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Economic analysis of impact assessment of production technology of paddy cultivation in North Konkan region of Maharashtra, India

[1]AD Chakranarayan, [2]SR Torane, [3]PJ Kshirsagar, [4]SS Torane and [5]RA Bhosale

[1]Ph.D. Scholar, Department of Agricultural Economics, DBSKKV Dapoli, Maharashtra, India

[2]Deputy Director of Research (AE) & Head, Department of Agricultural Economics, DBSKKV, Dapoli, Maharashtra, India

[3]Associate Professor, Department of Agricultural Economics, DBSKKV Dapoli, Maharashtra, India

[4]Assistant Professor, Department of Agricultural Economics, DBSKKV Dapoli, Maharashtra, India

[5]M.Sc Student, Department of Agricultural Economics, DBSKKV Dapoli, Maharashtra, India

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Corresponding Author: AD Chakranarayan

Abstract

The Present study is to examine Economic analysis of impact assessment of production technology of paddy cultivation in North Konkan region of Maharashtra, India. The study was undertaken by taking 180 sample farmers during the year 2022-23. To collect information from the sample area, an interview schedule and survey approach were utilized. The objective was achieved by using CACP cost concepts and Technology adoption index. The cost of cultivation (C3) Paddy was observed highest in case of low adopter group and lowest in case of high adopter group. The overall cost of production was Rs. 2873 per quintal. And gross returns from Paddy were found to be Rs. 81300 per hectare. The overall technology adoption index score was 65.28 indicating further scope for increasing adoption levels and thereby reducing per quintal cost. The benefit cost ratio at cost B2 at overall level was 1.39. Indicating profitability of Rice when human labour was not considered however at cost C3 it was not profitable. (B.C ratio 1:0.74) the profitability have clearly shown positive relationship with technology adoption which was also indicated by negative correlation between technology adoption and per quintal cost (-0.36). the one per cent increase in adoption reduce unit cost of cultivation by Rs. 11 the more use of mechanization that the labour cost which contributes at larger portion (59.96%) can be reduced and supported by technology adoption the rice can be more improved.

Keywords: Adoption, quintal, indicating

1. Introduction

Rice holds the position of being the world's third most produced agricultural crop, surpassed only by sugarcane and corn, with an estimated global production of 518.14 million tons in the 2022-23 periods. In India, rice plays a crucial role in ensuring food security, being a major crop cultivated in both monsoon and winter seasons. As the second-largest global producer of rice, India contributes 21 per cent of the world's production from 28 percent of the global rice-growing area. Maharashtra, particularly the Konkan region, holds significance in India's rice production. The Konkan region, renowned as the "rice bowl" of the state, is known for cultivating aromatic rice varieties like *Ambemohar* and *Kolam*. Rice farming in this region relies on *rainfed* practices, utilizing the favorable climate and monsoon rainfall. The present study in the North Konkan region aims to provide valuable insights for rice growers, focusing on the economic aspects of technological changes in rice production. The adoption of recommended technologies, including improved rice varieties, tillage operations, and seed technology, is crucial for increasing productivity. The study explores the adoption levels of these technologies, examines the relationship between technology adoption and its association with unit cost reduction in cost of cultivation.

2. Methodology

The study was conducted in the North Konkan region, where primary data was gathered from three districts (Raigad, Thane, and Palghar). From each district, three tahsils were selected randomly, and from each tahsil, two villages were selected randomly. Finally, 10 rice growers were selected randomly from each of the chosen villages, resulting in a sample of 180 rice growers from 18 villages in 9 tahsils across 3 districts. For the selection of farmers, list of paddy growers were obtained from the respective District Superintendent Agriculture officers (Government body undertaking various departmental activities of joint Director of Agriculture, Government of Maharashtra). To fulfill the stated objective, primary data were tabulated and analysed as per suitable statistical and economic tools. Formulas and add-ons available on MS Excel were also used for further analysis of the data. There are more than 40 technologies recommended by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli (Agricultural University) for rice growers in Konkan region for rice production. However, out of these 21 technologies were selected and they were

grouped into 10 technology components (groups).

2.1 Technology Adoption Index of each rice growers was estimated by using following formula (Anupama 2005) [1]

$$TAI = \frac{1}{n}\left(\frac{AX_1}{RX_1} + \frac{AX_2}{RX_2} + \cdots + \frac{AX_n}{RX_n}\right)$$

A)

Where,
n = No. of technologies
AXi = Actual use of selected technology
RXi = Recommended use selected technology

Excess used was observed in case of seed and nitrogen the following formula was used for calculating adaption index in case of excess use.

B) Excess use up to 200 per cent
Single Technology Adoption Index (STAI)

$$\textbf{STAI} = 2 - \left(\frac{AX_1}{RX_1}\right) \times 100$$

Where, 2 = constant
The STAI index was calculated for seed and nitrogen
C) Excess use up to 300 per cent
Single Technology Adoption Index (STAI)

$$STAI = 2 - \left(\frac{AX_1}{RX_1}\right) \times 100$$

Where, 3 & 2 is constant.

D) For excess use more than 300 per cent
Input use for 400 and 500 per cent the same formula was used for replacing the constant by 4 and 3 for 400 per cent and 5 and 4 for 500 per cent excess use.
In the present study for calculating the total adoption index for input for each farmer the sample farmer was grouped into three categories of level. The Classification was carried out with the help of mean and standard deviation criteria, such as.

1. Group I (Low adopters) = less than AM-SD
2. Group II (Moderate adopters) = (AM-SD) to (AM+SD)
3. Group III (High Adopters) =Greater than AM+SD

Where,
AM - Arithmetic Mean of Technology Adoption Index of all the farmers and all the technologies
SD - Standard Deviation of Technology Adoption Index.

2.2 Different cost concepts used in working out cost of cultivation
The cost of cultivation of the four major crops identified was worked out using the method specified by Commission for Agricultural cost and Prices (CACP) New Delhi.

Cost A_1: It includes all actual expenses in cash and kind incurred in production by the farmer. It includes - Value of hired human labour, Value of machinery power, Value of bullock labour, Value of seed, Value of manure, Value of rab material, Value of fertilizers, Land revenue, cesses and other taxes, Interest on working capital and Depreciation on implements and farm buildings

Cost A_2: It includes;
Cost A_1 + rent paid for leased- in land

Cost B_1: It includes;
Cost A_2 + interest on fixed capital (excluding land)

Cost B_2: It includes;
Cost B_1 + rental value of owned land

Cost C_1: It includes;
Cost B_1 + imputed value of family labour

Cost C_2: It includes;
Cost B_2 + imputed value of family labour

Cost C_3: It includes:
Cost C_2 + 10 per cent of cost C_2 as management cost

2.3 Association between technology adoption and unit cost
The Pearson correlation coefficient was used find out relation between technology adoption and unit cost of cultivation. The regression coefficient was used to find out the extent effect of technology adoption on unit cost reduction.

3. Results and Discussions

3.1 Distribution of sample rice growers as per level of adoption

The farmers selected for *kharif* rice were divided into three groups based on their level of technology adoption, as shown in Table 1.

Table 1: Distribution of sample rice growers as per level of adoption

Sr. No.	Category of technology adoption	Technology adoption index	Range of technology adoption index (per cent)	No. of sample rice growers	Percentage
1	Low	below 0.56	0 to 56.67	39	21.67
2	Medium	0.56 to 0.74	56.68 to 74.09	98	54.45
3	High	above 0.74	above 74.09	43	23.88
	Total/Overall		65.38 (Standard Deviation = 8.71)	180	100.00

The sample farmers were categorized as low adopters (21.67 per cent), medium adopters (54.45 per cent), and high adopters (23.88 per cent), depending on their technology adoption index, which ranges from 0 to 0.56, 0.56 to 0.74,

and above 0.74, respectively. The overall technology adoption index of the sample farmers was 65.38 per cent. The majority of the farmers were classified as medium adopters at 54.44 per cent, followed by high adopters at 23.88 per cent, and lastly, low adopters to the extent of 21.66 per cent.

3.2 Per hectare quantity of input used for different adopter group in paddy cultivation

Table 2, provides insights into the per-hectare utilization of inputs in the observed context. The overall per-hectare utilization of key inputs such as seed, farmyard manure (FYM), and fertilizers N, P, K were noted at 42.50 kg, 4.48 quintals, 75.28 kg, 17.39 kg, and 7.66 kg, respectively. In terms of labour, the per-hectare utilization for rice production varied among the low, medium, and high adopter groups, with figures of 214.42 human days, 210.50 human days, and 198.50 human days, respectively. Additionally, the total machine hours utilized were 8.60 hrs, 8.84 hrs, and 8.58 hrs.' for low, medium, and high adopters, respectively. Notably, across all groups and at the overall level, family day labourers were observed to be more extensively utilized than hired labourers. This data underscores the distribution of inputs and labour resources among different adopter groups, providing valuable insights into technology adoption and input use in paddy cultivation.

Table 2: Per hectare quantity of input used for different adopter group in paddy cultivation

Sr. No.	Items	Unit	Group			
			Low (N=39)	Medium (N=98)	High (N=43)	Overall (N=180)
1	**Hired human labour**					
	i) Male	Days	31.12	32.12	30.15	31.43
	ii) Female	Days	43.21	42.14	43.09	42.59
2	Bullock labour	Pair days	0.77	1.10	1.50	1.01
3	Machine hrs.	Hrs.	8.60	8.84	8.58	8.72
4	Seed	Kg	40.36	42.76	43.83	42.50
5	FYM	Quintal	4.18	4.37	5.76	4.48
6	Rab Material	tons	0.22	0.23	0.23	0.22
7	Fertilizer (kg)	N	71.81	75.76	77.86	75.28
		P	15.71	17.36	18.89	17.39
		K	7.12	7.06	9.44	7.66
8	**Family Labour**					
	i) Male	Days	65.03	63.15	56.11	61.87
	ii) Female	Days	75.06	73.09	69.15	72.57
9	**Total Labour day**					
	Male	Days	96.15	95.27	86.26	93.30
	female	Days	118.27	115.23	112.24	115.16
	Total		214.42	210.50	198.50	208.46

Table 3: Cost of cultivation of different adopter groups (Figures in Rs.)

Sr. No	Item	Group			
		Low	Medium	High	Overall
1	**Hired Human labour (Days)**				
	i) Male	10942 (9.84)	11311 (10.39)	12070 (11.33)	11412 (10.49)
	ii) Female	14194 (12.76)	14428 (13.26)	11942 (11.21)	13783 (12.67)
2	Bullock labour (Days)	800 (0.71)	1245 (1.14)	1500 (1.40)	1210 (1.11)
3	Machine charges (hrs)	6024 (5.41)	6189 (5.68)	6866 (6.45)	6315 (5.80)
4	Seed (kg)	2624 (2.36)	2780 (2.55)	2850 (2.67)	2763 (2.54)
5	Manures	1674 (1.50)	1749 (1.60)	2884 (2.70)	2004 (1.84)
6	**Fertilizers (in terms of nutrients) (kg)**				
	1) N	1424 (1.28)	1520 (1.39)	1558 (1.46)	1509 (1.38)
	2) P	802 (0.72)	886 (0.81)	964 (0.90)	887 (0.81)
	3) K	179 (0.16)	176 (0.16)	237 (0.22)	192 (0.17)
7	Rab Material (Rs)	871 (0.78)	898 (0.82)	972 (0.91)	910 (0.83)
8	Incidental charges and repairing (Rs)	1080 (0.97)	1081 (0.99)	1561 (1.46)	1112 (1.02)
9	Working capital (Item 1 to 8)	38733 (34.83)	39142 (35.98)	40410 (37.96)	39356 (36.19)
	Interest on Working capital	2324 (2.09)	2349 (2.15)	2424 (2.27)	2361 (2.17)
10	Land revenue, Cess & Taxes (Rs)	100 (0.08)	114 (0.10)	98 (0.09)	108 (0.09)
11	Depreciation on implements (Rs)	861 (0.77)	892 (0.82)	876 (0.82)	881 (0.81)
12	Cost A1	42018 (37.79)	43745 (40.21)	42767 (40.17)	43137 (39.66)
13	Interest on fixed capital	1021 (0.91)	1192 (1.09)	1064 (0.99)	1125 (1.03)
14	Cost B1(A1+ interest on fixed	43018 (38.69)	44397 (40.81)	43830 (41.17)	43963 (40.42)
15	Rental value of own land	12655 (11.38)	13601 (12.50)	14336 (13.46)	13571 (12.48)
16	Cost B2 (B1+ rental value of own land)	55695 (50.09)	58507 (55.78)	59456 (55.85)	58124 (53.45)
17	**Family labour (Days)**				
	Male	19595 (17.62)	22105 (20.32)	22847 (21.46)	21738 (19.99)
	Female	22524 (20.25)	18275 (16.80)	14460 (13.58)	18284 (16.81)

18	Cost C1(B1 +family labours)	88423 (79.52)	85317 (78.43	81138(76.22)	84992 (78.16)
19	Cost C2 (B2 + family labours)	101078	98887	96764	98855
20	Cost C3	111186 (100)	108776 (100)	106440 (100)	108740 (100)
21	**Yield**				
	i)Main produce	67534	73236	75906	72638
	ii)By produce	9000	8100	9635	8662
22	Total	76534	81336	85540	81300
23	Net Return	-34652	-27440	-20900	-27440
24	B:C Ratio	1:0.68	1:0.74	1:0.80	1:0.74

Figures in parentheses indicate percentage to total cost (C3)

(a) Per Hectare Cost of Cultivation: Low Adopters

Table 3 outlines the per-hectare total cost of cultivation (C3) for low adopters, amounting to Rs. 111,186. This cost was distributed across various components, with Cost-A1 at Rs. 42,018, Cost-B1 at Rs. 43,018, and Cost-B2 at Rs. 55,695. Additional expenses, including seed, manure, and fertilizers N, P, and K, constituted 2.26 per cent, 1.50 per cent, 0.72 per cent, 0.16 per cent, and 0.13 per cent of the total cost, respectively. Family labour played a substantial role, contributing 37.87 per cent to the total cost. The gross value of the main and by-products was Rs. 76,534.

(b) Per Hectare Cost of Cultivation: Medium Adopters

Table 3 reveals the per-hectare total cost of cultivation (C3) for medium adopters as Rs. 108,776. Components such as Cost-A1, Cost-B1, and Cost-B2 were Rs. 43,745, Rs. 44,397, and Rs. 58,507, respectively. Input percentages for seed, manure, fertilizer components N, P, and K were 2.55 per cent, 1.07 per cent, 1.39 per cent, 0.81 per cent, and 0.16 per cent, respectively. Family labor constituted 37.15 per cent of the total cost. The gross value of main and by-products was Rs. 81,336.

(c) Per Hectare Cost of Cultivation: High Adopters

For high adopters, Table 3 indicates a per-hectare total cost of cultivation (C3) at Rs. 106,440, with Cost-A1, Cost-B1, and Cost-B2 at Rs. 42,767, Rs. 43,830, and Rs. 59,456, respectively. Input percentages for seed, manure, fertilizer N, P, and K were 1.46 per cent, 0.90 per cent, 1.46 per cent, 0.90 per cent, and 0.22 per cent, respectively. Family labor contributed 35.05 per cent to the total cost. The gross value of main and by-products was Rs. 85,540.

(d) Per Hectare Cost of Cultivation: Overall Adopters

At the overall level, the per-hectare total cost of cultivation (C3) was Rs. 108,740. Components such as Cost-A1, Cost-B1, and Cost-B2 were Rs. 43,137, Rs. 43,967, and Rs. 58,124, respectively. Input percentages for seed, manure, fertilizer N, P, and K were 2.54 per cent, 1.84 per cent, 1.38 per cent, 0.81 per cent, and 0.17 per cent, respectively. Family labour contributed 36.80 per cent to the total cost. The gross value of main and by-products was Rs. 81,300, resulting in a benefit-cost ratio of 1:0.74, indicating a lack of profitability in rice cultivation in the studied area. Notably, human labour accounted for the maximum share of paid-out costs at 23.16 per cent, followed by machine charges at 5.80 per cent. The high percentage share of human labor emphasizes the need for mechanization to potentially reduce the total cost of cultivation.

3.4 Profitability of rice Cultivation at different group of technology adoptions

Table 4: Profitability of rice cultivation at different group of technology adoptions

Sr. No.	Particulars	Group			
		Low	Medium	High	Overall
1	Yield q/ha	33.10	35.90	37.20	35.60
2	Value of main product	67534	73236	75906	72638
3	Value of by product	9000	8100	9635	8662
4	Gross income	76534	81336	85540	81300
5	**Cost of cultivation**				
	Cost A1 (Rs`)	42018	43745	42767	43137
	Cost B1 (`Rs)	43018	44397	43830	43963
	Cost B2 (Rs`)	55695	58507	59456	58124
	Cost C1 (Rs`)	88423	85317	81138	84992
	Cost C2 (`Rs)	101078	98887	96764	98855
	Cost C3 (Rs)	111186	108776	106440	108740
6	**Profit at**				
	Cost A1 (Rs`)	34516	37591	42773	38163
	Cost B1 (`Rs)	33516	36939	41710	37337
	Cost B2 (Rs`)	20839	22829	26084	23176
	Cost C1 (`Rs)	-11889	-3981	4402	-3692
	Cost C2 (`Rs)	-24555	-17551	-11224	-17555
	Cost C3 (Rs)	-34652	-27440	-20900	-27440
7	**Input- Output ratio**				
	Cost A1 (`Rs)	1.82	1.85	2.00	1.88
	Cost B1 (`Rs)	1.77	1.83	1.95	1.84
	Cost B2 (Rs`)	1.37	1.39	1.43	1.39
	Cost C1 (`Rs)	0.86	0.95	1.05	0.95
	Cost C2 (Rs`)	0.75	0.82	0.88	0.82
	Cost C3 (Rs)	0.68	0.74	0.80	0.74

The analysis of input utilization and cultivation costs across different adoption categories low adopters, medium adopters, and high adopters revealed notable variations in yield levels and profitability for rice cultivation. The findings, presented in Table 3.4, illustrate that per-hectare yields increased from 33.10 quintals in low adopters to 37.20 quintals in high adopters, with an overall yield of 35.60 quintals. Gross returns per hectare were highest for high adopters at Rs. 85,540, followed by medium adopters at Rs. 81,336 and low adopters at Rs. 76,534. Profitability was evident at the Cost A1, Cost B1, and Cost B2 levels, with positive benefit-cost ratios of 1:1.88, 1:1.84, and 1:1.39, respectively, at the overall level. However, the benefit-cost ratio was less than one at the C3 cost level for all adoption categories, resulting in an overall ratio of 1:0.74. Notably, at the Cost B2 level, the benefit-cost ratios exceeded one in all groups, reaching the highest in the high adopter group at 1:2.00, followed by medium adopters at 1:1.85, and low adopters at 1:1.82. Conversely, at the C1, C2, and C3 cost levels, the benefit-cost ratios were negative, indicating non-profitability for low, medium, and overall adopters. This comprehensive analysis sheds light on the varying economic outcomes associated with different levels

of technology adoption in rice cultivation.

3.5 Unit cost reduction

The analysis of unit cost of reduction was carried out to ascertain relation between technology adoption index and per quintal cost of rice cultivation. The details of analysis on this aspect on are given in table 5

Table 5: Unit cost reduction in rice cultivation

Sr. No.	Particulars	Group			
		Low	Medium	High	Overall
1	output (q/ha)	33.11	35.90	37.20	35.60
2	Gross Returns	76534	81336	85540	81300
3	**Cost per hectare**				
	Cost A1	42018	43745	42767	43137
	Cost B1	43018	44397	43830	43963
	Cost B2	55695	58507	59456	58124
	Cost C1	88423	85317	81138	84992
	Cost C2	101078	98887	96764	98855
	Cost C3	111186	108776	106440	108740
A	**Cost per quintal**				
	Cost A1 (Rs.)	998	992	890	968
	Cost B1 (Rs.)	1027	1011	919	993
	Cost B2 (Rs.)	1410	1404	1339	1390
	Cost C1	2398	2150	1922	2149
	Cost C2	2780	2529	2342	2539
	Cost C3	3086	2804	2602	2873
B	**Decrease or increase in cost of cultivation**				
	Cost A1 (Rs.)	0	1727	749	1119
	Cost B1 (Rs.)	0	1379	812	945
	Cost B2 (Rs.)	0	2812	3761	2429
	Cost C1	0	-3106	-7285	-3431
	Cost C2	0	-2191	-4314	-2223
	Cost C3	0	-2410	-4746	-2446
C	**Unit cost reduction per quintal**				
	Cost A1	0	0.60	12.13	2.99
	Cost B1	0	1.58	11.75	3.47
	Cost B2	0	0.42	5.30	1.45
	Cost C1	0	11.53	24.76	11.57
	Cost C2	0	9.92	18.70	9.50
	Cost C3	0	9.13	15.68	6.90

It is seen from table that, technology adoption has positive influence on cost reduction. The per quintal cost of cultivation of *kharif* rice reduced from Rs. 3086 per quintal in low adopters to Rs. 2602 in high adopters and at the overall level it was Rs. 2873. Thus, unit cost reduction analysis of rice production in study area indicated that cultivation of rice by using adoption of recommended technology reduce cost of per quintal production of rice.

3.6 Association between adoption index and unit cost reduction

3.6.1 Regression analysis between adoption index and per quintal cost of paddy

The information regarding regression analysis between adoption index and per quintal cost of paddy are presented in table 6.

The attempt was made to examine functional relationship between adoption index and per quintal cost of paddy with the help of regression analysis. In which adoption index is independent variable (x) and per quintal cost of paddy is dependent variable (y). The value of coefficient (adoption index) was -0.36. The coefficient of adoption index was statistically significant at one per level.

Table 6: Regression analysis between adoption index and per quintal cost of paddy

Sr. No	Variable	Coefficient	P value	SE	t -Stat
1	intercept	3.08	8.76	0.42	7.18
2	Adoption Index (X)	-0.36*	0.003	0.12	-2.92
F- Test		8.58			
R^2		0.30			

It was inferred that one per cent increase in adoption index will decline per quintal cost by 0.36 per cent. It was also observed that average per quintal cost of low group was Rs. 3086 hence, as the adoption index increase by one per cent the per quintal cost of low group will decrease Rs. 11, hence which underlines the importance of technology adoption with respect of reduction in cost of cultivation.

3.6.2 Pearson's correlation co-efficient of adoption index with per quintal cost of paddy production

The information regarding Pearson's correlation co-efficient of adoption index with per quintal cost of paddy production are presented in table 7

Table 7: Pearson's correlation co-efficient of adoption index with per quintal cost of paddy production

Variables	Adoption index (X1)	Per quintal cost (X2)
Adoption index (X1)	1	
Per quintal cost (X2)	-0.21	1

The attempt was made to assess association between the adoption index and per quintal cost by using Pearson's correlation co-efficient. It was found that the value of the correlation coefficient was -0.21, which indicate there is negative correlation. It means as the adoption index increase per quintal cost will decline

4. Conclusion

The investigation demonstrated that the application of recommended technologies in paddy cultivation yielded favorable returns for the sampled farmers. Consequently, the benefit-cost ratios at Cost-C1, C2, and C3 levels at the overall level were determined to be 1:0.95, 1:0.82, and 1:0.72, respectively, indicating that rice cultivation was more profitable in the high level of adoption category compared to the low and medium categories. However paddy was profitable at cost A1 with B.C. ratio 1: 1.88. similarly B.C ratio at cost B1 and B2 at overall level were 1.84 and 1.39 respectively indicating its profitability when family labour were not considered. The study's conclusion highlighted that as technology adoption increased, the benefit-cost ratio also showed an upward trend. This positive correlation underscored the beneficial impact of technology adoption on the economics of rice cultivation. The one per cent in technology adoption results in 0.36 per cent decreases in per quintal cost of cultivation of Paddy. The labour was one of the major item of cost C (59.87%) indicating the importance of mechanization for reducing cost of cultivation in addition to technology adoption In essence, the economic analysis of rice production in the study area strongly suggested that cultivating rice through

the adoption of recommended technologies was a financially viable and profitable endeavor.

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