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Agroecological Intensification and Crop Diversification of Rice-based Cropping Systems

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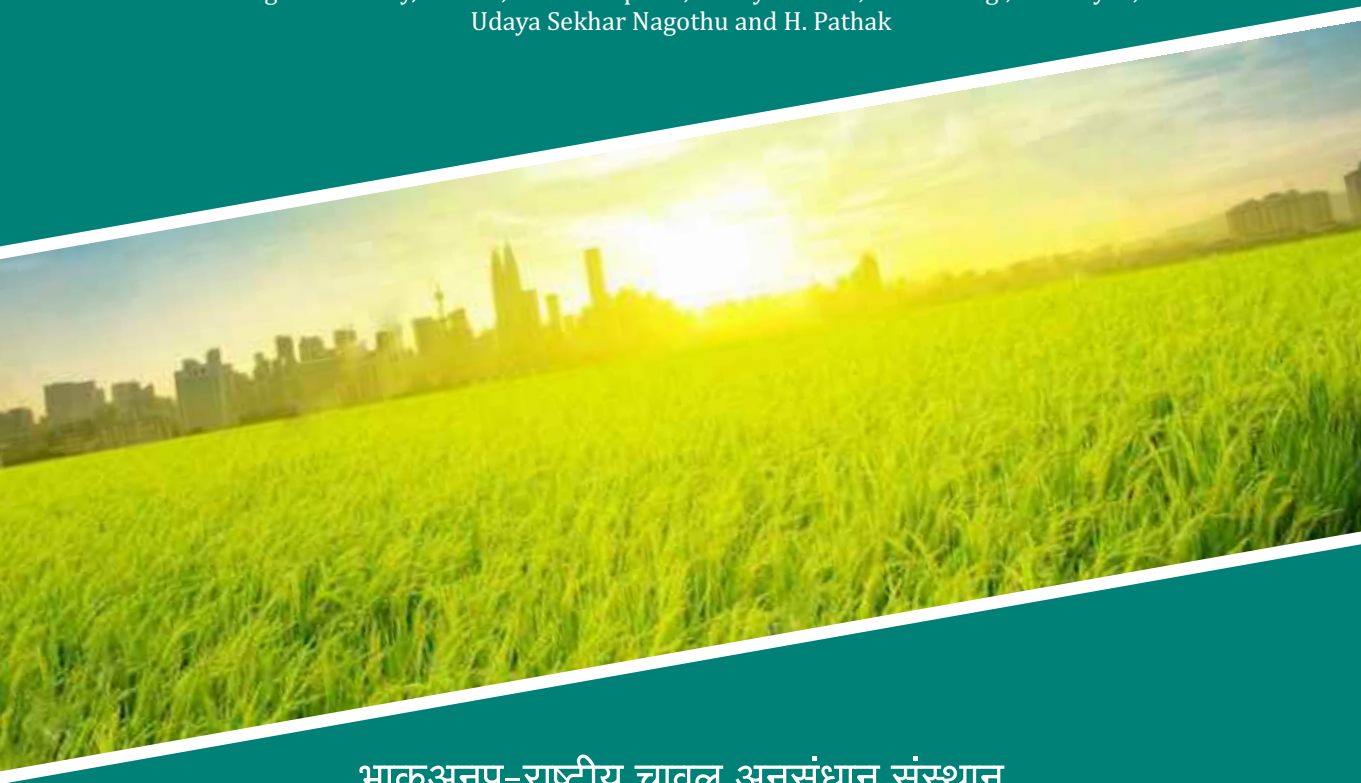

भाकृअनुप-राष्ट्रीय चावल अनुसंधान संस्थान

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Agroecological Intensification and Crop Diversification of Rice-based Cropping Systems

Agroecological intensification of rice-based cropping system aims at achieving maximum system productivity with minimum environmental impact by managing and organizing crops in a way that they utilize the available resources efficiently with beneficial interactions among themselves. Based on agroecological conditions, market and domestic necessities and facilities available with farmers, major rice-based cropping systems recommended for Eastern India are rice-cereals (rice - rice/maize), rice-pulses (rice - greengram/ blackgram/ horsegram/ lathyrus) and rice-oilseeds (rice - groundnut/ toria/ sunflower/ sesame) cropping system. The management needs of the crops in a system changes, based on the crops taken in succession due to carryover and interaction effects among the crops. The agroecological intensification and management options for major rice-based cropping systems are presented in this leaflet for benefit of the farming community.

Rice -Rice/Maize cropping system

Rice-rice is the major cropping system in eastern India. The system is practiced in 3 lakh hectares in irrigated areas of Odisha and is practiced in irrigated areas using lot of irrigation water. There is a need for practicing water saving rice production technologies or diversification of the system with the low water requiring crops. The system can be further intensified with introduction of a third crop in the system for higher productivity and profitability.The primary rice crop may be transplanted or direct-seeded but the second crop may be aerobic rice or maize to save irrigation water.

Rice-maize is an emerging cropping system in Eastern India. Rice-zero tillage maize enhances the productivity as well as the profitability of the system. Small farmers can sell the cob in the market to get a good price.The management practices for rice-maize cropping system is presented below.

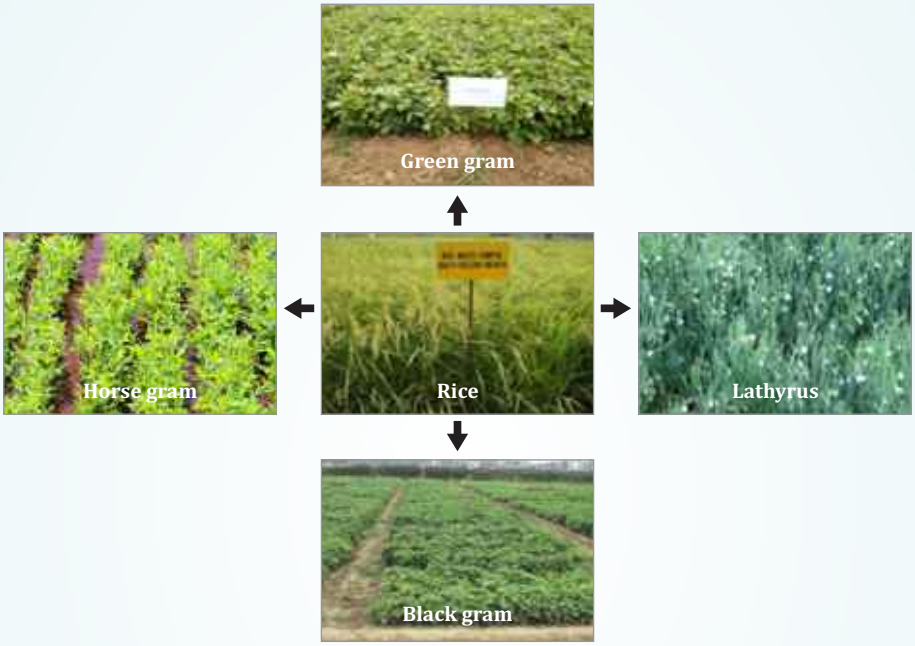
- Maize varieties suitable for cultivation in Odisha are Vivek 27, Prakash, Malaviya hybrid Pro 311, Bio 9681, Seed Tech 2324, PAC 705 whereas CR Dhan 200, CR Dhan 203, CR Dhan 205, CR Dhan 206are suitable aerobic rice varieties.
- After rice, maize may be planted with a Zero-till seed drill, Turbo happy seeder or Combo happy seeder without any field operation with minimal disturbance of the soil and the surface residues.
- Evaporation loss from the maize crop field can be arrested by covering the soil with organic farm waste like straw or retention of crop residues. Important crops suitable for mulching in maize are sesbania, sunhemp, greengram, blackgram, etc.
- Maize crop should be supplied with the recommended dose of chemical fertilizer in conventional crop but 25% additional N fertilizer should be applied in zero tillage maize. The fertilizer should be placed near the seed.
- Application of Atrazine (1kg a.i./ha) or Pendimethalin (1kg a.i. /ha) or tank mix application of Atrazine + Pendimethalin (500 g a.i. each/ha) or Alachlor + Atrazine (1.25 kg+ 375g a.i. /ha) can effectively control annual weeds in rabi maize. Simultaneous planting of greengram/blackgram as cover crop on the either sides of maize row on beds is effective in controlling complex weed flora.
- Rice - maize cropping system can be further intensified with introduction of cowpea as a third crop in the system to reduce the N requirement of the system by incorporation in the rice crop.
- Intensive cropping systems like rice - maize - cowpea, incorporation of residue of cowpea with 75% recommended dose of fertilizer (RDF) to rice followed by RDF to maize with rice residue/straw mulching and 50% RDF to Cowpea is recommended for sustainable production from the system.

Rice-Pulse cropping system

Rice-pulse cropping systems are mainly suitable for limited water conditions in irrigated areas or rainfed rice growing areas. The suitable pulses after rice are greengram, blackgram, horsegram and lathyrus in rainfed areas where as soybean can be a better option in irrigated areas. The management practices for various rice - pulses cropping systems are presented below.

- Direct-seeded rice with comparatively 10 days shorter duration varieties should be practiced in wet season for a better pulse crop in the dry season. In case of transplanted rice, the hard pan should be broken by deep ploughing with disc or chisel plough once in three years and leveled well. Rice should be applied with sufficient FYM or compost @ 5 to10 t/ha to increase the organic carbon content of the soil and enhancing the moisture and nutrient holding capacity of soil.
- In areas with limited irrigation or supplemental irrigation facility, soybean, blackgram or greengram should be grown. In rainfed areas, the crops should be selected based on the availability of residual soil moisture. In situations, where it is expected that land would be too dry for ploughing at the time of rice harvesting, lathyrus should be sown as paira crop two weeks before the harvesting. If the moisture content of the soil is expected to be at saturation and above, black gram should be preferred as a paira crop where as if moisture content at or below field capacity and can be ploughed, greengram or blackgram may be taken up. In medium and upland conditions where rice crop is harvested early and moisture is expected to be less, horse gram should be cultivated as paira crop.

- Short duration and yellow mosaic virus (YMV) tolerant varieties like Virat, IPM 2-3, IPM 2-14, PUSA 1572, PDM 11, Samrat of greengram; PU-31,Sarala, Prasad, Ujala IPM 2-3 of blackgram; Ratan, Prateek of lathyrus and Urmi, Payur 2 and PHG 9 of horsegram should be grown in rice fallows.
- Seed priming should be done by soaking the seed 3-4 hours followed by shade drying. Normal seed rate should be followed in irrigated crops where as 25% more seed should be taken up in rainfed broadcasted and paira crop.
- Seed treatment with fungicide like carbendazim (2g/kg of seed) or Thiram (3g/kg of seed) along with Ammonium molybdate @ 3g /10 kg of seeds, appropriate rhizobium culture @ 50 g/kg of seed is beneficial.
- Foliar spray of DAP (2%) or 1% DAP + 1% MOP should be done at 20 and 40 days after sowing to supplement N, P and K to the crops.
- Post emergence herbicides like Quizalofop ethyl @ 50 g a.i./ha at 3 weeks crop growth stage or Imazethapyr @ 75 g a.i./ha at 15-20 days crop stage should be applied to control weeds in pulses.

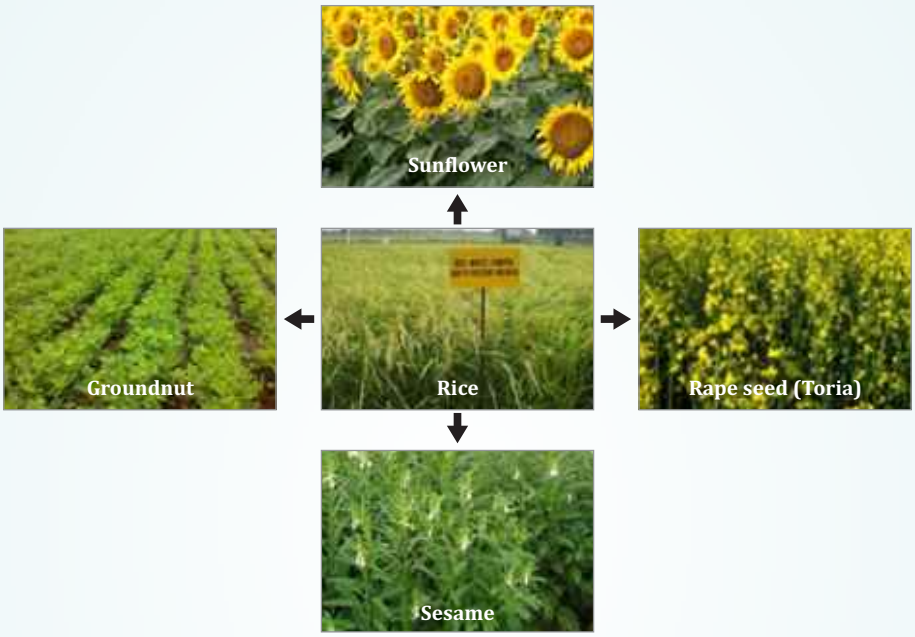


Rice - Oilseeds cropping system

Under limited moisture situations, such as tail end area of irrigation command, tank fed area and well irrigated areas, oilseed crops like groundnut, sunflower, sesame etc. can be profitably cultivated. There is great potential of rabi/summer groundnut in rice fallows on residual moisture in flood plains in Odisha. Rapeseed/Mustard (Toria) can be another option in low temperature areas in Northern Odisha. As a summer crop, sesame can be profitably grown after rice. In the upland areas of Odisha, groundnut (kharif) and sunflower are more remunerative as compared to upland rice. The management practices for various rice - oilseeds cropping systems are presented below.

- High yielding varieties i.e. ICGV-91114, JL-24, Kadiri-6, TAG-26, ICGS-11 and Smruti of groundnut, Morden, KBSH 1 and KBSH 44 of sunflower, M 27, Pusa Agrani, Anuradha and Parbati of rapeseed /mustard and Uma, Prachi, Kanchan and Nirmala varieties of sesame are suitable for Odisha.
- Groundnut should be fertilized with 20 kg N, 40 kg P_2O_5, 20 kg K_2O kg/ha and gypsum 250-500 kg/ha as basal. Application of green manures i.e. Sesbania and Crotoliaria at 10t/ha to rice compared to no green manure application significantly increased grain yield of rice – groundnut cropping system. Lime should be applied basing on the pH value for correction of soil acidity. Gypsum should be applied in sulphur and calcium deficient soils @ 250 kg/ha close to the base of the plants at 20-25 days after sowing on either side and incorporated in the soil so that it remains in top 3 cm of soil. If zinc deficiency is observed, apply zinc sulphate 50 kg/ha once in 3 seasons.
- Application of N: P: K @ 80:40:40 kg/ha under timely sown condition and @ 100:50:50 kg/ha under late sown condition along with sulphur @ 40 kg/ha, zinc sulphate @ 25 kg/ha and borax 10 kg/ha is sufficient for rapeseed /mustard. Half of the nitrogen to applied as basal dose and half at 30-45 days after sowing at the first irrigation. For rainfed crop apply the full recommended dosages of nutrients at the time of sowing. Replacing of di-ammonium phosphate with single super phosphate (SSP) (250kg/ha) resulting in availability of sulphur. Neem-coated urea is recommended to use as source of nitrogen. It is advised that gypsum @ 200 kg/ha should be applied as basal dressing, if SSP is not used as the source of phosphorus.
- Integrated nutrient supply by partly substituting 25 per cent recommended N fertilizer with equivalent amount of FYM to rice should be practiced for sustainability of rice sunflower cropping system.

- Oilseed crops must be weed free up to 45 days after sowing by inter-cultivation at 20 and 40 DAS followed by one hand weeding. The groundnut crop should not be disturbed by weeding or intercultural operation after 45 DAS. Pre-planting application of herbicides viz., Fluchloralin @ 1.0 kg (a.i.)/ ha or Pendimethalin @ 1.0 kg (a.i.) /ha or Oxadiazon @ 1.0 kg (a.i.)/ ha or Thiobencarb @ 1.0 kg (a.i.)/ ha in moist soil at 1 day before sowing by mixing with 500 l/ha of water effectively control the weeds. Light hoeing should be given for incorporation of herbicide in the soil to avoid loss through volatilization and photo-decomposition. Wherever, pre-emergence herbicides could not apply, weeds can be controlled by post-emergence herbicides by spraying Imazethaphyr @ 750 ml/ha or Quizalofop ethyl @ 1.0 l/ha at 20 DAS when the weeds are at 2 leaves stage. For effective control of Orobanchae in rapeseed/mustard, crop rotation and foliar spray of glyphosate @25 and 50g/ acre at 30 and 55-60 DAS is recommended.



- Seeds should be treated with Imidachloprid @ 2 ml / kg seed followed by Tebuconazole 2ds @ 1g or Mancozeb @ 3 gm / kg seed. If the seed is dormant, soak it in 0.05 % Ethrel solution for 12 hours followed by shade drying. Trichoderma viride seed treatment @ 4 g/kg seed for rot prone areas. Rhizobium inoculation is necessary for groundnut in non-traditional areas and rice fallows. For quick germination and better stand in dryland conditions, soaking of seeds in fresh water for about 10 hours is recommended.
- The Soaking of mustard seeds in 0.025% aqueous pyridoxine hydrochloride solution for 4 hours improves germination. The incorporation of 25% nitrogen through FYM + 75% by chemical fertilizer + 100% sulphur significantly enhanced the use efficiency of nitrogen and sulphur in both seed and stover of crop.
- Maintenance of optimum population by judicious thinning at 10-15 days after germination to retain single healthy plant per hill is essential for obtaining optimum yields in sunflower.
- Honey bees play a very important role in increasing seed set in sunflower. Maintaining 5 hives/ha facilitates optimum pollination, besides yielding valuable honey. Avoid spray of insecticide at the blooming period as it affects the visit of pollinators (bees). If absolutely essential, spray or dust after 3.00 PM preferably with relatively safer insecticides.
- Application of $MgSO_4$ has shown increased seed filling as well as seed yield. Boron application at ray floret opening stage improves seed set, filling percent, test weight, yield and quality.

Conclusion

Rice-based production system is the major livelihood option of eastern Indian people. Crop diversification and intensification of the system can help in improving the livelihood of the farming community. As most of the farmers are small-holders largely depending upon the rice-based cropping system, emphasis should be given for managing the system as a whole instead of the individual crops. The system-based recommended management practices for rice-maize, rice-pulses, rice-oilseed crops will help in developing resilience to the small-holders of eastern India.

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