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A field survey to identify the problems in adaptability of Direct Seeded Rice

Muhammad Tahir Latif[1]*, Falak Sher[1], Adnan Bashir[1], Muhammad Asghar[1], Naeem Faisal[1], Muzzammil Hussain[2]

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ABSTRACT

During Kharif (July –October) 2015 a field survey study was conducted to identify the problems in adaptability of direct seeded rice (DSR) from three districts falling in Adaptive Research zone Gujranwala, Pakistan. Sixty farmers who had cultivated both transplanted rice and DSR were selected by convenience sampling method due to time and cost constraint and interviewed for primary data collection. The results revealed that DSR practice was adopted on 21.1% of the rice area on surveyed farms. Additional grain yield (11%) was estimated for traditional transplanted crop than DSR. Major problems raised by the farmers regarding DSR practice were more weed infestation, more disease/pest attack, less yield, more fertilizer requirement and more lodging factor. Total economic cost of production and net income for transplanted rice were respectively 11.3% and 9% higher than DSR. However Benefit cost ratio difference was found non-significant between both sowing methods. Expense on land preparation, labor charges for nursery management and transplanting, and irrigation expense for continuous flooding were the factors for higher cost of transplanted rice production. Therefore it was concluded that both sowing methods might be alternative to each other keeping in view the availability of labor, water and soil type.

INTRODUCTION

Rice (*Oryza sativa*) is the second major cereal crop in Pakistan after wheat. In Punjab it is being cultivated on an area of 1.7 million hectares with total production of 3.5 million tons that accounts 51% of total national production of rice in Pakistan (GOP 2014). More than 70% of basmati rice production in the country is contributed by Gujranwala, Sheikhupura, Narrowal, Sialkot, MandiBahaudin Din, Okara, Hafizabad, and Jhang districts of Punjab (Abedullah et al. 2007).

In direct seeded rice (DSR) method the rice is cultivated from seeds sown directly in the field rather than by transplanting seedlings from nursery. There are three principal methods of establishing the DSR: dry seeding (sowing dry seeds into dry soil), wet seeding (sowing pre-germinated seeds on wet puddled soil) and water seeding (seeds sown into standing water) (Farooq et al. 2011).

In recent years, there had been a shift from transplanted rice (TPR) to DSR cultivation in several countries of Southeast Asia. Low wages and adequate water promoted transplanting, whereas high wages and low water availability for rice crop directed toward DSR (Pandey and Velasco 2005). This shift was principally brought about by the expensive labour component for transplanting and farm labour shortage which resulted in delayed rice sowing (Chan and Nor 1993). The development of short duration, early-maturing cultivars and efficient nutrient management techniques along with increased adoption of integrated weed management methods had encouraged many farmers to switch from transplanted rice to DSR culture. This technology was highly mechanized in some developed nations like U.S, Europe and Australia. This shift should substantially reduce crop water requirements and emission of greenhouse gases. The reduced emission of these gases helped in climate change adaptation and mitigation, enhanced nutrient relations, organic matter turnovers, carbon

[1] Adaptive Research Farm, Gujranwala 2Directorate of Agriculture (Farm Training and Adaptive Research) Gujranwala
*Email: tahirr_uaf@hotmail.com

sequestration and also provided the opportunity of crop intensification. However weed and nematode infestation were major problems which caused higher yield losses in DSR. Other associated problems with DSR were increased incidences of blast disease, crop lodging impaired kernel quality, increased panicle sterility and stagnant yields across the years (Ekta et al. 2013). In Asia dry seeding was extensively practiced in rainfed lowlands, uplands, and flood-prone areas, while wet seeding in irrigated areas (Azmi et al. 2005). At present 23% of rice is direct seeded globally (Rao et al. 2007). Direct seeding helped to reduce water consumption by about 30% as it saved from transplanting nursery, puddling and maintaining 4-5 inches of water continuously. The farmer saves about Rs. 1400 per acre in cultivation cost even than to date no specific varieties have been developed for this purpose.

As nursery transplantation method is mostly adopted by the farmers and required plant population cannot be attained due to scarcity of skilled labor (Baloch et al. 2000). Mechanical transplanting has been tried out with no success in the past. To overcome this problem direct seeding of rice seems only the alternative technique of rice cultivation. Also direct seeded crop flowers earlier leading to reduction in crop duration by one week (Santhi et al. 1998).

Based on the reviewed research papers, potential advantages of DSR and problems of shortage of labor this field survey study was conducted to identify the problems in adaptability of direct seeded rice (DSR) as well as to make economic comparison between transplanted rice and direct seeded rice methods.

MATERIALS AND METHODS

The survey study was conducted in Adaptive Research zone Gujranwala, Pakistan during kharif 2015. Among the six districts of the zone three districts namely Gujranwala, Sialkot and Hafizabad were purposively included in sampling frame due to more area of rice crop (GOP 2015). The detail is given in Table 1.

To select the farmers from these three districts, convenience sampling method was adopted due to time and cost constraint. Therefore twenty farmers from each district making a total of sixty respondent farmers were interviewed. Among all rice varieties Super basmati variety was better and viable option for DSR because of better pest resistance, high tillering, more yield and good cooking quality (Awan et al. 2016). Hence it was decided to make a comparative analysis between DSR and TPR for super basmati variety. Moreover the problems in adoption of DSR technology were also sorted out in the study. A well-structured and pretested questionnaire was employed for data collection which included the detailed information regarding production methods and constraints in adoptability of direct seeded rice. The procedure adopted by Naeem et al. (2007) and Muhammad et al. (2016) was used for estimating the economic cost of production, gross revenue, net returns and benefit cost ratio.

RESULTS AND DISCUSSION

On overall basis DSR practice was adopted on 204 acres out of 965 acres of cultivated rice equivalent to 21.1% of surveyed rice area. Respondent farmers were using a varied seed rate (17-44 kg ha^{-1}) with a mean of 30 kg ha^{-1} and were seeding rice through seven different methods i.e. broadcasted soaked seed in moisture soil condition (38%), broadcasting of dry seed in dry soil and applying irrigation afterwards (29%), broadcasting of dry seed in *wattar*condition (15%), broadcasting soaked seed in dry soil followed with immediate irrigation (9%), broadcasting sprouted seed in *wattar*condition (3%), drilling of dry seed in *wattar* condition (4%) and drilling of soaked seed in *wattar* condition (2%).

On an average the duration of DSR and TPR crop were recorded as 122 and 130 days (including nursery period) respectively; thus DSR might had the comparative advantage over TPR by saving of one week time duration.

Problems in adoptability of DSR practice

Major problems raised by the farmers regarding DSR were more weed infestation, more disease/pest attack, less yield, more fertilizer requirement and more lodging. The detail is given below.

i. Less yield

The grain yield was the key concern of farmers and they made every attempt to raise their average grain yield. The average grain yield of rice crop obtained in transplantation method (3.95 t ha^{-1}) was 11% higher than DSR method (3.56 t ha^{-1}) with significant difference. The reasons of this increase in grain yield of transplanted rice were that the farmers were well experienced with transplanting practice, puddled soil condition favored rice growth and the prevailing varieties had been developed under transplanting method. These results are in accordance with Hussain et al. (2005)

Table 1. District wise rice area in Adaptive Research zone, Gujranwala, Pakistan (2015-16)

District	Gujranwala	Hafizabad	Sialkot	Narowal	M.B.Din	Gujarat	Total
Area ('000'acre)	556	330	325	164	161	88	1624
% share of rice area	34.24	20.32	20.01	10.10	9.91	5.42	100.00

who reported that higher paddy yield was obtained in line transplanting crop as compared to DSR. Similar findings were reported by Bouman and Toung (2004) who reported that most water saving technique in rice crop resulted in loss of yield.

The yield in DSR is correlated with precision land leveling. In Philippines, an estimated average yield loss of 0.9 t ha^{-1} due to deficient land leveling was observed (Lantican et al. 1999). In DSR technique, water productivity was increased by 18.78% under laser leveled fields but the yield under DSR was less (2.96%) compared to TPR (Jat et al. 2006).

ii. More weeds intensification

Majority (84%) of the farmers practicing DSR reported the issue of *Panicumantidotale* (Bansi grass), *Paspalumdistichum* (Naru grass) or *Dactylocteniumaegyptium* (Madhana grass), *Cynodondactylon* (khabbal grass) or *Cyprus rotundus* (Deela) which were not properly controllable by any herbicide. Moreover 29% farmers in the present study area broadcasted dry seed in dry soil field and applied irrigation afterwards which might be one of the reasons for more weeds population. According to Rao et al. (2007) and Tomita et al. (2003) high weed infestation was the major bottleneck in DSR especially in dry field conditions whereas most of the weeds in TPR were controlled by flooding, unlike in DSR. More than 50 weed species infesting direct seeded rice caused major losses to rice production worldwide. When farmers shift from TPR to DSR the weed flora changed dramatically due to habitat change.

The cost of herbicide application was more in case of direct seeded rice because in transplanted rice due to continuous flooding a large flora of weeds remains suppressed. It also facilitated the efficacy of applied weedicides. Where as in case of DSR the weeds population were more which resulted in lower yield. Similar results were reported by Hussain et al. (2008) that weeds posed a serious threat to direct seeded rice crop by competing for nutrients, light, space and moisture thorough out the growing season.

iii. More diseases/pest attack

In case of direct seeded rice crop the attack of Brown Leaf Spot (BLS), Bacterial Leaf Blight (BLB), Rice Stem borer (RSB) and Leaf Folder (RLF) were 15%, 23.16%, 18.26% and 13.26% respectively while for transplanting rice crop these were 3.22%, 12.24%, 6.31% and 7.52% respectively. Due to increase in attack of BLS (366%), BLB (85%), RSB (189%) and RLF (76%) the quality of grain was affected and yield remained low in DSR. However the application of granular insecticides was only effective under standing water conditions. The short description is given in Table 2 and Figure 1.

Table 2.Disease/Insect pest attack on TRP and DSR methods

Disease/Insect pest attack	TRP	DSR	Increase over TRP (%)
BLS	3.22	15	365.84
BLB	12.54	23.16	84.69
RSB	6.31	18.26	189.38
RLF	7.52	13.26	76.33

Rice crop was susceptible to various diseases. Among those rice blast was one of the most devastating for both cultivation methods (Bonman and Leung 2004; Farooq et al. 2011). The severity of rice blast increases under water limited conditions (Bonman 1992). Water deficit and shift from transplanting to direct seeding, favored neck blast spread. Savary et al. (2005) also reported increased attack of BLS disease in DSR compared with TPR.

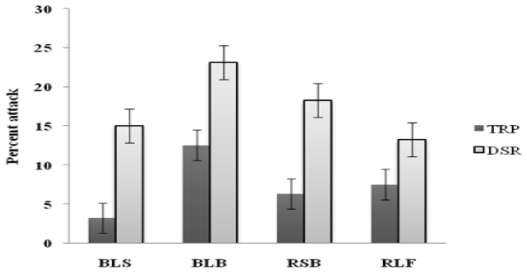

Figure 1. Comparison Disease/Insect pest attack between TRP and DSR methods

iv. More fertilizer requirement

According to survey findings 69% farmers reported that the DSR required more (47.49%) fertilizer than TPR. From Table 3 it is clear that the more use of urea (18%), DAP (57%), SSP (55%) and SOP (78%) was estimated in DSR. In

Table 3. Fertilizer applied in DSR and TPR (bag ha^{-1})

	Transplanted rice		Direct seeded rice		
Detail	Mean	Std. Dev.	Mean	Std. Dev.	Percent increase over TPR
Urea	2.04	1.28	2.49	0.67	18.07
DAP	0.2	0.61	0.46	0.52	56.52
SSP	0.09	0.66	0.2	0.46	55.00
SOP	0.04	0.23	0.18	0.39	77.78
Average fertilizer difference					51.84

Table 4. Reasons for less adaptability of DSR

Reasons	Response (% of farmers)
More weeds population	93
More disease/pest attack	85
Less Yield	83
More fertilizer expenditure	69
More lodging	62
More Laborious activity	42
More water requirement	37

continuously flooded rice the process of puddling limited the percolation losses in field and maintained a saturated soil profile and growth of many weeds (Sahid and Hossain 1995).

Table 5. Cost of production of DSR and transplanted rice crop (Rs.ha^{-1})

Detail of cost components	DSR	TPR	% difference
Land preparation	9475	11350	19.79
Nursery and transplanting/seed and sowing	4050	9550	135.80
Irrigation	32500	44500	36.92
Fertilizer	15660	13200	-15.71
Farm yard manure	2555	2130	-16.63
Micronutrients (zinc, boron etc.)	2210	2000	-9.50
Plant protection measures (weeds, insect pests and disease control)	8120	6750	-16.87
Total input cost	74570	89480	19.99
Mark up on investment for six months @ 9.5% excluding water rates	2600	3300	26.92
Harvesting & threshing	8000	7880	-1.50
Land rent for six months	49400	49400	0.00
Management charges for six months @ Rs.14000 per 100 acres	2076	2076	0.00
Total economic cost of production	136646	152136	11.34

Land preparation and water management were the principal factors causing the nutrient dynamics in both systems i.e. DSR and TPR. Mostly in DSR, land is prepared dry and soil remained aerobic throughout the season, nutrient dynamics are altogether different than that of the TPR, where land is prepared in standing water and soil is kept flooded during most of the season due to which soil fertility is increased due to rottening of organic matter.

v. More crop lodging

The mean crop lodging in DSR was recorded as 22.88% while for transplanting rice it was 11.58%. Lodging is defined as "the permanent vertical displacement of the stem of a free-standing crop plant" (Berry et al. 2004). It had been observed more often in DSR than in TPR during recent years (Farooq et al. 2011). In addition, mechanical harvesting of lodged crop was a challenge.

Table 6. Summary of economic parameters

Description	DSR	TPR
Yield (mound ha^{-1})	88.92	98.8
Price per mound (Rs)	1700	1700
Income (Rs ha^{-1})	151164	167960
Total economic cost of production (Rs ha^{-1})	136646	152136
Net income (Rs ha^{-1})	14518	15824
Benefit cost ratio	1.11	1.10

Among the interviewed farmers practicing DSR; 33% of the farmers had planned to continue DSR due to less labour required for sowing, no puddling, less irrigation expenses and higher yield of wheat just after DSR crop while 67% of the farmers were not willing to continue this method due to the reasons which have been described in Table 4.

Economic analysis

Total cost of production for transplanting rice was Rs. 152136 ha^{-1} which was 11.34% higher than DSR. The reasons of this increased cost were more expenses on land preparation (19.79%), labor charges for nursery management and transplanting (135.80%), and irrigation expense for continuous flooding (36.92%). Rice is a hydrophytes crop and it flourishes well under anaerobic conditions. So it needs a lot of water for its better growth. According to farmers point of view the high cost of irrigation was just due to puddling and continuous flooding. Similar results were reported by Bouman et al. (2001). They stated that shortage of labor and high water requirement increase cost of production of rice crop. The detail is given in Table 5 and 6. The economic cost of production and net income were respectively 11.3% and 9% higher for transplanted rice than DSR. However Benefit cost ratio difference was found non-significant between both sowing methods.

CONCLUSION

DSR practice was adopted on 21.1% of the rice area on surveyed farms of Gujranwala agro-climatic zone. Direct seeded rice inspite of time and labor saving technique could not be adapted at large scale due to more weed infestation, more disease/pest attack, less yield, more fertilizer requirement and more lodging factor. Additional grain yield (11%) was estimated for traditional transplanted crop than DSR. However Benefit cost ratio difference was found non-significant between both sowing methods. Therefore it was concluded that both sowing methods might be alternative to each other keeping in view the availability of labor, water and soil type.

Moreover, enhanced role of extension department in disseminating the standardized DSR production technology can play a vital role as farmers are eager to adapt new technologies for rice production in the context of high cost of production particularly that of land preparation, irrigation and labor cost incurred on conventionally transplanted rice.

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