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The resource use efficiency in DSR and TPR method of paddy production in TBP and UKP command areas of North Eastern Karnataka

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Abstract
Thirty three hybrids were developed by crossing seven lines and three testers in L x T fashion for twenty six parameters for productivity and quality traits. The variance due to parents vs. hybrids was also significant for all traits except plant height at 45 DAS, internodal length 45 DAS, days to first flowering, fruit diameter and seed yield per plant. The lines L7, L1 and L3 may be utilized as parent stocks for breeding for, growth parameters, earliness, yield and quality traits *etc.*, among the hybrids L3 x T2, L7 X T2, L3 x T3, L1 x T3 and L7 x T2 showed specific combiner for almost characters as per results due to its an F_5 generation which attain homozygosity so, selection is effective for quality traits of fruits. The information presented here about quality traits of okra showed the potential nutritional importance of okra and it has role in improved nutrition.

Keywords: Rice, Direct Seeded Rice, resource use efficiency, command area

Introduction
Rice is the world's most important crop and is a staple food for more than half of the world's population. Worldwide, rice is grown on 161 mha, with an annual production of about 759.6 mt of paddy. About 90 per cent of the world's rice is grown and produced in Asia (FAO, 2017) [1]. India is the second largest producer and consumer of rice in the world, rice production in India crossed the mark of 100 mt in 2012-13 and reached 103.8 mt in 2016 which accounts for 21.13 per cent of global production in 2016, the productivity of rice in India has increased from 1,984 kg/ha in 2004-05 to 2391 kg per hectare in 2014-15. Cultivating a single kilo of rice requires 2,500 liters of water, India has over 24 mha under irrigated paddy, so in order to produce 100 mt of rice it takes approximately 250 billion liters of water.

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 labor, 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. 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.

In Karnataka, rice is cultivated in command areas of Cauvery, Tungabhadra and Upper Krishna where transplanting is the predominant method of cultivation.

In Western Ghats and high rainfall areas, rice is cultivated as drill sown rice. It is one of the most important cereal crop grown in the Tungabhadra Project (TBP) area and Upper Krishna Project (UKP) area of North East Karnataka with mono-cropping as the common crop rotation practice in this region.

It is evident from the past experiences that, DSR method is associated with high weed infestation incidences. Direct seeding of rice is possible provided there is a good crop establishment as well as adequate weed control methods are available to keep the crop free from weeds. 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.

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. In order to achieve the objectives of the study, the data collected from farmers were subjected to the statistical analysis. For this purpose the following statistical tools were used to explore the relevant inferences, tabular analysis, production function and MVP to MFC ratio.

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.

$$Y = a\, X_1^{b1}.\, X_2^{b2}.\, X_3^{b3}.\, X_4^{b4}.\, X_5^{b5}.\, X_6^{b6}.\, X_7^{b7}.\, e^{u}$$

The logarithm form of the above equation is:

log

$$Y = \log a + b1 \log x_1 + b2 \log X_2 + b3 \log X_3 + b4 \log X_4 + b5 \log X_5 + b6 \log X_6 + b7 \log X_7 + u \log e$$

Where,

Y = Gross returns per farm (Rs. /acre)
X_1 = Land (acre/household)
X_2 = Seed cost (Rs. /acre)
X_3 = Fertilizer cost (Rs. /acre)
X_4 = Plant Protection Chemicals cost (Rs. /acre)
X_5 = FYM cost (Rs. /acre)
X_6 = Herbicides cost (Rs. /acre)
X_7 = Labour cost (Rs. /acre)
a = Constant / intercept term
u = Random variable
e = 2.718

In the above equation, output is taken as Y. while, b1 to b7 are the elasticity coefficients of the respective inputs. The co-efficient of multiple determinations (R^2) was worked out to test the goodness of fit of the model.

Production function analysis was carried out separately for DSR and TPR method of paddy cultivation.

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.

$$\text{MVP of } x_i^{th} \text{ resource} = b_i \frac{Y}{Xi}$$

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.

Results and Discussion

To assess the resource use efficiency of the inputs such as seeds, FYM, plant protection chemicals, herbicides, chemical fertilizers, labour cost and machine labour cost were taken into consideration for paddy cultivation. Data from Table 1 indicated that the use of seeds was almost double in case of TPR method of paddy cultivation when compared to DSR method and it was due to sufficient seeding rates were obtained by DSR farmers by using specialized seed drill for sowing operation and the findings of this research are in contrast to the findings of research conducted by Malabayabas *et al.* (2013) [2] in which they have mentioned that the seed rate and seed cost is more in DSR method in order to attain more seeding rate. Use of FYM and chemical fertilizer was also more in TPR method when compared to DSR method. Among the chemical fertilizers Nitrogen fertilizer was more used in TPR method by 28.75 per cent more than the DSR method, similarly, Phosphorous and Potassium fertilizers usage was more in TPR method by 12.61 and 9.91 per cent compared to DSR method of paddy cultivation. Due to excess usage of chemical fertilizers, the occurrence of pest and diseases was also more in TPR fields and the farmers of TPR method have spent 13.34 per cent more on plant protection

chemicals. On the other hand data indicated that, the cost incurred for herbicides was more in DSR by 77.28 per cent than the TPR method of paddy cultivation.

The extent of FYM use was lower than the recommended level. While, remaining all the inputs such as seeds and chemical fertilizers were used more than the recommended package of practices (Table 1).

The popularly used Cobb-Douglas production function was fitted separately for DSR and TPR methods of paddy cultivation to analyze the resource use efficiency and the results are presented in the Table 2. Regression coefficient (R^2) for different resources used in DSR and TPR method of paddy production was 0.986 and 0.965 respectively, which indicated the suitability of the model for both the methods, which also indicates that 98.6 and 96.5 per cent of the variations in paddy yield in both the methods were influenced by the explanatory variables included in the model. Parameters such as chemical fertilizers and herbicides have shown the significant contribution towards the yield with a significance level at 1 per cent in DSR while chemical fertilizers and herbicides and PPC have shown significance at 1 per cent and seed cost at 5 per cent significant level in TPR method of paddy production.

Comparative cost analysis for DSR and TPR method in both command areas was also carried out for farmers of owned land and leased in land farmers and presented in Table 3, Table 4 and Table 5. To enhance productivity and production of their cultivation, many farmers have made heavy investments in farm machinery and irrigation structures. But as the farm land of most of the farmers are not enough to realize the full benefits of such types of investments, such farmers increase their farm size through purchasing and/or leasing in additional land to reduce underutilization. However, as the purchase of land is not a common phenomenon due to price factor from buyer's side and lack of willingness from seller's side, land lease market in both the command areas has developed as a common mechanism to balance the demand and supply of land and thus as an alternative to land sale marketing system. It is evident from Table 3 and Table 4 that the cost of cultivation of DSR method of paddy in TBP and UKP command areas had minimal difference of 0.97 and 0.68 per cent among own land farmers and leased in farmers, respectively and difference in cost of cultivation of TPR method in both the command areas was 1.37 and 1.04 per cent among own land farmers and leased in farmers, respectively. And hence the comparison on cost of cultivation of DSR and TPR method of paddy cultivation has no significant change with respect to change in location.

From Table 5 it is evident that, the cost of cultivation of TPR method of paddy cultivation was more than the DSR method by 27.28 among own land farmers and 20.82 per cent for the leased in farmers. Except herbicides, hand weeding, herbicide application and machine labour cost for sowing, all the other material cost were more in TPR method for paddy cultivation. There was more infestation of weed in DSR method of paddy cultivation, due to which the farmers of DSR have incurred those costs. It is also evident from the results that, higher cost exists in TPR method of paddy cultivation with respect to material cost (Rs. 3,508.45 per acre) followed by machine labour cost (Rs. 2,450.00 per acre) and human labour cost (Rs. 2,157.75 per acre) than the DSR method and results are in line with the study conducted by Srigiri *et al.* (2015) [4]. Majority of the leased in and own land farmers in both the command areas were addicted to chemical fertilizers and applying hugely for one acre paddy. Few farmers are applying FYM to their paddy fields and both fertilizers and the FYM contribute the cost of cultivation of paddy heavily. There existed a higher cost of cultivation in TPR method by Rs. 8,646.89 per acre among own land as well as leased in farmers of both the command areas of North-Eastern Karnataka and it allows adoption of more sophisticated technology in farm operation that increases its efficiency and so the productivity of paddy cultivation.

The allocative efficiency of resource use was computed using marginal value productivity (MVP) and marginal factor cost (MFC) and is presented in Table 6. The farming practices adopted by the farmers in both the command area were very adverse and not an economical one and also the prices of some of the vital inputs like chemical fertilizers, farm yard manure and pesticides is very high. The results of allocative efficiency revealed that the MVP to MFC ratio in DSR method was less than one in case of PPC and herbicides and negative for labour, hence there was a scope to reduce the use of these resources as excess use of these resources imply additional investment and hence are uneconomical. All other factors such as land area, seed cost, fertilizers and FYM were having positive ratio and more than one in each case. It indicates that these resources are being used at suboptimum level and there exists the possibility of enhancing the yield of paddy by increasing their use. On the other hand MVP to MFC ratio in TPR method of paddy production for seed cost, PPC cost and herbicide cost were less than one and land area and labour have shown negative values, implying there exists a scope to reduce the use of these resources. Fertilizers costs and FYM were having positive ratio and more than one in each case and the findings are supported by the study conducted by Mehala *et al.* (2016) [3]. The paddy cultivation is really an expensive venture for any farmer. The cultivation cost can be minimized by only applying recommended dose of fertilizers and growing greener manuring crops like sum hemp, Glyricidia, Pongamia, *Pale Pesara* and other green manuring crops.

Table 1: Comparative input use pattern in TPR and DSR method of paddy cultivation in the study area (acre^{-1})

Sl. No.	Particulars	Unit	DSR (n=120)		Overall average	TPR (n=120)		Overall average	% change in DSR over TPR
			TBP	UKP		TBP	UKP		
1	Seeds	Kg	12.56	13.25	12.90	23.16	24.98	24.07	-46.40
2	FYM	Ton	3.20	3.10	3.15	4.20	4.15	4.17	-24.46
3	Plant protection cost	Rs.	468.00	450.50	459.25	540.00	520.00	530.00	-13.34
4	Herbicides cost	Rs.	780.50	790.80	785.65	450.50	435.80	443.15	77.28
5	**Chemical fertilizers**								
	a) N	Kg	75.50	72.80	74.15	103.60	101.50	102.55	-28.75
	b) P_2O_5	Kg	54.00	52.22	53.11	61.44	60.12	60.78	-12.61
	c) K_2O	Kg	33.40	31.66	32.53	39.16	33.06	36.11	-9.91

Table 2: Efficiency of resources used under both method of paddy cultivation in TBP and UKP command areas

Sl. No.	Parameters	DSR		TPR	
		Reg. co-efficient	p value	Reg. co-efficient	p value
1	Intercept	6.4822	$4.81E^{-55}$	3.2425	$2.21E^{-55}$
2	Area	0.3254	0.4528	-0.0019	0.5528
3	Fertilizer	0.4258**	$2.54E^{-05}$	0.1209**	$3.25E^{-05}$
4	FYM	0.4051	0.0942	0.0298	0.2426
5	Herbicides	0.1278**	0.0040	0.0997**	0.0030
6	Labour	-0.2717	0.6428	-0.1717	0.8428
7	PPC	0.0426	0.2210	0.2010**	$1.11E^{-11}$
8	Seed cost	0.0479	0.2043	0.0427*	0.0443

*= Significant at 5%
**= Significant at 1% level
NS = Non-Significant
Std. Error = Standard error
R^2 for DSR = 0.986
R^2 for TPR = 0.965
F = 658.50
N = 240 samples

Table 3: Cost of cultivation in DSR method of paddy cultivation among TBP and UKP command area farmers (Rs./acre)

Sl. No.	Particulars	TBP	UKP	Mean difference	% Change of cost in TBP over UKP
A	**Material cost**				
	1. Seeds	779.40	822.22	42.81	5.20%
	2. Chemical fertilizers	2992.00	2795.00	-197.00	-7.04%
	3. FYM	1576.11	1526.85	-49.26	-3.22%
	4. Plant protection chemicals	468.00	450.50	-17.50	-3.88%
	5. Herbicides	780.50	790.80	10.30	1.30%
	Sub total	6596.01	6385.37	-210.64	-3.29%
B	**Human labour cost**				
	1. Application of fertilizers and manures	1295.00	1232.00	-63.00	-5.11%
	2. Application of PPC	756.00	682.50	-73.50	-10.76%
	3. Hand weeding	3010.00	3202.50	192.50	6.01%
	4. Herbicides application	525.00	476.00	-49.00	-10.29%
	5. Irrigation	770.00	875.00	105.00	12.00%
	Sub total	6356.00	6468.00	112.00	1.73%
C	**Machine labour cost**				
	1. Land preparation	2130.00	1920.00	-10.00	-10.93%
	2. Sowing	500.00	500.00	0.00	0.00%
	3. Harvesting	2400.00	2500.00	100.00	4.00%
	Sub total	5030.00	4920.00	-10.00	-2.23%
D	Total variable cost with interest @ 7% (A+B+C)	19240.75	19017.51	-23.24	-1.17%
E	**Fixed cost**				
	1. Depreciation	3450.90	3450.90	0.00	0.00%
	2. Land rent	9027.15	9027.15	0.00	0.00%
	3. Land revenue	140.00	140.00	0.00	0.00%
F	Total fixed cost for leased in farmers with interest @ 9%	13753.68	13753.68	0.00	0.00%
G	Total fixed cost for owned farmers with interest @ 9%	3914.08	3914.08	0.00	0.00%
H	Total cost for leased in farmers (D + F)	32994.43	32771.19	-223.24	-0.68%
I	Total cost for owned land farmers (D + G)	23154.83	22931.59	-223.24	-0.97%

Table 4: Cost of cultivation in TPR method of paddy cultivation among TBP and UKP command area farmers (Rs./acre)

Sl. No.	Particulars	TBP	UKP	Mean difference	% Change of cost in TBP over UKP
A	**Material cost**				
	1. Seeds	1480.61	1596.97	116.36	7.28%
	2. Chemical fertilizers	5320.00	5571.66	251.66	4.51%
	3. FYM	2018.39	1994.36	-24.02	-1.20%
	4. Plant protection chemicals	540.00	520.00	-20.00	-3.84%
	5. Herbicides	450.50	435.80	-14.70	-3.37%
	Sub total	9809.50	10188.79	309.29	3.56%
B	**Labour cost**				
	1. Nursery preparation	637.00	742.00	105.00	14.15%
	2. Transplanting/sowing	2170.00	2275.00	105.00	4.61%
	3. Application of fertilizers and manures	2212.00	2184.00	-28.00	-1.28%
	4. Application of PPC	777.00	742.00	-35.00	-4.71%
	5. Hand weeding	889.00	798.00	-91.00	-11.40%
	6. Herbicides application	385.00	367.50	-17.50	-4.76%
	7. Irrigation	1435.00	1526.00	91.00	5.96%

	Sub total	8505.00	8634.50	129.50	1.49%
C	**Machine labour cost**				
	1. Land preparation	5040.00	4910.00	-130.00	-2.64%
	2. Sowing	0.00	0.00	0.00	0.00%
	3. Harvesting	2400.00	2500.00	100.00	4.00%
	Sub total	7440.00	7410.00	-30.00	-0.41%
D	Total variable cost with interest @ 7% (A+B+C)	27557.31	27994.72	437.40	1.56%
E	**Fixed cost**				
	4. Depreciation	3450.90	3450.90	0	0%
	5. Land rent	9027.15	9027.15	0	0%
	6. Land revenue	140.00	140.00	0	0%
F	Total fixed cost for leased in farmers with interest @ 9%	13753.68	13753.68	0	0%
G	Total fixed cost for owned farmers with interest @ 9%	3914.08	3914.08	0	0%
H	Total cost for leased in farmers (D + F)	41310.99	41748.40	437.40	1.04%
I	Total cost for owned land farmers (D + G)	31471.40	31908.80	437.40	1.37%

Table 5: Comparative cost of paddy cultivation under DSR and TPR method in both the command areas (Rs./acre)

Sl. No.	Particulars	DSR	TPR	Mean difference	% Change of cost in DSR over TPR
A	Material cost				
	1. Seeds	800.81	1538.90	737.98	-47.98%
	2. Chemical fertilizers	2893.50	5445.83	2552.33	-46.86%
	3. FYM	1551.48	2006.37	454.89	-22.67%
	4. Plant protection chemicals	459.25	530.00	70.75	-13.34%
	5. Herbicides	785.65	443.15	-342.50	77.38%
	Sub total	6490.69	9999.14	3508.45	-35.08%
B	**Labour cost**				
	1. Nursery preparation	-	689.50	689.50	-100.00%
	2. Transplanting/sowing	-	2222.50	2222.50	-100.00%
	3. Application of fertilizers and manures	1263.50	2198.00	934.50	-42.51%
	4. Application of PPC	719.25	759.50	40.25	-5.29%
	5. Hand weeding	3106.25	843.50	-2262.75	268.25%
	6. Herbicides application	500.50	376.25	-124.25	33.02%
	7. Irrigation	822.50	1480.50	658.00	-44.44%
	Sub total	6412.00	8569.75	2157.75	-25.17%
C	**Machine labour cost**				
	1. Land preparation	2025.00	4970.00	2945.00	-59.29%
	2. Sowing	500.00	0.00	-500.00	100.00%
	3. Harvesting	2450.00	2450.00	0.00	0.00%
	Sub total	4975.00	7425.00	2450.00	-32.99%
D	Total variable cost with interest @ 7% (A+B+C)	19129.13	27776.02	8646.88	-31.13%
E	**Fixed cost**				
	7. Depreciation	3450.90	3450.90	0	0%
	8. Land rent	9027.15	9027.15	0	0%
	9. Land revenue	140.00	140.00	0	0%
F	Total fixed cost for leased in farmers with interest @ 9%	13753.68	13753.68	0	0%
G	Total fixed cost for owned farmers with interest @ 9%	3914.08	3914.08	0	0%
H	Total cost for leased in farmers (D + F)	32882.81	41529.70	8646.89	-20.82%
I	Total cost for owned land farmers (D + G)	23043.21	31690.10	8646.89	-27.28%

Table 6: Allocative efficiency of different resources in DSR and TPR paddy cultivation in both the command areas

Sl. No.	Particulars	Variables							
		Output (per acre)	Land area (acre)	Seeds	Fertilizer	PPC	FYM	Herbicide	Labour
				(Rs./acre)					
DSR									
1	Geometric mean	5.58	0.7732	3.8172	4.3649	3.6763	4.0757	3.9162	4.5838
2	Marginal product		2.2732	1.5436	0.5373	0.0639	0.5472	0.1791	-0.3243
5	MVP:MFC		2.35	0.07	0.54	0.06	0.55	0.18	-0.33
TPR									
1	Geometric mean	5.76	0.9104	4.2357	4.6627	3.9155	4.2458	4.1562	4.9029
2	Marginal product		-0.0118	0.0995	0.1421	0.2814	0.0385	0.1315	-0.1919
5	MVP:MFC		-0.01	0.05	0.14	0.29	0.04	0.13	-0.20

Conclusion

Use of seeds was almost double in case of TPR method of paddy cultivation when compared to DSR method, while cost incurred on herbicides was more in DSR when compared to TPR. Extent of use of FYM was lower by 22.0 to 44.0 per cent in TPR and DSR method. While, remaining all the inputs such as seeds and chemical fertilizers were used more than the recommended package of practices. Comparison in cost of cultivation of DSR and TPR method of paddy cultivation has no significant change with respect to change in location. The

results of allocative efficiency revealed that the MVP to MFC ratio in DSR method was less than one in case of PPC and herbicides and negative for labour, hence there was a scope to reduce the use of these resources as excess use of these resources imply additional investment and hence are uneconomical. All other factors such as land area, seed cost, fertilizers and FYM were having positive ratio and more than one in each case. It indicates that these resources are being used at suboptimum level and there exists the possibility of enhancing the yield of paddy by increasing their use. 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. Also specialized training programs must be conducted on importance of organic manures as the usage of organic manures in the study area was less than the recommended dosage.

References

1. FAO. Rice market monitor. *Annual report* FAO, Rome, 2017.
2. Malabayabas AJ. Debbie Templeton and Singh Pratibha, Ex-ante impact of direct seeding of rice as an alternative to transplanting rice in the Indo-Gangetic Plain, Asian J Agric. Dev. 2013; 9(2):1-29.
3. Mehala V, Kumar SU, Parkash LV, Saroj Kumari. Impact of direct seeded rice on economics of paddy crop in Haryana. Int. J Agric. Sci. 2016; 8(62):3525-3528.
4. Srigiri D, Babu BH, Reddy AH, Reddy SA, Sathish PSR. Case study on direct sowing of paddy in selected mandals of Guntur district. Int. J Agric. Sci. Res. 2015; 5(6):9-14.