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Impact assessment of production technology of paddy in Maharashtra

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ABSTRACT

The primary data were collected 288 paddy cultivators for the period of 2013-14. Based on the data of costs and returns, benefit-cost ratio (BCR), yield gap analysis, resource use efficiencies, decomposition analysis, adoption index and impact, and constraints of improved paddy technology have been estimated in the study. For Maharashtra State as a whole, per hectare Cost 'C' was worked out to Rs.47,652.48 and its B:C ratio was 1.27. Per hectare cost of production has increased with the increase in technology adoption however, per unit cost has decreased with increase in technology adoption. Further; there was a 19.07 per cent yield gap between actual yield and yield of demonstration plot. The composite index of technology adoption was 49.89 per cent, which indicated that the sample farmers adopted less than 50 per cent recommended paddy production technology and obtained 36.01 q ha^{-1} yield. The contribution of different components on impact of paddy production technology was maximum in net returns (55.61 %).The constraint about adoption and impact of paddy cultivation were in high cost of inputs, adopted traditional methods, high wage rates, lack of technical knowledge and low price to produce. The improved paddy production technology method being more skill oriented, the study has observed that yields can be increased on adoption and the constraints are addressed on war-footing basis.

***Keywords*:** Adoption index, decomposition model, impact, production function, technology yield gap

Paddy (*Oryza sativa L.*) is one of the important cereal crops of the world and forms the staple food for more than 60 per cent of the world people. Rice has shaped the culture, diets and economics of thousand of millions of people. India is one of the leading rice producing countries of the world with cultivated area of 43.97 M ha and production of 100 Mt in 2011-12. The leading states in rice cultivation are: West Bengal, Uttar Pradesh, Orissa, Andhra Pradesh and Panjab. Maharashtra is one of the major rice growing states in India. Paddy is grown on 15.40 million ha with an annual production of 35.00 million tonnes and productivity at 1821 kg ha^{-1} during the year 2011-12. Maharashtra ranks 12th in production and 13th in productivity among major rice growing states of the country (India Stat.Com., 2012).

Paddy is the second largest important crop next to jowar in Maharashtra. The position of Maharashtra in rice production is comparatively poor. In the state, paddy is grown in districts with varying extent. However, the major rice growing districts are Thane and Raigad in Konkan region, Kolhapur and Nasik districts in Western Maharashtra region, Nanded and Parbhani districts in Marathwada region, Bhandara and Gondia districts in Vidarbha region (Mah.Stat.com., 2013).

The present study is an attempt to analyze the impact of improved technologies on paddy production in Marathwada regions of Maharashtra. The study undertaken so far had mostly focused on the favorable effects of technological change. The reasons for the rate of adoption lagging behind expectation have been virtually unexamined. Therefore, a study which focuses on both aspects of technical changes *i.e.* its impact on yield, returns etc. as well as the reasons for non adoption of improved technology assumes great importance. Considering the above facts it was necessary to analyzed the "Impact Assessment of Production Technology of Paddy in Maharashtra". With this background, present study was undertaken.

MATERIALS AND METHODS

The study was conducted in Maharashtra state as whole. Eight districts were selected on the basis of maximum area under paddy. From each district, 36 farmers were selected who were practicing improved production technology of paddy of cultivation on the basis of small, medium and large size group holding. The study was based on primary data which were collected of 288 paddy cultivators for the year 2013-14. The farmers were interviewed using specially prepared schedules. The farmers were also asked to prioritize the most important constraints they were facing in adopting improved method of paddy cultivation.

Cobb-Douglas type of production function

$$Y = aX_1^{b_1}X_2^{b_2}X_3^{b_3}X_4^{b_4}X_5^{b_5}X_6^{b_6}X_7^{b_7}\ldots\ldots X_n^{b_n}e^u$$

where,

Y = Output of main produce in quintals per hectare

a = Intercept

X_1 = Per hectare use of human labour in man days

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X_2 = Per hectare use of bullock in pair days
X_3 = Seed (kg) per hectare
X_4 = Per hectare use of manure in quintals
X_5= Nitrogen (kg) per hectare
X_6 = Phosphorus (kg) per hectare
X_7 = Potash (kg) per hectare
e^u = error term

Estimation of marginal value product

$$\text{Marginal value product of } X_i = b_i \frac{\bar{y}}{x} P_y$$

where,

bi = Elasticity of production of ith input
Y = Geometric mean of output
Xi = Geometric mean of of ith input
Py = Per unit price of output

Technological gap analysis

Yield gap was worked out as the difference between demonstration plot yield and actual farmer's yield. The following Cobb-Douglas type of production function was used for this purpose. (*Gaddi et al, 2002)* [8]

$$Y = a_0 H^{a_1} B^{a_2} M^{a_3} N^{a_4} P^{a_5} e^u$$

where,

Y = Output of main produce in quintals per hectare
a_0 = Intercept
H = Per hectare use of human labour in man days
B = Per hectare use of bullock in pair days
M = Per hectare use of manure in quintals
N = Nitrogen (kg) per hectare
P = Phosphorus (kg) per hectare
e^u = error term
a_1 to a_5 elasticities of production.

The combination of different resources to yield gap was estimated with the help of **Decomposition model**. The following functional form was used to work out the yield gap. *(Bisliah, 1977)*. The Chow test was conducted for checking the production elasticity of the two functions.

$$\text{Log } (Y_2/Y_1) = [\text{Log } (b_0/a_0)] + [(b_1-a_1) \text{ Log } H_1 + (b_2-a_2) \text{ Log } B_1 + (b_3-a_3) \text{ Log } M_1 + (b_4-a_4) \text{ Log } N_1 + (b_5-a_5) \text{ Log } P_1] + [b_1 \text{ Log } (H_2/H_1) + b_2 \text{ Log } (B_2/B_1) + b_3 \text{ Log } (M_2/M_1) + b_4 \text{ Log } (N_2/N_1) + b_5 \text{ Log } (P_2/P_1)] + [U_2 - U_1]$$

Technological adoption index

Technology Adoption Index (TAI) was worked out as per Kiresur *et al*. (1996) with the help of following formula.

$$TAI = \frac{A_1}{M_1} X\ 100$$

where,

Ai = Average adoption score registered by the farmer for particular component
Mi = Maximum adoption score registered by the farmer for particular component.

Constraints in adoption of improved production technology of paddy in Maharashtrta

The constraints were estimated with help of percentages.

RESULTS AND DISCUSSION

Resource use gap of paddy in Maharashtra

For the state as a whole (Table 1), per hectare resource use gap between yield on sample cultivators farm and demonstration plot was 19.07 per cent. The inputs of human labour, bullock power, manures and potash were utilized less than the demonstration plot, while in case of sample cultivators farm, the per hectare use of seed, nitrogen and phosphorous were utilized more than the demonstration plot, for poor germination, flooding condition, maintaining the plant population and to increase the grain production. It can be concluded that, for obtaining the desirable yield, resources should be used at optimum level. Similar findings were noted by Jayaram (1988) and Reddy *et al.*(1996).

Table 1: Resource use gap of paddy in Maharashtra (Per ha)

Sr. No.	Particulars	Demonstration plot	Sample cultivator	Absolute gap	Gap %
1	Total human labour (Days)	169.63	135.94	33.69	19.86
2	Bullock power (Pair days)	12.25	10.86	1.39	11.34
4	Seed (kg)	36.25	87.33	-51.08	-140.91
5	Manures (q)	93.75	17.07	76.68	81.79
6	Fertilizers (kg)				
a.	N	95.00	103.46	-8.46	-8.91
b.	P	50.00	96.62	-46.62	-93.24
c.	K	50.00	20.96	29.04	58.08
7	Yield (q)	44.50	36.01	8.49	19.07

Note:- Gap indicates excess use than recommendation
+ Gap indicates low use than recommendation

Table 2: Costs and return structure of paddy in Maharashtra (Per ha)

Sr. No.	Particulars Unit		Size groups Small	Medium	Large	Overall
1	Total cost					
	i) Cost 'A'	Rs.	31275.74	27718.11	28842.27	28953.60
	ii) Cost 'B'	Rs.	43225.95	40115.25	41525.15	41415.49
	iii) Cost 'C'	Rs.	49775.10	46343.85	47715.14	47652.48
2	Profit at					
	i) Cost 'A'	Rs.	26686.51	32966.71	33219.39	31925.19
	ii) Cost 'B'	Rs.	14736.30	20569.57	20536.51	19463.30
	iii) Cost 'C'	Rs.	8187.15	14340.97	14346.52	13226.31
3	Production	q	33.50	34.61	37.64	36.01
4	Gross income	Rs.	57962.25	60684.82	62061.66	60878.79
5	B:C ratio at					
	i) Cost 'A'		1.87	2.19	2.13	2.09
	ii) Cost 'B'		1.34	1.50	1.47	1.46
	iii) Cost 'C'		1.16	1.30	1.29	1.27
6	Per quintal cost	Rs.	1353.04	1219.66	1150.04	1202.83

Cost, returns, gross income and BC ratio of paddy in Maharashtra

It is revealed from table 2, at the overall level, State as whole per hectare cost of cultivation of paddy *i.e.* Cost 'C' was Rs.47,652.48 and gross income was Rs.60,878.79. At the overall level, per quintal cost of paddy was Rs. 1,202.83 and with B: C ratio 1.27. From the above discussion it is indicated that per unit cost of cultivation declined as size group increase and that results into more (1.30) profitability in medium size group. Therefore, this study suggests that, to make cultivation of paddy profitable, it is essential that the average yield should be raised and harvest prices should be remunerative. These findings were noticed by Hussain (2009).

Results of Cobb-Douglas type of production function in Maharashtra

Table 3 revealed that, the human labour (X_1), bullock labour (X_2), manures (X_4) and potash (X_1), were turned out statistically significant, Hence, it indicated that one unit increase in the manures and potash fertilizers will result into 0.09 and 0.04 per cent increase in the output, respectively. The other resources like seed, nitrogen and phosphorus fertilizers were not significant but positive i.e excess use. It indicates that they have positive impact on output. This result has confirmed with the findings of Rao Rama (2011).

Results of decomposition analysis in Maharastra

It is depicted from table 4, the results attributed by differences in cultural practice, whereas remaining 7.83 per cent of yield was due to difference in use of input. The maximum positive difference of input use level was found from phosphorous followed by potash, bullock labour, manures and nitrogen. Whereas, seed (-5.18 %) and human labour (-0.07 %) were contributing negatively towards the yield gap. Thus, the total difference in output was measurably caused by difference in cultural practices, rather than differences in input level. These finding confirmed the results reported by Basavaraja *et al.* (2008), and Rao Rama (2011).

Table 3: Results of Cobb-Douglas production function of paddy in Maharashtra

Sr. No.	Particulars	Small	Medium	Large	Overall
1	Intercept	1.5471	0.8151	0.9834	0.6048
2	Human labour in days (X_1)	0.5412*** (0.1809)	0.6848** (0.2980)	0.6410* (0.4129)	0.6863*** (0.2375)
3	Bullock labour in days (X_2)	0.3124** (0.1492)	0.1345* (0.0756)	0.1849** (0.0894)	0.0629** (0.0243)
4	Seed (X_3)	0.6451 (0.6932)	0.8791 (0.9876)	0.8795 (0.9989)	0.7945 (0.9978)
5	Manures in q (X_4)	0.0934*** (0.0365)	0.0727** (0.0374)	0.0612** (0.0320)	0.0993*** (0.0331)
6	Nitrogen (X_5)	0.0121** (0.0056)	0.0721* (0.0417)	0.0016 (0.0129)	0.0049 (0.0078)
7	Phosphorus (X_6)	0.0014 (0.0461)	0.0029 (0.0103)	0.0046* (0.0027)	0.0026 (0.0297)
8	Potash (X_7)	0.0456** (0.0176)	0.0316** (0.0124)	0.0316** (0.0147)	0.0478** (0.0216)
9	R^2	0.65	0.60	0.70	0.75
10	Observation	96	96	96	288
11	D.F.	88	88	88	280
12	F-value	22.96***	18.85***	15.04***	17.97***

(Figures in parentheses are standard errors of respective regression coefficients)

, ** and * indicates significance level at 10, 5 and 1 per cent level*

Technology adoption index on sample farm in Maharashtra

At the overall level adoption index (Table 5) of method of sowing technology component was maximum (89.93 %) on sample farms. State as whole the composite index of technology adoption was worked out to 49.89 per cent indicated that the sample farmers adopted less than 50.00 per cent recommended paddy production technology obtaining 36.01q ha^{-1} yield. The positive relationship was observed in between composite index and yield obtained on sample farms *i.e.* increase in composite index resulted in increase in yield. The similar findings were noticed by Sitadevi and Ponnarsai (2009).

Impact of improved paddy production technology in Maharashtra

The contribution of component on impact of paddy production technology (Table 6) net returns was maximum (43.97 %). The per hectare yield has increased from 26.67 to 36.01 quintal per hectare over the

difference level of adoption. The added yield was 10.96 q/ha over the local and improved method of adoption. Thus, for producing extra yield per hectare costs were also increased Rs.9,834.21 and added returns were also increased Rs. 17,189.51.The ICBR ratio indicates that the high adoption improved production technology adopter farmers were in profit with 1.75 ICBR ratio. It indicates that, the farmers should adopt the improved production technology for paddy to the fuller extent for maximizing returns and minimizing per unit cost. These results confirm the results noticed by Borah *et al.* (1986).

Table 4: Results of decomposition analysis in Maharashtra

Sr. No.	Source of productivity difference	Contribution %
A	Total difference observed in output	19.07
B	Source of contribution	
	1. Difference in cultural practices (Non neutral technological changes)	11.24
	2. Due to difference in input use level (Neutral technological changes)	
	a. Human labour	1.26
	b. Bullock labour	3.39
	c. Seed	-1.34
	d. Manure	-0.57
	e. Nitrogen	1.56
	f. Phosphorous	2.54
	g. Potash	1.04
C	Due to all inputs	7.83
D	Total estimated gap from all sources	19.07

Table 5: Technology adoption index of paddy in Maharashtra (%)

	Component	Size group			Overall
		Small	Medium	Large	
1.	Date of sowing	65.00	69.00	76.00	69.91
2.	Seed rate	58.00	65.00	70.00	64.24
3.	Variety	47.00	53.00	60.00	53.30
4.	Method of sowing	87.00	91.00	92.00	89.93
5.	Manures	24.00	35.00	40.00	32.98
6.	Nitrogen	62.00	68.00	73.00	67.70
7.	Phosphorous	53.00	65.00	68.00	62.04
8.	Potash	16.00	20.00	30.00	21.76
9.	Plant protection	11.00	18.00	22.00	17.01
	Composite index	44.19	50.76	54.73	49.89
	Yield (q)	33.50	34.61	37.65	36.01

Table 6: Impact of improved paddy production technology in Maharashtra

Sr. No.	Particulars	Local method	Improved method	impact %
A)	**Employments**			
	1. Total human labour (Man days ha^{-1})	112.99	135.94	16.88
	2. Bullock labour (Pairs days)	7.78	10.86	30.21
	3. Machine power in hrs	4.81	7.55	36.17
B)	**Yield ($q.ha^{-1}$)**			
	1. Main produce	26.67	36.01	30.43
	2. By-produce	33.62	43.38	23.07
C)	**Economics (Rs ha^{-1})**			
	1. Gross returns	43689.38	60878.79	28.24
	2. Cost of cultivation	37818.26	47652.48	20.64
	3. Net returns	5871.13	13226.42	55.61
D)	**B:C ratio**	1.16	1.27	
E)	**Cost effectiveness of improved paddy production technology**			
	1. Added returns	-	17189.51	-
	2. Added cost	-	9834.21	-
	3. Added yield (q)	-	10.96	-
	4. % increase in yield	-	43.74	-
	5. Cost ($Rs.q^{-1}$)	1509.70	1323.40	-
	6. Unit cost reduction ($Rs.q^{-1}$)	-	186.29	-
	7. % reduction	-	12.34	-
	8. ICBR ratio	-	1.75	-

Table 7: Constraints in adoption of improved production technology of paddy in Maharashtra

Sr. No.	Particulars	Group			Overall (N=288)
		Small (N=96)	Medium (N=96)	Large (N=96)	
1	Abnormal distribution of rainfall	54.17	45.83	54.17	51.39
2	High cost of Input	95.83	95.83	95.83	95.83
3	Use of traditional methods	70.83	41.67	33.33	48.61
4	Expensive and more labour required	95.83	95.83	87.50	93.06
5	Lack of Unawareness	62.50	70.83	70.83	68.06
6	Labour requirement is more	58.33	62.50	45.83	55.56
7	It is time consuming method	91.67	37.50	66.67	65.28
8	High wage rates	95.83	95.83	87.50	93.06
9	Lack of technical know-how	54.17	37.50	37.50	43.06
10	Low price to produce	79.17	58.33	54.17	63.89

Constraints in adoption of improved production technology of paddy in Maharashtra

The major constraint (Table 7) were high cost of inputs, abnormal distribution of rainfall, adopted

traditional methods, expensive and more labour required, high wage rates, lack of awareness, lack technical knowledge and low price to produce were the major constraints reported by farmers, respectively.

The resource yield gap of 19.07 per cent was noticed between demonstration plot yield and sample cultivator farms. The per quintal cost of production of paddy was Rs. 1,202.83, with 1.27 Benefit: cost ratio of paddy which was greater than unity. Therefore, paddy is profitable enterprise.

State as whole the composite index of technology adoption was worked out to 49.89 per cent indicated that the sample farmers adopted less than 50.00 per cent recommended paddy production technology obtaining 36.65 qtls/ha yield. The contribution of component on impact of paddy production technology, net returns was maximum (43.97 %) followed by gross returns and main produce. The high level adoption of paddy production technologies helped to increase the output maximization and cost reduction.

The study indicates that majority of the farmers yield levels remained obviously low. To increase their yield levels, there is a need to increase adoption of recommended technologies like use of HYV and hybrid varieties, fertilizers, plant protection and other technologies given by the University for increasing the rice productivity. There is a scope for extension agencies to educate the farmers for adopting recommended technologies

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