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Impact of modern technologies on rice production in Ratnagiri district (M.S.)

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Abstract
Rice (*Oryza sativa* L.), is an important food grain crop of Kokan region. For the fulfilling the food requirement of increasing population there is a need to increase the production and productivity of rice. The present study entitled, 'Impact of modern technologies on rice production in Ratnagiri district (M.S.)' was undertaken with two tahsils having maximum proportionate rice area to gross cropped area. Eight villages and 120 farmers were selected randomly from study area. The data collected pertains to agriculture year 2008-2009. The sample farmers were classified into three groups as per technological adaption index (TAI) as low (up to 33), moderate (34 to 66) and higher adapter (above 66).
It was observed from the study that the cropping pattern of the sample farmers was dominated by rice crop. The gross cropped area at overall level was 1.39 ha with cropping intensity of 111.2 per cent. As regards to input utilization, it was found that the farmers in high adoption category utilized the highest inputs per hectare as compare to low and moderate adoption category. Per hectare cost of cultivation was also found to be maximum (Rs. 57100.63) in high adoption category followed by Rs. 52793.35 and Rs. 47767.84 in moderate and low adoption category, respectively.
Per hectare gross returns obtained in different adopters from rice was Rs.46310, Rs.53437and Rs.59865 in low, moderate and high adoption category, respectively. The cultivation of rice in low adoption category was not found profitable at total cost level. Per hectare loss observed was to the tune of Rs. 1457.84 in low adoption category. The input-output ratio observed to 1:0.97 and 1:1.01 in low and moderate adopters while, it was 1:1.05 in high adopters. In all the three groups, more or less constant returns to scale were observed in the production of rice.
Deviation of inputs used was more in low adapter as compare to high and moderate adapter group.

Keywords: Adoptor, cost benefit ratio, cropping intensity, deviation, Technological Adoption Index (TAI)

Introduction
Rice (*Oryza sativa*) is one of the most important food grain crops of the world. Rice is the staple food of most of the people in Asia. The Asia-Pacific region produces and consumes more than 90 per cent of the world's rice. Therefore rice is not only a staple food of the region but also a way of life. Nearly two third of the world population depends primarily on rice for their daily quota of nutrients, more so in the developing nations. Rice is grown in 114 countries, in the world and it is cultivated on about 155.3 million hectares of area with total production of 426 million tons (Anonymous 2014). China, India, Indonesia and Bangladesh account for nearly 70 per cent of the global rice production.
It is necessary to pay attention to this crop to raise its per hectare yield and to bring about significant increase in its production. The average productivity of the crop is relatively low. Improvement in this crop can be brought about largely by advances in two directions i.e. by evolving high yielding and hybrid varieties and by adopting new technologies and by improving efficiency of existing inputs. Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth has given number of technologies to the farmers which are useful for boosting the rice productivity.
Among the various agronomic practices judicious use of manures and fertilizers is one of the important strategies for increasing production of rice per unit area. The breeding of high yielding varieties have laid the basis for rice production in India. These improved varieties can give the anticipated yield per unit area, when grown under favorable environmental conditions without which they are not able to manifest their maximum yield potential. The high yielding varieties are highly responsive to fertilizers. In India, taking into consideration soil having low levels of organic carbon it is a great challenge to feed hybrid rice with balanced nutrition.

Therefore more attention needs to be given on organic sources like FYM, poultry manures and green manuring crops with optimum use of chemical fertilizers.

More specially, green revolution denotes the large increase in crop yields which in recent years, resulted mainly from the development and adoption of new hybrids and the improved technology associated with their culture.

The present study is an attempt to analyze the impact of modern technologies on rice production in Ratnagiri district of Maharashtra. The studies 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. and seeks to bring out contrast between the different categories of adopters of improved production practices in rice production with a view to highlight the gap between the level of production, productivity, cost and returns. In the light of problems indicated above, the present study was undertaken in Ratnagiri district of Maharashtra state with the overall objectives of enquiring into the economic aspects of the impact of modern rice technology on costs, yields, returns, etc.

Methodology

The present study entitled, 'Impact of modern technologies on rice production in Ratnagiri district (M.S.)' was undertaken with two tahsils having maximum proportionate rice area to gross cropped area. Eight villages and 120 farmers were selected randomly from study area. The data collected pertains to agriculture year 2008-2009.

Analysis of data

For accessing the impact of technology following parameters were used

1. Proportion of area under HYV and hybrid rice
2. Recommended dose of NPK
3. Recommended dose of organic manure

On the basis of this information the 'Technology Adoption Index" of each farmer was estimated by using following formula.

$$TAI_i \quad \frac{1}{n}\frac{AH_i}{CA_i} + \frac{NA_i}{NR_i} + \frac{PA_i}{PR_i} + \frac{KA_i}{KR_i} + \frac{OA_i}{OR_i} \quad \times 100$$

Where,

i = Number of farmers say 1,2,3…….. 120

TAI_i = Technology adoption index of the i^{th} farmer

AH_i = Area under HYV and hybrid rice (ha)

CA_i = Total area under rice (ha)

NA_i = Quantity of nitrogen applied for rice (kg/ha)

NR_i = Recommended dose of nitrogen for rice crop (kg/ha)

PA_i = Quantity of phosphorus applied for rice (kg/ha)

PR_i = Recommended dose of phosphorus for rice crop (kg/ha)

KA_i = Quantity of potash applied for rice crop (kg/ha)

KR_i = Recommended dose of potash for rice crop (kg/ha)

OA_i = Quantity of organic manure applied for rice (kg/ha)

OR_i = Recommended dose of organic manure for rice crop (kg/ha)

Then the selected farmers were classified into three groups as

1. Low adopters (TAI_i = 0-33 %)
2. Moderate adopters (TAI_i = 34-66 %)
3. High adopters (TAI_i > 66 %)

Classification of sample farmers on the basis of Technology Adoption Index (TAI).

S. No	TAI Range (%)	No. of farmers	Adoption level
1.	Up to 33	24	Low
2.	34 to 66	68	Moderate
3.	Above 66	28	High
Total		120	

Then, the data collected from the selected farmers were analyzed by using suitable mathematical and statistical techniques such as percentage, ratios, average, frequency distribution etc. The separate analysis for estimation of cost, returns and profitability in each group was carried out to know the impact of technology on productivity and per quintal cost of cultivation of rice. Stander cost concepts were used in working out cost of cultivation.

Results and Discussion

1. Cropping pattern

The cropping pattern is the important factor influencing costs and returns on the farms. It also determines employment potential. Table 1 gives an idea about per farm area under different crops in different seasons.

It is seen from Table 1 that, at overall level out of the total cropped area of 1.39 ha, 0.51 ha (36.69%) was under *kharif* rice and 0.02 ha (1.44%) was under nagli crop. Pulses and vegetables were grown in *rabi* season. The area under pulses and vegetables were 0.06 ha (4.32%) and 0.08 ha (5.76%), respectively. The area under total *rabi* crops was only 0.14 ha (10.37%). The remaining 0.72 ha (51.80%) area was under perennial/horticultural crops.

It is also revealed form Table 1 that area under *kharif* rice in low, moderate and high adopters groups was 0.37 ha, 0.59 ha and 0.57 ha, respectively. The average area under nagli crop was 0.01 ha, 0.02 ha and 0.03 ha, in low, moderate and high adopters groups, respectively. The total area under *rabi/summer* season crops was 0.06 ha, 0.16 ha and 0.20 ha in low, moderate and high adopters groups, respectively. Area occupied by the perennials/horticultural crops in low, moderate and high adopters groups was 0.49 ha, 0.89 ha and 0.78 ha, respectively. Average net cultivated area was 1.25 ha. The cropping intensity was found to be 108.05 per cent on low adopters group, 110.67 per cent on moderate adopters group and 114.49 per cent on high adopters group whereas it was 111.2 per cent at overall level.

Table 1: Average cropping pattern of sample farms (Figures in ha.)

S. No	Particulars	Low adopters	Moderate adopters	High adopters	Overall
1	***Kharif* season**				
	a) Paddy	0.37 (39.36)	0.59 (35.54)	0.57 (36.08)	0.51 (36.69)
	b) Nagli	0.01 (1.06)	0.02 (1.20)	0.03 (1.90)	0.02 (1.44)
	Total (a + b)	0.38 (40.43)	0.61 (36.75)	0.60 (37.97)	0.53 (38.13)

2	*Rabi/Summer* season				
	a) Pulses	0.02 (2.13)	0.07 (4.22)	0.10 (6.33)	0.06 (4.32)
	b) Vegetables	0.04 (4.26)	0.09 (5.42)	0.10 (6.33)	0.08 (5.76)
	Total (a + b)	0.06 (6.38)	0.16 (9.64)	0.20 (12.66)	0.14 (10.07)
3	Perennials/Horticultural crops	0.49 (52.13)	0.89 (53.61)	0.78 (49.37)	0.72 (51.80)
4	Gross cropped area	0.94 (100.00)	1.66 (100.00)	1.58 (100.00)	1.39 (100.00)
5	Net cropped area	0.87	1.50	1.38	1.25
6	Cropping intensity (%)	108.05	110.67	114.49	111.20

(Figures in parentheses are percentages to gross cropped area)

2. Distribution of rice area under different varieties

Use of high yielding varieties (HYV) has been the main component of modern technology for increasing production. Several high yielding and hybrid varieties of rice have been evolved and released for cultivation by the University. Therefore, the area under different HYV was studied to know the extent of adoption of modern technology. The distribution of area under different varieties of rice is given in Table 2.

The important HYV's observed in the study area were Jaya, Karjat-184 and Ratnagiri-24 and hybrid variety was Sahyadri. The local varieties observed were Suvarna, Sonam and Kolamb. The total area under *kharif* rice was 66.55 hectares of which 65.14 per cent was under local varieties and 34.86 per cent was under HYV at overall level. Out of the total area under rice the area under different local varieties was found to be 53.12 per cent under Suvarna, 7.51 per cent under Sonam and 4.51 per cent under Kolamb. Whereas, the area under individual HYV was observed to be 14.12 per cent under Jaya, 10.74 per cent under Karjat-184, 1.13 per cent under Ratnagiri-24 and 8.87 per cent under Sahyadri. This shows that Suvarna variety was most popular among the cultivators as a local variety and in case of HYV; Jaya was most popular followed by Karjat-184. Percentage area under different varieties of rice indicated that the adoption of HYV and hybrid variety was more in high adapter as compare to low and moderate adapter groups.

Table 2: Distribution of area under different varieties of rice (Figures in ha.)

S. No	Particulars	Low adopters	Moderate adopters	High adopters	Total
A)	Local				
1	Suvarna	5.15 (58.52)	25.65 (61.51)	4.55 (28.35)	35.35 (53.12)
2	Sonam	2.00 (22.73)	1.80 (4.32)	1.20 (7.48)	5.00 (7.51)
3	Kolamb	1.00 (11.66)	1.20 (2.88)	0.80 (4.98)	3.00 (4.51)
	Total	8.15 (92.61)	28.65 (68.71)	6.55 (40.81)	43.35 (65.14)
B)	HYV				
4	Jaya	--	4.40 (10.55)	5.00 (31.15)	9.40 (14.12)
5	Karjat-184	0.30 (3.41)	4.35 (10.43)	2.50 (15.58)	7.15 (10.74)
6	Ratnagiri-24	0.35 (3.98)	--	0.40 (2.49)	0.75 (1.13)
C)	Hybrid				
7	Sahyadri	--	4.30 (10.31)	1.60 (9.97)	5.90 (8.87)
	Total (B+C)	0.65 (7.39)	13.05 (31.29)	9.50 (59.19)	23.20 (34.86)
	Grand Total	8.80 (100.00)	41.70 (100.00)	16.05 (100.00)	66.55 (100.00)

(Figures in parentheses are percentages to grand total)

3. Cost of Cultivation

The per hectare item wise cost incurred for cultivation of rice in *Kharif* season in low, moderate and high adopters groups is worked and presented in Table - 3.

3.1 Category wise per hectare cost of cultivation of rice

The per hectare cost of cultivation of rice on the farms of low, moderate and high adopters groups is presented in Table 3. It is seen from the Table 3 that per hectare total cost of cultivation (Cost-C) for low adopters worked to Rs. 47767.84, out of which Cost-A accounted for Rs. 20705.87 (43.35%) and Cost-B was Rs. 29289.66 (61.32%). Among the different items of cost human labour (both hired and family) shared 52 per cent of the total cost followed by bullock labour (11.62 %). Per hectare quantity of seed used was 60.02 kg and that of FYM was 4.78q. Per hectare quantity of nitrogen was 60.95 kg and applied in the form of urea. The use of phosphorus and potash application was not observed. Other inputs such as seed, fertilizer, FYM shared 1.91 per cent, 1.41 per cent, 3.75 per cent of the total cost, respectively. The yield obtained was 33.76 q of main produce and gross value of main and by produce came to Rs. 46310, which was less compared to the total cost. As a result, the benefit cost ratio was 0.97 which indicated that rice was not profitable in this category of

cultivator. Per hectare cost of cultivation of moderate adopters is (Cost-C) worked out to Rs. 52793.35, out of which Rs. 23651.57 (44.80 %) was Cost-A and Rs. 33560.15 (63.57 %) was Cost-B. Among the different items, human labour (both hired and family) shared 50.78 per cent of the total cost followed by bullock labour (11.01%). Per hectare quantity of seed used was 55.14 kg and that of FYM was 5.10q. The per hectare quantity of nitrogen, phosphorus and potash were 92.68 kg, 14.48 kg and 14.48 kg, respectively and applied in the form of urea and mix fertilizer like Suphala (15:15:15). Other inputs such as seed, fertilizer, FYM, rab material and plant protection shared 1.88 per cent, 2.98 per cent, 3.62 per cent, 2.27 per cent and 0.72 per cent of the total cost, respectively.

(Cost-C) worked out to Rs. 52793.35, out of which Rs. 23651.57 (44.80 %) was Cost-A and Rs. 33560.15 (63.57 %) was Cost-B. Among the different items, human labour (both hired and family) shared 50.78 per cent of the total cost followed by bullock labour (11.01%). Per hectare quantity of seed used was 55.14 kg and that of FYM was 5.10q. The per hectare quantity of nitrogen, phosphorus and potash were 92.68 kg, 14.48 kg and 14.48 kg, respectively and applied in the form of urea and mix fertilizer like Suphala (15:15:15). Other inputs such as seed, fertilizer, FYM, rab material and plant protection shared 1.88 per cent, 2.98 per cent, 3.62 per cent, 2.27 per cent and 0.72 per cent of the total cost, respectively. The yield obtained was 38.98 q of main produce and 43.05 q of by-produce. Gross value of main and by-produce came to Rs. 53437.

Table 3: Category wise per hectare cost of cultivation of rice

S. No	Items	Low Adaptor			Moderate			High Adaptor		
		Qty.	Rate (Rs.)	Amount (Rs.)	Qty.	Rate (Rs.)	Amount (Rs.)	Qty.	Rate (Rs.)	Amount (Rs.)
1	Hired human labour (Days)									
	i) Male	23.01	150.00	3451.50 (7.23)	27.95	150.00	4192.50 (7.94)	31.96	150.00	4794.00 (8.40)
	ii) Female	40.15	120.00	4818.00 (10.09)	47.92	120.00	5750.40 (10.90)	48.47	120.00	5816.40 (10.19)
2	Bullock labour (Pair days)	22.21	250.00	5552.50 (11.62)	23.24	250.00	5810.00 (11.01)	24.28	250.00	6070.00 (10.63)
3	Seed (Kg)	60.00	15.00	910.81 (1.91)	55.14	18.00	992.52 (1.88)	58.28	20.00	1165.60 (2.04)
4	FYM (Qtl)	4.78	375.00	1792.50 (3.75)	5.10	375.00	1912.50 (3.62)	6.00	375.00	2250.00 (3.94)
5	Rab material (Qtl)	6.50	250.00	1625.00 (3.40)	4.80	250.00	1200.00 (2.27)	5.20	250.00	1300.00 (2.28)
6	Fertilizer (Kg)									
	i) Nitrogen	60.95	11.09	675.67 (1.41)	92.68		1525.50 (2.90)	106.45		1839.00 (3.22)
	ii) Phosphorus	--			14.48			19.05		
	iii) Potash	--			14.48			19.05		
7	Plant protection (Litre)	0.214	500.00	106.97 (0.22)	0.755	500.00	377.50 (0.72)	0.877	500.00	438.50 (0.77)
8	Interest on working capital (13% for 6 months)			1230.64 (2.58)			1414.43 (2.68)			1538.74 (2.69)
9	Depreciation			364.28 (0.76)			353.22 (0.67)			399.54 (0.70)
10	Land revenue			178.00 (0.37)			123.00 (0.23)			165.00 (0.30)
	Cost-A			20705.87 (43.35)			23651.57 (44.80)			25776.78 (45.14)
11	Rental value of owned land (1/6th of gross value)			7718.33			8906.67			9977.58
12	Interest on fixed capital (10% on fixed capital)			865.46			1001.91			1212.66
	Cost-B			29289.66 (61.32)			33560.15 (63.57)			36967.02 (64.74)
13	Family labour									
	i) Male	45.52	150.00	6828.00 (14.29)	52.05	150.00	7807.50 (14.80)	55.14	150.00	8271.00 (14.48)
	ii) Female	79.83	120.00	9579.60 (20.05)	75.48	120.00	9057.60 (17.16)	77.35	120.00	9282.00 (16.26)
14	Supervision charges (@ 10% on Cost A)			2070.58			2368.10			2580.61
	Cost-C			47767.84 (100.00)			52793.35 (100.00)			57100.63 (100.00)
15	Yield									
	i) Main produce	33.76	1150.00	38824.00	38.98	1150.00	44827.00	43.85	1150.00	50427.50
	ii) By produce	37.43	200.00	7486.00	43.05	200.00	8610.00	47.19	200.00	9438.00
	Total			46310.00			53437.00			59865.50
16	B:C ratio			0.97			1.01			1.05

As a result, the benefit cost ratio was 1.01. per hectare total cost of cultivation of *kharif* rice in high adopters worked out to Rs. 57100.63, of which share of Cost-A was 45.14 per cent and that of Cost-B was 64.74 per cent. As regards, itemwise cost, it was found that maximum cost (30.73%) was incurred on family labour. Contribution of other items ranged from 0.29 per cent on land revenue to 17.47 per cent on rental value of owned land. The yield obtained by high adopters was 43.85 q of main produce and 47.19 q of by-produce. The gross returns of the main and by-produce was Rs. 59865.50, which is high as compared to other adopters groups. As a result, the benefit cost ratio was 1.05 indicated that rice was more profitable in high adopters than low and moderate adopters groups.

3.2 Profitability

Profitability of rice was worked out at different cost levels i.e. at Cost-A, Cost-B and Cost-C for low,

Table 4: Group Wise profitability at different cost levels (Figures in Rs.)

S. No	Particulars	Low adopters	Moderate adopters	High adopters
1	Gross income	46310.00	53437.00	59865.50
2	Cost-A	20705.87	23651.57	25776.78
3	Cost-B	29289.66	33560.15	36967.02
4	Cost-C	47767.84	52793.35	57100.63
5	Profit at Cost-A (farm business income)	25604.13	29785.43	34088.72
6	Profit at Cost-B (family labour income)	17020.34	19876.85	22898.48
7	Profit at Cost-C (net farm income)	-1457.84	643.65	2764.87

It is seen from Table 4, that yield of rice was profitable in moderate and high adopters groups. In low adopters group, yield of rice was profitable at Cost-A and Cost-B; however, there was a loss at cost 'C' level. In moderate and high adopters groups, yield of rice was profitable at all costs level. The profit at cost 'C' level (net profit) was more in high adopters than other groups. This revealed that the profitability was more in high adopters group. This was due to high technology adoption. The net returns were Rs. 2764.87 in high adopters and Rs. 643.65 in moderate adopters. The net loss in low adopters is Rs. 1457.84.

3.3 Yield and Returns

Yield and Returns of rice was worked out for low, moderate and high adopters groups and is given in Table 5.

Table 5: Yield and Returns in different groups

S. No	Particulars	Low adopters	Moderate adopters	High adopters
1	Yield (Q/ha)	33.76	38.98	43.85
2	Cost/ha (Rs.)	47767.84	52793.35	57100.63
3	Cost/Q (Rs.)	1193.16	1133.49	1086.95

It is seen from table 5. that per hectare yield was less in low adopters than moderate and high adopters. It was 43.85q in high adopters, 38.98q in moderate adopters and 33.76q in low adopters i.e. per hectare yield is directly related to adoption level. The per hectare cost was directly related to adoption level as, the adoption level was more, per hectare cost was more and vice-versa. As regards to per quintal cost of production, it was inversely related to adoption level. Per quintal cost of production was more in low adopters as compared to moderate and high adopters and it was less in high adopters.

4. Deviation of inputs used to its recommended one

Data were collected regarding utilization of different inputs like human labour, bullock labour, fertilizers and FYM actually used by the farmers. These inputs level were compared with the data on University farms. The deviation of inputs used by the cultivators in comparison with recommended doses was done and is presented in Table 6.

Table 6. revealed that the deviation of inputs used to its recommended one varied from different adopters groups. The estimated deviation was the highest for phosphorus and potash at all the adopters groups. The negative sign of deviation indicates that the per cent less input utilization to its recommended dose and positive sign indicates that per cent more utilization to its recommended one. In case of human labour, the deviation was more for low adopters (13.80%) than that for moderate (7.96%) and high (3.66%) adopters. The per cent deviation on bullock labour was 11.16 in low adopters, 7.04 in moderate adopters and 2.08 in high adopters.

Table 6: Deviation of inputs used to its recommended one

S. No	Particulars	Recommended dose	Actual utilization		
			Low adopters	Moderate adopters	High adopters
1	Human labour (days)	221	190.51 (-13.80)	203.4 (-7.96)	212.92 (-3.66)
2	Bullock pair (days)	25	22.21 (-11.16)	23.24 (-7.04)	24.28 (-2.08)
3	Nitrogen (Kg)	100	60.95 (-39.05)	92.68 (-7.32)	106.45 (+6.45)
4	Phosphorus (Kg)	50	- (-100.00)	14.28 (-71.44)	19.05 (-61.90)
5	Potash (Kg)	50	- (-100.00)	14.28 (-71.44)	19.05 (-61.90)
6	FYM (qtl)	100	4.78 (-95.22)	5.10 (-94.90)	6.00 (-94.00)

(Figures in parentheses are per cent deviation to its recommended one)

The deviation on nitrogenous fertilizers was found to be less in case of high adopters (6.45%) and moderate adopters (7.32%) but it was more in case of low adopters (39.05%). Regarding phosphorus and potash, deviation was same for each adopters group. It was 100 per cent for low adopters, 71.04 per cent and 61.9 per cent for moderate and high adopters groups. It was found that the deviation of FYM was 95.22 per cent, 94.90 per cent and 94 per cent in low,

moderate and high adopters group. In input utilization, as compared with recommended doses all the inputs were used in less quantity than recommended doses except nitrogen it was used in excess quantity by high adopters group. From the table 6, it was cleared that deviation is decreased according to technology adoption. As the technology adoption was more in case of high adopters, deviation in inputs used was less and vice-versa.

Conclusions

Following conclusions are drawn from the present study.

1) The per cent area under HYV and hybrid variety was more in high adopter as compared to low and moderate adopter groups.
2) As the technology adoption was more, the per hectare labour requirement was more.
3) Benefit cost ratio was more in high adopter than low and moderate adopter because of technology adoption was more in high adopter group.
4) The production of rice showed a net return of Rs. 2764.87/ha and 643.65/ha in high and moderate adopter groups, respectively. While in low adopter group, it showed a net loss of Rs. 1457.87/ha.
5) Deviation of inputs used was more in low adopter as compared to high and moderate adopter groups.

Policy Implications

The study indicates that the majority of the farmers (77%) either low or medium adopters of the recommended technology. Hence their yield levels are remained obviously low. To increase their yield levels, there is a scope for extension agencies to educate farmers for adopting recommended technologies.

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