE

Root-knot nematode (*Meloidogyne graminicola*)

Occurrence

It is a problem mainly of nursery as well as in well drained medium lands

Symptoms of damage

The seedlings/plants are stunted and yellowish in patches. When uprooted, small galls were seen on roots. Stand of seedling is poor and insufficient. In the fields plants become chlorotic and rarely reddish stimulating iron-toxicity symptoms; later leaves dry up. Production unthrifty.

Management

1. Two to three deep summer ploughings
2. Soaking of paddy seeds in 0.1% Carbofuran/ Monocrotophos solution for 12 hours or apply Cartaphydrochloride or Carbofuran or Phorate @ 0.3g a.i./m² in the nursery at sowing or root dip of the seedlings in 0.1% Carbofuran 25EC or Monocrotophos 40 EC for 12 hours before transplanting or application of commercially available *Pseudomonas fluorescence* @ 20g/m² during sowing of seeds.
3. Keeping water impounded in the field for more than one month delays nematode development and disease intensity.
4. Application of Neem cake @ 1ton/ha at 3 weeks before sowing / planting

Rice -root-nematode (*Hirschmanniella oryzae*)

Occurrence

It is a problem in nurseries, medium and low lands. It prefers flooded conditions.

Symptoms of damage

Symptoms of damage are nonspecific, growth retardation, chlorosis and there is reduction in number of tillers; several roots are discoloured, black and necrotic with cavities inside. Nematodes can be recovered from the roots. Under heavy infestation the leaves dry up prematurely from bottom top-ward; yield is reduced.

Management

1. Three deep summer ploughings.
2. Pre-sowing treatment of nursery with Cartap hydrochloride or Carbofuran or Phorate @ 0.3 g a.i./ m²
3. In the standing crop during tillering phase, application of Carbofuran or Phorate or Cartap hydrochloride @ 1 kg a.i./ha. Under controlled conditions of water.
4. Groundnut or Blackgram or mustard is to be included in the cropping sequence after rice crop.
5. Sowing of Dhanicha (*Sesbania*) 25 days prior to transplanting of paddy in the field and incorporated in the soil during final puddling before transplanting paddy.

White tip nematode (*Aphelenchoides besseyi*)

Occurrence

It occurs in all types of lands. Heavy dew and fog enhances the intensity of damage.

Symptoms of damage

It is a parasite of aerial parts of plants. The nematode is carried dormant in seeds and is reactivated when seeds start germinating. It moves to the tips of young seedlings and remains in leaf sheath and move upward with the growing stem and leaf where it feeds ectoparasitically. The leaf tip initially is light yellow to white and later becomes dark and dies. The base of flag leaves are often twisted. Panicles are generally smaller than normal with sterile flowers, leading to reduced yield.

Management

1. Pre-soaking of seeds overnight followed by sun drying for four days consecutively in April and May kill the seed borne nematodes.
2. Hot water treatment – Soak the seeds in hot-water at 52°C – 55°C for 15 minutes, following a presoak for 12 hrs in normal water if not sun-dried.
3. Precaution – After treatment, water should be drained off and seeds dried in shade before sowing.
4. Field sanitation is essential.
5. Alternate spraying of Carbofuran @ 0.2% and Triazophos @ 0.2%, at 40,60 and 80 days after sowing of seeds for medium duration paddy but two sprayings for short duration paddy at 40 and 60 days after sowing of seeds.

SUGARCANE

Parasitic nematodes (*Pratylenchus sp.*, *Hoplolaimus sp.*, *Criconebella sp.* etc)

Occurrence

It occurs through the year.

Symptoms and nature of damage

Infected plants exhibit chlorosis and stunted growth and poor response to fertilizer application. Roots show dark, round or elongated lesions. Symptoms are more pronounced in ratoon crops.

Management

1. Crop rotation with sunflower, sesame and mustard
2. Deep summer ploughing
3. Application of Carbofuran @ 0.4 kg a.i. /ac at the first earthing up of main/ratoon crop.
4. Apply FYM or Neem oil cake @ 200g/m² during land preparation or at the earthing up of main/ratoon crops.

VEGETABLES

BRINJAL/CHILLI/TOMATO

Root-knot nematode (*Meloidogyne incognita*)

Occurrence

It is the number one problem of vegetables. All medium and uplands which are regularly under any kind of vegetable/pulse/banana/gourds etc. always harbour high populations of the nematode. Lands which are flooded for more than one month in the Kharif are less infested. It is a problem equally in nurseries and fields.

Symptoms of damage

Plants are sickly, stunted and chlorotic; when uprooted show small to large galls depending on the duration of infestation of the plant; poor stand of seedlings in nursery. In the fields intensity of wilt is more if heavy infestation of the nematodes occur and there will be unthrifty production.

Management

1. Crop-rotation : Rotate vegetables after cereals, oilseeds or marigold or mustard or sesame.
2. Flooding – Either keep the land flooded for more than one month in the previous season or select a natural land type.
3. Nursery treatment – Apply Cartap hydrochloride or Phorate or Carbofuran @ 0.3g a.i/m² at the time of sowings.
4. Seedling root dip - Root dip the seedlings for 30 minutes in 0.05% Carbosulfan 25EC or Monocrotophos 40EC.
5. Field application – Apply fresh neem or karanj oilcake @ 2 tons/ha during planting or Application of Trichoderma @ 2.5 kg/hectare after incubation in 1 Q moist FYM for 10-15 days under polythene covering.
6. Resistant varieties – Brinjal – Kanta Baigan, Ghatikia white, Utkal Madhuri (BB44) and Utkal Anushree.
7. Chilli – Pusa Jwala, Sindhuri, Pusa Sada Bahar.
8. Tomato – Pusa Sel. 120; Hissar lalit, BT-12 and BT-17
9. Treatment of Trichoderma @ 2.5 gm/m² in the nursery bed.

Reniform nematode (*Rotylechulus reniformis*)

Occurrence

Similar land situation as those in brinjal/chilli/tomato.

Symptoms of damage

Symptoms are more generalised and non-specific stimulating poorly functioning root-system followed by stunting, chlorosis, unthrifty production, but no root galling.

Management

1. Crop rotation with cereals
2. Application Trichoderma @ 2.5 g/m² in the nursery bed.
3. Nursery treatment – same as under brinjal
4. Seedling root dip – same as under brinjal
5. Field application – same as under brinjal

BHINDI/COWPEA/CUCUMBER

Root-knot nematode

Occurrence

It is the number one problem of vegetables. All medium and uplands which are regularly under any kind of vegetable/pulse/banana/gourds etc. always harbour high populations of the nematode. Lands which are flooded for more than one month in the Kharif are less infested. It is a problem equally in nurseries and fields.

Symptoms of damage

Plants are sickly, stunted and chlorotic; when uprooted show small to large galls depending on the duration of infestation of the plant; poor stand of seedlings in nursery. In the fields intensity of wilt is more if heavy infestation of the nematodes occur and there will be unthrifty production.

Management

1. Crop rotation with cereals, oil seeds, marigold, mustard, sesame.
2. Seed Treatment – Treat the seeds with Carbosulfan 25 DS @ 3g/kg seed before sowing. Use little moisture with gum-arabic or simple moisture to moisten the seeds before treatment to allow better attachment of the chemical.
3. Field application – Fresh Neem or Karanj oilcake @ 2 tons/ha. at the time of last land preparation or application of Tricoderma @ 2.5kg/ha after incubation in moist 1Q FYM for 10 -15 days under polythene covering.
4. Resistant of variety – Cowpea cv. Swarna.
5. Seed treatment with Tricoderma @ 10g/kg. seed.

Reniform nematode

Occurrence

Similar land situation as those in brinjal/chilli/tomato.

Symptoms of damage

Symptoms are more generalised and non-specific stimulating poorly functioning root-system like stunting, chlorosis, unthrifty production, but no root galling.

Management

1. Crop rotation with cereals
2. Seed treatment with Trichoderma @ 10g/kg seed
3. Nursery treatment – same as under brinjal
4. Seedling root dip – same as under brinjal
5. Field application – same as under brinjal

GOURDS

Root knot nematode

Occurrence

Number one problem in all up and medium lands.

Symptoms of damage

As in brinjal

Management

- a) Treatment of pits – Pulverise the pit-soil and expose to sunlight by repeated raking. If possible heap 4"-6" dry trash and burn it before application of compost. Add 250g fresh Neem or Karanj cake at seed-sowing or 200g soil rich in Glomus (VAM) with spore load of 1000 to 2000 per pit.
- b) Seed Treatment – Where pit burning is not possible, treat the seeds with Carbosulfan 25 DS @ 3g/kg seed. Moisten the seeds lightly before chemical treatment or Treat the seeds with Trichoderma @ 10g/kg seeds.

BETELVINE

Root knot nematode (Champa-foolia roga)

Occurrence

The nematode is extremely serious in the plantation of betelvine in 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/m².
4. Use resistant vines name Berhampuri, Birkholi.
5. During planting of vines, application of Trichoderma @ 2.5kg/ha. (Trichoderma is mixed with 1Q. moist FYM and covered under polythene for 10-15 days to increase the spore load. Then FYM incubated Trichoderma is broadcasted in the field).

PESTICIDES: THEIR COMMON NAMES, FORMULATIONS AND TRADE NAMES

Common Name	Formulation	Trade Name
1. INSECTICIDES :		
A. Chlorinated Hydrocarbons:		
1. Lindane	WDP 6.5-25%	Lindane,Hexamar
	EC 30%	Lindane
	G.6-10%	Krishi Lindane,Utkal Lindane
2. Endosulfan	EC 35%	Thiodan, Parrysulfan.Krishi Endosulfan,Utkal Endosulfan, Hildan
	Dust 4%	Hildan, Endocel,Endotaf, Thiotox,.
3. Dicofol	EC 18.5%	Endosol, Kelthane, Hilfol
B. Organophosphates		
4. Dimethoate	EC 30%	Rogor, Cygus,Hexagor,ParryDimet,Corothate, Krogar-30.
5. Dichlorvos	EC 76%	DDVP,Nuvan,Marvex,Vapona,Suchlor,DIVAP,Agro DDVP,Luvon 76
6. Malathion	EC 50%	Malathion, Latholrock
	Dust 2-5%	Meltex,Malathion,Malamar,Matatox
	Solution 90-99%	Krishimalathion, Cythion,ParryMalathion, Hlthion,Kthion
7. Phosphamidon	EC 40%	Dimecron,Sumidon,Cildon,Kinadan,Umecron
	SL 40%	Hiton
8.Phorate	G.10%	Thimet,Foratox,Phorate,Granutox
	Dust 6%	Agrophorate,Volphor
9. Acephate	SP 75%	Asataf,Starthane,Aimthane
10. Ethofenprox	EC10%	Trebon, Nukil
11. Ethoprofos	G.10%	Mocap
12. Isazofos	G.3%	Miral
13. Triazophos	EC 40%	Hostathion, Sutathion, Trizer, Trizocel, Tarzan, Ghatak, Fulstop.
14. Ethion	EC 50%	Tafethion, Fosmite, Mitekill, Dhanumit
15. Methyl demeton	EC 25%	Metasystox, Hexametastox, Hymox, Dhanusystox
16. Monocrotophos	SL 36%	Nuvacron, Parryfos, Balwan, Sufos,
	WSC-36	Corophos, Monocil, Agromonare,Cadet, Aimocron, Monophos, Lufos, Hycrophos, Hilcron, Monodhan
17. Quinalphos	Dust 1.5%	Ekalux, Suquin, Kinalux
	EC 25%	Quinatox, Ekalux, Suquin
	G.5%	Agroquin, HLX-25, Quinilaux, Dhanulux
	21 AF	Ekalux
18. Phosalone	Dust 4%	
	EC 35%	Zolone
	Dust 2%	
19. Chlorpyrifos	EC 20%	Dhanusban, Coroban, Durmet, Ruban, Sacoban, Pyriban, Classic, Coroban, Tafaban, Rus Ban, Chlordel, Kri-Shan, Lentrek, Lethal, Trishul

Common Name	Formulation	Trade Name
20. Profenofos	EC 50%	Curacron, Prowess, Profenovip, Profex, Carina, Prahar
C. Carbamates		
21. Carbofuran	G.3%	Furadan, Diafuran, Furacarb
22. Carbaryl	Dust 4%	Sevin, Carbaryl, Hexavin
	G.6% &10%	Sevinflo
	WDP 50%	
23. Aldicarb	G.10%	Temic
24. Propoxur	EC 20%, Bait Aerosol 20%	Baygon
25. Carbosulfan	EC 20%	Posse
	ST 25%	Marshal
26. Thiodicarb	WP 75%	Larvin
27. Fenobucarb(BPMC)	EC 50%	Mahakill, Bipvin, Knock, Merlin
D. Combination insecticides		
28. Triazophos(35% EC)+ Deltamethrin (1% EC)		Spark 36% EC
29. Quinalphos (20% EC)+Cypermethrin(3%EC)		Viraat 23 EC
30. Acephate(25%EC)+Fenvalerate(3%EC)		Koranda 28EC
31. Chlorpyrifos(50%EC)+Cypermethrin(5%EC)		Ulka 505, Anaconda 55EC, Nurelle D, Nuracombi, Cannon, Stampede, Anth, Super-D.
32. Buprofezin + Deltamethrin		Dadeci 5-9 EC
33. Profenofos (40% EC) +Cypermethrin (4% EC)		Roket 44EC, Polytrin C
34. Phosalone(24%EC)+Cypermethrin(5%EC)		Sherlone 29 EC
35. Ethion (40%EC)+Cypermethrin(5% EC)		Nagata 45 EC, Colfos 405 EC
2.FUNGICIDES :		
36. Copper oxychloride	WDP 50%	Blitox, Fytolan, Cupramar, Captax, Zencap, Krishicopper, Shell Copper, Micop, Hexamar copper, Anrucop, Cupro Kylv, Blue Copper 50, Capex, Dhanu cop, Cupravit, Blimix, Parrycop, Devi copper, Nagcoper
37. Cuprous oxide		Copper Sandoz dust, Coppesan, Fungimar, Fytomix, Trust.
38. Captan	WDP 75-83%	Captan, Hexacap, Delfron, Deltan Dhanutan
	WP 50%	Captaf
39. Ferbam	WDP 50-80%	Ferbam, Hexaferb
40. 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
41. Thiram	WDP 75%	JK thiram, Hexathir, Thiride Vegfru thiram
42. Zineb	WDP 75%	Hexathane Blitane, Miltox, Devizeb, Disconz.
43. Ziram	WDP 80%	Zirade, Cuman-L, Hexazir, Zirlate, Ziride, Zitox, Dhanuk Z - 27
44. Maneb	WDP 50%	Dithane M-22
45. Wettable Sulphur	WDP 85%	Cosan, Micro Wettable Sulphur, Insulf, Dhanusulf, Thiovit, Spersul, Microsul, Sulcol, Sultaf. Sulphosan, Solfar, Spitox, Sulfex, Sulphotox, Hexasul.
46. Ediphenophos	EC 50%	Hinosan
47. Sulphur dust	Dust 70%	Sulphur dust

Common Name	Formulation	Trade Name
48. Difolatan	WDP 80%	Difolatan
49. Carbendazim	WDP 50%	Bavistin, Bengard, JK stein, Derosal, Subeej, Zoom, Aimcozim, Agni, Dhanustin, Calzin, Benzin Benfin, Carzim, Zen, Nirmool, Agrozim, Arrest.Stare
50. Kitazin	EC 48%	Kitazin
	Gr.17%	
51. Dinocap	EC 48%	Karathene
52. Hexaconazol	SC 5%	Contaf Plus
	SC 2%	Samarth
	EC 5%	Trigger
53. Captafol	WP 80%	Captafol, Captaf
54. Metalaxyl	48%	Ridomil,Krilaxyl
	WS 35%	Himil Gold & Metal -D
55.Oxycarboxin	EC20%	Plantvax
56.Propiconazole	EC 25%	Radar,Tilt
57.Tricyclazole	WP 75%	Beam, Trooper,Blastin.
58. Tridemorph	EC 80%	Calixin
59.Thiophanatemethyl	WP 70%	Topsin-M,Cercobin, Mopsin-M, Roko, Maxim, Prism
60. Fluzilazole	EC 40%	Cursar 40 EC
61. Chlorothalonil		Koboch
62. Tebuconazole	EC 25.9%	Folicur 250 EC
<u>Combination fungicides</u>		
63. Carbendazim(12%)+Mancozeb(63%)		Companion,Saaf,Sixer,Toptoo Care,CM75,Safaya
64.Metalaxyl (8%) + Mancozeb(64%)		Krilaxyl MZ 72 WP, Master,Sanchar,Spectra,Himil,Ridomil MZ 72 WP
65. Carboxin (37.5%) + Thiram(37.5%)		Vitavax Power
66.Carbendazim(8%)+Mancozeb(63%)		
67.Carbendazim(8%)+Mancozeb(48%)		
68. Metalaxyl(8%) + Mancozeb(42%)		
69. Cymoxanil(8%) + Mancozeb(64%)		Curzate M 48
3. ACARICIDES :		
70. Dicofol	EC 18.5%	Colonel S, Hilfol, Klin, Delcofol
71. Propargite	EC 57%	Omite, Allmite, Simbaa
4. RODENTICIDES :		
72. Zinc phosphide	80%	Ratox, Zinctox, Catch
73. (a) Anticoagulants		Ratafin, Warfarin, Coumachlor,
(b) 2 nd generation Anticoagulant		Bromadiolone, Broadifacoum
		Roban
5.ANTIBIOTICS :		
74. Streptomycin (90%) +Tetracycline hydrochloride (10%)		Streptocyclin
75. Bramonitropropanediolo	100%	Bactrinol (Multiplex)
76. Kasugamycin	SL 3%	Kasumin, Kasu-B, Biomycin
77. Validamycin	L 3%	Validacin, Rhizocin, Sheathmar-3
78. Streptomycin sulphate(9%)+ Tetracycline hydrochloride (1%)		Plantomycin

Common Name		Formulation	Trade Name
6. SYNTHETIC PYRETHROIDES :			
79. Permethrin		EC50%	Ambush
		EC 25%	Permasect
80. Cypermethrin		EC 10% & 25%	Cymbush, Colt, Super killer, Bilcyp, Cropmaster, Ripcord, Cypercine, Cyper kill, Tatacyper
81. Deltamethrin		EC 2.8%	Decis
82. Fenvalerate		EC 20%	Fenval, Sumicidin, Triumphcard, Tatafen, Fenrio, Field Marshal, Agrofen, Hyfen.
83. Alphamethrin		EC 10%	Axis, Stop
84. Alpha-cypermethrin		EC 10%	Farsa, Alphaguard, Alphakill
85. Lambda-cyhalothrin		EC 5%	Karate
		EC 2.5%	Kung Fu,Reeva, Warrior
86. Fluvalinate		EC 25%	Mavrik, Spur
87. Beta-cyfluthrin		EC 2.5%	
		SC 0.25%	Bullduck
7. MISCELLANEOUS GROUPS :			
88. Cartap hydrochloride		G 4%	Sanvex, Caldan, Padan
		SP 50%	Padan, Wartap 50 SP, Kritap, Sanvex 50SP, Indan-S.P, Dollar, Catriz.Josh
89. Fipronil		G .3%,SC5%	Regent
90. Diflubenzuron	<i>Chitin synthesis inhibitors</i> (Sl. No. 90-95)	WP 25%	Dimilin, Hilmilin
91. Buprofezin		WP 25%	Applaud
92. Diafenthiuron		SC 50%	Polo
93. Teflubenzuron		SC 15%	Nomolt
94. Flufenoxuron		WDC 10%	Cascade
95. Novaluron		EC 10%	Rimon, Caesar
96. Imidacloprid	<i>Neo-nicotinoids</i>	SL 17.8%	Confidor 200 SL, Tatamida, Tez, Admire, Merit, Hilmida, Victor, Media, Ultimo, Imicon, Josh
		WS 70%	Gaicho
97. Thiamethoxam		WG 25%	Actara, Anant,Evident
98. Acetamiprid		SP 20%	Pride, Ekka, Manik, Bismark, Tackil
99. Spinosad		SC 2.5%	Success
		SC 45%	Tracer
100. Indoxacarb		SC 14.5%	Avaunt

LIST OF PESTICIDES / PESTICIDE FORMULATIONS BANNED IN INDIA.

A. Pesticides Banned for Manufacture, Import and Use (24 nos.)

1. Aldicarb
2. Benzene Hexachloride
3. Calcium Cyanide
4. Chlordane
5. Copper Acetoarsenite
6. Dibromochloropropane
7. Endrin
8. Ethyl Mercury Chloride
9. Ethyl Parathion
10. Heptachlor
11. Menazone
12. Nitrofen
13. Paraquet Dimethyl Sulphate
14. Pentachloro Nitrobenzene
15. Pentachlorophenol
16. Sodium Methane Arsonate
17. Tetradifon
18. Toxaphene
19. Aldicarb
20. Chlorobenzilate (Use banned w.e.f. 17.07.2003)
21. Dieldrin (Use banned w.e.f. 17.7.2003)
22. Meleic Hydrazide (use banned w.e.f. 17.07.2003)
23. Ethylene Dibromide (use banned w.e.f. 17.07.2003)
24. TCA (Trichloro acetic acid (use banned w.e.f. 17.07.2003)

B. Pesticide / Pesticide formulations banned for use but their manufacture is allowed for export (3 nos.)

25. Nicotine Sulphate
26. Phenyl Mercury Acetate
27. Captafol 80% powder (use banned w.e.f. 17.07.2003)

C. Pesticide formulations banned for import, manufacture and use (4 nos.)

1. Methomyl 24%
2. Methomyl 12.5%
3. Phosphamidon 85%
4. Carbofuran 50% SP

Restricted Pesticides for use in India

1. Aluminium phosphide : Needs to be banned.
2. Carbaryl : Should not be sprayed on crops at flowering stage
3. DDT : Use in agriculture is banned
4. Lindane : Lindane generating smoke for indoor use is prohibited. Can be used for control of insect pests of field crops, termites in buildings and in sugarcane.
5. Methyl bromide : can be used under strict supervision.
6. Methyl parathion : It is permitted only on those crops where Honey bees are not acting as pollinators.
7. Methoxy ethyl mercury chloride : It is banned except seed treatment of potato and sugarcane.
8. Monocrotophos : Banned for use in vegetables
9. Sodium cyanide : Its use is restricted for fumigation of cotton bolls.

BIOPESTICIDES

Agricultural production has been almost static since 1989 despite pesticide consumption increasing at the rate of 20 % per annum. Crop loss worth 29,000 crore per annum due to pest and diseases has been recorded during this period. Agricultural Export worth of 4000 crore per annum is rejected due to high pesticide residue. Suicide by farmers has been reported frequently in Andhra Pradesh, Karnataka, Punjab, and Maharashtra due to total dependence on pesticides which has caused crop failures due to pest resurgence. Toxic effect of pesticides on man, livestock, fish and plants is well known. Indian food products contain 25 % more pesticide residue above tolerance level as compared to 2.5 % globally. Most pesticides used in India are either under extremely hazardous or highly hazardous categories. Use of globally banned/restricted pesticides to the tune of 55 % in Agriculture and 95 % in public health sector continue in our country.

Biopesticides are advantageous due to their eco-safety, target specificity, no development of resistance, reduced number of applications, yields & quality improvement, higher acceptability and value of produce for exports and suitability for rural areas. In view of the advantages of Biopesticides, these are widely accepted in the developed countries, amounting to around 10% share of agrochemical market in 2000 AD, with a growth rate of 10-15% per annum. There has been a total ban on use of chemicals in green houses in Europe and there is a niche market for "Green Label" (no chemicals used) vegetables and fruits, apart from clothes from organic cotton. The use of *Bacillus thuringiensis* in neighboring countries are high: China- 3000 tonnes, Malaysia-250 tonnes, Thailand-160 tonnes and Philippines – 300 tonnes in comparison to Indian's B.t. market approximately at 50 tonnes only.

The use of bio-pesticides & bio-control agents in India is increasing day by day. Many small entrepreneurs are coming up with the bio-pesticides and bio-control agents without quality consciousness.

The concept of bio-pesticides and bio-control in farming community is still in its infancy. Only 1% of 143 million ha crop area and only 2500 villages out of over 6 lakh villages in the country have been covered so far under IPM. Basic I.P.M. modules have been designed by agricultural scientists of I.C.A.R., SAUs and Directorate of Plant Protection, but these need to be refined for local needs. Efforts has been made to establish "organic cotton", "organic tea" and "organic vegetable" in different zones of the country to accelerate the growth of the biopesticides.

Lack of awareness among farmers about biological control of crop pests and the availability of quality Bio-control agents are considered to be the main constraints in implementation of this novel method of pest control in Orissa.. In this context, Orissa University of Agriculture and Technology, Bhubaneswar and the State bio control laboratories can play a great role for the proliferation of this method of pest control in the state. Recently, these laboratories are producing the egg parasitoid, *Trichogramma* spp. and *Chrysoperla carnea* for control of various pests of crop. Production is meager and concerted effort is required to produce large quantities of quality bio-agents for various crop ecosystems. The use of bio-pesticides like *Bacillus thuringiensis*, *Beauveria bassiana*, *Nomuraea rileyi*, *Verticellium lecanii* and Nuclear polyhedrosis viruses (NPV) of different pests should be popularized among the farming community. Efforts should be made to popularize fungal, bacterial and nematode antagonists like *Trichoderma* spp., *Glyocladium virens*, *Pseudomonas fluorescens*, *Bacillus subtilis* for different diseases of crops.

Sl. No.	Bio-control agents	Crop pests	Dose	Frequency of application.
1	<i>Trichogramma japonicum</i>	Paddy yellow stem borer Sugarcane top shoot borer	50,000/ha 50,000/ha	Six times at 10 days interval ----- do -----
2	<i>Trichogramma chilonis</i> <i>T. chilonis</i>	Paddy leaf folder, caseworm Maize borer Brinjal shoot and fruit borer Tomato fruit borer Cotton bollworms <i>Helicoverpa armigera</i> in pulses, oilseeds & vegetables	50,000/ha 75,000/ha 1,00,000/ha 1,00,000/ha 1,50,000/ha 1,00,000/ha	Six times at 10 days interval ----- do ----- ----- do ----- ----- do ----- 8 times at 10 days interval 6-8 times at 10 days interval
3	<i>Bracon hebetor</i> <i>B. brevicornis</i>	Coconut black headed caterpillar	500/ha	5-6 times at 10 days interval
4	<i>Goniozus nephantidis</i>	Coconut black headed caterpillar	500/ha	5-6 times at 10 days interval
5	<i>Chrysoperla carnea</i>	Sucking pests like aphids, jassids, whiteflies, mealy bugs in different crops Eggs and young larvae of Lepidopterous pests	1,00,000 first instar larvae	2-3 times at 10 days interval
6	<i>Coccinella septempunctata</i> , <i>C. transversalis</i> , <i>Chelemeres sexmaculata</i>	Sucking pests like aphids, jassids, whiteflies, mealy bugs in different crops Eggs and young larvae of Lepidopterous pests	500 adults/ha	2-3 times
7	<i>Chilocorus nigrita</i> <i>Pharoscymnus horni</i>	Sugarcane scale and mealy bugs	500 adults/ha	2-3 times
8	<i>Bacillus thuringiensis</i> var. Kurstaki	<i>H. armigera</i> , <i>Spodoptera litura</i> , Diamond back moth, Leaf eating caterpillars, Cutworms, Army worms and semiloopers of different crops.	1-2 kg/ha	2-3 times at 10 days interval

9	<i>Beauveria bassiana</i>	Caterpillars, Leaf and plant hoppers, Grasshoppers in different crops in high humidity condition	1-2 kg/ha	2-3 times at 10 days interval
10	<i>Metarrhizium anisopliae</i>	Planthoppers, leaf hoppers, pyrilla Whitegrubs, Rhinoceros beetle	1-2 kg/ha 1-2 kg/ha	2-3 times at 10 days interval Treatment of manure pits treatment and soil application
11	<i>Nomuraea rileyi</i>	<i>H.armigera</i> , <i>Spodoptera litura</i> , Diamond back moth, Leaf eating caterpillars, Cutworms, Army worms and semiloopers of different crops.	1-2 kg/ha	2-3 times at 10 day intervals in humid conditions
12	NPVs of <i>Helicoverpa armigera</i> <i>Spodoptera litura</i>	<i>Helicoverpa armigera</i> in different crops <i>Spodoptera litura</i> in different crops	250LE/ha in vegetables, pulses, oilseeds 500-750 LE/ha in Cotton 250LE/ha in vegetables, pulses, oilseeds 500-750 LE/ha in Cotton	2-3 times at 10 days interval

Fungal and bacterial biopesticides

Seed Treatment :

13	<i>Trichoderma herzianum</i>	Damping off in Beans, Cauliflower, Raddish, Cucumber and other vegetables in nursery. Collar rot, Root rot, Fungal wilt, Seed rot, Charcoal rot of of Cotton, Peas, Ginger, Soybean and vegetables	5g/kg of seed
14	<i>Trichoderma viridae</i>	Wilt of different crops	5g/kg of seed
15	<i>Glyocladium virens</i>	Collar rot, Root rot, Fungal wilt, Seed rot, Charcoal rot of of Cotton, Peas, Soybean and vegetables	5g/kg of seed

Soil Treatment

16	<i>Pseudomonas fluorescens</i>	Root rot ,Wilt complex, Damping off in Chick pea, Cotton and Vegetables	2.5 kg mixed wih 62.5 kg of FYM / ha
17	<i>Trichoderma herzianum, T. viridae</i>	----- do -----	----- do -----
18	<i>Bacillus subtilis</i>	Scab of potato	----- do -----

Foliar spray :

All the above bio pesticides can be applied as foliar sprays. Solutions are prepared by proper mixing of biopesticides with water. Generally 1 kg biopesticide are required for spraying with 500 litre of water for 1 hectare crop area. The spraying operation should be advocated during late after noon hours.

Biopesticides for plant parasitic nematodes

Biopesticides such as *T.viridae*, *P.fluorescens* and *Glomus* sp. are used in controlling plant parasitic nematodes.

19	<i>Trichoderma viridae</i>	Seed treatment Nursery bed Main field	10 g/kg of seeds 2.5 g /m ² 2.5 kg/ ha
20	<i>Pseudomonas fluorescens</i>	Seed treatment Nursery bed	10 g / kg of seeds 20 g / m ²
21	<i>Glomus spp.</i>	Nursery bed Existing tree Raising fruit/Forest seedling in polythene packets	100 g VAM / m ² 200 g VAM / tree 10 g VAM / packet

VAM – Vescicular Arbuscular Mycorrhiza

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 percent when the amount of spray solution and the percent 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 percent concentration of the finished spray solution. *For Example*, if 400 ml of 20 percent Chlorpyrifos emulsion is added to 200 litres of water, the concentration of the solution according to the above formula can be worked out as follows :

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

- (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:

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

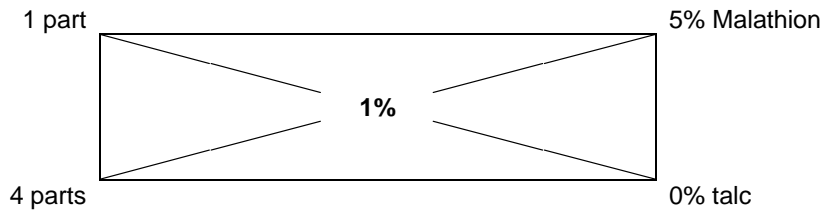
This will give the quantity of formulated insecticide required.
For Example, if 50 ml of actual Chloropyriphos is to be sprayed per acre, the quantity of 20 percent Chlorpyriphos emulsion required would be :

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

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.

For Example, if 5 percent Malathion dust is required to be diluted to 1% Malathion dust by adding talc, write the percentage concentration of Malathion dust (5%) and of talc 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 4 parts by weight of 5% Malathion dust will be required to be mixed with 1 part by weight of talc in order to get 1% Malathion dust.

ECONOMIC THRESHOLD LEVEL FOR MAJOR INSECT PESTS

Crop Pests

ETL level

Rice :

Stem borer	5% dead heart or 1 egg Mass / sq.m. or 1 adult moth / sq.m.
Gall midge	5% Silvershoot (at active tillering stage)
BPH / WBPH	8-10 insects / hill at vegetative stage 20 insects / hill at reproductive stage
GLH	20 – 30 insects / hill at active tillering stage 2 insects / hill (Tungro endemic area)
Leaf folder	2 freshly damaged leaves / hill at post active tillering stage
Gundhibug	1 nymph or adult / hill
Caseworm	1- 2 cases / hill
Hispa	1 adult or 1 – 2 damaged leaves / hill
Cutworm	4 – 5 larvae / sq.m.

Sorghum :

Shoot fly	10% dead heart
Stem borer	1 egg / Plant in 10% plants
Ear head bug	10% dead hearts
Midges	10 bugs / head
Mites	5 mites / sq. cm.

Cotton :

Leaf hopper	2 – 3 jassids per terminal shoot
Aphids	15 – 20 % infested plants
Boll worms –	
Spotted American boll worm	10% infested shoots / reproductive parts 5% damaged reproductive parts or 1 larva / plant or 2 eggs / plant
Pink boll worm	5 – 10% damaged reproductive parts
White fly	5 – 10 nymphs or adults / leaf
Mites	10 nos. / sq.cm

Sugarcane :

Early shoot borer	15% DH
Internode borer	5% internode damage
Top borer	5% cane damage
Pyrilla	2 – 3 nymphs or adults / leaf

Groundnut :

Jassids	5-10 nymphs or adults / plant
Thrips	5 thrips / terminal shoot
Leaf miner	2 – 5 miners / plant
Hairy caterpillar / <i>Spodoptera</i>	20 – 25% defoliation

Mustard :

Aphid	50 aphids / plant
Inflorescence webber	2.5 larvae / plant

Sesamum :

Leaf webber	1.2% twig damage
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Gram :

Pod borers	
(Before podding)	18 larvae / sq.m. (mixed instar)
(After podding)	4 – 5 larvae / sq.m.

Chilli :

Chilli thrips	2 nymphs or adults / twig
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Brinjal :

Shoot and fruit borer	10% fruit damage 3% shoot damage
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CROPPING SYSTEMS FOR DIFFERENT AGROCLIMATIC ZONES

NORTH WESTERN PLATEAU & NORTH CENTRAL PLATEAU ZONES (Sundargarh, Jharsuguda, Keonjhar & Mayurbhanj)

RAINFED	
Upland	
Sole crop	Vegetables, groundnut, arhar, castor, maize, jowar, jute, mesta, sweet potato, turmeric, niger, blackgram, greengram, sabai
Inter-cropping	Arhar+groundnut/greengram/blackgram/rice/ragi, Castor/ maize/ jowar+greengram/blackgram, Rice+mesta/maize/jowar/arhar
Sequence cropping	Minor millet -horsegram/greengram/niger/toria, Maize/jute/jowar/ rice-horsegram/greengram/castor/ groundnut/ niger/ toria, Groundnut-castor/horsegram/niger/greengram/blackgram/ horsegram/ toria
Medium land	Rice- toria /linseed/safflower, Rice-greengram/lentil/ bengalgram/ fieldpea, Rice-bengalgram/lentil/fieldpea sown in <i>Pyra</i> cropping
Low land	Rice-linseed/lentil/bengalgram/field pea sown in <i>Pyra</i> cropping
IRRIGATED	
Upland	Maize- potato/rapeseed mustard- sesame/vegetables, Groundnut/rice/sugarcane-groundnut/sesame/greengram (2 years), Rice- rapeseed mustard/wheat/maize-greengram/vegetables, Rice- potato/groundnut/vegetables-sesame/greengram/vegetables, Rice- greengram-groundnut, Jute-potato- sesame/ vegetables
Medium land	Rice-sugarcane-sesame, Rice- rapeseed mustard/potato/wheat/vegetable, Jute-rice-greengram/groundnut/blackgram
Low land	Rice- rapeseed mustard/blackgram/vegetables-rice, Jute-rice-blackgram- sesame, Rice-rice

WEST CENTRAL TABLE LAND & MID CENTRAL TABLE LAND ZONES (Sambalpur, Bargarh, Deogarh, Bolangir, Sonapur, Angul and Dhenkanal)

RAINFED	
Upland	
Sole crop	Vegetables, groundnut, arhar, castor, maize, mesta, ragi, greengram, blackgram, sesame
Inter-cropping	Arhar/rice+groundnut/greengram/blackgram/rice/ragi/arhar, Maize+ greengram/blackgram/cowpea
Sequence cropping	Rice -horsegram/greengram/groundnut/ toria, Groundnut- horsegram/castor
Medium land	Rice-greengram/blackgram/ toria
Low land	Rice-greengram/blackgram sown in <i>Pyra</i> cropping
IRRIGATED	
Upland	Maize/rice-groundnut/ potato/vegetables/rapeseed mustard-sesame, Groundnut- rapeseed mustard/maize-vegetables
Medium land	Rice-sugarcane-groundnut/sesame/greengram(2 years), Rice- rapeseed mustard/potato/wheat/groundnut-vegetables/ greengram/ cowpea, Rice- rapeseed mustard/tomato/potato/rice
Low land	Rice-rice

NORTH EASTERN GHAT, EASTERN GHAT HIGH LANDS, SOUTH EASTERN GHAT & WESTERN UNDULATING ZONES

(Kandhamal, Boudh, Gajapati, Raygada, Koraput, Nabarangapur, Malkangir, Kalahandi, Nuapara)

RAINFED	
Sole crop	Vegetables, ragi, maize, jowar, niger, groundnut, castor, soybean, turmeric, ginger, sweet potato, mesta, arhar, greengram, blackgram, cotton,
Inter-cropping	Arhar+rice/ragi/ maize/millet/groundnut/ greengram/ blackgram, Maize/jowar+ greengram/blackgram/cowpea, Castor+greengram/blackgram
Sequence cropping	Maize/jowar -horsegram/blackgram/ toria, Greengram-horsegram/mustard/niger/castor, Millet-niger/horsegram, Rice-greengram/blackgram/horsegram/ niger/ toria / groundnut
Medium land	Rice-groundnut/horsegram/castor. Rice-greengram/blackgram/gram/safflower/mustard, Rice-greengram/blackgram (Pyra)
Low land	Rice- greengram/blackgram/bengalgram/field pea / toria /linseed, Rice-field pea/bengalgram (Pyra)
IRRIGATED	
Upland	Vegetables/rice-wheat/potato/maize/rapeseed mustard/vegetable/tobacco/blackgram/fieldpea, Groundnut-maize/cotton/wheat/mustard/Vegetable, chilli-potato/vegetable, Maize-potato/rapeseed mustard/vegetable./wheat/pulses-vegetable, Rice-wheat/potato/vegetable-vegetable/ greengram/ blackgram/ groundnut, vegetable-potato-greengram
Medium land	Rice-rice, Rice-wheat/potato/maize/rapeseed mustard/chilli/vegetable/groundnut, Rice-wheat/potato/vegetable-greengram/sesame/vegetable
Low land	Rice-rice/wheat/Groundnut/vegetable, Rice-vegetable/potato/wheat-greengram/sesame, Rice-rice (Jhola)

NORTH-EASTERN COASTAL PLAIN AND EAST & SOUTH EASTERN COASTAL PLAIN ZONES

(Balasore, Bhadrak, Jajpur, Jagatsinghpur, Cuttack, Kendrapara, Ganjam, Khurda, Nayagarh & Puri)

RAINFED	
Upland	
Sole crop	Vegetables, groundnut, arhar, castor, ragi, rice, jute, sugarcane
Inter-cropping	Rice+groundnut/arhar/greengram/blackgram/ ragi, Maize + greengram/blackgram/arhar/mesta/ragi/rice
Sequence cropping	Groundnut -horsegram, Ragi/rice-groundnut/greengram/niger/ toria / horsegram, Maize-horsegram/greengram /niger, Jute/mesta- toria /horsegram/ blackgram/groundnut/greengram
Medium land	Rice-G.nut/ toria /blackgram/coriander, Jute-blackgram/ coriander, Rice-greengram- blackgram/coriander , Jute-rice
Low land	Rice-linseed/greengram/blackgram/ coriander, Jute-blackgram/greengram/fieldpea or as <i>chhata</i> , Jute-rice
IRRIGATED	
Upland	Veg/groundnut/rice-sugarcane-sesame (2 years), Rice-potato/groundnut/wheat/vegetable-sesame/vegetable/greengram, Jute-potato/wheat/Groundnut/rice-blackgram/ragi/vegetable
Medium land	Rice-groundnut/wheat/potato/rapeseed mustard/vegetable/sesame/rice, Jute-rice-blackgram-vegetable, Rice-sugarcane-sesame (2 yrs.)
Low land	Jute-rice-rice/vegetable/groundnut, Jute-rice-rice, Rice-rice

A.I.S., Bhubaneswar; June, 2008 - 2000