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Economic assessment of technology adoption in summer rice production in the Konkan region - methodology for excess adoption

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ABSTRACT

An attempt was made to study the economic assessment of technology adoption of summer rice and to suggest the methodology for measurement of technology adoption in case of excess adoption. Study is based on primary data collected from 120 summer paddy growers from Raigad district of Maharashtra, India. An attempt is also made to suggest a methodology for excess use of inputs up to any level which is more than the recommended level. As the per cent use of inputs more than the recommended level increases, the technology adoption index also decreases in the same proportion. The study revealed that seed was utilized in excess quantity in all groups and use of fertilizers was more in higher adoption group. Input gap was ranging from 33 per cent to 48 per cent which was higher in low adoption group. The total yield gap was 10.42 q (22.53 per cent). The increase in yield was 17.25 per cent more in high adoption group than the check (low adoption). It is concluded that, in addition to increase in adoption of technology by more number of farmers, the extent of adoption also needs to be increased for increasing productivity of rice, reducing yield gap and per quintal cost of rice production.

Key words : *summer rice, technology adoption, yield gap, unit cost reduction*

Rice is staple food crop of Konkan region of Maharashtra. In Konkan region, it occupies an area of about 4.20 lakh hectares is about 27.70 per cent of total area in Maharashtra state. The per hectare productivity of rice was 2.40 t and 2.27 t in wet and dry season, respectively (Anonymous, 2010). Crop productivity plays an important role in overall agricultural development. It is mainly influenced by factors like soil and climate, general potential of variety, crop management and plant protection measure used, etc. The technological improvement over the years expands output by raising the efficiency of input use. There is close relationship among the level of technology and agricultural productivity. Proper application of technological inputs at the recommended levels and better cultural practices are important in crop productivity in farmer's field. The present study is undertaken to bring out the contrast between different categories of adopter of improved practices in rice production in dry season with a view to highlight a gap between the level of input used and their production, productivity, cost and returns. An attempt has also been made to modify the technology adoption index because in case of excess adoption conceptually adoption index has to come down. The methodology and use of corrected technology adoption index formula have been suggested to calculate technology adoption index for individual technology as well as more than one technologies. It may be argued that, as farmers use more than recommended level of input so index should be zero, but in practice excess use of input always do not decrease the production and sometimes it increases or remains same. Obviously, in case of excess use of inputs, adoption index should not be zero. However, it should increase up to recommended level and then decrease gradually thereafter. The study was undertaken with the specific objectives to study the extent of adoption of technologies in dry season rice, to assess the input gap and yield gap in dry season rice and to study the economics of production at different levels of technology adoption.

MATERIALS AND METHODS

Among the four districts of Konkan region of Maharashtra state, namely Thane, Raigad, Ratnagiri and Sindhudurg, Raigad district of Maharashtra state was selected purposively and from this district two tahsils namely Mangaon and Karjat were selected purposively. From each selected tahasil, four villages and from each selected village, 15 farmers were selected randomly. Thus, final sample consisted of 120 farmers. The information from selected farmers regarding input use, production and responses to rice technology adoption was collected by survey method during 2010 and 2011.

There are more than 40 technologies recommend by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli for farmers in Konkan region for rice production. However, out of these 31 technologies were selected and they were grouped into 10 technology components. A particular technology consists of more than one sub-technologies and such sub-technologies were included in a component of technologies recommended (Table 1). The adoption index for qualitative and quantitative recommendations within a technology component was worked out by two different tools, qualitative and quantitative, and then they were standardized to 0 to 1 scale in order to bring uniformity in index, and were multiplied by 100 to give level of adoption in percentage. Technology adoption index (TAI) for individual technology as well as overall technology adoption index for all technologies were worked out.

The adoption index for recommended qualitative technologies was estimated by a scale developed by Supe and Sananse (2004). The adoption index for recommended quantitative technologies where use of input is upto recommended level, the TAI (Anupama, 2005) was used.

$$TAI = \frac{1}{K}\left(\frac{AX_1}{RX_1} + \frac{AX_2}{RX_2},...,+\frac{AX_k}{RX_k}\right)\times 100 ....(1)$$

Where, TAI = Technology adoption index, K = no. of technologies, AX_i = actual use of selected technology, RX_i = recommended use of selected technology

Table 1. Recommended technologies by Dr. BSKKV, Dapoli selected for the present study

Name of technology component		Technologies recommended
Tillage operations	Ploughing	1st (After harvest of wet season crop at wafsa condition)
F.Y.M./Green manure	a) 7.5 tonnes ha^{-1} F.Y.M. or compost before 2nd ploughing	
	b) 5 tonnes ha^{-1} green manure (*Glyricidia*-puddling)	
Seed technology	a) Varieties	Recommended varieties approximately 25
	1) Seed (Quantity ha^{-1})	50 to 60kg (coarse), 35 to 40 kg (fine), 20 kg (hybrid)
Herbicide	Weeding and oxydiarzil 6 EC 3ml lit^{-1} of water (600ml ha^{-1})	
Transplanting	a) Age of seedling	Dry season 35 to 40 days
	b) Spacing	Hybrid and HYV 20x15cm (mid and mid late varieties) or 15x15cm (early)
	c) No. of seedling hill^{-1}	HYV- 2 to 3 Hybrid – one
Fertilizers	a) Quantity (NPK)	HYV 120-50-50 Hybrid 150-50-50 Scented varieties 80-50-50
	b) Method of application	HYV-1) 40-50-50 (Puddling)
		2) 40- 0 -0 at 30 to 40 days after transplanting (DAT) tillering stage
		3) 40-0-0 (flowering) 80 to 90 (DAT)
	c) Green manure	5 tones (*Glyricidia*) 5 tones is applied at the time of puddling
Urea briquettes		On the same day after transplanting
		a) Depth-7 to 10 cm, b) Weight-2.7 gm, c) Placed at centre of four plants
Intercultural operations	Hoeing	30 to 35 days after transplanting
	Weeding	As per the intensity of weed
	Weedicide	Butachlor 50 EC, 1.5kg 4 to 5 days after transplanting
Water level	2 to 5 cm	Up to maximum tillering
	10 cm	10 days before and after of panicle initiation
	10 days	Removal of water before harvesting (days)
Harvesting	a) At 90% of grains maturity b) Use of Vaibhav sickle	

The formula given as per equation has limitation in producing conceptually appropriate values of adoption index when use of input is more than the recommended level. To overcome this, some modification in formulae is suggested in this article. If excess use, is observed in few inputs in such situation, in case of such respondents, and in case of such technologies in a given data set, extent of adoption can be worked out independently (by making modification in formulae) and then such $\frac{AX_i}{RX_i}$ value can be added in equation (1). However, it is appropriate when excess use is observed for few inputs but not in case of all inputs. In present study, excess use up to 200 per cent more than the recommended level was observed in case of seed, hence index value for seed was calculated by equation 2 and used in equation 1.

For calculating the adoption index for excess input use upto 200 per cent more than the recommended input level for individual input (technology) following formula was used.

Single Technology Adoption Index

$= 2 - (AX_1 / RX_1) \times 100$ .... (2)

Where, 2 = constant

The STAI index was calculated for seed technology component and it was used in equation – (1). However, if all the technologies have been used in excess up to 200 per cent in such situation corrected technology adoption index can be used.

$$CTAI = 2 - \left[\frac{1}{K} \left(\frac{AX_1}{RX_1} + \frac{AX_2}{RX_2} ;...,+ \frac{AX_k}{RX_k} \right) \right] \times 100$$

Where 2 = constant

The same analogy can be used for excess use for any extent such as 300 per cent, 400 per cent and 500 or more even than that per cent by changing constants in the formula. The formulae results with a hypothetical data with assumption that 100 kg of recommended level of nitrogen application which indicates that adoption index increase from zero to one and then decreases from one to zero at the maximum range of use of input (Table 9).

$$STAI = [3 - (AX_1/RX_1)] /2 \times 100$$

Where 3 is a constant (a) and 2 is a constant (b).

$$CTAI = \left[3 - \frac{1}{K} \left(\frac{AX_1}{RX_1} + \frac{AX_2}{RX_2} ,...,+ \frac{AX_k}{RX_k} \right) \right] / 2 \times 100$$

In the present study after calculating the total adoption index for inputs (qualitative and quantitative) for each farmer the sample farmers were grouped in to three categories of adoption level as mentioned.

Low adopters (less than mean)→ mean – Standard Deviation (SD)

Medium Adopters→ = Mean – SD to Mean + SD

High adopter (mere than mean) → Mean + SD

Input Gap = Recommended level- Actual use

Seed (kg)

Organic Manures (MT)

Chemical Fertilizers (kg) : N, P and K

a) Yield gap I = $Y_p - Y_d$

b) Yield gap II = Y_d - Y_a

c) Total yield gap = $Y_p - Y_a$

Where,

Y_p = Potential yield (Yield realized at research station)
Y_d = Demonstration yield (Yield realized on demonstration plots)
Y_a = Actual yield (Yield realized on sample farm)

RESULTS AND DISCUSSION

The selected sample farmers for summer rice were classified into three groups as per level of adoption (Table 2).

The sample farmers for summer rice are grouped into three categories namely Low adopters (11.67%), Medium adopters (65.83%) and High

Table 2. Distribution of Sample farmers for summer rice.

Category of technology adoption	Range of Technology adoption index	No. of sample farmers	Percentage
Low	0 to 35	14	11.67
Medium	36 to 69	79	65.83
High	Above 70	27	22.50

Overall technology adoption score for all technologies (%) = 52.72 (Standard Deviation = 17) adopters (22.50%). The majority of respondents were in medium group. Similar results were also obtained by Waman and Wagh (2009) while studying adoption of banana production technology in Jalgaon district (M.S.)

At overall level per hectare human labour was 193 days, followed by bullock labour 17.37 pair days and machine labour 4.23 hrs (Table 3). The seed rate per hectare was 59.70kg the use of manure was 2.69 MT and fertilizer nutrients used were 70.02 kg N, 29.48 kg P and 16.78 kg. K. The per hectare summer rice productivity was 3.58 t. The per hectare labour use

Table 3. Per hectare input use for summer rice cultivation

Input	Unit	Low adopters	Medium adopters	High adopters	Overall
Human Labour					
Male	Days	118.30	96.18	82.18	92.78
Female	Days	119.90	100.20	97.00	100.30
Bullock labour	Days	20.58	18.77	14.26	17.37
Machine labour	Hrs	3.25	3.81	5.17	4.23
Seed	Kg	67.54	60.27	57.28	59.70
Manures	M T	1.24	2.31	3.64	2.69
Fertilizers N	Kg.	36.87	64.09	86.55	70.02
P	Kg.	18.65	28.54	33.07	29.48
K	Kg.	8.64	16.68	18.37	16.78
Yield	t	3.25	3.48	3.82	3.58

was observed to decline with level of technology adoption, while use of all other inputs increased. The per hectare productivity had positive relationship with increase in adoption of technology in summer rice cultivation.

The input gap was estimated to recommended levels of input use namely seed, organic manure, chemical fertilizers (Table 4).

It is seen that farmers in the study were observed to use excess (18.14%) seed, on the other hand the extent of input gap for manures 64.08 per cent, chemical fertilizer 41.65 per cent for N, 41.04 per cent for P and 66.44 per cent for K. This highlighted that there is still scope to increase use of manures and fertilizers. For increasing summer rice productivity across different farms. The input gap for manures and fertilizers has reduced considerably with level of technology adoption. Wide gap was observed between

Table 4. Per hectare input gap and productivity in sample farm

Input	Recommended level	Low adopters	Medium adopters	High adopters	Overall
Seed	50 kg	-17.5 (-35.08)	-10.3 (-20.54)	-7.28 (-14.56)	-9.7 (-18.14)
Organic Manures	75 Q	62.6 (83.47)	51.9 (69.20)	38.6 (51.47)	48.06 (64.08)
Chemical Fertilizers					
N	120 kg	83.13 (69.28)	55.91 (46.59)	33.45 (32.17)	49.98 (41.65)
P	50 kg	31.35 (62.70)	21.46 (42.92)	16.93 (33.86)	20.52 (41.04)
K	50 kg	41.36 (82.72)	33.84 (67.68)	31.63 (63.26)	33.22 (66.44)
Productivity	46.25 q	32.58	34.84	38.2	35.83

(Figures in parentheses indicate percentage to recommended level.)

recommended level and actual use of inputs. The results are in conformity with Subramanyam (1987) in his study on economic investment in mango in Karnataka.

The per hectare yield was observed to reduce due to increase in input use. The short fall in total rice production (Total yield gap) per hectare on sample farms reduced from 13.67 q to 8.05 q with increase in level of technology adoption. More specifically yield gap II reduced from 10.92 q in Low (TAI) group to 5.30 q in High (TAI) group (Table 5).

The per hectare cost of cultivation (Cost C) was ₹ 34477 at the overall level, of which share of

Table 5. Yield gap in summer rice production

Particulars	Low adopters	Medium adopters	High adopters	Overall
Research station yield		46.25		
Demonstration yield		43.50		
Yield on sample farms	32.58 (70.44)	34.84 (75.33)	38.2 (82.59)	35.83 (77.47)
Yield gap - I	2.75 (5.95)	2.75 (5.95)	2.75 (5.95)	2.75 (5.95)
Yield gap - II	10.92 (23.61)	8.66 (18.72)	5.30 (11.46)	7.67 (16.58)
Total yield gap	13.67 (29.56)	11.41 (24.67)	8.05 (17.41)	10.42 (22.53)

(Figures in parentheses are percentage of yield gap to research station yield, Figures in quintals)

Cost A was 68.57 per cent (₹ 23629) and Cost B was 87.24 per cent (₹ 30076). Amongst the group, Cost C was ₹ 38120 in Low group, ₹ 34786 in medium group and ₹ 33926 in High group (Table 6).

profit ₹ 491 in Medium group and ₹ 4409 in High group. The benefit cost ratio also increased from 0.87 to 1.13 with an overall average of 1.05 (Table 7).

Table 6. Per hectare cost of cultivation of summer paddy

Particulars	Low adopters	Medium adopters	High adopters	Overall	
				Amount	Per cent
Hired Labour a) Male	9875	8782	7222	8324	24.14
b) Female	8540	7312	7470	7435	21.57
Bullock labour	3087	2816	2139	2605	7.56
Machine labour	813	953	1292	1058	3.07
seed	1059	945	898	936	2.72
Plant protection chemicals	86	254	424	86	0.25
Manures	608	1132	1786	1320	3.83
Fertilizers N	176	307	414	335	0.97
P	59	90	104	93	0.27
K	15	29	32	29	0.08
Land revenue and cess + irrigation fee	805	823	854	832	2.41
Depreciation	214	264	241	253	0.74
Other (repairing charges)	314	324	350	332	0.96
Cost A	25650	24029	23225	23639	68.57
Rental Value of Land	5514	5880	6389	6029	17.49
Interest on Fixed Capital	385	408	411	408	1.18
Cost B	31550	30316	30026	30076	87.24
Family Labour a) Male	4320	2760	2640	2810	8.15
b) Female	2250	1710	1260	1591	4.61
Cost C	38120	34786	33926	34477	100.00

(Figures in Rupees)

The per hectare productivity has increased from 32.58 q in Low group to 38.2 q in High group with an overall average of 35.83q. In summer rice cultivation, in Low group negative profit of ₹ 5033 turned to positive

Table 7. Profitability of summer rice cultivation

Particulars	Low adopters	Medium adopters	High adopters	Overall
Yield q ha^{-1}	32.5	34.8	38.2	35.8
Value of main product	30137	32227	35335	33144
Value of by product	2950	3050	3000	3028
Gross Income	33087	35277	38335	36172
Cost A (₹)	25650	24029	23225	23639
Cost B (₹)	31550	30316	30026	30076
Cost C (₹)	38120	34786	33926	34477
Profit at				
Cost A	7436	11248	15110	12532
Cost B	1537	4961	8309	6096
Cost C	-5033	491	4409	1695
Benefit Cost Ratio at				
Cost A	1.29	1.47	1.65	1.53
Cost B	1.05	1.16	1.28	1.20
Cost C	0.87	1.01	1.13	1.05

How the increased levels of technology adoption index of summer rice has reduced per quintal cost of rice cultivation (Table 8). It is clearly seen that, technology adoption has positive influence on cost reduction. The per quintal cost of cultivation of summer

Table 8. Unit cost reduction in summer rice cultivation

Particulars	Low adopters	Medium adopters	High adopters	Overall
Output q ha^{-1}	32.5	34.8	38.2	35.8
Increase in output (%)	0	6.94	17.25	9.98
Cost A ha^{-1} (₹)	25650	24029	23225	23639
Cost B ha^{-1} (₹)	31550	30316	30026	30076
Cost C ha^{-1} (₹)	38120	34786	33926	34477
Unit cost assessment				
Cost A (₹)	787.30	689.68	607.99	659.73
Cost B (₹)	968.37	870.15	786.01	839.36
Cost C (₹)	1170.04	998.45	888.10	962.18
Unit cost reduction				
Cost A (₹)	0	97.62	179.30	127.56
Cost B (₹)	0	98.22	182.36	129.01
Cost C (₹)	0	171.58	281.93	207.84

Table 9. Use of nitrogen kg ha^{-1} and adoption index

Up to recommended level		Excess use 100<200%		Excess use100<300%		Excess use100<400%		Excess use 100<500%	
Per cent use	A.I.	Per cent use	A.I.	Per cent use	A.I.	Per cent use	A.I.	Per cent use	A.I.
10	0.10	110	0.90	110	0.95	110	0.97	110	0.98
20	0.20	120	0.80	120	0.90	120	0.93	120	0.95
30	0.30	130	0.70	130	0.85	130	0.90	130	0.93
40	0.40	140	0.60	140	0.80	140	0.87	140	0.90
50	0.50	150	0.50	150	0.75	150	0.83	150	0.88
60	0.60	160	0.40	160	0.70	160	0.80	160	0.85
70	0.70	170	0.30	170	0.65	170	0.77	170	0.83
80	0.80	180	0.20	180	0.60	180	0.73	180	0.80
90	0.90	190	0.10	190	0.55	190	0.70	190	0.78
100	1.00	200	0.00	200	0.50	200	0.67	200	0.75
		210	0.45	210	0.63	210	0.73		
		220	0.40	220	0.60	220	0.70		
		230	0.35	230	0.57	230	0.68		
		240	0.30	240	0.53	240	0.65		
		250	0.25	250	0.50	250	0.63		
		260	0.20	260	0.47	260	0.60		
		270	0.15	270	0.43	270	0.58		
		280	0.10	280	0.40	280	0.55		
		290	0.05	290	0.37	290	0.53		
		300	0.00	300	0.33	300	0.50		
			310	0.30	310	0.48			
			320	0.27	320	0.45			
			330	0.23	330	0.43			
			340	0.20	340	0.40			
			350	0.17	350	0.38			
			360	0.13	360	0.35			
			370	0.10	370	0.33			
			380	0.07	380	0.30			
			390	0.03	390	0.28			
			400	0.00	400	0.25			
				410	0.23				
				420	0.20				
				430	0.18				
				440	0.15				
				450	0.13				
				460	0.10				
				470	0.08				
				480	0.05				
				490	0.02				
				500	0.00				

A.I. - Adoption Index, (Adoption index ranges between zero to one and it can be expressed in per cent terms by multiplying it by 100)

rice reduced from ₹ 1170 per quintal in Low group to ₹ 888 in high group and at the overall level it has declined by ₹ 282/-.

The formulae suggested in methodology for excess adoption may be utilized. If a single input is utilized in excess quantity, then formulae given as Single Technology Adoption Index (STAI) can be used and then added to equation 1 for respective input as explained earlier. If all the inputs are used in excess then Corrected Technology Adopted Index (CTAI) for respective data set (maximum use more than recommended level) can be used (Table 9). The figure shows how an adoption index increases up to recommended level and decreases there after and reaches to minimum at a maximum level of use of input. (more than the recommended level).

The suggested formulae give mathematically correct and conceptually acceptable results for any level of excess use (in hundred terms). Farmer generally do not use inputs more than 500 per cent than recommended level, however, with as on academic interest, the constants up to 1000 per cent are given below. In the same way constants can be used for any level (in hundred terms).

The study has revealed that adoption of technologies in summer rice cultivation has increased rice production in summer season. The increased productivity with technology adoption has considerably influenced unit cost of cultivation. Ultimately it has resulted into saving in cost of cultivation. The excess adoption was only in case of seed. It has been observed in general in some crops particularly vegetables, flowers, fruits, some inputs are applied at more than recommended level. In such cases of excess adoption the formulae suggested in the present article can be utilized.

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