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The impact of DSR method on output and income levels of paddy farmers in NEK region of Karnataka: An economics analysis

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Abstract
Rice *(Oryzae sativa L.)* is the world's most important crop and is a staple food for more than half of the world's population. In India, rice is grown in an area of 44.6 million ha with a production of 109.5 million tonnes and average productivity of 2.62 tonnes per ha. In India rice is commonly grown by transplanting seedlings in the puddle soils which is less economically feasible compared to Direct Seeded Rice (DSR). Hence the most promising option for the future is to adopt direct sowing of rice in place of transplanting. Globally 23.00 per cent of rice cultivated is being observed as direct seeded. An effort has been made in this investigation to address various issues and the benefits of DSR over TPR and how best the labour, land, capital, water and time can be utilized with DSR method of rice cultivation. There may be variations in the cost of cultivation even between two different sample areas. This will have an impact on returns also. The study was conducted in TBP and UKP command areas in NEK region of Karnataka. Slightly higher yield in UKP command area was noticed, but total cost was higher in TBP command area and overall there existed higher net returns of Rs. 223.24 per acre for DSR method. The average net gain in DSR method of paddy cultivation for both the command areas pooled together was Rs. 2,145.52 per acre. The family incomes of DSR and TPR farmers have a difference of Rs. 66,436.80 per family which was 12.85 per cent higher among the TPR farmers. It can be concluded that, DSR is an important resource conservation technique; hence the farmers should be motivated through different media to adopt this enterprise.

Keywords: Paddy, DSR method, TPR method, gross returns, net returns, leased in land

Introduction
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 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 sow sesame or leave the land fallow after the optimum sowing time.

Direct seeded rice (DSR) refers to the process of establishing a rice crop directly from seeds sown in the field rather than by transplanting rice (TPR), where seedlings are prepared from the nursery then transplanted to the main field. Globally 23.00 per cent of rice cultivated is being observed as direct seeded (Rao *et al*., 2007) [4]. Labour saving of DSR method is induced by preparation of nursery and TPR, causes the reduction of 11.2 per cent in total production cost. A physiological shock to crop due to uprooting and harmonizing during re-establishment after the transplanting is clearly avoided. DSR method avoids repeated puddling, preventing soil degradation and plow-pan formation, higher economic returns, DSR crops are faster and easier to plant, consume less water by 30 to 40 per cent (Jehangir *et al*., 2005) [1]. Facilitates timely establishment of rice and succeeding crops as crop matures 10-15 days earlier, reduces production cost, and increases yields by 10 per cent, saves energy, labor, fuel, and seed, solves labor scarcity problem and reduces drudgery of labors.

Although, scientific research in agriculture is moving fast and new technologies are being added continuously in order to increase the crop yields, the level of adoption of DSR method has to be enhanced by equipping farmers with body of knowledge surrounding the method as a pre-requisite to adoption process. Therefore, an effort has been made in this investigation to address various issues and the benefits of DSR over TPR and how best the labour, land, capital, water and time can be utilized with DSR method of rice cultivation.

Methodology

The study was conducted in TBP and UKP command areas in NEK region of Karnataka. Wherein, the rice production is the major agriculture production activity and farmers have adopted DSR method of paddy production, as adoption of DSR is slowly increasing in this area due to extension of awareness and knowledge. As paddy production and processing is hugely observed in the TBP and UKP command areas of Karnataka. And for proper comparison of the data, study was carried out with respect to DSR and TPR method of paddy cultivating farmers in TBP and UKP command areas of North-Eastern Karnataka.

Selection of sample respondents for the study were taken from TBP and UKP command areas of North East Karnataka, majorly covering North Eastern Dry Zones viz. Raichur, Yadagir districts and Northern Dry Zones which includes Ballari and Koppal districts of Karnataka. Totally four districts were covered in the study, from each one of the district 60 respondents were selected, among which 30 (25 only own land and 5 own land + leased in) respondents were practicing TPR method while remaining 30 (25 only own land and 5 own land + leased in) respondents were practicing DSR method of paddy cultivation. Total number of DSR and TPR respondents collected from both the command areas was 120 each. Among the selected districts, the data was collected from the major talukas and villages, where the paddy cultivation was extensively carried out. And the total number of respondents selected for the study was 240 in the study area. The information collected from the respondents for the purpose of the study was quantified, categorized and tabulated.

Results and Discussion

There may be variations in the cost of cultivation even between two different sample areas. This will have an impact on returns also. Hence an attempt was made to study the variation in the cost and to identify the causes for such variation. In order to assess the input and output level of DSR and TPR method of paddy cultivation and cost and return structure of paddy cultivation the data borrowed from Table 1 and 2 depicted that, there was a slightly higher yield in UKP command area but total cost was higher in TBP command area and overall there existed a higher net returns of Rs. 223.24 per acre for DSR method paddy cultivation (Table 1). Returns per rupee invested were more for leased in and owned land farmers in UKP command area than that of TBP command area. It can concluded that, the rich farmers of UKP command area possessed good managerial ability and farm machinery may want to lease in land from poor land owners to adjust the operational holdings with their resource endowments.

For TPR method of paddy cultivation in TBP command area have yielded more productivity with less total cost when compared to the UKP command area (Table 2). Further, while analyzing the cost factor TBP command area is placed better than the UKP study area in terms of both variable cost and fixed cost. The reason is due to qualitative cultivable land available in TBP command area compared to UKP command area where only meager area of quality land is available. Total cost incurred by both the own land and leased in farmers was also more in UKP command area than the TBP command area, this is again due to diminishing marginal utility, where the repeated use of land increases the variable cost by putting more chemical fertilizers and PPCs etc.

While data from Table 3 revealed that, the yield of TPR method was more than DSR method by 11.20 per cent, similar results were found by Manohar *et al.* (2017) [2]. There existed a higher total cost of cultivation in TPR method of paddy cultivation by Rs. 8,646.88 per acre than the DSR method. However from the combined analysis of TBP and UKP command area, one may find that the average yield is much higher in TPR method, because of which there happened to be higher gross return of Rs. 7,537.50 per acre. But when compared to net returns, DSR method has earned Rs. 1,109.39 per acre more than the TPR method farmers in both the command areas of North-Eastern Karnataka. Returns per rupee invested for owned farmers were quite higher compared to leased in farmers of both methods. Number of irrigations was more in TPR method of paddy cultivation than the DSR method, which is clear that the irrigation water and number of irrigations were less in DSR method of paddy cultivation by 46.15 per cent. A very small proportion of households own disproportionately very large amount of land while a predominant majority has a very little land and these farmers cultivate paddy for their livelihood security, so efforts should be made to increase the returns per rupee to leased in farmers also.

The additional costs and returns incurred in the paddy farms were analyzed and are presented in Table 4, Table 5 and Table 6. Findings of the partial budgeting clearly indicated that the net gain was higher in farmers practicing DSR over TPR. From the Table 4 and 5 it is evident that, in case of DSR it was profitable due to savings in nursery cost, preparatory tillage, transplanting, seeds cost, fertilizers, FYM, PPC, labour cost and incentives and the similar results were found by Shanwad *et al.* (2015) [5]. While the cost in DSR method towards hand weeding, herbicides cost and application cost of herbicides and machine labour cost for sowing operation accounted for higher cost compared to TPR method in both the command areas. The net gain obtained from substituting DSR method for TPR method of paddy cultivation was found to be profitable by Rs. 349.99 and Rs. 3,937.06 per acre in TBP and UKP command areas, respectively.

Whereas the average net gain in DSR method of paddy cultivation for both the command areas pooled together was Rs. 2,145.52 per acre (Table 6) and the results are in parallel with the study conducted by Younas *et al.* (2016), Mehala *et al.* (2016) and Srigiri *et al.* (2015) [7, 3, 6]. It is concluded from the partial budgeting analysis that the adoption of DSR technique would provide an additional profit to the farmers and thus the hypothesis of higher profitability in DSR method of paddy cultivation was accepted.

Data from Table 7 was used to assess the family income of leased in land sample farmers of DSR method with respect to transplanting farmers and it was concluded that family income of DSR and TPR farmers through crop cultivation was 96.78 and 98.28 per cent, respectively which clearly signifies that the farmers primarily depend on agriculture for their family income while remaining income was from non-agriculture activities. It was also observed that the family income of DSR

and TPR farmers have a difference of Rs. 66,436.80 per family which was 12.85 per cent higher among the TPR farmers.

On the other hand family income of own land DSR and TPR farmers with respect to transplanting farmers was presented in Table 8 and results also signifies that family income per acre of DSR and TPR own land farmers through crop production was 97.52 and 98.59 per cent, respectively. The family income of TPR farmers was higher by Rs. 93,775.61 per family and it accounted for 14.33per cent more than the DSR farmers.

And when income of both the leased in and owned land farmers was pooled together, income of DSR and TPR farmers from agriculture was 97.19 and 98.45 per cent, respectively (Table 9). DSR respondent farmers diversified their sources of income in both the command areas and earned more income than the TPR sample farmers. Even then, there existed a higher income among TPR farmers by Rs. 80,106.20 per family and this was due to the higher operational land holdings among the TPR farmers than that of the DSR sample farmers.

Table 1: Cost and return structure of paddy under DSR method of paddy cultivation in both command areas (acre^{-1})

Sl. No.	Particulars	DSR		Difference (TBP-UKP)	% change in TBP over UKP
		TBP	UKP		
1	Yield (Q)	26.32	26.76	0.44	1.64%
2	Number of irrigations	13.00	15.00	2.00	13.33%
3	Total variable cost (Rs.)	19240.75	19017.51	−223.24	−1.17%
4	Total fixed cost of owned land farmers (Rs.)	3914.08	3914.08	0.00	0.00%
5	Total fixed cost of leased in farmers (Rs.)	13753.68	13753.68	0.00	0.00%
6	Total cost of owned land farmers (Rs.)	23154.83	22931.59	−223.24	−0.97%
7	Total cost of leased in farmers (Rs.)	32994.43	32771.19	−223.24	−0.68%
8	Gross return (Rs.)	59220.00	60210.00	990.00	1.64%
9	Net return for owned land farmers (Rs.)	36065.17	37278.41	223.24	0.97%
10	Net return for leased in farmers (Rs.)	26225.57	27438.81	223.24	0.68%
11	Returns per rupee for owned farmers	2.55	2.62	0.07	2.67%
12	Returns per rupee for leased in farmers	1.79	1.83	0.04	2.30%

Price is (2,250 Rs.) same for paddy produced by DSR and TPR method

Table 2: Cost and return structure of paddy under TPR method of paddy cultivation in both command areas (acre^{-1})

Sl. No.	Particulars	TPR		Difference (TBP-UKP)	% change in TBP over UKP
		TBP	UKP		
1	Yield (Q)	30.33	29.45	−0.88	−2.98%
2	Number of irrigations	25.00	27.00	2.00	7.40%
3	Total variable cost (Rs.)	27557.31	27994.72	437.41	1.56%
4	Total fixed cost of owned land farmers (Rs.)	3914.08	3914.08	0.00	0.00%
5	Total fixed cost of leased in farmers (Rs.)	13753.68	13753.68	0.00	0.00%
6	Total cost of owned land farmers (Rs.)	31471.40	31908.80	437.40	1.37%
7	Total cost of leased in farmers (Rs.)	41311.00	41748.40	437.40	1.04%
8	Gross return (Rs.)	68242.50	66262.50	−1980.00	−2.98%
9	Net return for owned land farmers (Rs.)	36771.10	34353.70	−2417.40	−7.03%
10	Net return for leased in farmers (Rs.)	26931.50	24514.10	−2417.40	−9.86%
11	Returns per rupee for owned farmers	2.16	2.07	−0.09	−4.32%
12	Returns per rupee for leased in farmers	1.65	1.58	−0.07	−4.43%

Price is (2,250 Rs.) same for paddy produced by DSR and TPR method.

Table 3: Cost and return structure of paddy under DSR and TPR method of paddy cultivation in both the command areas (acre^{-1})

Sl. No.	Particulars	Aggregate		Difference (DSR-TPR)	% change in DSR over TPR
		DSR	TPR		
1	Yield (Q)	26.54	29.89	3.35	11.20%
2	Number of irrigations	14.00	26.00	12.00	46.15%
3	Total variable cost (Rs.)	19129.13	27776.02	8646.88	31.13%
4	Total fixed cost of owned land farmers (Rs.)	3914.08	3914.08	0.00	0.00%
5	Total fixed cost of leased in farmers (Rs.)	13753.68	13753.68	0.00	0.00%
6	Total cost of owned land farmers (Rs.)	23043.21	31690.10	8646.88	20.82%
7	Total cost of leased in farmers (Rs.)	32882.81	41529.70	8646.88	27.28%
8	Gross return (Rs.)	59715.00	67252.50	7537.50	11.20%
9	Net return for owned land farmers (Rs.)	36671.79	35562.40	−1109.39	−3.11%
10	Net return for leased in farmers (Rs.)	26832.19	25722.80	−1109.39	−4.31%
11	Returns per rupee for owned farmers	2.59	2.12	−0.47	−22.16%
12	Returns per rupee for leased in farmers	1.81	1.61	−0.19	−11.72%

Price is (2,250 Rs.) same for paddy produced by DSR and TPR method.

Table 4: Partial budgeting of farmers practicing DSR over TPR method of paddy cultivation in TBP command area (Rs./acre)

Debit	Rs.	Credit	Rs.
DSR over TPR in TBP command area			
A. Increase in costs		C. Decrease in costs	
1. Sowing 2. Herbicide cost 3. Hand weeding cost 4. Application of herbicides	500.00 330.00 2121.00 140.00	5. Nursery preparation 6. Transplanting 7. Land preparation 8. Seeds 9. Chemical fertilizers 10. FYM 11. PPC cost 12. Application of fertilizers 13. Application of PPC 14. Labour cost for irrigation	637.00 2170.00 2910.00 701.21 2328.00 442.28 72.00 917.00 21.00 665.00
B. Decrease in returns	9022.50	D. Increase in return	1600.00
Total (A+B)	12113.50	Total (C+D)	12463.49

Net gain Rs./acre [(C+D)-(A+B)] = 349.99

Table 5: Partial budgeting of farmers practicing DSR over TPR method of paddy cultivation in UKP command area (Rs./acre)

Debit	Rs.	Credit	Rs.
DSR over TPR in UKP command area			
A. Increase in costs		C. Decrease in costs	
1. Sowing 2. Herbicide cost 3. Hand weeding cost 4. Application of herbicides	500.00 355.00 2404.50 108.50	5. Nursery preparation 6. Transplanting 7. Land preparation 8. Seeds 9. Chemical fertilizers 10. FYM 11. PPC cost 12. Application of fertilizers 13. Application of PPC 14. Labour cost for irrigation	742.00 2275.00 2990.00 774.75 2776.66 467.15 69.50 952.00 59.50 651.00
B. Decrease in returns	6052.50	D. Increase in return	1600.00
Total (A+B)	9420.50	Total (C+D)	13357.56

Net gain Rs./acre [(C+D)-(A+B)] = 3937.06

Table 6: Partial budgeting of farmers practicing DSR over TPR method of paddy cultivation in both the command areas (Rs./acre)

Debit	Rs.	Credit	Rs.
DSR over TPR in both the command areas			
A. Increase in costs		C. Decrease in costs	
1. Sowing 2. Herbicide cost 3. Hand weeding cost 4. Application of herbicides	500.00 342.50 2262.75 124.25	5. Nursery preparation 6. Transplanting/sowing 7. Land preparation 8. Seeds 9. Chemical fertilizers 10. FYM 11. PPC cost 12. Application of fertilizers 13. Application of PPC 14. Labour cost for irrigation	689.50 2222.50 2950.00 737.98 2552.33 454.71 70.75 934.50 42.25 658.00
B. Decrease in returns	7537.50	D. Increase in return	1600.00
Total (A+B)	10767.00	Total (C+D)	12912.52

Net gain Rs./acre [(C+D)-(A+B)] = 2145.52

Table 7: Impact of DSR on income levels among leased-in sample farmers in both the command areas (Rs./family)

Sl. No.	Particulars	DSR Farmers	TPR Farmers	Difference (TPR-DSR)	% of DSR over TPR
1	Agriculture income				
	a) Crops				
	1) *Kharif* crop	176556.00 (39.20)	227904.00 (44.09)	51348.20	22.53%
	2) Rabi crop	23295.10 (5.17)	8078.08 (1.56)	−15217	−188.37%
	3) Summer crop	147277.00 (32.70)	181243.00 (35.07)	33965.97	18.74%
	b) Crop by-products	79384.00 (17.62)	82378.50 (15.94)	2994.43	3.63%
	c) Agricultural labour	1820.00 (0.40)	1620.50 (0.31)	−199.50	−12.31%
	d) Dairy	3800.00 (0.84)	5280.00 (1.02)	1480.00	28.03%
	e) Poultry	600.00 (0.13)	210.00 (0.04)	−390.00	−185.71%
	f) Goat / sheep	3185.80 (0.71)	1223.50 (0.24)	−1962.30	−160.38%
	Total agriculture income	435917.60 (96.78)	507937.40 (98.28)	72019.80	14.18%
2	Non-agriculture income				

	a) Petty business	4935.50 (1.10)	5052.50 (0.98)	117.00	2.32%
	b) Contractual work	6560.00 (1.46)	2260.00 (0.44)	−4300.00	−190.27%
	c) Other source income	3000.00 (0.67)	1600.00 (0.31)	−1400.00	−87.50%
	Total non-agriculture income	14495.50 (3.22)	8912.50 (1.72)	−5583.00	−62.64%
	Grand total income (1+2)	450413.10 (100.00)	516849.90 (100.00)	66436.80	12.85%

*Figures in parenthesis are percentage to total

Table 8: Impact of DSR method of paddy cultivation on income levels among own land sample farmers in both the command areas (Rs./family)

Sl. No.	Particulars	DSR Farmers	TPR Farmers	Difference (TPR-DSR)	% of DSR over TPR
1	Agriculture income				
	a) Crops				
	1) *Kharif* crop	241300.00 (43.04)	315083.00 (48.15)	73782.49	23.42%
	2) Rabi crop	25791.10 (4.60)	9248.08 (1.41)	−16543.00	−178.88%
	3) Summer crop	188660.00 (33.65)	217623.00 (33.26)	28962.49	13.31%
	b) Crop by-products	80320.00 (14.33)	91898.50 (14.04)	11578.43	12.60%
	c) Agricultural labour	1965.00 (0.35)	1720.50 (0.26)	−244.50	−14.21%
	d) Dairy	4035.00 (0.72)	6180.00 (0.94)	2145.00	34.71%
	e) Poultry	800.00 (0.14)	210.00 (0.03)	−590.00	−280.95%
	f) Goat / sheep	3846.80 (0.69)	3223.50 (0.49)	−623.30	−19.34%
	Total agriculture income	546718.70 (97.52)	645186.30 (98.59)	98467.61	15.26%
2	Non-agriculture income				
	a) Petty business	5394.50 (0.96)	4052.50 (0.62)	−1342.00	−33.12%
	b) Contractual work	5310.00 (0.95)	3260.00 (0.50)	−2050.00	−62.88%
	c) Other source income	3200.00 (0.57)	1900.00 (0.29)	−1300.00	−68.42%
	Total non-agriculture income	13904.50 (2.48)	9212.50 (1.41)	−4692.00	−50.93%
	Grand total income (1+2)	560623.20 (100.00)	654398.80 (100.00)	93775.61	14.33%

* Figures in parenthesis are percentage to total

Table 9: Impact of DSR method of paddy cultivation on income levels among leased in and own land sample farmers in both the command areas (Rs./family)

Sl. No.	Particulars	DSR Farmers	TPR Farmers	Difference (TPR-DSR)	% of DSR over TPR
1	Agriculture income				
	a) Crops				
	1) *Kharif* crop	208928.00 (41.33)	271493.00 (46.36)	62565.30	23.04%
	2) Rabi crop	24543.10 (4.86)	8663.08 (1.48)	−15880.00	−183.31%
	3) Summer crop	167969.00 (33.23)	199433.00 (34.05)	31464.20	15.78%
	b) Crop by-products	79852.00 (15.80)	87138.50 (14.88)	7286.43	8.36%
	c) Agricultural labour	1892.50 (0.37)	1670.50 (0.29)	−222.00	−13.29%
	d) Dairy	3917.50 (0.77)	5730.00 (0.98)	1812.50	31.63%
	e) Poultry	700.00 (0.14)	210.00 (0.04)	−490.00	−233.33%
	f) Goat / sheep	3516.30 (0.70)	2223.50 (0.38)	−1292.80	−58.14%
	Total agriculture income	491318.00 (97.19)	576562.00 (98.45)	85243.70	14.78%
2	Non-agriculture income				
	a) Petty business	5165.00 (1.02)	4552.50 (0.78)	−612.50	−13.45%
	b) Contractual work	5935.00 (1.17)	2760.00 (0.47)	−3175.00	−115.04%
	c) Other source income	3100.00 (0.61)	1750.00 (0.30)	−1350.00	−77.14%
	Total non-agriculture income	14200.00 (2.81)	9062.50 (1.55)	−5137.50	−56.69%
	Grand total income (1+2)	505518.00 (100.00)	585624.00 (100.00)	80106.20	13.68%

* Figures in parenthesis are percentage to total

Conclusion

In order to protect natural resources especially water, there is need to replace puddled transplanted rice with the DSR. DSR facilitates timely establishment of rice and succeeding winter crops. Unlike puddle fields, DSR fields do not crack and thus helps in saving irrigation water. Surface retained residue serve as physical barrier to emergence of weeds, moderate the soil temperature in summers and winters, conserve soil moisture, add organic matter and nutrients to the soil on decomposition. Direct seeded rice is an important resource conservation technique. So, farmers should be motivated through different media to adopt this enterprise. This will also help to save agricultural environment in the state which is the most prominent need of the hour. Timely DSR crop establishment during mid May to mid-June (or 15-20 days before commencement of monsoon) is deciding factor for the success of the crop. Irrigation water supply from the canals in both the command areas must be ensured at the sowing time.

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