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Dry direct seeded rice: A viable alternate crop establishment method for sustainable crop production in Odisha

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Rice is the principal food crop of Odisha and cultivated in six different ecosystems under rainfed and irrigated ecologies covering about 47% of total gross cropped area. Transplanting of rice seedlings in puddled soil is most common method of crop establishment but no more economically viable and ecologically sound. However, direct seeding of rice is a process of crop establishment where the seeds are sown directly in the main field and has several advantages over conventional transplanting. Direct seeded rice is less labour intensive, higher water productivity, reduced cost of production, conserves soil health and environmentally safe and sustainable under the scenario of climate change. Dry direct seeding practiced under semi deep water and deep-water rice ecosystem during wet season. Under irrigated ecologies dry direct seeding is also gaining popularity under shallow lowlands. Selection of suitable varieties, seed treatment, sowing of seeds by seed drill at optimum time followed by integrated weed management, nutrient management and need based pest management will ensure crop yield equivalent to transplanted rice with reduce cost of production and minimum soil and environment degradation.

Varieties: There is no specific varieties exclusively developed for dry direct seeding. Some of the varieties suitable for direct seeding are listed in table 1. Suitable varieties are selected considering the ecology and crop growing period.

Table 1: suitable varieties for dry direct seeding of rice

Variety	Duration	Avg yield (t/ha)	Grain quality
CR Dhan 307 (Maudamani)	135	7.0	Short Bold
CR Dhan 800	140	5.75	Medium slender
Pooja	150	4.5	Medium slender
CR Dhan 409 (Pradhan Dhan)	160-165	4.7	Long slender
Swarna Sub 1	145	5.2	Medium slender, tolerant flash flood for12-14 days

Varshadhan	160	3.5 -4.0	Long bold
Durga	155	4.3	Medium bold
Sarala	150	4.75	Medium slender
Hasanta	145-150	5.5 to 6.5	Medium slender
CR Dhan 801	140	6.3	Short bold
CR Dhan 802	140	6.5	Short bold
CR 1009 Sub 1	150	5.5 to 6.5	Medium slender

Seed Treatment: Treat the paddy seeds with Carbendazim 50 WP @ 2.0 g/kg of seed or *Trichoderma harzianum* and/or *Pseudomonas fluorescens* @ 10g /kg of seeds before sowing (Fig. 1). In blast endemic area, seed should be treated with Trycyclazole 75 WG (Baan or Bim) @ 0.6 g/kg of seed.

Crop Establishment: Cultivate the land after harvest of the previous crop preferably with a MB plough or cultivator. Summer ploughing should be done after summer showers. Final land preparation may be done with pre-monsoon showers for sowing. To achieve optimum plant population adequate land leveling either by using advanced laser leveler or tractor drawn common leveler is advocated. Sowing of dry treated seeds should be done by tractor or power tiller drawn seed drill (Fig. 2). Among various seed drills used for direct seeding conventional seed cum fertilizer drill having inclined plate metering mechanisms are most suitable for DSR. About 12-14 kg of seeds are sufficient for one acre area. Maintain spacing of 22.5 to 25 cm between rows and 10 cm in-between hills (Fig. 3).

Weed Management: Crop-weed competition is the most critical yield limiting factor in dry direct seeded rice and cause yield reduction up to 90%. Initial 15-45 days are critical for weed management. The following Integrated weed management may be followed for efficient weed control.

Always use weed seed free seeds, well decomposed organic manures and keep field bunds neat and clean as preventive measure to minimize weed load. Application of pre or early post emergence herbicide followed by mechanical weed control found promising under DDSR in lowlands (Fig. 4).

Table 2. Recommended herbicides for dry direct seeded rice (use any one of the herbicide or herbicide combination at right dose, right time and in right method)

S.N	Name	Trade name	Dose	Time of application
1	Pendimethalin 30 EC	Stomp	1250 ml/acre	0-3 DAS
2.	Bispyribac Sodium 10 SC	Nominigold	120 ml/acre	10 DAS or at 2-3 leaf stage of weeds
3	Fenoxaprop-p-ethyl + Ethoxysulfuron (tank mix)	Rice star + Sunrise	250 + 40g/acre	15-20 DAS or at 3-4 leaf stage of weeds
4	Metsulfuron methyl 10% + chlorimuron ethyl 10% WP (Ready mix)	Almix	24 g/acre	8-10 DAS or at 2-3 leaf stage of weeds
5	Cyhalofop-Butyl 5.1% + Penoxsulam 1.02%	Vivaya	1000 ml/acre	15-20 DAS or at 2-4 leaf stage of weeds

Apply herbicide using sprayer with 250-350 l/ha water when there is sufficient soil moisture, uniformly over the crop field. Flat fan nozzle or flood jet cut nozzle is recommended for application of herbicides. To control second flush of weeds, use power paddy weeder or cono weeder at 30-40 DAS (Fig. 5).

Nutrient management: Nutrient management is another important cultural practice to maximize the yield and profitability of direct seeded rice. Always apply fertilizer and manures as per soil test results. In case of non-availability of soil test report apply recommended dose as mentioned in table 3 as blanket dose.

Table 3. Recommended fertilizer dose and time of application in dry direct seeded rice

Category of land	Fertilizer dose (kg/acre)			Time of application
	N	P	K	
Medium land	24	12	12	Basal Full P, Full K 50% N at tillering 15-20 DAS 25% N at (35-40DAS) 25% N at PI (55-60 DAS)
Medium low and lowland	32	16	16	Basal Full P,Full K ,50% N at tillering 15-20 DAS ,25% N at (45-50 DAS),25% N at PI (65-75 DAS)
Low land where top dressing not possible	16	8	8	All fertilizer as basal dose

Always use CLCC for top dressing of Nitrogenous fertilizer. Apply first dose of top dressing when there is sufficient soil moisture at 3-5 days after application of post emergence herbicide. Prevent the flow of water from field to field at least for seven days.

Water management: For achieving optimum grain yield, rice crop should not face any moisture stress at tillering, panicle initiation, boot leaf stage, heading/ panicle emergence and flowering/ anthesis (reproductive phase) as these are important critical crop growth stages for water stress in rice. During these stages, soil moisture level should be maintained at saturation level by supplemental irrigation. Keep suitable drainage facilities to drain out excess rain water at undesirable time. Drain out water at the dough stage i.e., 10 to 12 days before harvesting for uniform maturity and use of reaper for harvesting

Insect pest and Disease management: In dry direct seeded rice, insect pest like stem borer and leaf folder are common in early stage of crop growth. Brown Plant Hopper cause severe yield reduction during later stage of crop growth. Brown leaf spot and leaf blast are common diseases which interfere the yield of direct seeded rice. Always follow integrated insect pest and disease management practices to minimise the yield loss.

- Whenever the number of male moths of stem borer /trap reaches 4 or 5 apply Azadiractin 0.15% neem seed

kernel-based EC formulation@ 800 ml/acre **or,** chlorantraniliprole 4% GR @ 4 kg/acre may be applied mixing with sand at 1:1 ratio **or** spray chlorantraniliprole 18.5% SC @ 60 ml/acre in 200 litres of water **or** cartap hydrochloride 4 G @ 10 kg/acre.

- When infestation of BPH exceeds ETL (5-10 hoppers/hill), it is advised to alter the micro-climate of the rice plant by alternate wetting and drying (water should not stand in field for long time). If problem still persists, spray Azadirachtin 0.15% w/w (minimum) neem seed kernel-based EC formulation @ 800 ml/acre **or** Triflumezopyrim 10SC @ 94 ml/acre **or** Pymetrozine 50% WG @ 120 g/acre **or** Dinotefuran 20% SG @ 80g /acre or Imidacloprid 17.8% SL @ 50 ml/acre **or** Acephate 75% SP @ 400 g/acre. Use 200 litre of water to spray in one-acre area.
- Use Quinolphos 25EC @ 400 ml/acre **or** chlorpyriphos 20EC @ 500ml/ acre and it should be applied in the morning hours at the base of the crop to control Ear cutting caterpillar.
- Spray with Propiconazole 25% (Tilt) @ 1ml/litre, **or** (Rhizocin 3L, **or** Sheathmar 3L) @ 2 ml/ litre of water) or Tebuconazole 50%+ Trifloxystrobin 25% (Nativo 75 WG) @ 0.4g/litre **or** Contaf 5 EC (Hexaconazole 5EC) @ 2ml/ litre of water **or** Thifluzamide 24SC @ 1ml/ litre of water to manage Sheath blight.
- Spray carbendazim 50 WP @ 2g/litre of water **or** trifloxystrobin 25% + tebuconazole 50% @ 0.4 g per litre of water **or,** edifenphos 50 EC @ 200 ml/acre in 200 litres of water to control blast disease
- To control Neck/Panicle Blast spray Tebuconazole 50%+ Trifloxystrobin 25% (Nativo 75 WG) @ 80 gm in 200 litres of water per acre, **or** Isoprothiolane (Fugione 40 EC @300 ml/Acre) **or** Aureofungin sol 25 gm/acre. Otherwise, spray leaf extracts of Bael (25 g fresh leaves) **or** Tulsi (25 g fresh leaves) or Neem (200 g fresh leaves) per litre of water to control the disease.

Harvesting: Harvest the crop at physiological maturity when 85% of grains turned brown at 25% moisture by combiner or manually. Sundry the threshed seeds uniformly in cemented floor/ Tarpaulin sheet for 1-2 days to bring down the moisture level to 14% for milling purpose. But for seed purpose the seeds should be dried up to 12 % moisture.

Yield and Economics: Under optimum level of management dry direct seeded rice results grain yield at per with transplanted rice. Dry direct seeded rice recorded 32% higher water productivity as compared to conventional transplanted rice. Cost of cultivation is comparatively less in dry direct seeded rice due to elimination of nursery and transplanting. This method also helps in reduction of CH_4 emission by 18-20% as compared to puddled transplanting of rice.

Zero tilled direct seeded rice (ZTDSR): From an experiment conducted at the research farm of ICAR-IIWM, Bhubaneswar (Fig. 6) it was observed that ZTDSR registered an average yield of 4.2 t/ha (Var. MTU 1010) which was 10% lower than the puddled transplanted rice (PTR). The water use in ZTDSR (888 mm) was 20% lower than the PTR with a water productivity of 4.7 kg/ha-mm. The cost of cultivation (during 2022-2023) in ZTDSR was Rs. 37863/- with a net return of Rs. 60251/-. The cost of cultivation in ZTDSR was 35% lower and the net return was 18% higher compared to PTR. ZTDSR saved energy input in labour, fuel and machinery by 45%, 32% and 59% compared to PTR.

Conclusion:

Crop establishment in DSR using multipurpose seed drill and weed control by integration of mechanical and herbicidal means ensures establishment of optimum plant population and minimization of crop weed competition at early stage of crop growth which ultimately reflects yield maximization with reduced cost of cultivation. Direct seeding in dry soil also maintains soil health with less effect on emission of methane gas thus safe guarding our environment without any penalty on crop yield. ZTDSR saves water and energy input with reduced cost of cultivation. DDSR is gaining popularity as a viable alternate to conventional transplanted rice in almost all agroclimatic zones of Odisha.

Fig. 1: Seed Treatment with Trichoderma formulation

Fig 2: Sowing of dry rice by seed drill

Fig 3. Field View of Dry direct seeded rice

Fig 4: Application early post emergence herbicide at 2-3 leaf stage of weeds

Fig. 5: Mechanical weed control by power paddy weeder

Fig. 6: Field view of ZTDSR at maturity stage