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Research Note

RESOURCE USE EFFICIENCY AND INVESTMENT APPRAISAL OF MANGO IN RAINFED ECOSYSTEM OF JAMMU DISTRICT OF INDIA

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ABSTRACT

The present investigation was conducted in Jammu district of Jammu and Kashmir state during the year 2008. Two blocks were selected from Jammu district having the highest area under mango fruit. Cobb-Douglus function was used to study the relationship between output and various inputs. Coefficient of variation was calculated in order to analyze the instability in cropped area, yield and net returns. The study on per hectare costs of mango indicated that on an average the cost A, cost B and cost C were Rs. 1523.95, Rs. 4456.20 and Rs. 12910.80, respectively. The benefit cost ratio with respect to cost A was 9.31, 3.28 with respect to cost B and 1.10 with respect to cost C. Human labour was significant and underutilized in mango in all groups except in 20-24`h year group where it was non significant and over utilized. Manures + fertilizers, plant protection and pruning and training over utilized in 10-14`h year group while as in other groups these inputs were under utilized in all groups except pruning + training in the overall group where it was over utilized. The pruning + training were over utilized upto 14`h year and from 15'h year onwards it was underutilized. The instability was found higher in case of area as compared to yield and net returns.

I. INTRODUCTION

Agriculture, the most important industry of India contributes about 18.5 per cent of the national income and is a primary source of livelihood providing employment directly or indirectly to 52 per cent of its population (Economic survey, 2007-08). Horticulture crops cover only 18.98 million hectares (ha) i.e. 13.27 per cent of total cultivated area (7.2 million ha under vegetables and 5.51 mha under fruits) but contribute 28 per cent of the gross domestic product in agriculture (Mittal, 2007). India is the world's second largest producer of fruits and vegetables and contributes 13.3 and 10 per cent of vegetables and fruits, respectively, in the world. Mango, the king of fruits, accounts for 40 per cent of the national fruit production, 42 per cent of the land under its cultivation and 40 per cent of its fruit exports from the country (APEDA, 2008). Fruit growing has become a major industry and contributes largely to the export trade of Jammu and Kashmir. Out of 2,416 thousand ha of the total geographical area of the state, the net sown area is only 733.68 thousand hectares while as the area under fruit crops is 283.14 thousand hectares, i.e. 38.59 per cent of the total cultivable

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area with 65 per cent under fresh fruits. The total area under mango in Jammu and Kashmir is 9.33 thousand hectares with the production of 17.58 thousand metric tons (Database Digest of Statistics, 2008). But it is unfortunate that the average productivity of mango (1.88 tonnes per hectare) in the state is much below the national average. Thus apart from the increasing productivity of these crops through various technological interventions, it became necessary to evaluate and quantify how much efficiently the resources are utilized as well as working out their economics, besides the risks involved in cultivation of mango.

II. DATA AND METHODOLOGY

The present study was conducted in Jammu district of Jammu and Kashmir state. The data were collected on various aspects of establishment of orchards, maintenance cost, and economic returns for the orchards from 60 orchardists of four villages. The age of these mango orchards ranged from less than one year to 28 years. From each selected village, the mango orchardists were grouped into following four size groups of holdings:

i) Marginal : 0.01 to 1.00 hectares

ii) Small : 1.01 to 2.00 hectares

iii) Medium : 2.00 to 3.00 hectares

As there was not a single orchardist who belonged to large size group, so the evaluation of that group could not be made possible.

The age of the orchards were grouped into six groups viz. 5 to 9 year, 10 to 14 year, 15 to 19 year, 20 to 24 year, 24 to 28 year and overall group which included the whole age of the orchard as was done by Wani *et al.,* 1993. First to 4th year was not taken as these were the non bearing years.

Resource use Efficiency

In order to study the relationship between output and various inputs used, Cobb- Douglas production function was used as was done by Wani *et al.,* 1993. This function is used extensively in agricultural production function analysis. The functional form applied is given as under:

$$Y_t = \beta_0 \left(\prod_{i=1}^{n} x_i^{\beta_i} \right) u_t \qquad (i = 1, 2, 3, \ldots, n)$$

Where Y and Xi (i = 1, 2, 3,..., n) are the output and levels of inputs, respectively. The constant β_o and β_i's (i = 1, 2, 3,..., n) represent the efficiency parameters and the production elasticties of the respective input variables for the given population at a particular period, t.
The fitted Cobb-Douglas production function may be written for the present case with five input variables with log transformation as:

$$\log y = \log a_o + b_1 \log x_1 + b_2 \log x_2 + \ldots + b_5 \log x_5$$

Where

y = Output of mango in quintals as dependent variables
x_1 = Human labour in man days
x_2 = Manure and fertilizers (Rs)

x_3 = Expenditure on plant protection (Rs)
x_4 = Expenditure on irrigation (Rs)
x_5 = Expenditure on training and pruning (Rs)
a_o = Constant
b's = Elasticities of production of respective resource categories

To examine the productivity of different inputs used in production of studied fruits, marginal value productivities of inputs were estimated at geometric mean levels of inputs. To calculate Marginal Value Productivity (MVP) of resource x_i the following formula was used.

$$MVP = b_i \frac{GM(Y)}{GM(x_i)}$$

Where ,

$MVP(x_i)$ = marginal value productivity of ith resource
b_i = regression coefficient. (estimated)
$GM(Y)$ = geometric mean of output
$GM(x_i)$ = geometric mean of inputs.

Costs and Returns

The total input costs of mango production was distributed under three heads using the cost concepts A, B and C as done by Mali *et al* (2004).

Cost A included the cost on hired human labour, total bullock labour, planting material value, value of manures and fertilizers, irrigation charges, depreciation on implements and machinery, land revenue, interest on working capital and establishment cost of each fruit.

Cost B represented cost A plus the imputed cost on account of rental value of the land and interest on fixed capital.

Cost C comprised of cost B plus imputed value of family labour. Thus cost C represented the total cost of cultivation.

Economic Viability

The techniques used for evaluating the economic viability were net present value (NPV), payback period, internal rate of return (IRR) and benefit – cost ratio (BCR), as done by Sikka *et al.* (1992).

Net present value

Net Present value (NPV) of an investment is the discounted value of all cash inflows and cash outflows of the project during its life time. It can be computed as

$$NPV = \sum_{t=0}^{n} \{(B_t - C_t) / (1+r)^t\}$$

Internal Rate of Return (IRR)

Internal Rate of Return is the rate of return at which the Net Present Value of a stream of payments/incomes is equal to zero.

$$\sum_{t-0}^{n} \{(B_t - C_t) / (1 + IRR)^t\} = 0$$

Benefit Cost Ratio (BCR)

The benefit cost ratio (BCR) of an investment is the ratio of the discounted value of all cash inflows to the discounted value of all cash outflows during the life of the project. It can be estimated as follow

$$BCR = \sum_{t-0}^{n} \{(B_t)/(1+r)^t / \sum_{t-0}^{n} [(C_t) / (1 + r)^t\}$$

where,

B_t = gross returns in time t

C_t = variable cost in time t

r = rate of interest

t = time period (t = 1,2,3,……,i,……,28)

Pay Back Period

The Payback period is defined as the length of time required to recover an initial investment through cash flows generated by the investment.

$$\text{Pay Back Period} = \frac{\text{Cost of investment}}{\text{Annual net cash flow}}$$

Instability:

The instability in cropped area, yield and net returns was studied by calculating coefficient of variation, as was done by Jhagrawat and Varghese (2008).

$$C.V = \frac{\sigma}{\overline{X}} \times 100$$

Where

C.V = Coefficient of variation

σ = Standard deviation

$\overline{X}$ = arithmetic mean

III. RESULTS AND DISCUSSION

Resource use efficiency

In the age group of 5- 9 years the regression coefficients of mango (Table 1) for human labour with positive sign indicated that with one per cent increase in the use of this input keeping all other inputs constant, could increase the return of the crop to 0.89 per cent. All the regression coefficients were less than unity thereby indicating operation of diminishing returns. It could be seen from the Table 1 that marginal value productivity of all the explanatory variables were positive indicating that additional one rupee spent on these inputs would add to gross returns by Rs. 6.95, Rs. 7.65, Rs. 541 and Rs. 128 respectively and hence, still existed a scope to invest more on these inputs.

Table 1. Estimated regression coefficients of various factors, their standard errors and MVP of mango production (5^{th} – 9^{th} year)

Variables	Regression coefficients	Standard error	MVP
Constant	0.616**	0.186	
Human labour (X_1)	0.890**	0.331	6.95
Manures and Fertilizers(X_2)	0.228	0.355	7.65
Plant protection(X_3)	0.001	0.014	541
Pruning and training(X_5)	0.001	0.009	128
F value	31.06		
Coefficient of determination (R^2)	0.951		

Note: ** Significant at 5% level of significance

In the age group of 10- 14 years the regression coefficients of mango (Table 2) for human labour with positive sign indicated that with one per cent increase in the use of this input keeping all other inputs constant , could increase the return of the crop to 1.51 per cent. The contribution of manures + fertilizers, plant protection and pruning + training were however negative thereby indicating that one per cent increase of these inputs, keeping all other inputs constant, could decrease the output by 0.41 per cent in case of manures + fertilizers, 0.04 per cent in case of plant protection and 0.03 per cent in case of pruning + training. The marginal value productivity of human labour was positive while that of manures + fertilizers, plant protection and pruning + training were negative hence indicating their excess use and should be avoided to check the fall of returns in the mango orchards in the age of 10- 14 years.

Table 2. Estimated regression coefficients of various factors, their standard errors and MVP of mango production (10^{th}–14^{th} year)

Variables	Regression coefficients	Standard error	MVP
Constant	0.262	0.134	
Human labour(X_1)	1.510*	0.121	11.13
Manures and Fertilizers(X_2)	- 0.406**	0.129	- 8.33
Plant protection(X_3)	- 0.038**	0.013	- 700
Pruning and training(X_5)	- 0.029*	0.007	121
F value	71.26		
Coefficient of determination (R^2)	0.912		

Note: * Significant at 1% level of significance ** Significant at 5% level of significance

Similarly in the age group of 15- 19 years the regression coefficients of mango (Table 3) for human labour, manures + fertilizers, plant protection and pruning + training with positive sign indicated that with one per cent increase in the use of these inputs keeping all other inputs constant, could increase the return of mango fruit by 0.28 per cent, 0.87 per cent, 0.02 per cent

and 0.01 per cent, respectively. All the regression coefficients taken together were less than unity thereby indicating operation of diminishing returns. The marginal value productivity of all the explanatory variables were positive showed that additional one rupee spent on these inputs would add to gross returns by Rs. 0.67, Rs. 6.16, Rs. 655.2 and Rs. 225.7, respectively and hence there still existed a scope to invest more on these inputs. The regression coefficient of mango in the age group of 20- 24 years (Table 4) showed that the regression coefficient of manures + fertilizers with positive sign indicated that with one per cent increase in manures + fertilizers, the return of output could be increased by 1.4 per cent. The MVP of manures and fertilizers indicated that an additional one rupee spent on manures and fertilizers could add to the gross return by Rs. 9.05, hence there was scope of investing more on manures + fertilizers.

The results of regression coefficient of mango in the age group of 25- 28 years (Table 5) showed that the regression coefficient of human labour with positive sign indicated that with one per cent increase in human labour, the return of output could be increased by 1.07 per cent. From the table 5 it could be observed that there was scope of investing more on human labour as well as on manures + fertilizers. The result of regression coefficient of overall group of mango (Table 6) indicated that regression coefficients of human labour and manures and fertilizers with positive sign indicated that one per cent increase in the use of these inputs, keeping other inputs constant, could increase the return by 0.45 per cent and 0.67 per cent respectively. The MVP as shown in Table 6 indicated that an additional rupee spent on human labour, manures + fertilizers and plant protection could add to gross returns by Rs. 2.62, Rs. 19.98 and Rs. .1913 respectively, hence there was scope of investing more on these inputs. The MVP of pruning + training indicated that with an additional rupee invested on it will reduce the gross returns and hence should be checked.

Table 3. Estimated regression coefficients of various factors, their standard errors and MVP of mango production (15^{th} –19^{th} year)

Variables	Regression coefficients	Standard error	MVP
Constant	1.216*	0.056	
Human labour(X_1)	0.276**	0.082	0.67
Manures and Fertilizers(X_2)	0.867*	0.090	6.16
Plant protection(X_3)	0.017*	0.004	655.20
Pruning and training(X_5)	0.014*	0.003	225.70
F value	965.99		
Coefficient of determination (R^2)	0.945		

Note: * Significant at 1% level of significance** Significant at 5% level of significance

Table 4. Estimated regression coefficients of various factors, their standard errors and MVP of mango production (20^{th} –24^{th} year)

Variables	Regression coefficients	Standard error	MVP
Constant	1.326*	0.070	
Human labour(X_1)	- 0.211	0.102	-0.47
Manures and Fertilizers(X_2)	1.400*	0.112	9.05
F value	1087.15		
Coefficient of determination (R^2)	0.934		

Note: * Significant at 1% level of significance

Table 5. Estimated regression coefficients of various factors, their standard errors and MVP of mango production (25^{th} – 28^{th} year)

Variables	Regression coefficients	Standard error	MVP
Constant	0.046*	0.017	
Human labour(X_1)	1.065*	0.006	2.35
Manures and Fertilizers(X_2)	0.001	0.007	0.002
F value	51.04		
Coefficient of determination (R^2)	0.899		

Note: * Significant at 1% level of significance

Table 6. Estimated regression coefficients of various factors, their standard errors and MVP of mango production (overall)

Variables	Regression coefficients	Standard error	MVP
Constant	0.879*	0.104	
Human labour(X_1)	0.453**	0.152	2.62
Manures and Fertilizers(X_2)	0.674*	0.166	19.98
Plant protection(X_3)	0.009	0.011	1913
Pruning and training(X_5)	- 0.003	0.007	-102
F value	66.40		
Coefficient of determination (R^2)	0.951		

Note: * Significant at 1% level of significance ** Significant at 5% level of significance

Establishment cost

The operation wise per hectare cost in different size groups of holdings for the first year is presented in Table 7. The total costs in first year for the establishment of mango orchards were Rs. 15593.03 in marginal orchards, Rs. 12435.38 in small orchards and Rs. 12062.45 in

medium orchards. The first year establishment costs were found to be highest in case of marginal orchards followed by small and medium orchards, thereby indicating that first year establishment costs decrease with the increase in the size of holdings. The reduced costs can be attributed to the internal economies. The internal economies are mainly because of the various factors such as efficient management, labour economies, technical economies, marketing economies etc. Parayil (1995) was of the same opinion. The year wise establishment costs per hectare of mango are presented in Table 8. The total establishment costs per hectare incurred on mango were Rs. 25262.23 in marginal orchards, Rs. 26207.40 in small orchards and Rs. 26984.55 in medium orchards. The year wise establishment costs in marginal orchards were Rs. 15593.03 in the first year, Rs. 2994.55 in the second year, Rs. 3116.50 in the third year and Rs. 3558.15 in the fourth year. In small orchards the year wise establishment costs were Rs. 12435.38 in the first year, Rs. 4256.48 in the second year, Rs. 4444.55 in the third year and Rs. 5071.00 in the fourth year. The year wise establishment costs per hectare in medium orchards were Rs. 12062.45 in the first year, Rs. 4619.65 in the second year, Rs. 4643.48 in the third year and Rs. 5658.98 in the fourth year. On an average the total establishment costs for all categories together were Rs. 25413.35 with Rs. 15212.18 spent during the first year, Rs. 3156.35 in second year, Rs. 3283.08 in third year and Rs. 3761.75 in the fourth year. The costs in the second year onwards were low mainly because the costs were required only for the aftercare i.e. manuring and hoeing etc. Similar findings were those of Rajesh *et al.* (2000).

Table 7. Operation wise first year establishment costs per hectare of different size groups in mango orchards

Item	Marginal	Small	Medium	Overall
Digging, filling and planting	5697.45	3619.20	2361.55	5413.05
Preparation of land	4033.28	2152.38	1702.10	3798.83
Planting material	1243.08	1416.58	1893.68	1279.23
Training and pruning	0.00	0.00	0.00	0.00
Irrigation	0.00	0.00	0.00	0.00
Manures and fertilizers	495.40	322.43	259.70	473.10
Plant protection	0.00	0.00	0.00	0.00
Interest on working capital	1376.30	901.28	746.05	1315.70
Land Revenue	0.00	0.00	0.00	0.00
Depreciation	257.50	272.50	1012.50	283.93
Earned value of rented land (EVRL)	2223.23	3349.15	3649.00	2364.58
Interest on fixed capital	266.80	401.90	437.88	283.75
Total	15593.03	12435.38	12062.45	15212.18

Table 8. Year wise per hectare establishment costs of different size groups in mango orchards

Year	Marginal	Small	Medium	Overall
I	15593.03	12435.38	12062.45	15212.18
II	2994.55	4256.48	4619.65	3156.35
III	3116.50	4444.55	4643.48	3283.08
IV	3558.15	5071.00	5658.98	3761.75
Total	25262.23	26207.40	26984.55	25413.35

Operational costs

The per hectare operational costs consists of yearly expenses on the maintenance of bearing garden such as family and hired human labour, manures and fertilizers, plant protection and pruning and training. The item wise operational costs in mango are presented in Table 9. The cost A which included all the variable costs excluding the family human labour were Rs. 1514.48 in marginal orchards, Rs. 1474.48 in small orchards and Rs. 1898.13 in medium orchards, whereas on an average it was Rs. 1523.95. The cost B which included the fixed costs in addition to cost A were Rs. 4261.98 in marginal orchards, Rs. 5498.03 in small orchards and Rs. 6997.50 in medium orchards with an average of Rs. 4456.20. The cost C i.e. total item wise operational costs were Rs. 13011.98 in marginal orchards, Rs. 12248.03 in small orchards and Rs. 11885.13 in medium orchards. The decrease of costs from marginal to small farmers could be because of the internal economies but highest costs in case of medium farmers could be because of the mismanagement of the orchards due to larger size.

Table 9. Item wise per hectare operational costs of different size groups in mango orchards

Item	Marginal	Small	Medium	Overall
Hired Human labour	399.98	505.20	876.25	424.63
Irrigation	0.00	0.00	0.00	0.00
Training and pruning	25.00	32.50	10.00	25.13
Manures and fertilizers	918.75	775.58	802.88	902.98
Plant protection	12.50	7.50	7.50	11.93
Interest on working capital	158.25	153.70	201.50	159.30
Cost A	**1514.48**	**1474.48**	**1898.13**	**1523.95**
Land revenue	0.00	0.00	0.00	0.00
Depreciation	257.50	272.50	1012.50	283.93
EVRL	2223.23	3349.15	3649.00	2364.58
Interest on fixed capital	266.78	401.90	437.88	283.75
Cost B	**4261.98**	**5498.03**	**6997.50**	**4456.20**
Family human labour	8750.00	6750.00	4887.63	8454.60
Cost C or Total cost	**13011.98**	**12248.03**	**11885.13**	**12910.80**

Returns

The returns per year from mango orchards per hectare were worked out for different age groups are presented in Table 10. The returns were worked out up to 10th year of age of orchard, between 11th to 15th year and above 15th year of orchards. These groups were made on the fact that the returns upto 10th year was low whereas from 11th to 15th year the returns were increasing and from the 16th year onwards the returns almost remained constant. The returns up to 10th year of age were Rs. 8426.83 in marginal orchards, Rs. 9610.43 in small orchards and Rs. 14098.38 in case of medium orchards. The returns per hectare from 11th to 15th year were Rs. 21213.4 in marginal orchards, Rs. 43845.5 in small orchards and Rs. 36208.25 in medium orchards, while as from the 16th year onwards the returns per hectare were Rs. 22512.93 in marginal orchards, Rs. 56918.00 in small orchards and Rs. 43721.00 in medium orchards. The low returns in case of marginal farmers in all the growing stages could be mainly attributed to the sale of the produce in the local market where the prices are low. Another reason for the low returns was the exploitation of these farmers by the middlemen. Such type of farmers mainly sold their fruits on the trees fetching those low prices. This was also the main reason for low returns in case small farmers' upto 10th year. After the 10th year, the small category farmers sold their produce in the mandies, and their returns were even more than that of the medium farmers. These results were in close conformity with the results of Garg and Yadav (1975).

Table 10. Returns per hectare per year from different size groups in mango orchards

	Marginal	Small	Medium	Overall
Upto 10 years	8426.83	9610.43	14089.38	8714.20
10th to 15th Year	21213.40	43845.50	36208.25	23599.18
Above 15th year	22512.93	56918.00	43721.00	26086.93

Economic Viability

The economic viability of mango orchards is presented in Table 11. The net present value was worked out to Rs. 4081.57 in marginal orchards, Rs. 14537 in small orchards and Rs. 11890 in medium orchards. The internal rate of return was 18.94 per cent in marginal orchards, 18.67 per cent in small orchards and 17.00 per cent in case of medium orchards. The benefit cost ratio was 1.06, 1.72 and 1.95 in marginal, small and medium, orchards, with pay back period of 6.3, 6.3 and 7.0 years respectively. On an average the net present value of mango orchards was Rs. 4802.52 having internal rate of return of 18.85 per cent, benefit cost ratio of 1.14 and having a payback period of 6.4 years. The less net present value of the marginal farmers was mainly because of the less age of the orchards as compared to that of small and medium farmers, while as, the lowest benefit cost ratio in case of marginal farmers was mainly because of the low returns and high costs.

Table 11. Economic viability of different size groups of mango orchards

Group	Net present value (Rs.)	Internal rate of return (%)	Benefit cost ratio	Payback period (years)
Marginal	4081.57	18.94	1.06	6.3
Small	14537.19	18.67	1.72	6.3
Medium	11890.00	17.00	1.95	7.0
Large	-	-	_	-
Overall	**4802.52**	**18.85**	**1.14**	**6.4**

Instability

The results of instability in mango orchards (Table 12) indicated that instability in area, yield and net returns were higher. The overall coefficient of variation for cropped area, yield and net returns was 98.94, 83.03 and 82.02 per cent. Among the different age groups the coefficient of variation for area was more than 100 per cent in all the groups except 10-14 year group where it was 98.39 per cent. The coefficient of variation for yield was highest (57.91 per cent) in the age group of 5-9 years and it decreased as the age of the orchards increased. In case of net returns the coefficient of variation for yield was highest (61.22 per cent) in the age group of 5-9 years and it decreased as the age of the orchards increased. The instability in mango was mainly due to the dependence of the yield on the rains. The coefficient of variation for area was found comparatively higher than that of yield and net returns. These results were similar to those of Umesh *et al.* (1991).

Table 12. Instability using coefficient of variation (per cent) of cropped area, yield and net returns for mango.

Age group	Area	Yield	Net returns
5^{th} to 9^{th} year	100.78	57.91	61.22
10^{th} to 14^{th} year	98.39	39.20	40.11
15^{th} to 19^{th} year	100.86	23.32	25.11
20^{th} to 24^{th} year	102.85	18.41	22.38
24^{th} to 28^{th} year	102.85	18.41	22.38
Overall	**98.94**	**83.03**	**83.02**

IV. SUMMARY AND CONCLUSION

The inputs involved in the production of mango cultivation varied significantly at different age groups. The regression coefficient values of selected inputs mainly human labour, manures and fertilizers, plant protection and pruning and training varied significantly at the six age groups of five years from 5 to 28 years. Major items of the total establishment costs were digging, filling and planting, preparation of land and earned value of rental land. The first year establishment costs were very high as compared to other establishment year costs. The total establishment costs per hectare incurred increased as the size of the orchards increased. The study on per hectare operational costs of mango indicated that the total costs was Rs. 13011.98, Rs. 12248.03 and Rs. 11885.13 in case of marginal, small and medium orchards. On an average the net present value of mango orchards worked out to Rs. 4802.52 with

internal rate of return of 18.85 per cent, 1.14 benefit cost ratio and payback period of 6.4 years.

Thus it may be concluded that the growing of mango in the rainfed areas of Jammu district is profitable and measures should be taken to increase the area under the mango growing particularly in the rainfed areas to improve the economic conditions of the poor which have to suffer huge losses in field crops due the failure of timely monsoons in the region.

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