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Adoption Status of Direct Seeded Rice Technology by the Farmers of Punjab

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ABSTRACT

Direct-seeded rice (DSR) is a possible alternative to conventional puddled transplanted rice, where rice crop is seeded directly in non-puddled fields. The study was conducted to ascertain the adoption status of recommended practices of DSR. Personal interviews were conducted to collect data from randomly selected 210 farmers from three districts representing different agro-climatic regions of Punjab. Study revealed that selected farmers had adopted DSR on 49.20 per cent of their total area under paddy cultivation. Slightly higher number of selected farmers had adopted *Tar-Wattar*, a new technique of DSR over dry soil method. Only 18.52 per cent respondents had applied first irrigation as per recommendations of *Tar-Wattar* method, whereas majority (67.59%) had applied first irrigation before 21 days. 26.67 per cent farmers had adopted most suitable variety PR-126 and sown it at recommended time. However, in case of other varieties, majority of farmers did not follow recommended time of sowing. A smaller number of farmers have applied zinc, iron and sulphur fertilizers to ameliorate micro nutrient deficiencies. Average yield of others varieties and PR 126 were found to be nearly identical, but due to lesser cost of cultivation in DSR as compared to transplanted rice, adopter farmers' fetched higher net return.

INTRODUCTION

Rice (*Oryza sativa* L.) is staple food for more than 60 per cent of the global population (Bista, 2018; Ashraf et al., 2006). India is the second largest producer of rice in the world being superseded only by China in the gross annual output (Dhillon et al., 2010). In India, Rice crop is grown on an area of 43.79 million hectares with a total production of 112.91 million tons (Anonymous, 2019). Punjab state plays an important role in rice production and has highest productivity of rice in India. The area under paddy during *kharif* season in 2020 was 31.42 lakh hectares in the state with a record production of 189.18 lakh tonnes of paddy (Bhardwaj, 2017; Anonymous, 2021). Rice is a water guzzler crop and has 1800 mm irrigation requirements (Baweja et al., 2017). The conventional puddled transplanting of rice (PTR) is water, capital, energy and labour-intensive practice (Bhatt et al., 2021). Punjab is one of the most fertile land on the earth. To meet the food requirements of country, the area under rice and wheat was increased in Punjab, but more extraction of water from the groundwater leads to underground water depletion. It is apparent that underground water in the major rice growing areas of the state is declining at the rate of 0.23m per year causing serious concern and raising doubt about the future sustainability of the rice-based system (Humphreys et al., 2010). The average water table depth in the state was 7.32 m in 1998 which has been decreased to 12.79 m in 2012 (Gupta et al., 1995; Baweja et al., 2017). Looming water crisis, water-intensive nature of rice cultivation and rising labour costs drive the search for alternative management methods to increase water productivity in rice cultivation. Direct seeded rice (DSR) has received much attention because of its low-input demand. Direct-seeded rice is a possible alternative to conventional puddled transplanted rice, where rice crop was sown through direct seeding in non-puddled fields, these fields were suitable approaches for water saving and labour (Singh et al., 2009). Direct seeded rice technology also

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decreased green-house gas emissions and adapt to climate risks (Sebestian et al., 2017). *Tar-wattar* direct seeded rice is an improved version of existing DSR technology, in which the pre-sowing irrigation is applied after laser levelling the field. Field is cultivated and prepared When it attains good soil moisture condition and paddy seeds are sown immediately. An important variation from the earlier direct seeded rice technology is delaying the first irrigation to 21 days (Singh et al., 2021). Thus, the present study was planned to analyzed adoption status of direct seeded rice in Punjab state.

METHODOLOGY

The study was conducted in three agro-climatic regions i.e. sub-mountain undulating, central plain and south-western regions of Punjab state. One district from each agro-climatic region was selected for the study. Sangrur district from central plain, Gurdaspur from sub-mountain undulating and Fazilka from south western region were selected for the study. List of farmers practicing DSR were obtained from Department of Agriculture and Farmer Welfare and respective Krishi Vigyan Kendras. Further, 70 farmers were selected randomly from each selected district for the present study. Thus, total sample size for study was 210 farmers. Punjab Agricultural University has research and recommended *tar-wattar,* a new technique of DSR in the year 2020. A well-structured and pre-tested, interview schedule was developed for eliciting data from the farmers incorporating all the items on which information was required by keeping in view of the objectives. The data were collected on adoption of recommended cultivation practices of direct seeded rice i.e. sowing method, time of sowing, seed treatment, fertilizers use pattern, herbicides and irrigations etc. The data were analysed with the help of package SPSS. Economic analysis was done by calculating the gross income considering the minimum support price provided for rice crop by the government. Net income was calculated by formula as a difference of gross income and variable cost. Cost Benefit Ratio (CBR) was calculated by dividing gross income (Kumar & Meena, 2021) by total cost of production.

RESULTS AND DISCUSSION

Adoption of DSR

Total area under paddy crop was 1429.6 ha whereas DSR technology was adopted on 809.8 ha by the respondents. It was further revealed from data in Table 1 that area under DSR was maximum in Fazilka district (68.89%) followed by Gurdaspur (53.69%) and Sangrur (48.68%). The increase in adoption can be attributed to the facts that during Covid pandemic period there was severe shortage of labour and machineries necessitate the farmers to adopt DSR technologies. In Gurdaspur district, 17.57 per cent of sown area was ploughed by the farmers however, 12.59 per cent area was ploughed by the respondents of Sangrur district. Only 9.98 per cent area was ploughed by the farmers of Fazilka district. Discussion with farmers inferred that the ploughed area was severely affected by weeds which caused poor performance of direct seeded rice in weed-crop competition there by coercing the farmers to plough their fields.

Direct seeded rice is mainly practiced by two methods i.e. dry soil method and *Tar-wattar* method. *Tar-wattar* DSR is a novel technique developed and recommended by PAU in 2020 to reduce water footprints in rice cultivation. In this technique, pre-sowing irrigation is applied and primed seed is sown in a *Tar-wattar* condition. A major difference from conventional dry-DSR is delay in applying first irrigation which is applied at three weeks after sowing (21 days). Data regarding method of sowing in DSR cultivation in Table 2 reveals that slightly higher number of respondents (51.43%) used *Tar wattar* method for sowing than the dry soil method. *Tar wattar* method is advantageous over dry soil method in weed management and water consumption. It is also evident that majority of the respondents (94.76%) used DSR drill. Further survey revealed that 60.48 per cent of them used it on custom hiring basis. It might be due to the reason that DSR drill was expensive to purchase and farmers preferred to hire it for sowing. Few farmers (5.23%) have made some modifications in their happy seeder machine to directly sow the rice crop. It is evident from data in Table 2 that farmers have grown more than one variety at their farms. It was found that 26.67 per cent of farmers had adopted most suitable variety PR-126 recommended by Punjab Agricultural University for DSR. PR-126 is a short duration variety and advantageous for weed management. Variety PR 111 was grown by 13.33 per cent of respondents. Pusa 44 is a long duration variety

Table 2. Adoption of sowing methods and variety in DSR technology by the farmers

Practice	Category	Percentage*
Sowing Method	*Tar wattar* (recommended)	51.43
	Dry soil method	48.57
Implement used	DSR Drill	94.76
	Modified happy seeder	5.24
Paddy variety*	PR111	13.33
	PR114	11.91
	PR 121	4.76
	PR 122	0.95
	PR126	26.67
	PR 127	6.19
	PR 128	11.91
	PR 129	9.05
	PUSA 44	41.42

*Multiple Response

Table 1. Adoption of direct seeded rice technology by the farmers

District	Total area under paddy (Area in ha)	Area under DSR (%)	Ploughed area (%)	Net area under DSR (%)
Fazilka	448	308.6 (68.89)	30.8 (9.98)	277.8 (62)
Sangrur	515.2	250.8 (48.68)	31.6 (12.59)	219.2 (42.55)
Gurdaspur	466.4	250.4 (53.69)	44 (17.57)	206.4 (44.25)
Total	1429.6	809.8 (56.65)	106.4 (13.14)	703.4 (49.20)

Figures in Parentheses are indicated percentage to their respective total

Table 3. Adoption of agronomic practices by the respondents under DSR technology

S.No.	Agronomic parameter	Categories	Percentage	Average	S. D
1	Seed rate (kg/ha)	Less than recommended (14-19)	39.05	22.64	2.51
		Recommended (20-25)	54.29		
		More than recommended (26-30)	6.67		
2	Seed treatment	Treated	91.91	-	-
3	Spacing between row to row (inches)	Less than recommended (7)	2.86	8.84	0.44
		Recommended (8)	10.48		
		More than recommended (9)	86.67		
4	Depth of sowing (inches)	Less than recommended (<1.25)	37.62	1.39	0.79
		Recommended (1.2-1.5)	59.05		
		More than recommended (>1.5)	3.33		
5	Time of sowing (Others than PR-126 variety) (n=209)	Before 15 June	51.19	-	-
		Recommended (1-15 June)	47.37		
		After 15 June	5.26		
	Time of sowing (PR 126) (n=56)	Before 16 June	26.79		
		Recommended (16-30 June)	67.86		
		After 30 June	5.36		
6	Number of irrigations	18-23	19.05	24.95	4.52
		24-29	75.24		
		30-34	5.71		
7	Scheduling of first irrigation in dry soil (n=102)	Recommended (Immediately after sowing)	81.37	1.23	2.30
		After 2-3 days	18.63		
	Scheduling of first irrigation in *Tarr-wattar* (n=108)	Before 21 days	67.59	18.70	8.51
		Recommended (21 days)	18.52		
		After 21 days	13.89		

and hence not recommended for DSR. However it was grown by 41.42 per cent of respondents under direct seeding technology.

Almost half of respondents (54.29%) used recommended seed rate of 20-25 kg/ha (Table 3). Most of the farmers (91.91%) have done seed treatment before sowing. Majority of the respondents (86.67%) sown their crop at wider spacing and only 10.48 per cent of the respondents has adopted recommended plant spacing. Majority of the respondents has adopted recommended depth of sowing whereas 3.33 per cent of respondents sown seeds more than recommended depth of sowing**.** Major reason for increase in depth of sowing was found to be lack of knowledge to operate the machine. The machine should be operated by trained person in order to avoid this situation. The recommended time of sowing PR 126 variety is 16-30 June while recommended time of sowing for others varieties is 1 to 15 June (Anonymous, 2021a). In the case of PR 126 variety around 67.85 per cent of respondents has adopted the recommended sowing time whereas 26.78 per cent of respondents sown the paddy seed before recommended time. Only 5.35 per cent of respondents sown their paddy seeds after the recommended time. Majority of the respondents (75.24%) had applied the 24-29 number of irrigations, however 19.05 per cent of respondents had applied 18-23 irrigations. It is clear from table 3 in dry soil method that majority of respondents (81.37%) applied first irrigation as per recommendations. In *Tarr-wattar* method only 18.52 per cent of the respondents applied first irrigation as per recommendations and 67.59 per cent apply first irrigation before 21 days.

The respondents were using both pre-emergence and post-emergence herbicides. Data in Table 4 showed that the recommended herbicide i.e., Stomp 30 EC (Pendimethalin) was used by 97.14 per cent respondents. However, majority of them (77.45%) used recommended dose of herbicides. As many as 52.85 per cent of respondents used Sathi 10 WP (Pyrazosulfuron Ethyl) and out of them 51.35 per cent respondents used the recommended dose of this herbicide. In case of post-emergence herbicides, Nominee Gold 10 EC (Bispyribac) was the most preferred herbicide used by majority of the respondents. Although most of them (51.65%) were using recommended dose of Nominee Gold 10EC (Bispyribac) but considerable percentage (41.21%) were using higher than recommended dose of herbicide. Similar pattern was observed in case of Ricestar 6.7 EC (Fenoxaprop), which was used by 5.71 per cent of respondents, out of which only one fourth was using recommended doses of this herbicide and 25 per cent of them were using more than recommended dose. Almix 20 WP (Metasufuron Methyl + Chlorimuron Ethyl) was applied by 7.61 per cent of respondents and many of them were found to be using more than recommended doses of herbicide.

Usage pattern of fertilizers in DSR

DSR cultivation practice requires more precision as compared to puddled rice cultivation. As for the nitrogen requirement is concerned, all of the respondents had used urea and most of them (43.81%) applied it in recommended dose while 40.95 per cent of farmers has applied more than recommended dose of urea fertilizer (Table 5). Only 15.24 per cent of respondents used them in less than recommended dose. Majority of the respondents (73.78%) applied 63-72 kg/ha DAP fertilizer at their fields, whereas 19.51 per cent of respondents applied 50-62 kg/ha DAP at their fields. The requirement of potash was met with the application of muriate of potash, whereas only 7.14 per cent of respondents applied muriate of potash at their fields. It is evident from the data that lesser number of farmers applied micronutrient fertilizers like zinc, iron and sulphur to ameliorate their deficiency in crop. Importance of judicious use of fertilizers in rice crop was also emphasized in the studies conducted by Sidhu et al., (2014); Jayalakshmi et al., (2021).

Table 4. Adoption of weed management practices in DSR by the farmers

S.No.	Name of herbicides	f(%)	Dose (per/ha)	%*
1	Stomp 30EC (Pendimethalin)	204(97.14)	Less than recommended (<2500 ml)	17.16
			Recommended (2500 ml)	77.45
			More than recommended (>2500 ml)	5.39
2.	Sathi 10WP (Pyrazosulfuron ethyl)	111(52.85)	Less than recommended (<150 g)	10.81
			Recommended (150 g)	51.35
			More than recommended (>150 g)	37.84
1	Nominee Gold 10EC (Bispyribac)	182(86.67)	Less than recommended (<250 ml)	7.14
			Recommended (250 ml)	51.65
			More than recommended (>250 ml)	41.21
2	Ricestar 6.7EC (Fenoxaprop)	12(5.71)	Less than recommended (< 1000 ml)	50
			Recommended (1000 ml)	25
			More than recommended (>1000 ml)	25
3	Almix 20WP (Metsufuronmethyl + chlorimuron ethyl)	16(7.61)	Less than recommended (<20 g)	12.50
			Recommended (20 g)	31.25
			More than recommended (>20 g)	56.25

* Multiple Response

Table 5. Fertilizer use in DSR technology by the farmers

Fertilizers	Dose (kg/ha)	Percentage
Urea	Less than recommended	15.24
	Recommended (325)	43.81
	More than recommended	40.95
DAP	50-62	19.51
	63-72	73.78
	73-87	6.71
	Not applied	21.90
Potash	Applied	7.14
Zinc	Applied	45.83
Iron	Applied	37.50
Sulphur	Applied	9.05

Yield obtained and average expenditure under DSR technology

Average yield of Pusa 44 variety was found to be 74.75 q/ha whereas average yield realized by the farmers from PR 126 was found to be 74.60 q/ha (Table 6). The others varieties including (PR111, PR114, PR121, PR122, PR127, PR128 and PR129) contributed to an average yield of 74.50 q/ha at farmers fields under DSR technology. The difference in yield between all varieties as shown in table is almost the same even though Pusa 44 has slightly higher yield than other varieties.

Cost benefit ratio

Among the DSR and transplanted puddle rice, the maximum gross return was obtained with the conventional transplanting technology (Rs. 146150) as compared to DSR (Rs. 137825). Gross returns among sowing technology were higher due to higher grain yield obtained. The net return was maximum in DSR technology (Rs. 109045) as compared to conventional transplanting (Rs. 108413). Higher net return with DSR technology was due to its lesser cost of cultivation (Rs. 28780) as compared to conventional transplanting (Rs. 37737). The increased labour cost, puddling operation and repair of machinery increases cultivation cost in transplanted rice. The benefit cost ratio was higher with DSR technology (4.78:1) as compared to conventional transplanting (3.87:1). Higher B:C ratio with DSR technology was also due to its lesser cost of cultivation as compared to mechanical transplanting and conventional method of paddy cultivation/ transplanting (Table 6). DSR technology was also found to beneficial and economical by Mishra et al., (2017).

Table 6. Average yield and Cost benefit analysis of DSR in comparison to transplanted rice

Particulars	DSR	PTR
Average yield (q/ha)		
Pusa 44 (n=87)	74.75	79.90
PR 126 (n=56)	74.60	80.40
Others varieties (PR111, PR114, PR 121, PR 122, PR 127, PR 128, PR 129) (n=122)	74.50	82.30
Overall	74.61	80.86
Returns (Rs./ha)		
Cost of Cultivation	28780	37737
Gross Return	137825	146150
Net Return	109045	108413
Cost benefit ratio	4.78	3.87

CONCLUSION

Although few farmers started the DSR from the year 2007, the number of respondents gradually increased in successive years but in 2020, there was huge jump in adoption of DSR during COVID period. It can be attributed to the facts of labour shortage during COVID period compelling farmers to search alternatives to the conventional transplanting method of rice cultivation. Study concluded that farmers seem enthusiastic in adopting DSR technology; however there are significant adoption gaps in recommended cultivation techniques at farmer fields. DSR technology proved its potential to provide higher net returns in comparison to conventional puddled transplanted rice. Although average yield of rice under DSR technique was found to be almost similar to that of transplanted rice, but still immense potential exists for yield maximization by the adoption of recommended crop production practices. Study underlines the importance of extension interventions to disseminate DSR practices like *Tar-wattar* method of sowing, efficient weeds management practices and enhancement of grower skills through trainings for its adoption at farmers' fields.

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