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## Comparative economics of climate smart rice cultivation systems in Mandya district of Karnataka

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#### Abstract

Rice is an important cereal crop and is the staple food in most of the countries of the world. There is always growing population and increasing demand for food on one hand and on the other there is increasing changes in the climate which is affecting the productivity of the crop and also rice cultivation is effecting the environment. The study is an attempt to assess the economics of climate smart practices such as SRI (System of Rice Intensification), aerobic cultivation, dry seeded rice farming which will aid in sustainable rice production. The total cost of cultivation was found to be highest in conventional method which was Rs. 50926.44 per acre and was lowest in aerobic method (Rs.43.444.07/ha). Similarly, in SRI method and DSR method the cost of cultivation was Rs.48949.92 and Rs.46002.74 per acre, respectively. Across all cultivation systems the yield was found to be highest in SRI method (33.2 quintals) and gross and net returns were also highest in case of SRI method (Rs. 70336 and Rs. 21386.08).

**Keywords:** System of rice Intensification, aerobic method, costs and returns

#### Introduction

The Indian economy has always been based on agriculture. It has to support almost 17 percent of world population from 2.3 percent of world geographical area and 4.2 percent of world's water resources. The world has recognised Indian agriculture's accomplishment as food grain production rose from 50.8 million tonnes during 1950-51 to 316.06 million tonnes in 2021 (Anonymous, 2021-22), out of which 127.93 million tonnes is contributed by rice alone. Rice continues to hold the key component of sustainable production of food in the country. India has occupied the first place in area and second place in production of rice after China, contributing 28.53 percent of the world's area and 14.61 percent of world's production with 44.19 million hectares and 104.4 million hectare. (INDIASTAT, 2016). In the year 2020-21, India produced 124.37 million tonnes of rice and covered area of 45.77 million hectares with productivity of 2717 kg per hectares.

With respect to Indian scenario is concerned, the major states with highest area under rice cultivation are Uttar Pradesh (5678 '000 ha), West Bengal (5585.63 '000 ha), Odisha (4038.24 '000 ha). In terms of production, the major rice producing states are West Bengal (16524.44 '000 tonnes), Uttar Pradesh (15520.02 '000 tonnes), Punjab (12783.65 '000 tonnes) and Chandigarh has the highest productivity with 55 q/ha followed by Punjab (43.66 q/ha), Andhra Pradesh (33.93 q/ha).

The production, accessibility, and availability of food are under constant strain in many nations due to the growing global population, climate change, and depleting natural resources. Rice production is adversely impacted by factors like rising temperatures, variable rainfall, intermittent access to water and a variety of biotic and abiotic pressures that reduce output. The goal is to increase productivity and strengthen food security on a sustainable basis, improving human wellbeing in the process. Rice cultivation is both an important sequester of carbon dioxide from the atmosphere and an important source of greenhouse gases (e.g. methane and nitrite oxide) emission. In 2004, for example, rice sequestered about 1.74 billion tonnes of CO<sub>2</sub> from the atmosphere to produce about 1.16 billion tonnes of biomass.

Climate change poses a serious and growing threat to global food security. Climate change's effects include rising temperatures, an increase in extreme weather occurrences, water shortages, and other things. Rising sea levels, ocean acidification, land degradation, ecosystem disruption, and biodiversity loss could seriously jeopardise agriculture's ability to feed the most vulnerable, impeding the eradication of hunger, malnutrition, and poverty.

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Thus in order to overcome the impacts of climate change there is a need to adopt climate smart agricultural practices for rice cultivation. Climate smart agriculture is the practice of adopting agricultural practices which help in increasing productivity and income, adapting to the effects of climate change and also in reducing the emission of GHGs in to the atmosphere.

The study is an attempt to assess the different climate smart practices such as system of rice intensification (SRI), aerobic and drum seeded rice (DSR) cultivation systems. The SRI method is aimed at increasing the yield of rice. Aerobic method is a practice where rice is grown aerobically when it is directly sown on non-puddle aerobic soil with more irrigation and fertiliser while using optimal high yielding rice types. And DSR is a technique of rice cultivation where farmers directly sow the paddy seeds in the field without transplanting process.

### Materials and Methods

The study was carried out in Mandya district of Karnataka. Simple random and snowball sampling technique was employed for the selection of sample respondents under each of the cultivation system i.e. conventional, System of Rice Intensification (SRI), aerobic and drum seeded rice (DSR) method. Thirty farmers under each of the cultivation system were selected for the study. A total of 120 farmers were selected for the study.

### Descriptive statistics

Frequency, percentage and arithmetic mean were worked out for the purpose of comparison among different cultivation systems

$$A = (x_1 + x_2 + x_3 + \dots + x_n) / n$$

Where,

A = Arithmetic mean

$x_1 + x_2 + x_3 + \dots + x_n$  are the value of individual items

n = number of individuals

### Cost of Cultivation

The cost of cultivation (Rs./ha) was calculated on per acre basis for every cultivation system by taking into account the inputs, labour and operational cost etc. Cost of cultivation included total variable cost and total fixed cost.

**Variable Cost:** Variable cost was used in the present study includes the cost of labour, seed value and power tiller.

**Fixed Cost:** Fixed cost includes the depreciation cost of land and interest on fixed capital.

### Returns concepts

**A. Gross returns:** The total quantity of rice produced was multiplied with its selling price gives the gross returns.

**B. Net returns:** It is the difference between gross return and total costs incurred in rice cultivation.

### Results and Discussion

#### Costs and returns analysis of different rice cultivation systems

##### Cost of rice cultivation

The estimation of total cost of cultivation took into account

explicit costs on inputs, labour cost, imputed costs of family labour and other owned factors. The table 1 depicts the details on cost of cultivation per acre for rice across different cultivation systems. The following section gives the information on different items of costs involved in rice cultivation such as variable cost and fixed cost.

### Variable cost

It was found that the cost of seeds were Rs. 816 per acre in conventional method, Rs. 640 in SRI method, Rs. 573.75 in aerobic method and Rs. 646.67 in DSR method. The quantity of seed used was highest in DSR method i.e. 18.50 Kg per acre followed by the aerobic method which requires 18.13 Kg. Overall, the seed cost was high in case of conventional method because the different varieties have been used in different cultivation systems whose prices vary across cultivation systems. FYM required for rice cultivation vary from one to 3 tractor loads. Cost of FYM was highest in case of conventional i.e. Rs.5296.30, Rs 4000 in case of SRI method, Rs.4937 in aerobic method and Rs. 4666.67 in DRI method. The quantity of fertilizer used was highest in conventional and DRI method which was 170.33 Kg and 175.17 Kg per hectare respectively.

But the cost of fertilizer vary marginally across different cultivation systems and it was found lowest of Rs.3348 per acre, this is because of comparatively lower quantity of fertiliser was used in aerobic method. It also observed that cost of plant protection chemicals was highest in case of DSR method i.e. Rs. 3663.98 and this is due to more usage of weedicide because of higher weed incidence. The cost of plant protection chemical in case of conventional, SRI and aerobic was found to be Rs. 2343.07, 2610.69 and 2740.56 respectively. The cost of micronutrients in conventional method was found to be highest which was Rs. 937.50 followed by SRI (Rs. 580/ acre), aerobic (Rs. 580/acre) and DSR method (Rs. 400/acre). The results also revealed that the irrigation cost was found to be highest in conventional method which was 709.20 because of higher water usage which was around 38.40 acre inches. Irrigation water cost was lowest in aerobic rice cultivation method that is around Rs. 359 per acre with water use of 18.36 acre inch. In SRI and DSR method irrigation cost was Rs.482 and Rs.569 respectively with water usage was 25.16 acre inch and 30.18 acre inch per acre respectively.

It was also found that human labour cost was major components of variable cost in specific and total cost in general. The number of human labour was used highest in conventional method i.e. 36.22 man days, which costs around Rs.14730.37. The reason for this would be, farmers might be less mechanised. It was found lowest in aerobic method of rice cultivation i.e. Rs. 8457.50 that uses 19.90 man days. The human labour cost in SRI and DSR method was found to be Rs.14028 and Rs.899. The results also reveals that, across all the rice cultivation systems bullock labour was used marginally, zero utilisation in case of aerobic and DSR method. The farmers in DSR method were more mechanised than their counterparts which was found to be 6.71 hours and total machine labour cost in this method was Rs.7888.70. The machine labour cost in conventional was Rs. 6077.78, in SRI and aerobic method it was around Rs. 7096.67 and Rs. 5275 respectively. Overall, it was concluded that the rice cultivating farmers in the study area were well mechanised.

The share of total variable cost in total cost was highest in

conventional method which was around Rs.38394.78 and it accounts for 75.39 percent. It was also found that the total variable cost in SRI method was Rs.36719.58, in aerobic

method it was Rs.28110.30 and in DSR method the variable cost was Rs.33727.85.

**Table 1:** Cost and returns under different rice cultivation systems (Rs. /acre)

Sl. No	Particulars	Conventional		SRI		Aerobic		Drum seeded Rice	
		Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost
I	Variable costs								
	Seed (kgs)	13.00	816.00	7.30	640.00	18.13	573.75	18.50	646.67
	FYM (Tractor load)	2.86	5296.30	1.80	4000.00	2.12	4937.50	1.93	4666.67
	Fertilizers (Kgs)	170.33	3601.33	156.00	3680.00	160.50	3348.00	175.17	3655.33
	Plant protection chemicals		2343.07		2610.69		2740.56		3663.98
	Micronutrients		937.50		580.00		580.00		400.00
	Irrigation ( acre inch)		709.20		482.00		359.00		569.00
	Human labour (Man days)	36.22	14730.37	33.40	14028.00	19.90	8457.50	22.20	8991.00
	Bullock labour (BP days)	1.00	1371.43	1.00	1200.00	0.00	0.00	1.00	1040.00
	Machine labour (Hours)	5.53	6077.78	5.64	7096.67	2.95	5275.00	6.71	7888.70
	Interest on WC @ 7 %		2511.81	14.36	2402.22	14.25	1838.99	15.79	2206.49
	Total variable costs		38394.78 (75.39)	219.50	36719.58 (75.01)	217.85	28110.30 (64.70)	241.29	33727.85 (73.31)
II	Fixed costs								
	Depreciation		1788.98		1019.95		1290.87		1059.72
	Land revenue		400.00		400.00		400.00		400.00
	Rental value of land		9000.00		9500.00		12000.00		9500.00
	Interest on fixed capital @ 12 percent		1342.68		1310.39		1642.90		1315.17
	Total fixed costs		12531.66 (24.61)		12230.35 (24.99)		15333.78 (35.30)		12274.89 (26.69)
III	Total cost of cultivation		50926.44	219.50	48949.92	217.85	43444.07	241.29	46002.74

### Fixed cost

The total fixed cost incurred by the farmers practicing aerobic cultivation method was highest than their counterparts, which was Rs.15333.75. It was noticed that cost incurred by the farmers in other systems vary marginally across different cultivation systems. The major component of fixed cost was the rental value of land in all the cultivation systems. Rental value in conventional, SRI, aerobic and DSR method was Rs.9000, Rs.9500, Rs.12000 and Rs.9500 respectively. Land revenue was found to be Rs.400 across all the system and it accounts small share of total fixed cost. The depreciation cost of conventional, SRI, aerobic and DSR method was Rs.1788.98, Rs.1019.95, Rs.1290.87 and Rs.1059.72 respectively.

The total cost of cultivation was found to be highest in conventional method which was Rs. 50926.44 and it is due to higher usage of human labour. The total cost was found lowest in aerobic method (Rs.43.444.07) because there is no nursery preparation and transplanting activity which reduces human labour cost. Similarly, in SRI method and DSR method the cost of cultivation was Rs.48949.92 and Rs.46002.74 respectively.

### Yield and returns

The results of the table 2 indicate yield and return structure of

paddy under different rice cultivation systems. Across all cultivation systems the yield was found to be highest in SRI method (33.2 quintals) due to the fact that there are more number of tillers obtained per hill i. e. 30 to 40 tillers thereby increasing the yield. The average yield in conventional method was 25.5 quintals which is followed by the drum seeded rice (23.57 quintals) and aerobic methods (23.13 quintals). Gross and net returns were highest in case of SRI method (Rs. 70336 and Rs. 21386.08) this is because of higher yield. The gross returns in drum seeded rice cultivation was found to be Rs.53426.17 then in conventional and aerobic rice cultivation method it was found to be Rs. 54493.30 and Rs. 48984.38 respectively. Net return was found to be lowest in case of conventional method which was Rs.3566.89. This was due to higher cost incurred especially for human labour. It was also found that, net return in aerobic and DSR method was Rs.5540.30 and Rs. 7423.43. Gross return per variable cost was found to be highest in SRI method of cultivation i.e. Rs. 1.92 per acre. Gross return per COC was also highest in case of SRI method (Rs. 1.44/ac) followed by DSR (Rs 1.16/ac), aerobic (Rs.1.13/ac) and conventional (Rs. 1.07/ac) method of rice cultivation. Net return per quintal was also highest in case of SRI method (Rs.641.26) followed by the DSR (Rs.314.99), aerobic (Rs.239.58) and conventional method (Rs.139.88)

**Table 2:** Yield and returns of paddy under different rice cultivation systems (Rs. /acre)

Particulars	Conventional			SRI			Aerobic			DSR		
	Qty	Price/ Unit (Rs.)	Total (Rs.)	Qty	Price/ Unit (Rs.)	Total (Rs.)	Qty	Price/ Unit (Rs.)	Total (Rs.)	Qty	Price/ Unit (Rs.)	Total (Rs.)
Main product (qtls)	25.50	1720.00	43860.00	33.20	1730.00	57436.00	23.13	1675.00	38734.38	23.57	1755.00	41359.50
By product (Tractor load)	2.13		10633.33	2.00		12900.00	2.00		10250.00	2.07		12066.67
Gross returns (Rs.)			54493.33			70336.00			48984.38			53426.17
Net returns (Rs.)			3566.89			21386.08			5540.30			7423.43
Total Fixed cost			12531.66			12230.35			15333.78			12274.89
Total variable cost			38394.78			36719.58			28110.30			33727.85
Cost of cultivation (Rs./acre)			50926.44			48949.92			43444.07			46002.74
Cost of production (Rs./q)			1997.12			1474.40			1878.66			1952.03
Gross returns over VC(Rs./acre)			16098.55			33616.42			20874.08			19698.32
Gross returns over COC(Rs./acre)			3566.89			21386.08			5540.31			7423.43
Gross returns over COP(Rs./acre)			52496.22			68861.60			47105.71			51474.14
Gross returns per VC (Rs./acre)			1.42			1.92			1.74			1.58
Gross returns per COC (Rs./acre)			1.07			1.44			1.13			1.16
Gross returns per quintal (Rs.)			2136.99			2118.55			2118.24			2267.02
Net returns per quintal (Rs.)			139.88			644.16			239.58			315.00
Returns per rupee of expenditure (net returns per COC)			0.07			0.44			0.13			0.16

### Conclusion

Among the different rice cultivation systems, the total cost of cultivation was found to be highest in conventional method which was Rs. 50926.44 per acre. The total cost was lowest in aerobic method (Rs.43,444.07) and similarly, in SRI method and DSR method the cost of cultivation was Rs.48949.92 and Rs.46002.74 respectively. SRI method of rice cultivation was found to be producing the highest returns because of higher yield with highest yield compared to their counterparts. Thus, the study suggests adoption of either SRI or aerobic method on a larger scale so that farmers can obtain higher returns with SRI method of rice cultivation or reduce costs with aerobic method of cultivation.

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