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Research Article

ECONOMIC ANALYSIS OF NEW TECHNOLOGIES IN RICE PRODUCTION IN THANJAVUR DISTRICT OF TAMIL NADU

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Abstract: The present study examines the impact of new technologies *viz*., System of Rice Intensification (SRI) and Direct-Seeding of Rice (DSR) in paddy cultivation in Thanjavur District. Result indicates, the yield and profit were higher in DSR and SRI as compared to conventional method. The gain in yield was 13.32 % in SRI and 15.60 % in DSR as compared to conventional method. The estimated cost of production was lower in DSR and SRI than conventional due to its fewer requirements of inputs and labour. The realized profit was more in DSR (₹ 45825.41/ha) and SRI (₹ 40791.20/ha) than conventional method (₹ 20721.63/ha). However, lack of skilled labour in transplanting young seedlings and line sowing, more weed infestation and poor germination of seeds were the major constraints faced by the farmers while using DSR and SRI technologies.

Keywords: *SRI, DSR, Cost of cultivation, Profitability, Constraints in rice production*

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Introduction

Rice (*Oryza sativa*) is one of the most important cereal crops of world. In India, 43.57 million ha of cultivated land is under rice cultivation with the production of 104.32 million tonne [2]. Growing demand for rice and food security concerns in developing countries rice production have to be increased by 50 per cent by 2025 [6]. In Tamil Nadu, rice is the major food crop with area of 2.6 million ha with a production of 8.19 million tonnes [3]. Increasing input cost and low procuring price results shifting of farmers from agriculture to other occupations. To sustain the rice production with the limited resources more efficient approaches are need for the economic rice production. In the recent times input intensive technologies *viz*., System of Rice Intensification (SRI) and Direct-Seeding of Rice (DSR) and Alternate Wetting and Drying (AWD) are recommended for farmer's adoption to conserve water, overcome labour scarcity and to minimize the input use. However the adoption of these technologies is very low among the farmers. It was reported that the average yield was 27 per cent high in SRI than conventional [1] and also cost of cultivation in SRI is 10 per cent lower than conventional method [7]. Like SRI, DSR is also a feasible alternative to conventional puddled transplanted rice, the net returns were four per cent higher and cost of cultivation is fifteen per cent less in DSR than conventional method [4]. However, adoption of these technologies is very low among the farmers [5]. Besides there are no holistic studies to assess the profitability, labour utilization pattern and constraints in adoption of new technologies when compared to conventional method of paddy cultivation. Therefore this study has been undertaken with the objective of analysing the economics of rice cultivation under new technologies and their potential over the existing conventional method.

Materials and Methods

Selection of study area

Thanjavur district of Tamil Nadu was selected based on larger area under paddy cultivation (1.77 Lakhs ha) and accounts of 8.87 per cent of the total paddy area in the state [3]. The multistage random sampling technique was followed to select 180 sample households from the district of Thanjavur.

Data collection

The primary data were collected during the year 2018-19 (Thaladi season) through a well-structured interview schedule. Farmers who cultivate rice variety CR1009 under conventional, SRI and DSR methods of cultivation is selected for this study. Since this variety is being used predominantly in the study area. The secondary information was collected from Agriculture Department and statistical office of Thanjavur district.

Analytical tools

Conventional Analysis

Conventional analysis involving calculation of percentages and averages were carried out to interpret the data related to cost, returns, input use, general characteristics of sample farmers, size and distribution of farm holdings in the study area.

Estimation of cost and Returns

The modern cost and returns concepts were used in data analysis. Costs were classified under fixed and variable cost headings *viz*., Farm Yard Manure (FYM), Fertilizer, Plant Protection Chemicals (PPC), Seeds, Human labour, Machine labour and so on. Individual costs were added up to arrive at Total Variable Cost (TVC), Total Fixed Cost (TFC) and Total Cost (TC). Output quantity was multiplied with the price realized to arrive at Gross Income (GI). Net Income (NI) was calculated by deducting total cost from Gross Income. Gross Income was divided by the total cost to arrive at return per rupee of expenditure.

Garrett's ranking technique

Constraints in adoption and continuing new technologies in paddy cultivation in the study area were analyzed using the Garrett's ranking technique. The order of merit given by the rice farmers for each statement was converted into ranks by using Garrett's ranking technique.

$$\text{Percent position} = 100*(R_{ij} - 0.50) / N_j$$

Where, R_{ij} = Rank given for the i^{th} statement by j^{th} respondent.

N_j = Number of statements ranked by j^{th} respondent.

Table-1 *General characteristics of the sample respondents*

SN	Particulars	Convn. (n=60)	Percentage to total	SRI (n=60)	Percentage to total	DSR (n=60)	Percentage to total
I	Average age of the farmer (years)	56		48		50	
II	Education (Numbers)						
	Illiterate	10	16.67	4	6.67	3	5.00
	Primary (1-5)	15	25.00	11	18.33	12	20.00
	Middle (6-8)	13	21.67	10	16.67	10	16.67
	Secondary (9-10)	9	15.00	13	21.67	11	18.33
	Higher secondary (9-10)	8	13.33	11	18.33	13	21.67
	Diploma/Graduate	5	8.33	11	18.33	11	18.33
	Sub total	60	100.00	60	100.00	60	100.00
III	Type of farmer (ha)						
	Marginal (< 1)	5	8.34	9	15.00	22	36.67
	Small (1 to 2)	26	43.33	20	33.33	28	46.67
	Medium (2 to 4)	20	33.33	19	31.67	6	10.00
	Large (>4)	9	15.00	12	20.00	4	6.66
	Sub total	60	100.00	60	100.00	60	100.00
IV	Family type (Numbers)						
	Nucleus	44	73.33	47	78.33	50	83.33
	Joint	16	26.67	13	21.67	10	16.67
	Sub total	60	100.00	60	100.00	60	100.00
V	Family composition (Numbers)						
	Male	3		2		3	
	Female	3		2		4	
	Average family size	6		4		7	
VI	Agriculture as occupation (Numbers)						
	Main	42	70.00	45	75.00	29	48.33
	Subsidiary	18	30.00	15	25.00	31	51.67
	Sub total	60	100.00	60	100.00	60	100.00
VII	Average area under paddy cultivation (ha)	2.34		2.67		1.34	
VIII	Average farming experience (years)	30		27		26	
IX	Average annual income(₹)						
	Agriculture	34,766		39,140		28,393	
	Others	2,13,978		2,43,492		2,44,126	

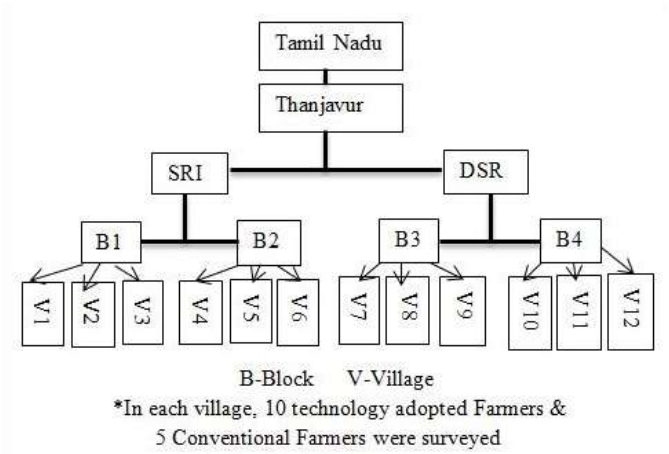

Fig-1 Design of the study

Results and Discussion

General characteristics of the sample respondents

The study was largely based on the primary data collected from the sample farms. Hence, general characteristics of the sample respondents is presented in Table 1 which would help to know more about the socio-economic factors that influence the decisions of the sample farmers.

It was observed that, the average age of the sample farmers of conventional, SRI and DSR was 56, 48 and 50 respectively. Similarly average experience was 30, 27 and 26. This indicates older and experienced farmers practice conventional method whereas young farmers adopt new technologies. Among the sample farmers 16.67 per cent conventional farmers were illiterate, it is high when compare to the other two systems. This may be one of the reasons for non-adoption of new technologies. Large and medium farmers (16 to 52 per cent) practices conventional method whereas most of the marginal and small farmers (48 to 83 per cent) under resource (water and labour) constraint were practicing SRI and DSR technologies. Average area under paddy cultivation was 2.34 ha in conventional, SRI 2.67 ha in SRI and DSR 1.34 ha in DSR.

Economics of rice cultivation

In order to understand the economics of rice production, the cost of production was worked out and discussed in this section. The results of cost analysis are presented in [Table-2]. The overall total cost of rice cultivation was worked out to be ₹ 67,508, ₹ 60,412 and ₹ 57,972 in conventional, SRI and DSR cultivation respectively. Of which, the share of total fixed cost ranged from 18 to 20 per cent in all the three methods. The remaining 72 to 80 per cent was accounted by the total variable cost. Among the variable cost, labour cost found to be high which ranged from 55 to 58 per cent. Since the human labour deployed in nursery preparation and transplanting operation was low in DSR method. Hence the human labour cost incurred low in DSR method (₹14,671) as compared to SRI (₹ 20,159.32) and conventional method (₹ 23,810). On the other hand DSR needs well ploughed soil and even surfaced land for seed germination and easy management requires more deployment of machine labour that fetches more machine labour cost of ₹17645 than conventional and SRI accounting ₹ 13,203 and ₹ 14,724 respectively. The expenditure on fertilizers was the second major variable cost; the results showed that conventional method (₹ 6,732.17) incurred more fertilizer cost than DSR (₹ 6,145.22) and SRI (₹ 5,236.05). This cost included expenditure on farmyard manure, fertilizers such as nitrogenous (urea), phosphatic (di-ammonium phosphate) and potassic (muriate of potash); and micro nutrients including gypsum, and bio-fertilizers. The bio-fertilizers like *azospirillum*, phosphobacteria were also used by the farmers as a source of nutrients. The cost on bio-fertilizer was higher in DSR method (₹ 66.69) than conventional (₹ 41.99) and SRI method (₹ 46.37). The cost of plant protection chemicals (PPC) was higher in the DSR (₹ 2563.69) than conventional (₹1540.74) and SRI (₹ 1377.84) method of cultivation. The reason might be that pest and disease resistant was low in DSR due to high plant population .The seed rate was 35 kg/ha in SRI, 64 kg/ha in DSR and113 kg in conventional method. Hence it observed that the expenditure incurred on seed was less both in SRI (₹ 1074.45) and DSR (₹ 2316.37) than conventional (₹ 3733.41) due to less seed rate. The farm machineries were widely used for ploughing, planting, harvesting and transportation activities to reduce human drudgery. The share of machine labour cost ranged from 18 to 30 per cent in total cost of which DSR incurred high cost.

Table-2 *General characteristics of the sample respondents*

SN	Particulars	Convn.	Percentage to total	SRI	Percentage to total	DSR	Percentage to total
A.	Variable cost						
I	Labour cost (₹)						
1	Human labour cost						
	Male	13704.38	20.30	13910.22	23.03	7780.50	13.42
	Female	10106.40	14.97	6249.10	10.34	6891.30	11.89
	Sub-total (1)	23810.78	35.27	20159.32	33.37	14671.80	25.31
2	Machine cost						
	Field preparation	5187.00	7.68	5022.33	8.31	10641.58	18.36
	Transplanting	710.13	1.05	2230.00	3.69	0.00	0.00
	Harvesting and threshing	6190.29	9.17	6154.52	10.19	6172.41	10.65
	Transportation	1115.60	1.65	1317.33	2.18	831.57	1.43
	sub-total (2)	13203.02	19.56	14724.18	24.37	17645.56	30.44
	Total labour cost	37013.80	54.83	34883.50	57.74	32317.36	55.75
II	Input cost (₹)						
1	Seeds	3733.41	5.53	1074.45	1.78	2316.37	4.00
2	Seed treatment	11.73	0.02	23.47	0.04	12.97	0.02
3	Irrigation cost	3997.28	5.92	2964.00	4.91	0.00	0.00
4	FYM	1288.17	1.91	2066.92	3.42	1737.58	3.00
5	Fertilizer						
	Urea	979.36	1.45	505.12	0.84	810.41	1.40
	DAP	3080.09	4.56	2382.91	3.94	3193.51	5.51
	MOP	2487.29	3.68	2127.51	3.52	1920.23	3.31
	Micronutrient	80.28	0.12	133.38	0.22	154.38	0.27
	Gypsum	63.16	0.09	40.76	0.07	0.00	0.00
	Bio fertilizer	41.99	0.06	46.37	0.08	66.69	0.12
	Sub-total (5)	6732.17	9.97	5236.05	8.67	6145.22	10.60
6	PPC						
	Weedicide	871.29	1.29	725.76	1.20	1943.06	3.35
	Insecticide	479.38	0.71	542.04	0.90	500.58	0.86
	Fungicide	190.06	0.28	110.03	0.18	120.04	0.21
	Sub-total (6)	1540.73	2.28	1377.83	2.28	2563.68	4.42
7	Other cost	139.97	0.21	164.67	0.27	197.60	0.34
		17443.46	25.84	12907.39	21.37	12973.42	22.38
	Interest on working capital @ 7%	1221.04	1.81	903.52	1.50	908.14	1.57
	Sub-total (II)	18664.50	27.65	13810.91	22.86	13881.56	23.95
	Total variable cost (A)	55678.30	82.48	48694.41	80.60	46198.92	79.69
B.	Fixed cost (₹)						
1	Land revenue	29.64	0.04	29.64	0.05	29.64	0.05
2	Rental value of owned land	8932.61	13.23	8932.61	14.79	8932.61	15.41
3	Depreciation	1599.99	2.37	1499.98	2.48	1550.00	2.67
	Interest on fixed capital @ 12%	1267.47	1.88	1255.47	2.08	1261.47	2.18
	Sub-total (B)	11829.71	17.52	11717.70	19.40	11773.72	20.31
	Total cost (A+B)	67508.01	100.00	60412.11	100.00	57972.64	100.00
	Returns						
	Yield (kg)	4675.71		5394.48		5540.21	
	Price (₹/kg)	18.00		18.00		18.00	
	Income from by product (₹)	4066.86		4102.67		4074.27	
	Gross returns(₹)	88229.64		101203.31		103798.05	
	Total cost of cultivation (₹)	67508.01		60412.11		57972.64	
	Net returns (₹)	20721.63		40791.20		45825.41	
	Benefit cost ratio	1.31		1.68		1.79	

Table-3 *Constraints faced by farmers*

SN	Constraints	Garrett score	Rank
	Conventional		
1	Labour shortage	66.87	I
2	Increase in operation cost	58.12	II
3	Low procuring price	49.75	III
4	Rat problem	43.54	IV
5	Ground water depletion	30.74	V
	SRI		
1	Skill in transplanting young seedlings	65.68	I
2	Unwilling of labour to do line sowing	56.08	II
3	Lack of skill in nursery preparation	48.84	III
4	Lack of cooperation from neighbour farmers	45.96	IV
5	Difficulty in using cono weeder	32.43	V
	DSR		
1	Monsoon failure	66.44	I
2	High machine labour cost	55.77	II
3	More weed infestation	48.68	III
4	Poor germination of seeds	45.03	IV
5	Lodging of matured crop	33.08	V

The yield realization was high in DSR (5540.21 kg/ha) than SRI (5394.48 kg/ha) and conventional (4675.71 kg/ha). The cost of production per tonne of paddy was lower in DSR (₹ 10,540) than the SRI (₹ 11,187) and conventional method (₹ 14,363) of rice cultivation. Similarly net return realized was higher in DSR (₹ 45,825) followed by SRI (₹ 40791) and conventional method (₹ 20721). The overall benefit-cost ratio was 1.31 under conventional, 1.68 under SRI and 1.79 under DSR method. Summing-up, the rice cultivation under SRI and DSR method is more profitable than the conventional method.

Constraints faced by farmers in rice cultivation

The problems faced in rice cultivation under conventional, SRI and DSR method were analyzed using Garrett's ranking technique and the results are presented in [Table-3]. The conventional farmers expressed that labour shortage, increase in operation cost, low procuring price; rat problem and ground water depletion were the most important problems. Whereas in the case of SRI, farmer's skill in transplanting young seedlings, unwilling of labour to do line sowing, lack of skill in nursery preparation, lack of cooperation from neighbour farmers, difficulty in using

cono-weeder were the major constraints. Similarly DSR farmers also expressed that monsoon failure, high machine labour cost, more weed infestation, poor germination of seeds and lodging of matured crop are some of the most faced problems.

Conclusion

The cost of production per tonne of paddy is lower in DSR (₹ 10,540) than the SRI (₹ 11,187) and conventional method (₹ 14,363) of rice cultivation. The net return realized is higher in DSR (₹ 45,825) followed by SRI (₹ 40,791) and conventional method (₹ 20,721). The study has revealed that adoption of DSR technique would help to increase rice production without increasing the area under rice cultivation. The increased productivity and net returns in DSR and SRI indicates that adoption of these technologies is most promising and profitable among rice farmers under the resource constraint in the future.

Application of research: This study is useful to know the economics of paddy cultivation under different methods and find out the cost-effective technology. This study also reveals that the constraints in adoption of new technologies in paddy farming and serve as a source to researches and policy makers in taking appropriate policy decisions.

Research Category: Production Economics

Abbreviations:

SRI - System of Rice Intensification

DSR - Direct-Seeding of Rice

AWD – Alternate wetting and drying

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Study area / Sample Collection: Thanjavur District of Tamil Nadu.

Cultivar / Variety / Breed name: Rice - CR 1009

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Ethical Committee Approval Number: Nil

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