Reg. No.:03/2004-05
SOCIETY FOR SCIENCE AND NATURE

Registered under Societies Registration Act XI of 1860
www.scienceandnature.org

Date of Acceptance: May 15, 2022 **Published:** June 08' 2022

POPULARIZATION OF DIRECT SEEDED RICE TECHNIQUE IN NORTH WEST ALLUVIAL PLAIN ZONE OF WEST CHAMPARAN DISTRICT, BIHAR UNDER CLIMATE RESILIENT PROGRAM

R. P. Singh[1], S.K. Gangwar[2], R. K. Jha[3], Abhik Patra[1], Pankaj Malkani[1], D. K. Tiwari[2], Gagan Kumar[1], Abhinav Kumar Singh[1, 2], M. S. Kundu[4] and Anupama Kumari[4]

[1]Krishi Vigyan Kendra, Narkatiaganj, Bihar, India (DrRPCAU, Pusa, Samastipur, Bihar)
[2]Krishi Vigyan Kendra Madhopur, Bihar, India (DrRPCAU, Pusa, Samastipur, Bihar)
[3]Professor-cum-Chief Scientist (Agronomy), Dr Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India
[4]Directorate of Extension, Education, Dr Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

INTRODUCTION

Agriculture is the main stay of our rural economy and the substance of life of the people. Rice (*Oryza sativa* L.) is one of the most important cereal crop in the world and a staple food of the global population. Rice is indeed one of the oldest types of cereal recorded in the history of mankind. Being the major source of food after wheat, it meets 43 percent of the calorie requirement of more than 70 percent of the Indian population. The cultivation of rice in intensive subsistence agriculture becomes synonymous with agriculture. India is the second largest producer of rice in the world being superseded only by China in the gross annual output. Rice covers about 69 percent of the cultivated area and is the major crop covering about 63 percent of the total area under food grains. It is one of the most important food crops of India in term of area, production, and preferred food item throughout the country. India is the second largest producer and consumer of rice in the world and also fulfills food demand for more than two third of the Indian population. In order to meet the domestic demand of the increasing population, India produces 122.27 million tons of rice from an area of 45.07 million hectares with productivity of 2713 kg/ha during 2020- 21 (Agricultural Statistics at a Glance, 2021). It is also one of the most important food crops of Bihar and is mostly grown in North West Alluvial Plain Zone regions in rice-wheat cropping system. In Bihar, it occupied 3.02 million ha with a production of 6.88 million t and average productivity of 2276 kg ha^{-1} (Agricultural Statistics at a Glance, 2021). The productivity of crops in the state is far below the national average in state rice is grown in versatile adaptation from precarious moisture as rain-fed upland to deep water areas having 3-4 meter water as a deep water crop with many intermediate situations in between. The diverse ecological situation. Varying climate and pedagogical diversities make rice cultivation a highly risky venture resulting in overall poor productivity of the crop in the state. In Bihar, around 33 percent of total rice area in the state is under assured irrigation while the remaining 67 percent is in under rain-fed situation. In last few years Bihar state is suffering from several drought in rice growing district of

Date of Acceptance: March 10, 2022 **Published:** June 08'' 2022

Bihar.

In India, rice is predominantly grown as puddled transplanted rice (PTR) under irrigated or assured rainfall conditions. Puddled transplanted rice-based production systems are high energy and cost intensive, and result in a less profitable production system. PTR is also not very environment-friendly due to its relatively higher methane emissions. In consequence, there is an imperative need to identify possible suitable crop establishment methods, specifically for rice production systems, to reduce the adverse impacts of climate change and increase productivity and profitability. Direct seeded rice (DSR) systems have significant potential to reduce the environmental footprint and increase production. Nowadays, productivity has become stable due to present crop cultivars. In India, most of the farming community use long-duration rice varieties (>140 days), which postpone the planting of succeeding winter crops (wheat, winter maize, lentil, chickpea, potato, mustard, linseed etc.). Alternative suitable winter crops are decisive and largely depend on the rice harvesting. Puddled transplanted rice is an energy-intensive crop establishment method for rice and is known to degrade the soil system and negatively impact succeeding winter crops. To overwhelm the limitations of late seeding, alternative techniques must be adopted. DSR might be a suitable alternative to advance climate-resilient methods in an efficient manner (Brown *et al.*, 2021).

In the traditional transplanting system (TPR), puddling creates a hard pan below the plough-zone and reduces soil permeability. It leads to high losses of water through puddling, surface evaporation and percolation. Water resources, both surface and underground, are shrinking and water has become a limiting factor in rice production. Huge water inputs, labour costs and labour requirements for TPR have reduced profit margins. In recent years, there has been a shift from TPR to DSR cultivation in several countries of Southeast Asia. This shift was principally brought about by the expensive labour component for transplanting due to an acute farm labour shortage, which also delayed rice sowing. Low wages and adequate water favour transplanting, whereas high wages and low water availability suit DSR. TPR has high labour demands for uprooting nursery seedlings, puddling fields and transplanting seedlings into fields. DSR is a major opportunity to change production practices to attain optimal plant density and high water productivity in water- scarce areas. Traditionally, rice is grown by transplanting one-month-old seedlings into puddled and continuously flooded soil (Farooq *et al.*, 2011). Such an alarming rate of groundwater decline and water crisis is forcing researchers and farmers to consider the dry direct-seeded rice (DSR) production system.

Direct seeding of rice refers to the process of establishing a rice crop from seeds sown in the field rather than by transplanting seedlings from the nursery. There are three principal methods of direct seeding of rice (DSR): dry-DSR/dry seeding (sowing dry seeds into dry soil), wet-DSR/wet seeding (sowing pre-germinated seeds on wet puddled soils) and water- DSR/water seeding (seeds sown into standing water). Dry seeding has been the principal method of rice establishment since the 1950s in developing countries.

Direct seeded rice (DSR) is the only viable option to reduce unproductive water flows. Direct seeded rice as a resource conservation technology which has several advantages over transplanted puddled rice system (TPR). It helps in reducing water consumption as it does away with the raising of seedlings in nursery,puddling and transplanting.

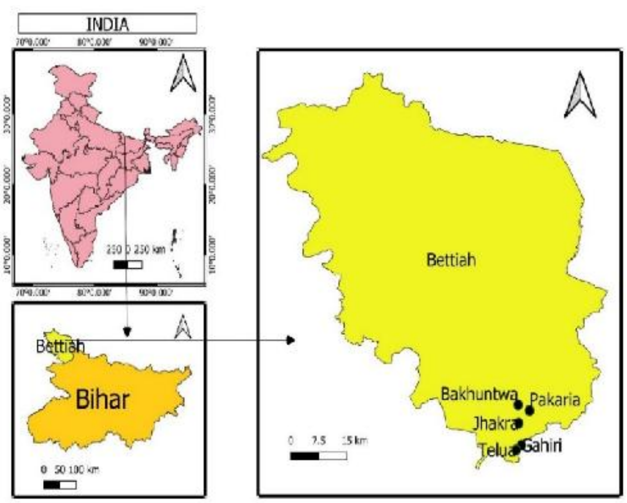
Date of Acceptance: March 10, 2022 **Published:** June 08'' 2022

The benefits include savings in labour (40–45%), water (30– 40%), fuel/energy (60–70%), and reductions in greenhouse gas emissions (Yaduraju *et al.*, 2021).

METHODOLOGY

Experimental site details

The present study was conducted in the selected villages of West Champaran district of Bihar. The farmers of this village had small, marginal and large paddy growers. The overall climatic condition of the district is Cold and Humid in nature. The



rainfall in the region is received through South West Monsoon. The area receives heavy rainfall during monsoons. The average annual rainfall reported from the district of West Champaran is 1472 mm with Terai region receiving very heavy rainfall. In last few years Bihar state is suffering from several drought in rice growing district of Bihar and other environmental calamities. The Krishi Vigyan Kendra, West Champaran were conducted demonstrations in North West Alluvial Plain Zone of West Champaran parts. All demonstrations were conducted in an area of 410 acres under climate resilient agriculture program during *kharif* seasons of two consecutive years 2021-22 to 2022-23 at 595 farmer's fields of five villages i.e. Pakadiya, Baikunthawa, Jhakhara, Telhua and Gahari of block Nautan for resource conservation in rice by introducing direct seeded rice (DSR). Thesoils of the experimental fields were sandy clay loam to clay loamy in texture, with average pH 7.6.

Field preparation and planting methods

Interested large, medium and small holding farmers were purposely selected for direct seeded rice (DSR). Land labeling wascompleted after the harvest of rabi crops throughlaser land leveler for uniform irrigation water standing, seed germination, and weed control. After Land labeling, the soil was pulverized conventionally with the help of 2-3 harrowing followed by planking for DSR. Direct seeded rice was sown in lines giving row-to-row spacing of 20 cm using a seed rate of 30 kg/ha at 2.5-3.0 cm depth with the help of multi crops planter machine. Whereas, traditionally transplanted rice fields were conventionally-tilled as DSR and puddled for smooth transplanting of rice seedlings. Sowing of rice seeds in main field for DSR and sowing rice seeds in nursery for TPR was done on the same date to evaluate the economical parameters. Whereas, 2-3 healthy seedlings of 20-25 days old were transplanted/hill at a spacing of 20 cm × 15 cm in TPR. Rajendra Swarna 3335, Rajendra Neelam, and Rajendra Mahsuri-1 varieties were used for both DSR and TPR inall experimental years. Sowing of seeds in nursery for TPR as well as for DSR was done in the first fortnight of June before the onset of moonson.

Seed treatment and nutrient management

Seeds were treated with Carbendazim @ 2.5g/kg seed, *Azotobactor* culture @ 20 g/kg seed, and

Date of Acceptance: March 10, 2022 **Published:** June 08'' 2022

PSB culture @20 g/kg seed before sowing of seed in main fields/nursery plots. The recommended dose of fertilizer (100 kg N, 40 kg P_2O_5, and 20 kg K_2O) was applied through urea, diammonium phosphate (DAP), and muriate of potash (MOP). Half dose of N and full dose of P_2O_5 & K_2O were applied as a basal and the remaining half dose of N was applied as top dressing in two equal splits at tillering and panicle initiation stages.

Weed control

Weed control in DSR was done by using Pendimethalin 30% EC @ 1.0 kg a.i./ha as pre-emergence with 500 liters of water just after sowing followed by tank-mixed Bispyribac sodium 10% EC @ 25 g a.i./ha as post-emergence at 20-22 days after sowing using knap-sack sprayer fitted with flat- fan nozzle. While, In TPR only post-emergence herbicide *i.e.* Bispyribac sodium 10% EC @ 25 g a.i./ha was used at 20-25 days after transplanting (DAT).

Irrigation management

Irrigation was given to maintain soil water level at field capacity in DSR, whereas,in TPR 5.0 cm depth of water was applied in each irrigation after complete disappearance of water.

Field visits, extension activities, data collection and analysis

Demonstrated crops were visited regularly by the scientists of KVK and SRF during different stages of crop growth and upgraded the skill of beneficiaries during the course of training and visit programmethat helped them in performing various field operations like labeling, sowing, irrigation, spraying, weed control, harvesting etc. Finally, field day/crop cutting was demonstrated before farmers in the villages and local extension functionaries to show the superiority of the technology for disseminating the message at a large scale. The crop was raised under irrigated conditions under the recommended package of practices. Yield attributes and yields (grain and straw) of crop were recorded at harvest stages. Gross and net returns were calculated based on grain and straw yields and their prevailing market prices, while benefit: cost ratio was calculated by dividing gross returns by total cost of cultivation. Feedback information was received from the farmers during training, visit field day/crop cutting for further improvement inresearch and extension programs.

RESULTS AND DISCUSSION

Impact of DSR and TPR technique on weeds, insect-pests and disease management

A significant challenge to the effectiveness of the direct seeded rice (DSR) method is weed infestation. The pre-emergence application of Pendimethalin 30% EC @ 1.0 kg a.i./ha in DSR and 20-22 days after transplanting of TPR without using any herbicide the weed flora *i.e. Echinochloa colona, Echinochloa crus-galli, Dactyloctenium aegyptium, Leptochloa chinensis, Cyperus rotundus, Cynodon dactylon, Digitaria sanguinalis, Elusine indica, Eclipta alba* etc., intensity were found higher in DSR technique than the TPR. A very less infestation of diseases and insect-pest was recorded due to the control of weed flora at proper time. Herbicides facilitate easier, timely, economical, and convenient control of weeds in rice considering the higher cost, drudgery, and lower efficacy of other weed control options.

Reg. No.:03/2004-05
SOCIETY FOR SCIENCE AND NATURE

Registered under Societies Registration Act XI of 1860
www.scienceandnature.org

Date of Acceptance: May 15, 2022 **Published:** June 08' 2022

Impact of DSR and TPR technique on yield and yield attributing traits of different rice varieties

The impact of direct seeded rice technique on yield and yield-attributing traits of different rice varieties is depicted in table 1. The results revealed that the plant height of 110-112 cm, 140-155 cm and 90-100 cm was recorded in Swarna 3335, Rajendra neelam and Rajendra mahsuri-1, respectively in DSR planting methods, while it was recorded 116-120 cm, 145-155 cm and 92-110 cm respectively in TPR technique. Panicle length 24 cm, 25 cm and 23 cm was recorded by DSR technique and 26 cm, 28 cm and 26 cm by TPR technique in rice varieties of Swarna 3335, Rajendra neelam and Rajendra mahsuri-1, respectively. Data showed that the no. of seeds/panicle significantly varied from 215 to 225, 128 to 157 and 111 to 145 by DSR technique and 220 to 225, 136 to 160 and 115 to 150 by TPR technique in rice varieties of Swarna 3335, Rajendra neelam and Rajendra mahsuri-1, respectively. The leaf length for Swarna 3335, Rajendra neelam and Rajendra mahsuri-1 were 50-61 cm, 35-38 cm, and 33-40 cm respectively for DSR, while for transplanting paddy it were 51cm, 37cm, and 38cm respectively. The leaf length were found to be similar for both methods of paddy. The leaf width for DSR and transplanted rice were (1.5cm &, 1.4cm), (1.15cm, & 1.1 cm), and (1-1.15cm, & 1.2cm) for Swarna 3335, Rajendra neelam and Rajendra mahsuri-1 paddy variety respectively. The results revealed smaller length of transplanted paddy in comparison to DSR paddy technique. The weight of 10 seeds for the DSR and TPR technique was (0.25g, & 0.22g), (0.28g, & 0.26g), and (0.22g, & 0.27g) for Swarna 3335, Rajendra neelam and Rajendra mahsuri-1 paddy variety. The paddy yield was observed as 46.8 q/ha, 46 q/ha and 45.2 q/ha for Swarna 3335, Rajendra Neelam and Rajendra mahsuri-1 in DSR paddy technique while for TPR it was 55 q/ha, 48 q/ha, and 49 q/ha respectively. The yield of paddy in TSP technique was more as compared to DSR technique for all the above paddy varieties under same management practices. The straw yield under DSR and TPR technique were (73.2 q/ha, & 70 q/ha), (78.8 q/ha, & 80 q/ha), and (76.5 q/ha, & 75 q/ha) for Swarna 3335, Rajendra neelam and Rajendra mahsuri-1, respectively. The straw yield were more in TPR technique as comparison to DSR technique. The biological yield for DSR and TPR were observed as (120 q/ha, & 125 q/ha), (124.8 q/ha, 128 q/ha), and (120.8, 124 q/ha) for Swarna 3335, Rajendra neelam and Rajendra mahsuri-1, respectively. The biological yield were found to be more in TPR technique as comparison to DSR technique. The findings of the result also support the finding of Jat *et al.*, (2022).

Impact of DSR and TPR technique on economics of rice crop:

The economics of rice crop production under DSR and TPR technique were estimated and the results have been presented in table 2. Different variables like high-yielding variety seed, planting techniques, fertilizers, herbicide, bio-fungicide, bio-insecticide and chemical pesticides etc. were considered as a technological intervention. It is clearly indicated that the DSR method incurred the maximum net returns of Rs. 46600/ha with minimum total cost of cultivation of Rs. 3850/ha. Maximum cost of cultivation (Rs. 51000/ha) was involved in TPR. The reduction in the cost of cultivation in DSR to the tune of Rs, 12500/ha as compared to TPR was mainly due to an increase in farm labours in various field operations like nursery preparation, transplanting, field preparation, and irrigation water etc. The highest benefit: cost ratio (2.21) was also incurred in DSR method, which accounted 22.09 percent higher over traditionally transplanted rice (TPR).

Date of Acceptance: March 10, 2022 **Published:** June 08'' 2022

CONCLUSIONS

Time is saved as direct-seeded crop can be established earlier, which can lead to increased production. The costs of nursery raising and puddling of fields are saved and tillage costs in direct seeding are less. Farmers' priority is to minimize production costs. Direct seeding saves a lot of diesel fuel, which is much more expensive. There is a saving of labour, particularly on labour employed in nursery raising, uprooting of seedlings, and transplanting. Savings of water in field preparation and later in the crop season can be achieved. The transplanted crop cannot be left dry for more than 1-2 days, whereas a direct–seeded crop can be left dry for 8-10 days or even more. Savings in tillage, labour, and water reduce production costs and increase net returns. Direct-seeded rice crops mature earlier than transplanted ones by nearly 10 days and subsequent crops of potato, green peas or rapeseed can benefit. Direct seeding may facilitate triple cropping and crop diversification such as rice-potato-onion in Bihar. After direct-seeded rice, the residual soil moisture is high and the soil physical conditions may be better, which is advantageous to the following *rabi* crop-wheat, lentils, or chickpea. Savings of seed as farmers use up to 80 kg ha^{-1} of seed for transplanting because of risks of nursery raising. Direct-seeded crops are raised with only 30-40 kg ha^{-1} of seed. Fertilizer-use efficiency may be greater in direct seeding as the fertilizer is placed close to the seed by a drill. Insect and pest infestations in direct-seeded rice are fewer. The following wheat crop has fewer weeds.

REFERENCES

Agricultural Statistics at a Glance. 2021. Directorate of Economics and Statistics, Government of India, Ministry of Agriculture, Department of Agriculture and Cooperation, New Delhi.

Brown, B.; Samaddar, A.; Singh, K.; Leipzig, A.; Kumar, A.; Kumar, P.; Singh, D.K.; Malik, R.; Kumar, V.; McDonald, A. (2021). Understanding decision processes in becoming a fee-for-hire service provider: A case study on direct seeded rice in Bihar, India. *Journal of Rural Studies*, 87; 254–266.

Farooq, M.; Siddique, Kadambot, H.M.; Rehman, H.; Aziz, T.; Dong-Jin Lee and Wahid, A. (2011). Rice direct seeding: Experiences, challenges and opportunities. *Soil and Tillage Research*, 111: 78-95.

Jat, R.K.; Meena, V.S.; Kumar, M.; Illathur, J.; Reddy, R. and Pandey, A.C. (2022). Direct Seeded Rice: Strategies to Improve Crop Resilience and Food Security under Adverse Climatic Conditions. Technical note, MDPI, Land, 2022, 1-14.

Yaduraju, N.T.; Rao, A.N.; Bhullar, M.S.; Gill, J.S. and Malik, R.K. (2021). Direct-Seeded Rice (DSR) in India: New opportunities for Rice Production and Weed management in post- COVID-19 pandemic period. *Journal of Asian Pacific Weed Science Society*, 3(2): 30-48.

Date of Acceptance: March 10, 2022 **Published:** June 08'' 2022

Table 1: Impact of DSR and TPR on yield and yield attributing traits of different rice varieties under real farming situation

SN	Traits of rice varieties	Swarna 3335		Rajendra Neelam		Rajendra Mahsuri-1	
		DSR	TPR	DSR	TPR	DSR	TPR
1.	Panicle length	24 cm	26 cm	25 cm	28 cm	23 cm	26 cm
2.	Plant height	110-112 cm	116-120 cm	140-155 cm	145-155 cm	90-110 cm	92-110 cm
3.	No. of tiller	9-13	10-16	11-13	12-16	10-16	10-18
4.	Leaf length	50-61 cm	51 cm	35-38 cm	37 cm	33-40 cm	38 cm
5.	Leaf width	1.5 cm	1.4 cm	1.15 cm	1.1 cm	1-1.15 cm	1.2 cm
6.	No. of seeds/panicle	215-225	220-225	128-157	136-160	111-145	115-150
7.	Wt. of 10 seed	0.25 gm	0.22 gm	0.28gm	0.26 gm	0.22 gm	0.27 gm
8.	Paddy Yield	46.8 q/ha	55 q/ha	46 q/ha	48 q/ha	45.2 q/ha	49 q/ha
9.	Straw yield	73.2 q/ha	70 q/ha	78.8 q/ha	80 q/ha	75.6 q/ha	75 q/ha
10.	Biological yield	120 q/ha	125 q/ha	124.8 q/ha	128 q/ha	120.8 q/ha	124 q/ha

Table 2: Impact of DSR and TPR on economical attributing traits

Planting techniques	Yield (qt/ha)	Gross cost (Rs/ha)	DSR Cost reduction against TPR (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	DSR Net returns increase over TPR (%)	B:C Ratio	BCR increase over TPR (%)
TPR	50.67	51000	12500	92500	41500	-	1.81	-
DSR	46	38500		85100	46600	12.29	2.21	22.09