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	<u>Up land</u> Rainfed (Unbunded)	Heera, Kalinga-III
		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 (Gujurat Agro Industires Corporation, Ahmedabad), Naveen sickle (CIAE, Bhopal), Dev sickle (Dev industries, Bangalore). For hard soil and non-lodgeed 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-geminated 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 sustainance 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 tlllering. 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$\pm$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 $N\text{-}P_2O_5\text{-}K_2O/m^2$ 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 tlllering. 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 loosing 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 posses 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 m^2 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 ceasation of monsoon and become ready for harvest after recession of water from the field. Further, conditions of sunshine and temperature after ceasation 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 stangnant water situation in deep water ecosystems.

Production Technology Recommendations

1) <u>Land Preparation & Sowing of Seeds</u>

- Open the land immediately after harvest with mould board plough with optimum moisture in the field, which facilitates sowing before the onset of mansoon.
- 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 P_2O_5/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 prophylatic 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-P_2O_5-K_2O/ha

Semi dwarf : 80-30-30 kg N-P_2O_5-K_2O/ha

Local : 40-20-20 kg N-P_2O_5-K_2O/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/m^2
- Time of planting : Mid July
- Spacing : 20 cm x 15 cm
- Seedlings/hill : One or two
- Fertilizer dose : 120-60-60 kg of N-P_2O_5 -K_2O/ha
- Full P, K and half N as basal, 25% N at tillering and 25% N at panicle initiation stage.
- Water management: Cyclic submergence (5$\pm$2 cm) 3 days after disappearance of ponded water.

Follow other package of practices as under transplanted rice.