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# Resource Use Efficiency and Constraints in the Production of Direct Seeded Rice in Haryana, India

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The present study was conducted during 2022-23 in three districts namely, Kurukshetra, Karnal and Yamunanagar in Haryana with the objective to analyse the resource use efficiency and constraints in the production of direct seeded rice (DSR). To achieve the objective of the study Cob-Douglas production function technique was used. The result of the study revealed that inputs like machine labour and irrigation in direct seeded basmati paddy and seed, human labour and irrigation in direct seeded non-basmati paddy were greater than one indicating underuse of these resources. The seed, chemical fertilizers and human labour in direct seeded basmati paddy while chemical fertilizers and machine labour in direct seeded non-basmati paddy were less than one which indicated the overuse of these inputs. As DSR technology is a water, labour and energy saving practice, it needs to be popularized among the farmers by offering viable solutions the problems faced by the rice growers. Weed infestation and management, iron deficiency, non-availability of DSR drill and difficulty in land preparation were the major problems faced by the farmers in the production of DSRs which warrant appropriate remedial solutions.

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## 1. INTRODUCTION

"In recent years, there has been a shift from TPR to DSR cultivation in several countries of Southeast Asia. This shift was principally driven by water scarcity issues and expensive labour component for transplanting under acute farm labour shortage. Direct-seeding of rice has the potential to provide several benefits to farmers and the environment over conventional practices of puddling and transplanting. Direct seeding helps reduce water consumption by about 30.00 per cent as it eliminates raising of seedlings in a nursery, puddling, transplanting under puddled soil and maintaining 4-5 inches of water at the base of the transplanted seedlings. Direct seeding (both wet and dry), on the other hand, avoids nursery raising, seedling uprooting, puddling and transplanting and thus reduces the labour requirement" [1]. "In addition to labour savings, the demand for labour is spread out over a longer period in DSR than in transplanted rice" [2]. The crucial task of transplanting needs heavy labor in conventional tillage (CT-TPR), which frequently leads to a labor shortage. Therefore, DSR aids in maximizing the use of family labor and reducing reliance on hired labor. DSR is established earlier than TPR without growth delays due to the avoidance of transplant injury, which also accelerates physiological maturity and lessens vulnerability to late-season dryness.

"In India rice is being cultivated in wide range of ecosystems from irrigated, shallow lowlands to mid-deep lowlands and deep water to uplands and transplanting is the chief method of rice cultivation. In India rice is commonly grown by transplanting seedlings in the puddled soils, the puddling and transplanting require great amount of water and labour, both of which are becoming progressively scarce and expensive, resulting in reduction of profit in rice production. The most important challenges are to guarantee a sufficient rice supply in response to the growing and urbanizing population as well as to alleviate poverty. For every one billion people added to the world's population, 100 mt of more rice need to be produced annually with less land, less water and less labour, in more efficient environmentally friendly production systems. However, farmers who are practicing transplanting method are facing difficulty due to scarcity of water and increasing labour wages, which established the situation of scarce resources and reduced profits" [3]. Thus, "Direct Seeded Rice is gaining popularity among farmers of India as in other Asian countries. The most promising option for the future is to adopt direct sowing of rice in place of transplanting; DSR overcomes the problem of seasonality in labour requirement for rice nursery raising and transplanting operations. Non-development of ground water in *kharif*, late onset of monsoon and drudgery of operations often delays rice transplanting which leads to late vacation of fields, risk of cracking of soil under limited water supply, forcing farmers to plant wheat after the optimum sowing time. DSR is a plough towards a new set of principles based on minimal soil disturbance, management of crop residues and innovative cropping systems is the good option of farming under rice-wheat cropping system" [3].

It is clear from previous experiences that the DSR approach is linked to high rates of weed infestation. If the crop is well established and there are sufficient weed control techniques available to keep the crop weed-free, direct sowing of rice is feasible. As a result, an attempt has been made in this inquiry to address a variety of concerns, the advantages of DSR over TPR, and how labor, land, capital, water, and time may be used most effectively using the DSR technique of rice cultivation.

## 2. METHODOLOGY

Haryana state was selected for this study as farmers are rapidly adopting modern methods of crop cultivation. Karnal, Kurukshetra and Yamunanagar districts were selected purposively due to widespread adoption of modern methods of crop production. The list of farmers who had adopted DSR technology was obtained from KVKs and state Department of Agriculture and Farmers' Welfare, Haryana. From these lists, using simple random technique, 30 farmers were selected who were growing direct seeded rice (DSR). Among 30 DSR farmers 11 farmers were growing basmati DSR and 19 farmers were growing non-basmati DSR were finally chosen for the ultimate analysis. Primary data were collected during the years 2022-23 with the help of interview schedule using survey method. For the study's purposes, the data gathered from the farmers was quantified, categorized, and collated. The information gathered from farmers was analyzed statistically in order to meet the study's goals. The following statistical tools were

employed for this aim to investigate the pertinent inferences: tabular analysis, production function, and MVP to MFC ratio.

## 2.1 Analysis of Resource Use Efficiency

The resource use efficiency was studied by fitting the Cob-Douglas production function for the farm level data. The analysis was carried out based on the average values of all the farms. In the present study, the Cobb-Douglas production function of the following type was used for analysis.

$$Y = a\ X_1\ b_1.\ X_2\ b_2.\ X_3\ b_3.\ X_4\ b_4.\ X_5\ b_5.\ eu$$

The logarithm form of the above equation is:

$$\log Y = \log a + b_1 \log x_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + u \log e$$

Where,

Y = Gross returns per farm (Rs. /ha.)
$X_1$ = Seed (Rs./ha.)
$X_2$ = Chemical fertilizers (Rs. /ha.)
$X_3$ = Human labour (Rs. /ha.)
$X_4$ = Machine labour (Rs. /ha.)
$X_5$ = Irrigation (Rs. /ha.)
a = Constant / intercept term
eu = Random error

In the above equation, output is taken as Y. while, $b_1$ to $b_5$ are the elasticity coefficients of the respective inputs. The coefficient of multiple determinations ($R^2$) was worked out to test the goodness of fit of the model. Production function analysis was carried out for DSR method of paddy cultivation.

## 2.2 Allocative Efficiency

The ratios of the MVP to MFC among individual resources were used to judge the allocative efficiencies. The computed Marginal Value Product (MVP) was compared with the Marginal Factor Cost (MFC) or opportunity cost of the resource to draw inferences. A resource is said to be optimally allocated when it's MVP = MFC.

The marginal value products (MVP's) were calculated using the geometric mean levels of the variables using the formula.

MVP of $x_i^{th}$ resource = $bi\frac{\bar{Y}}{\bar{X}i}$

Where,

Y = Geometric mean of gross returns in different farming systems.
$X_i$ = Geometric mean of $i^{th}$ independent variable
$b_i$ = Regression coefficient or elasticity of production $i^{th}$ independent variable This analysis was carried out in order to identify the possibilities of increasing gross returns under a given farm situation.

# 3. RESULTS AND DISCUSSION

## 3.1 Resource use Efficiency in Basmati DSR and Non-Basmati DSR

The value of the coefficient of multiple determination, R square ($R^2$ estimated 0.4682 and 0.4624) indicated that 46.82 and 46.24 percent of variation in the total gross income of basmati DSR and non-basmati DSR, respectively was explained by explanatory variables included in the model. Out of five independent variables included in the model, three variables in basmati and one variable in non-basmati under DSR had statistically significant effect on the income attained from rice cultivation. The variables like seed and machine labour (10% level of significance) and chemical fertilizers (5% level of significance) in basmati DSR and chemical fertilizers (10% level of significance) in non-basmati DSR were reported.

The estimated marginal value product (MVP) and efficiency ratios of different inputs used in rice production were presented in Table 1. The efficiency ratio of the inputs: machine labour (1.32) and irrigation (1.02) in basmati DSR and seed (1.34), human labour (1.24) and irrigation (1.11) in non-basmati DSR were greater than one indicating that the uses of these inputs were underuse. While, seed (0.44), chemical fertilizers (0.74) and human labour (0.61) in basmati DSR and chemical fertilizers (0.66) and machine labour (0.39) in non-basmati DSR were less than one indicated over utilization of these resources and the findings are supported by the study conducted by Deshetty et al. [3].

## 3.2 Constraints Impending in the Cultivation of DSR

Constraints impended by DSR farmers are presented in Table 2. Weeds are the major problem in DSR. Weeds compete with crop for food shelter and nutrients and affect the growth and yield of crop plants Rao et al. [4]; Karingua et al. [5]. The DSR farmers reported that high

weed infestation (93.33%) was one of the most serious constraints in DSR as they emerge simultaneously with paddy crop due to absence of puddling operation Bhurer et al. [6]. DSR field requires laser land levelling each year before sowing, otherwise, water standing problem occurs in the field. Laser land levelling provides good and uniform crop stand that leads to improved weed control efficiency and nutrient use efficiency Jat et al. [7]. Requirement of laser land levelling each year (90.00%) was the second major constraint in DSR followed by off-type plants or variety mixture problem also arose in the field of direct seeded rice. Out of total respondents, 86.67 per cent of respondents reported the problem related to variety mixture. DSR farmers also reported the problem of high cost of weed control (83.33%). Direct seeding of rice is practised with specific machinery known as DSR drill. But this drill was available only in the cooperative societies (one or two drills/society) in villages. Some rich farmers also had their own DSR drill. Farmers had to wait for their turn for sowing with DSR drill. So this was a major problem arising in DSR. The study reported that 73.33 per cent of the respondents faced the problem of non-availability of seed drill. Yield is the main criteria for the success of any crop. Some farmers believed that direct seeding of rice gave low yield due to more weed competition than the transplanting method, 66.66 per cent farmer reported problem of low productivity. Iron deficiency is the major deficiency that appears in the direct seeded rice field. Due to this deficiency, chlorosis among the young seedlings appears after three weeks of sowing and after some time whole plant will die Joshi et al. [8]. Insects are the major problem of any crop. Sometimes, whole crop is affected by insects and yield is reduced drastically.

**Table 1. Estimation of resource use efficiency of inputs used in direct seeded paddy cultivation**

| Particulars | Basmati-DSR | | | | | |
|---|---|---|---|---|---|---|
| | **GM** | **Coefficients** | **MVP** | **MFC** | **R= efficiency ratio** | **Efficiency** |
| Seed | 1789 | 0.23* | 0.44 | 1 | 0.44 | Over utilized |
| Chemical fertilizers | 22504 | 0.52** | 0.74 | 1 | 0.74 | Over utilized |
| Human labour | 17614 | 0.42 | 0.61 | 1 | 0.61 | Over utilized |
| Machine labour | 7413 | 0.82* | 1.32 | 1 | 1.32 | Under utilized |
| irrigation | 5984 | 0.62 | 1.02 | 1 | 1.02 | Under utilized |
| $R^2$ | 0.4682 | | | | | |
| Particulars | **Non-basmati-DSR** | | | | | |
| Seed | 1110 | 0.64 | 1.34 | 1 | 1.34 | Under utilized |
| Chemical fertilizers | 21592 | 0.45* | 0.66 | 1 | 0.66 | Over utilized |
| Human labour | 3741 | 0.70 | 1.24 | 1 | 1.24 | Under utilized |
| Machine labour | 12285 | 0.25 | 0.39 | 1 | 0.39 | Over utilized |
| irrigation | 6049 | 0.66 | 1.11 | 1 | 1.11 | Under utilized |
| $R^2$ | 0.4624 | | | | | |

*** Significant at 5% level; * Significant at 10% level*

**Table 2. Constraints impending the cultivation of DSR in Haryana**

**N=30**

| **S. No.** | **Particulars** | **No. of farmers** | **%** |
|---|---|---|---|
| 1 | High weed infestation | 28 | 93.33 |
| 2 | Requirement of laser land levelling each year before sowing to avoid water standing problem | 27 | 90.00 |
| 3 | Off-type plants or Variety mixture | 26 | 86.67 |
| 4 | High cost for weed control (manual weeding and herbicide spray) | 25 | 83.33 |
| 5 | Less availability of DSR drills machine for marginal and small farmers | 22 | 73.33 |
| 6 | Low yield in DSR or reduction in yield | 20 | 66.66 |
| 7 | High infestation of insect-pest and diseases | 12 | 40.00 |
| 8 | Deficiency of micro nutrients (Iron), which leads to chlorosis in young seedlings | 11 | 36.67 |
| 9 | Non-availability of short duration varieties (deleted) | 09 | 30.00 |

More than 50.00 per cent of rice growers are reported to face insect-pest problem in puddle that as well as non-puddle rice Diagne et al. [9]. In the present study, 40.00 per cent of respondents reported that high infestation of insect-pest and diseases was the major problem of DSR. Study revealed that deficiency of micro-nutrients (iron) (36.37%) of the respondents faced the problem of iron deficiency in direct seeded rice. The problem of non-availability of short duration varieties (30.00%) was reported by DSR farmers [10].

## 4. CONCLUSION

The study concluded that the efficiency ratio of the inputs like machine labour and irrigation in direct seeded basmati paddy whereas seed, human labour and irrigation in direct seeded non-basmati paddy were greater than one indicating underuse of these resources. The seed, chemical fertilizers and human labour in direct seeded basmati paddy while chemical fertilizers and machine labour in direct seeded non-basmati paddy were less than one which indicated the overuse of these inputs. As DSR technology is a water, labour and energy saving practice, it needs to be popularized among the farmers by offering viable solutions for problems faced by the rice growers. Weed infestation and management, iron deficiency, non-availability of DSR drill and difficulty in land preparation were the major problems faced by farmers of DSRs which warrant appropriate remedial solutions. Farmers should be awarded to adopt better weed management practices for achieving potential yield of basmati and non-basmati paddy under direct seeded conditions.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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