



## Response of different Establishment Method on Yield Evaluation of Rice (*Oryza Sativa L.*) Under Rice-Wheat Cropping System, India

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### Abstract

Introduction/ Background: Field experiments/On Farm trial (OFT) were conducted at Farmers field of village, Halsi, Lakhisarai under the supervision of ICAR-Krishi Vigyan Kendra, BAU, Bihar, India in 2012-13 and 2013-14. **Objective:** To establish a uniform plant stand for the maximum yield and net return ultimately for the drudgery reduction. **Methodology:** The experimental trial was laid out in a Randomized block design replicated four times (Number of Farmers) with six treatments comprising of transplanted rice (Farmers practices), system of rice intensification (SRI) square transplanted, DSR- Zero-tillage (dry seeding), direct seeded rice (DSR)- broadcasting (dry seeding), DSR- Drum seeded (dry seeding) and DSR- wet seeded (sprouted seeding). **Result:** Among the different establishment methods, SRI planting significantly influenced the growth, yield attributing characters and yield, but relatively was on par with transplanted rice. The maximum plant height, number of tillers m<sup>-2</sup>, panicle length, leaf area Index (LAI), number of filled grains panicle<sup>-1</sup>, number of unfilled grain panicle<sup>-1</sup>, test weight, grain yield (5712 kg ha<sup>-1</sup>), straw yield (7950 kg ha<sup>-1</sup>) and net return (Rs. 50,409.30 ha<sup>-1</sup>) were recorded under SRI (square transplanted) but which were on par with transplanted rice and DSR- Zero-tillage while benefit cost ratio was significantly highest (2.56) under DSR- Zero-tillage. Lowest grain yield, straw yield and gross return were observed under DSR- broadcasting and lowest net return were recorded under DSR- wet planted (sprouted seeds) and lowest B:C ratio were found under Transplanted rice. **Conclusion:** System of rice intensification (SRI) having higher yield followed by puddled transplanted rice, DSR- drum seeder (sprouted seed) and DSR- zero-tillage. DSR- zero-tillage is a viable, long-lasting and appropriate substitute to puddled transplanted rice and to be the most profitable methods with minimize the cost of cultivation.



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### Introduction

Rice is one of the principle and immensely cultivated crop in tropical and sub-tropical regions in India as well as in the world as it is staple food for more than 60% of the world's population. Among the cereals total production of rice in India is 115.63 million tones in 2019-2020 (Anonymous).<sup>1</sup> India holds second rank after China in the world and its share is about 21.2% in the world during 2015. Traditional method of transplanting of rice in puddle soil is tedious method, which has high water requirement for raising the nursery as well as puddling for bed preparation during the transplanting. Puddling form the thick layer on the upper layer of the soil and minimize the percolation losses but affect the physical condition

of soil and wastage of time. The conventional rice planting method is transplanting which involves seedling preparation in nurseries and replanting in puddled soils (Chen).<sup>4</sup> Puddling is a common process by which cultivating soil in 2.5 to 5.0 cm standing water and finally bed prepared for transplanting (Bouman and Tuong).<sup>3</sup> In most of the Asian countries transplanting is widely practiced (Mabbayad and Obordo).<sup>15</sup> The benefit of the conventional puddled rice increased nutrient availability in soil basically iron, zinc and phosphorous and also reduce the weed population (Surendra).<sup>21</sup> The puddled soil create anaerobic conditions to increase nutrient availability (Sanchez).<sup>20</sup>



**Fig.1: Different crop establishment techniques of rice (*Oryza sativa* L.)**

Direct seeded rice (DSR) through using zero-till drill is one of the alternate methods of rice sowing without puddling of the soil. This is easiest method of sowing where no rising of the seedling required. This method save water and minimize cost of production and maintain physical condition of soil. In this method seed should be sown by using tractor drawn zero-till drill. This system sowed seed properly without the wastage of time and money in raising seedling. This enhances the productivity of rice with minimum water requirement as compared to traditional rice transplanting. Direct seeding of rice and transplanting are the two common methods of rice establishment (Kumar;<sup>11</sup> Kumar<sup>12</sup>). Conventional transplanting of the aged seedlings into puddled soil is easy and most used method by the majority of farmers of Asian

countries. Traditional method of transplanting is more strenuous, time consuming and higher cost of production than DSR (Hashimoto).<sup>9</sup> The area under traditional rice in world is going to decrease due to limitation of water and labour therefore, alternate method of transplanting should be promoted for enhancing the crop and water productivity (Farooq<sup>7</sup>; Farooq<sup>8</sup>, Datta<sup>6</sup>). Wet DSR is primarily done under labour shortage situation and is currently practiced in Malaysia, Thailand, Vietnam, Philippines and Sri Lanka (Pandey and Velasco).<sup>17</sup> Farmers of many Asian countries were adopting DSR technology over conventional puddle transplanting since DSR method of rice establishment requires less labour, time, drudgery and cultivation cost (Bhushan<sup>2</sup>; Pandey and Velasco<sup>17</sup>). Rice can be also sown by

broadcasting in which dry seed is used for sowing without the definite row arrangement. Drum seeder is also one of the noble practices for sowing of rice by using dry and wet sprouted seed. In this method seed should be filled in drum and moved manually in to the puddle field. This is method of the line sowing where mortality rates is very low by using sprouted seeds in drum seeder. System of rice intensification (SRI) is another method of rice transplanting which requires less water for preparation of nursery and seed bed for transplanting. This method is less time consuming since 12 days old seedling is used for planting and low transplanting shocks. This is method of alternate wetting and drying in rice production system also known aerobic rice system of transplanting.

Method of establishment is one of the cultural practices, which influences the rice crop through its effect on growth and development (Kumar).<sup>13</sup> Keeping these facts in view, present investigation/ on farm trials (OFT) was under taken to study the establishment methods on yield evaluation of Rice (*Oryza sativa* L.) under rice- wheat cropping system, India as shown in Figure 1.

## Material and Method

### Site of Experiment

A field experiment {On farm Trial (OFT)} was conducted in village, Halsi, Lakhisarai, under the supervision of ICAR-Krishi Vigyan Kendra, Lakhisarai, Bihar in 2012-13 and 2013-14 on "Response of different establishment method on yield evaluation of rice (*Oryza sativa* L.) under rice-wheat cropping system, India.

### Design of Experiment and Treatments

The experiment/ on farm trial was laid out in Randomized Block Design with four replications (No of farmers), comprised of six treatment viz, T<sub>1</sub>- Transplanted rice (Farmers Practices), T<sub>2</sub>- System of rice intensification (SRI) square transplanted, T<sub>3</sub>- DSR- Zero-tillage (dry seedlings), T<sub>4</sub>- Direct seeded rice (DSR)- Broadcasting (dry seeding), T<sub>5</sub>- DSR- Drum seeded (dry seeding), T<sub>6</sub>- DSR- wet seeded (sprouted seedlings).

### Good Agronomic/ Agricultural Practices (GAP)

Genotype of rice namely Rajendra Mansuri-1 (RM-1) was sown/ transplanted by different methods during kharif season in the second fortnight of May

and harvested in the second fortnight of October. In system of rice intensification (SRI), 12 days old seedlings were transplanted with keeping the distance of 25cm x 25 cm. Under the manual transplanting, 21- 24 days old seedling were used for transplanting keeping the distance 20cm x 15 cm. For drum seeding the pre germinated seeds were sown by using eight row paddy drum seeder in a puddled soil and soaked seeds were sown for wet seeding method. For DSR-Zero-tillage the dry seeds were sown by using zero-till drill in a moist unploughed soil while a dry seed is used for broadcasting in dry ploughed soil under DSR-Broadcasting. Recommended dose of FYM @ 10 tones ha<sup>-1</sup> was applied in the field in the month of May before sowing of seeds and before monsoon. Recommended dose of fertilizer was applied in the form of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O @ 120 kg, 60 kg and 60 kg ha<sup>-1</sup> through Urea, Di-ammonium phosphate and Muriate of potash, respectively. Various intercultural operations and plant protection measures were adopted for the crop timely.

### Soil Status of Experiment

Texture of the soil at the experiment site was clay loam and 7.60 pH value of the soil was recorded. The value of various soil properties present in the experiment fields were 237.6 kg ha<sup>-1</sup> available N, 11.2 kg ha<sup>-1</sup> P<sub>2</sub>O<sub>5</sub> and 149.20 kg ha<sup>-1</sup> K<sub>2</sub>O. The percentage of available organic matter present in the soil was 0.68%.

### Data Analysis

Observations on growth and yield attributing were recorded at different stage and at harvest. The grain and straw yield were recorded and economics was worked out. The economics was computed by using the prevalent prices of inputs and outputs. To test the significance difference, the trial data collected and analysed with the procedure described by (Cochran and Cox)<sup>5</sup> and adopted by Cheema and Singh (1991) in statistical package CPCS 1.

## Results and Discussion

### Growth and Yield Attributing Characters

The growth and yield attributing character of rice viz., plant height, number of leaves m<sup>-2</sup>, total leaf area, number of tillers m<sup>-2</sup> and all others showed significant differences at harvesting stage due to crop establishment techniques in rice. Among the various crop establishment methods that

were adopted during the research, system of rice intensification system of planting recorded significantly the highest plant height, number of effective tillers, leaf area index, Nos. of filled grain per panicle and test weight (Table 1). The maximum plant height (94.20 cm), number of effective tillers  $m^{-2}$  (485), leaf area index (5.31), numbers of filled grains per panicle (195) and test weight (25.90 g) were recorded under SRI planting but these parameters were on par with transplanted rice. The conformity of similar findings of growth and yield attributing parameters were reported by (Kumar).<sup>13</sup> Transplanting of young age seedlings in system of rice intensification method of transplanting might have established quick and early in the

field force be resulted to higher growth and yield attributing characters (Krishna).<sup>10</sup> Transplanted rice higher yield and yield attributing characters over DSR- broadcasting, DSR- Zero-tillage and DSR-drum seeder DSR- wet seeded. Similar result was also reported by (Prasad).<sup>18</sup> Transplanting method significantly increased the growth and yield attributes over drum seeding of sprouted seeds under puddle condition (Kumar).<sup>14</sup> Significant increase in plant height, number of effective tillers, LAI, number of filled grains per panicle and test weight were observed under DSR-drum seeded and DSR-Zero-tillage of planting as compared to DSR-wet seeded and DSR- broadcasting establishment methods.

**Table 1: Establishment methods of rice on growth and yield attributes (Pooled data of two year)**

Treatments	Plant height (cm)	Effective tillers / $m^2$	Panicle length (cm)	LAI	No. of filled grain/ panicle	No. of unfilled grain/ panicle	Test weight (g)
Puddled transplanting (Farmer's practices)	86.20	456.80	19.40	5.11	185	20.00	25.89
System of Rice Intensification (SRI)	94.20	485.00	19.80	5.31	195	18.00	25.90
DSR-Broadcasting	74.60	362.40	13.60	3.70	152	22.00	24.00
DSR-Zero tillage	77.80	392.60	14.80	4.11	175	21.00	24.55
DSR-Drum seeder	82.20	416.40	16.40	3.90	182	21.00	24.55
DSR- Wet seeded (sprouted)	76.78	382.00	13.80	3.89	170	22.00	24.11
SE $d\pm$	2.40	8.62	0.60	0.30	3.80	-	0.10
CD (P=0.05)	7.36	26.76	1.80	1.00	12.00	NS	0.32

### Grain and Straw Yield

Among the crop establishment methods (Table 2) shows that system of rice intensification (Square planting), found to have higher grain yield of 5712  $kg\ ha^{-1}$ . However, it was statistically on par with puddled transplanted rice which produced 5534  $kg\ ha^{-1}$ . Whereas, DSR- broadcasting (dry seeded) rice recorded significantly lesser grain of 4832  $kg\ ha^{-1}$ . SRI (Square transplanting) recorded 3.11% higher yield than puddled transplanted rice, 7.93% higher yield over DSR- drum seeder (sprouted), 11.67% higher yield over DSR- zero-tillage, 15.10% higher yield over DSR- wet seeded (sprouted) and 15.40% higher yield over DSR- broadcasting rice. The straw yield was also found highest under the SRI (7950  $kg\ ha^{-1}$ ) followed by puddled transplanting (7851  $kg\ ha^{-1}$ ), DSR- drum seeder (7610  $kg\ ha^{-1}$ ), DSR- Zero-tillage (7305  $kg\ ha^{-1}$ ), DSR- broadcasting

(7151  $kg\ ha^{-1}$ ) and DSR- wet seeded (sprouted) (7100  $kg\ ha^{-1}$ ). The higher yields was due to favourable growing condition and highest growth and yield attributing characters with higher photosynthesis resulted source to sink conversion, which consecutively resulted in higher grain and straw yield. The result was in close conformity to those of (Netam).<sup>16</sup> Transplanting method recorded the highest grain and straw yields over dry seeding and puddle sowing of sprouted seeds (Prasad).<sup>18</sup> Samra and Dhillon<sup>19</sup> reported higher yield under puddled transplanted rice as compared to puddling with broadcasting sprouted seed and line sowing of sprouted seed. Highest grain yield and straw yield of hybrid rice were recorded under transplanting over drum seeding of sprouted seeds under puddle condition (Kumar).<sup>14</sup>

**Table 2: Establishment methods on rice yield ( kg ha<sup>-1</sup>) and economics (Rs ha<sup>-1</sup>) (Pooled data of two years)**

Treatments	Grain yield (kg ha <sup>-1</sup> )	Straw yield (kg ha <sup>-1</sup> )	Cost of cultivation (Rs. ha <sup>-1</sup> )	Gross return (Rs. ha <sup>-1</sup> )	Net return (Rs. ha <sup>-1</sup> )	B:C ratio
Puddled transplanting (Farmer's practices)	5534	7851	36,800	84877	48,077	2.30
System of Rice Intensification (SRI)	5712	7950	37,200	87,609	50,409	2.35
DSR-Broadcasting	4832	7151	29,600	74,705	45,105	2.52
DSR-Zero tillage	5045	7305	30,250	77,634	47,384	2.56
DSR-Drum seeder	5259	7610	32,450	80,947	48,504	2.49
DSR- Wet seeding (sprouted seed)	4850	7100	31,250	76,305	44,505	2.38
SE d±	120	150	--	1,410	1,050	0.02
CD (P=0.05)	348	476	--	4,267	3,265	0.08

**Economics**

It is visible from the Table 2 that among the different planting methods system of rice intensification shows highest gross return (Rs. 87,609 ha<sup>-1</sup>) and net return (Rs. 50409 ha<sup>-1</sup>) but the net return were found at par with puddled transplanting (Rs. 48,077 ha<sup>-1</sup>) and DSR- zero-tillage (Rs. 47,384 ha<sup>-1</sup>). This was might be due to due to higher grain yield, import better return for every rupee charges in the form of cost of cultivation. Table 2 & Fig 3 & 4 shows that DSR- zero-tillage to be the most beneficial treatment in terms of higher return and benefit cost ratio (2.56) among the all crop establishment method. This efficacy may be due to lower cost of cultivation and on account of higher grain yield. The lowest returns (Rs. 44,505 ha<sup>-1</sup>) were gated under DSR- wet seeding (sprouted) which was the result of lowest grain yield under the different establishment methods. The highest net monetary returns and benefit cost ratio over dry seeding and puddle sowing of sprouted seeds(Prasad).<sup>18</sup> Highest net income (Rs 23413 ha<sup>-1</sup>) and B:C ratio (1.34) of hybrid rice were recorded under transplanting over drum seeding of sprouted seeds under puddle condition (Kumar)<sup>14</sup>. Maximum benefit cost ratio (1.34) was obtained from treatment direct seeded rice (DSR) (Kumar).<sup>12</sup> The result is in close conformity to those of (Netam).<sup>16</sup>

**Conclusions**

It is concluded that among the establishment methods system of rice intensification (SRI) listed higher growth, yield attributes, grain and straw yield. This was followed by puddled transplanted rice, DSR- drum seeder (sprouted seed) and DSR- zero-tillage. DSR- zero-tillage is a viable, long-lasting and appropriate substitute to puddled transplanted rice, DSR- drum seeder and SRI which skips nursery and transplanting and to be the most profitable methods which also minimize cost of production.

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**Conflict of interest**

The authors declare that they have no conflict of interest.

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