Farmer’s Field Evaluation of Direct Seeded Rice vis-à-vis Puddled Transplanted Rice in Kapurthala, Punjab

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ABSTRACT
The direct seeded rice (DSR) has emerged as an economically viable and sustainable option for timely rice establishment due to labor shortage amid Covid-19 pandemics. The crop production practices differ greatly among puddled transplanted rice (PTR) and DSR. Therefore, we compared the performance of different rice varieties viz. PR-121, PR-126 and Pusa-44 under two contrasting establishment methods (PTR vs. DSR). The study highlights that of the total area under rice, the highest area under DSR was in Sultanpur Lodhi block (about 68.2%), while the lowest area in Dhilwan block (about 41.9%). Results revealed higher benefit-cost ratio of rice establishment under DSR technology, compared with the PTR technology, regardless of the rice variety due to reduced (about 23.9%) cost of cultivation associated with rice establishment under DSR technology. About 68.9 per cent of the respondents perceived PTR as low cost effective, while about 4.7 per cent perceived PTR as highly cost effective. Conversely, about 16.0 per cent of respondents perceived DSR as low cost effective, while a large proportion (about 55.7%) perceived DSR as highly cost effective. About 14.1, 76.4 and 10.4 per cent of PTR farmers, while about 10.4, 69.8 and 14.1 per cent of DSR farmers perceived it as low, medium and highly profitable.

INTRODUCTION
Rice (Oryza Sativa) is an important cereal crop cultivated on about 13.5 million ha (Mha) in South Asia (Bhatt et al., 2021). It has been highly resources-, labor- and energy-intensive crop established after wheat (Triticum aestivum L.) in rice-wheat cropping system (Singh et al., 2019; Dhillon & Vatta, 2020). During the last few decades, rice productivity has either diminished or stagnant in the region (Bhatt and Kukal, 2015; Singh et al., 2021) with rapid decline in underground water in north-western India (Bhatt et al., 2021), large production of rice residue and its open field burning (Gupta et al., 2020), besides large emission of greenhouse gases (GHGs) (Singh et al., 2020; Singh et al., 2021) and deterioration of soil health (Bhatt et al., 2021). Recently, amid Covid-19 pandemics, rice growers have faced another problem of severe human labor shortage (Chaba & Damodara, 2020; Singh et al., 2020), due to imposed restrictions for the migratory labor from the adjoining states (Mukhra et al., 2020; Bhatt & Singh, 2021). The pandemics have changed the rice establishment method from traditionally puddled transplanted rice (PTR) to direct seeded rice (DSR) in entire north-western India (Singh et al., 2005; Bhatt & Singh, 2021). Under these water and labor shortage situations, farmers searched for some suitable alternative, of which un-puddled DSR emerged as economically viable option (Pandey & Velasco 2005; Kumar & Ladha, 2011; Bhardwaj & Sidana, 2019). The DSR has advantage of timely rice establishment and efficient weed management in a single tractor operation. Additionally, the DSR has co-benefits of avoiding puddling (a wet tillage), transplanting and maintaining standing water for initial two weeks after seedling transplanting (Gill & Bhullar, 2021). During kharif-2020, the majority of the farmers...
adopted DSR for the first time, and therefore, adopted diverse crop production and management practices which are entirely different from those adopted under PTR fields. The yield performance of DSR depends largely on effective weed management, efficient nutrient management, and ensured poor germination and optimum plant population besides several and other factors (Gautam et al., 2021; Reddy et al., 2018; Dhillon & Mangat, 2018). The present study was therefore, conducted to compare the performance of different crop production and management practice adopted by the rice growers in two different rice establishment methods viz. DSR vs. PTR in different administrative blocks of Kapurthala district of Punjab (north-western India).

METHODOLOGY

The present study was conducted in the Kapurthala district of Punjab during March-2021. Kapurthala district has 5 administrative blocks viz. Sultanpur Lodhi, Kapurthala, Phagwara, Dhilwan and Nadala. The data on total rice area under DSR, varieties established, weed management, crop grain yield were recorded from the respondent farmers in semi-structured questionnaire through face-to-face interviews. In the present study initially there were 106 respondents, of which about 13.2 per cent study sites were ploughed by the farmers due to partial to complete crop failure. Therefore, the present study analyzed data on only 92 respondents, who by the adoption of diverse management practices harvested their crops at maturity. The list of the DSR farmers was obtained from the state Department of Agriculture and Farmers’ Welfare, Punjab are the respondents were randomized selected from different villages representative of each administrative block. The data on total area under DSR and PTR method of rice establishment were recorded from each selected respondent. The information on rice variety established and weed management measures followed for pre-and post-emergence control measures was recorded. All data were compared among DSR and PTR and the yield difference from crop yield potential, district average, state average and national average were estimated. The economic analysis of DSR and PTR technology was done based on average cost of cultivation, average gross returns, average net returns, benefit-cost ratio etc. The average gross returns were calculated as a product of rice grain yield and the minimum support price decided by the Government of India (GOI) for 2021. The average net returns were calculated by subtracting the average cost of cultivation from average gross returns. The benefit-cost ratio was calculated as a ratio of average gross returns and average cost of cultivation.

Average gross returns (Rs. ha⁻¹) = Rice grain yield (Mg ha⁻¹) x MSP (Rs. Mg⁻¹)
Average net returns (Rs. ha⁻¹) = Average gross returns (Rs. ha⁻¹) - Average cost of cultivation (Rs. ha⁻¹)
Benefit - cost ratio = \frac{Average \ gross \ returns \ (Rs. \ ha^{-1})}{Average \ cost \ of \ cultivation \ (Rs. \ ha^{-1})}

Farmer’s perception on DSR and PTR method of rice establishment was evaluated based on problem solving, understandability, practicability, cost effectiveness, profitability, sustainability, compatibility, accessibility, acceptability and on preference scale.

RESULTS AND DISCUSSION

Area, varieties and weed management under DSR vis-à-vis PTR

These results revealed that of the total area under rice, about 54.2 per cent area was under DSR, while about 45.8 per cent area was under PTR (Table 1). Among different blocks, the highest area under DSR was in Sultanpur Lodhi (about 68.2%), and the lowest in Dhilwan (about 41.9%). In other blocks, the per cent area under DSR technology was about 56.5 per cent in Kapurthala, about 43.5 per cent in Phagwara and about 60.9 per cent in Nadal. About 82.3 per cent of total area was laser leveled by the farmers before rice establishment under DSR technology. The laser leveled area was lowest in Phagwara (about 64.9%) and the highest (about 94.8%) in Sultanpur Lodhi block. These results revealed that PR-121 was the most preferred variety in the study region, covering about 80 per cent of total rice area. The highest DSR area under PR-121 was in Sultanpur Lodhi (about 91%), and the lowest (about 70%) in Phagwara block, while about 85 per cent in Kapurthala and Nadala, about 86 per cent in Nadal blocks. Average across the blocks, PR-126 covers about 9 per cent, while Pusa-44 covers about 11 per cent of total rice area in Kapurthala district. The dominance of PR-121 variety over PR-126 and Pusa-44 has been ascribed to its better performance in the region (Bharaj et al., 2014). The study highlights that of the total area under rice, the highest area under DSR was in Sultanpur Lodhi block (about 68.2% of total rice area), which could be ascribed to heavy textured soils, higher water table and the highest area under laser leveled technology (Table 1). On the other hand, the lowest area under DSR technology was in Dhilwan block (about 41.9% of total rice area) which was ascribed to light textured soils particularly near Beas river (Rafie & Kumar).

Table 1. Area and rice varieties under direct seeded rice (DSR) in Kapurthala district of Punjab, India

<table>
<thead>
<tr>
<th>Administrative blocks</th>
<th>Sultanpur Lodhi (n=22)</th>
<th>Kapurthala (n=23)</th>
<th>Phagwara (n=20)</th>
<th>Nadal (n=21)</th>
<th>Dhiwan (n=20)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of total rice area under DSR</td>
<td>68.2</td>
<td>56.5</td>
<td>43.5</td>
<td>60.9</td>
<td>41.9</td>
<td>54.2</td>
</tr>
<tr>
<td>% of total land area laser leveled before DSR</td>
<td>94.8</td>
<td>74.1</td>
<td>64.9</td>
<td>89.7</td>
<td>84.8</td>
<td>82.3</td>
</tr>
<tr>
<td>Number of DSR farmers and sown cultivars</td>
<td>20 (91)†</td>
<td>17 (85)</td>
<td>13 (70)</td>
<td>18 (85)</td>
<td>17 (86)</td>
<td>85 (80)</td>
</tr>
<tr>
<td>PR-121</td>
<td>–</td>
<td>03 (10)</td>
<td>04 (17)</td>
<td>02 (10)</td>
<td>02 (10)</td>
<td>09 (09)</td>
</tr>
<tr>
<td>PR-126</td>
<td>–</td>
<td>02 (09)</td>
<td>03 (5)</td>
<td>03 (13)</td>
<td>01 (5)</td>
<td>01 (4)</td>
</tr>
<tr>
<td>Pusa-44</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>12 (11)</td>
</tr>
</tbody>
</table>

†Figures in parenthesis represent values in percent of farmers in a particular block.
Weed management practices and moisture regime for direct seeded rice (DSR) establishment in Kapurthala district

<table>
<thead>
<tr>
<th>Blocks</th>
<th>Weed management method (% of total respondents)</th>
<th>Moisture regime for DSR establishment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PTR Post-emergence</td>
<td>DSR Chemical</td>
</tr>
<tr>
<td></td>
<td>Manual</td>
<td>Pre-emergence</td>
</tr>
<tr>
<td>Sultanpur Lodhi</td>
<td>100</td>
<td>3.4</td>
</tr>
<tr>
<td>Kapurthala</td>
<td>100</td>
<td>4.3</td>
</tr>
<tr>
<td>Phagwara</td>
<td>100</td>
<td>4.7</td>
</tr>
<tr>
<td>Nadala</td>
<td>100</td>
<td>5.0</td>
</tr>
<tr>
<td>Dhillwan</td>
<td>100</td>
<td>4.5</td>
</tr>
<tr>
<td>Mean</td>
<td>100</td>
<td>4.4</td>
</tr>
</tbody>
</table>
rice varieties under PTR, while Rs. 31.8 x 10^3 ha^{-1} under DSR depicting saving of Rs. 7,600 ha^{-1}. The higher cost of cultivation for PTR technology was ascribed to expenditure on nursery establishment, diesel cost for wet-tillage (puddling) and seedling transplanting cost (Chauhan et al., 2012; Bhatt et al., 2021). The average gross returns were Rs. 140.1, 136.9 and 143.4 x 10^3 ha^{-1} for PR-121, PR-126 and Pusa-44, respectively under PTR technology. However, under DSR technology, average gross returns were Rs. 125.7, 122.2 and 126.1 x 10^3 ha^{-1}, respectively. These results revealed higher benefit-cost ratio of rice establishment under DSR technology, compared with the PTR technology, regardless of the rice variety. It could be ascribed to reduced (about 23.9%) cost of cultivation associated with rice establishment under DSR technology than the PTR technology. Lower required labor and unpuddled conditions were main factors for better economic profitability of DSR (Singh et al., 2005; Dhakal et al., 2015).

**CONCLUSION**

As compared to the PTR that suffered from higher labor, water and energy issues, DSR proved to be more profitable and environment friendly rice establishing option in the region. In spite of reported lower yields in all the studied blocks of the district due to higher weed pressure DSR reported with higher profits in all preferred rice cultivars due to required lower labor requirements and cost of field preparation than PTR. Hence, the present study concludes that DSR must be preferred in the water and labor scarce region over the PTR due to its lesser costs of cultivation and drudgery.
REFERENCES


