International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 1285-1289

Received: 15-01-2019
Accepted: 19-02-2019

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Resource use efficiency in rejuvenated and non-rejuvenated mango orchards in south *Konkan* region of Maharashtra

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Abstract
An attempt has been made to study the comparative economics of rejuvenated and non-rejuvenated mango orchards in south Konkan region of Maharashtra. The study was undertaken with a sample of 80 mango growers selected randomly out of which 40 farmers were among the rejuvenated group and 40 were among non-rejuvenated mango growers. The coefficient of multiple determination (R^2) was 0.9642 in rejuvenated orchards indicated that 96.42 per cent variation in mango production was explained by variables included in the function. The coefficient of multiple determination (R^2) in case of non-rejuvenated orchards was 0.9129 indicated that 91.29 per cent variation in mango production was explained by variables included in the function. Ratios of MVP/FC were more than unity in case of manure, urea, single super phosphate and sulphate of potash indicating the scope of expanding the use of these inputs. But the expenditure on other variables such as Cultar (Paclobutrazol), plant protection chemicals and human labour needs to be curtailed in the both groups. The resource use efficiency for rejuvenated and non-rejuvenated mango orchards revealed that mango growers needs to be given adequate technical knowledge for resource management and their optimum use. The mango farmers can increase their profitability in mango production by proper reallocation of resources.

Keywords: Mango, resource use efficiency, rejuvenated and non-rejuvenated orchard etc.

1. Introduction
India is the major mango growing country, contributing nearly 46.74 per cent of world's area and 40.48 per cent of world's production respectively. In India the area under mango cultivation is 2262.75 thousand ha and production is 19686.92 thousand MT with productivity 8.7 MT/ha. In Maharashtra state, approximately 514.87 thousand MT of mango is produced over an area of about 157.07 thousand ha indicating a productivity of 3.27 MT/ha. The *Konkan* region in the Maharashtra state is famous for Alphonso mango production with an area of about 0.1 million ha under mango cultivation. However, the production is only 1.34 Lakh MT with a productivity of about 2.07MT/ha. Particularly, the two districts of the region viz. Ratnagiri and Sindhudurg are known as 'Mango Baskets'.
Rejuvenation is the process of pruning and after pruning management of the plants to make them productive by utilizing the existing root system, which means restoring the productive capacity of the trees. The rejuvenation makes the plant manageable, easy for adoption of appropriate package of practices, improving vigour and yield. Thus rejuvenation in mango is adoption of suitable pruning, adequate nutrient and plant protection management, development of appropriate canopy and other management operations in a holistic manner.
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli has developed and recommended rejuvenation of the old and senile orchards for increasing yield as well as fruit size of mango under the project "Centre of Excellence for Mango". Total 240 training cum awareness programmes were organized at village level through which more than 6900 farmers have been trained regarding the technology developed under the project in Ratnagiri and Sindhudurg district. Particularly in Konkan region age of mango orchards is bet when 40 to 60 years. The productivity of Alphonso mango is low, because of old age orchard, difficult to manage the insect-pest control and other management practices in of Alphonso mango orchards.

2. Methodology
For present study two districts *viz.* Ratnagiri and Sindhudurg were selected purposively. From each district two tehsils were selected and from each tehsils five villages were selected

randomly. From each village two rejuvenated and two non-rejuvenated orchards were selected. Thus data were collected from 40 rejuvenated and 40 non-rejuvenated mango growers. The data were collected by survey method through personal interviews from the selected farmers, with the help of pre-tested schedule specially designed for the purpose.

Selected sample farmers were classified according to the age of orchards after rejuvenation of mango. This stratification is carried out with the help of mean and standard deviation as follows.

Group-I: A.M. – S.D. to mean + S.D

Group-II: > A.M. + S.D.

The data collected from mango growers were analysed with simple statistical tools and presented to draw meaningful conclusions.

a) Tabular analysis

The data were processed for arriving at desired conclusion and it was arranged in suitable tables and cross tables. Simple statistical tools such as arithmetic mean, percentage and ratios were used.

3.9 Functional analysis

The Cobb-Douglas type of production function was employed to estimate the resource use efficiency in mango production. The following Cobb-Douglas type function was used in the present study.

$$Y = AX_i^{bi}e$$

Where,

Y = Per hectare mango yield.

b_i = Regression coefficient of respective variables.

e = Error term.

X_i= Explanatory variable

Such as,

X_1 = Manures (T)/ ha.

X_2 = Nitrogen (Kg)/ha.

X_3 = Phosphorus (Kg)/ha.

X_4 = Potassium (Kg)/ha.

X_5 = Cultar/ growth regulator (Rs)/ha.

X_6 = Plant protection (Rs)/ha.

X_7 = Human labour (man days)/ha.

3.10 Marginal productivity

The following formula was used for calculation of marginal physical product and marginal value product.

1. Marginal physical product (M.P.P.)

$$M.P.P.\ X_i = b_i \frac{Y}{X_i}$$

Where,

b_i = Production elasticities of input.

Y = Geometric mean of output.

X_i = Geometric mean of input.

2. Marginal value product (M.V.P)

$MVPX_i$ = MPP X_i × Price per unit of output

3. Marginal cost (M.C.)

MC = price per unit of the input.

3.11 Resource Use Efficiency

After estimating the MVP, the resource use efficiency of different resources was judged with the help of MVP to factor cost ratio as given below

- MVP/FC = 1 Optimum use of resources.
- MVP/FC < 1 Excess use of resources.
- MVP/FC > 1 Under utilization of resources.

4. Result and Discussion

A) Composition of sample farmers according to age of rejuvenation of mango orchards

The selected sample farmers were classified in to two categories of rejuvenation age specified in the methodology. The composition of farmer is given in Table 1, indicated that selected farmers were grouped in two categories. Group-I means orchards which were rejuvenated before four years and Group-II i.e. age of rejuvenated orchards was more than 4 years.

In rejuvenation technology after pruning of tree in first year there was no any yield. Then gradually the yield goes on increasing. Thus farmers were categorized as group-I and group-II on the basis of age of orchard after rejuvenation practice. Accordingly 9 farmers were found in group-I (age of rejuvenated orchards was less than 4 years), 31 farmers were found in group-II (age of rejuvenated orchards was more than 4 years). The area under rejuvenated orchards in group-I was 6 ha. While in group-II it was 20.02 ha. The average size of rejuvenated farm was 0.67 and 0.65 ha in group-I and group-II, respectively.

Table 1: Composition of sample farmers according to age of rejuvenation of mango orchards.

Sr. No.	Category	Age (years)	No. of farmers	Area under rejuvenated mango orchards (ha)	Average size of farm (ha)
1	Group –I	< 4	9	6.00	0.67
2	Group –II	>4	31	20.02	0.65
	Total		40	26.02	
Mean = 3.00 Standard Deviation = 1.24					

B) Composition of sample farmers of non-rejuvenation of mango.

For comparison purpose 40 farmers from non-rejuvenated group were selected. The details of non-rejuvenated mango orchards are given in Table 2.

Table 2 revealed that the average size of mango orchard was 2.84 ha with average number of trees 291.00. Out of total number of trees per farm bearing trees were 261 and non-bearing trees were 30. Per hectare proportion of bearing trees were 89.47 per cent and non-bearing tree was 10.53 per cent. The average age of orchards was 42.46 years.

Table 2: Composition of sample farmers of non-rejuvenation of mango.

Sr. No.	Particulars	
1	Area per orchard (ha.)	2.84
2	Age of orchard (year)	42.46
3	Number of trees	
A)	Per farm (No.)	
	i) Bearing	261 (89.69)
	ii) Non-bearing	30 (10.31)
	Total	291 (100.00)
B)	Per hectare (No.)	
	i) Bearing	85 (89.47)
	ii) Non-bearing	10 (10.53)
	Total	95 (100.00)

(Figures in parentheses are percentage to total)

C) Per hectare input utilization and expenditure incurred for rejuvenated and non-rejuvenated mango orchards.

The information regarding per hectare input utilized and cost incurred for different input used in rejuvenated and non-rejuvenated orchards given in Table 3.

For rejuvenated mango orchards it is observed that quantity of input used was higher in case of group-II as compared to group-I. The total expenditure incurred was also higher in case of group-II as compared to group-I. The total expenditure in group-II was Rs. 39003 and for group-I was Rs 26737. High utilization of inputs in group-II as compared to group-I was due to the age of trees and the canopy growth.

Further it was observed that at overall level of rejuvenated orchards input utilization and cost incurred was high as compared to non-rejuvenated orchards. Overall input cost incurred for rejuvenated group was Rs. 36243 while Rs. 33952 for non-rejuvenated group. Non-rejuvenated orchards are senile and neglected by the farmers due to low yield. But rejuvenated orchards are managed with proper dose of fertilizers, plant protection chemicals therefore expenses incurred are more.

Table 3: Per hectare input utilization for rejuvenated and non-rejuvenated mango orchards.

Sr. No.	Inputs	Unit	Non-rejuvenated mango orchards (N=40)	Rejuvenated Mango orchards		
				Group I (N=9)	Group II (N=31)	Overall (N=40)
1	Chlorophyriphos	Quantity (lit.)	-	2.00	3.38	3.07
		Value (Rs.)	-	1700	2873	2609
2	Qunalphos	Quantity (lit.)	-	1.00	2.45	2.12
		Value (Rs.)	-	810	1985	1721
3	Bordeaux mixture	Quantity (lit.)	-	1.09	2.25	1.99
		Value (Rs.)	-	164	338	298
4	Manures	Quantity (T)	4.40	2.80	4.90	4.43
		Value (Rs.)	6600	4200	7350	6641
5	**Fertilizers**					
	i) Urea	Quantity (Kg.)	325.00	267.33	320.00	308.15
		Value (Rs.)	2275	1872	2240	2157
	ii) SSP	Quantity (Kg.)	385	297.77	375.30	357.86
		Value (Rs.)	3465	2680	3378	3221
	iii) Sulphate of potash	Quantity (Kg.)	196.75	225.45	287.76	273.74
		Value (Rs.)	3935	4509	5755	5475
6	**Cultar/Growth regulator**					
	i) Cultar/ Paclobutrazol	Quantity (lit.)	0.75	0.15	0.30	0.27
		Value (Rs.)	5850	1170	2340	2077
	ii) Gibberellic acid	Quantity (lit.)	0.002	0.09	0.10	0.10
		Value (Rs.)	20	900	1000	978
7	**Plant protection chemicals**					
	A) Insecticide					
	i) Cypermethrin	Quantity (lit.)	4.31	3.87	5.37	5.03
		Value(Rs.)	2371	2129	2954	2768
	ii) Quinalphos	Quantity (lit.)	4.03	2.77	3.98	3.71
		Value(Rs.)	3264	2244	3227	3003
	iii) Imidacloprid	Quantity (lit.)	2.00	1.38	1.06	1.13
		Value(Rs.)	2820	1946	1495	1596
	iv) Thiamethoxam	Quantity (lit.)	2.88	1.74	2.4300	2.27
		Value (Rs.)	1123.20	679	948	887
	v) Lambda	Quantity (lit.)	2.00	1.56	3.25	2.87
		Value (Rs.)	1600	1248	2600	2296
	Fungicide					
	i) Bavistin	Quantity (lit.)	4.25	3.30	3.55	3.49
		Value(Rs.)	629	489	526	517
	Total Value (Rs.)		33952	26737	39003	36243

D) Functional analysis

The production function expressing per ha yield in quintal as a function of different input (factors) used in the mango production was estimated to know the resource use efficiency in mango production. A Cobb-Douglas type production function was employed for the purpose. The results of functional analysis are given in Table 4.

Rejuvenated orchards

It is observed from Table 4. that the elasticity coefficient for manures (X_1), urea (X_2) and single super phosphorous (X_3) were positive and found statistically significant at 5 per cent level of probability whereas, the elasticity coefficient though positive for sulphate of potash (X_4) but found out to be statistically non significant indicating non significant effect of these variables on yield of mango. The elasticity coefficient for cultar/growth regulator (X_5), plant protection chemicals (X_6) and human labour days (X_7) were negative (-0.0199, -0.0165 and -0.0006 respectively).

The value of coefficient of multiple determination (R^2) was 0.9642 indicated that 96.42 per cent variation in mango production was explained by variables included in the function. The sum of production elasticity was 0.8257.

Non-rejuvenated orchards

Table 4. revealed that the elasticity coefficient for manures (X_1), urea (X_2) and sulphate of potash (X_4) were positive and found to be statistically significant at 5 per cent level of probability whereas, the elasticity coefficient though positive for single super phosphorous (X_3) and human labour days

(X_7) but found out to be statistically non significant indicating no significant effect of these variable on yield of mango. The elasticity coefficient for Cultar/growth regulator (X_5) was negative and significant at 5 per cent level of probability indicating excessive use of Cultar/ growth regulator. The elasticity coefficient for plant protection chemicals (X_6) was found negative (-0.0449).

The value of coefficient of multiple determination (R^2) was 0.9129 indicated that 91.29 per cent variation in mango production was explained by variables included in the function.

Table 4: Elasticity coefficients for selected variables.

Sr. No.	Variables	Rejuvenated	Non-rejuvenated
1	Intercept	0.6973* (-0.3290)	0.1062 (-0.4112)
2	X_1 - Manure (T)	0.0496* (-0.0217)	0.2090* (0.0715)
3	X_2 - Urea (Kg)	0.1797* (0.0737)	0.2357* (0.0653)
4	X_3 - SSP (Kg)	0.2845* (0.1242)	0.1109 (0.0742)
5	X_4 - Sulphate of potash (Kg)	0.2746 (0.1420)	0.2419* (0.1047)
6	X_5 - Cultar/Growth regulator (Rs.)	-0.0199 (0.0227)	-0.0066* (0.0031)
7	X_6 - Plant Protection Chemical (Rs.)	-0.0165 (0.0177)	-0.0449 (0.0319)
8	X_7 -Human labour (Days)	-0.0006 (0.0189)	0.0201 (0.0298)
9	R^2	0.9642	0.9129
	Return to scale ($\sum$ bi)	0.8257	0.8694

* Significant at 5 per cent level of probability

(Standard error of each variable are given in respective parenthesis)

Resource use efficiency

Marginal value product and factor price for selected variables for rejuvenated orchards group is given in Table 5.

The marginal value product of different variables viz., manures (X_1), urea (X_2) single super phosphorous (X_3) and sulphate of potash (X_4) was positive. Ratio of MVP/FC were more than unity in case of manure, urea, single super phosphorous and sulphate of potash indicating the scope of expanding the use of these inputs. But the expenditure on other variables *i.e.* Cultar/growth regulator, plant protection chemicals and human labour needs to be curtailed.

The information regarding marginal value product and factor price for selected variables for non- rejuvenated orchard groups are given in table 6.

The marginal value product of different variables viz., manures (X_1), urea (X_2) single super phosphorous (X_3) and sulphate of potash (X_4) was positive. Ratio of MVP/FC was more than unity in case of manure, urea, single super phosphorous and sulphate of potash indicating the scope of expanding the use of these inputs. But the expenditure on other variables *i.e.* Cultar/growth regulator, plant protection chemicals and human labour needs to be curtailed.

The resource use efficiency for rejuvenated orchards revealed that mango growers have to be given adequate technical knowledge for resource management and their optimum use. The mango farmers can increase their profitability in mango production by proper allocation of resources, particularly urea. Single Super Phosphate and Sulphate of Potash.

Table 5: Marginal value product and factor price in Rejuvenated mango orchards.

Sr. No.	Variables	MPP	MVP	MVP/FC	Remarks
1	X1 - Manure (T)	0.5670	2635.39	1.7568	Under utilization
2	X2 - Urea (Kg.)	0.0785	365.08	52.1533	Under utilization
3	X3 - SSP (Kg.)	0.1148	533.54	59.2814	Under utilization
4	X4 - Sulphate of potash (Kg.)	0.1691	785.82	39.2906	Under utilization
5	X5 - Cultar/Growth regulator (Rs.)	-0.00015	-0.7013	-0.00009	Excess use
6	X6 - Plant Protection Chemical (Rs.)	-0.00025	-1.1220	-0.0017	Excess use
7	X7 - Human labour (Days)	-6.07539E-05	-0.2823	-0.001	Excess use

Table 6: Marginal value product and factor price in Non- rejuvenated mango orchards.

Sr. No.	Variables	MPP	MVP	MVP/FC	Remarks
1	X1 - Manure (T)	0.6056	2934.98	1.95	Under utilization
2	X2 - Urea (Kg.)	0.0251	121.47	17.35	Under utilization
3	X3 - SSP (Kg.)	0.0148	71.54	7.94	Under utilization
4	X4 - Sulphate of potash (Kg.)	0.04482	217.37	10.86	Under utilization
5	X5 - Cultar/Growth regulator (Rs.)	-0.0001	-0.536	-0.0001	Excess use
6	X6 - Plant Protection Chemical (Rs.)	-0.0003	-1.498	-0.002	Excess use
7	X7 - Human labour (Days)	0.0042	20.208	0.067	Excess use

5. Conclusion

Input cost incurred by rejuvenated group was higher than non-rejuvenated group. The resources like manures and fertilizers were found underutilized. While there was excess utilization of growth regulators (Cultar), plant protection chemicals and human labours. The Resource use efficiency analysis in mango production indicated that there should be proper management of existing resource use, to increase production of mango.

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