International Journal of Research in Social Sciences
Vol. 9 Issue 9, September 2019,
ISSN: 2249-2496 Impact Factor: 7.081
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

Resource Use Efficiency of Mandarin Orange Production in Tinsukia District of Assam

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ABSTRACT

The study was conducted in Tinsukia district of Assam to examine the resource productivity and resource use efficiency in orange production. Results of the ordinary least square (OLS) estimates of the parameters for the sampled orange farms showed that regression co-efficient of plant population was positive and significant in all the size categories of farms. The regression co-efficient of manure and fertilizer was found positive and significant at 1 per cent probability level in marginal and medium farms. The regression co-efficient of human labour was found positive in all the size categories of farms, whereas it was found significant at one per cent probability level in marginal and medium farms. The regression co-efficient of plant protection chemical was found significant at 1 per cent probability level in marginal and small farms showing significant contribution of plant protection chemical to gross income in these farm sizes and there is still scope for increasing the expenditure. The returns to scale in all size categories of farms were well above unity.

Key words: Resource use efficiency, orange cultivation, marginal value product, regression co-efficient, return to scale

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Introduction

Citrus fruits are of particular interest because of its high content of vitamin C and refreshing juice. Among the various types of citrus fruits grown in India, orange (mandarin), sweet orange (mausambi), and lime/lemon are of commercial importance. North East India is the native place of many citrus species. Among the various types of citrus fruits grown in India, mandarin orange occupies a prominent position and accounts for over 50 per cent of the citrus area (Deka *et al.* 2012).

Soil and climatic condition of Assam is suitable for growing majority of the fruit crops. Among these, banana and citrus fruits specially mandarin orange are grown at commercial scale and have a great socio-economic importance for the people of Assam. Although, the productivity of orange in Assam is lower compared to other states of India, there is ample opportunity for increasing productivity and total production of this crop through technology adoption coupled with expansion of crop area. However, the orange growers/ producers are having limited resources; so, utilization of their limited resources in a most efficient way is very much important for maximization of profit. Keeping in view the above aspects, the present study was under taken with the specific objective to analyse the resource utilisation pattern and resource use efficiency in cultivation of orange across different farmer's size groups in Assam , particularly in Tinsukia district where orange is grown commercially .

Research Method

The study was carried out in Tinsukia district of Assam (India) and the district was selected purposively for being the highest producer among various orange producing districts of Assam.

A sample of 150 orange (Mandarin) growers was selected following a multistage random sampling technique. Among three civil sub divisions of the district, for data collection, only two subdivisions namely, Tinsukia and Margherita were purposively selected for having major area under orange plantation .From the two sub divisions three blocks namely, Kakopathar, Hapjan and Margherita were selected based on area and the concentration of orange growers .In the next stage, from each block five orange growing villages were selected randomly. A list of orange growers was prepared for each selected village and from that list, 10 orange growers were selected randomly from each village for final data collection.

The selected sample fruit growers were categorised into 3 categories according to their area under orange cultivation *viz*., Marginal (<1ha), small (1.01 to 2 ha) and medium (2.01 to 3 ha) and sample fruit growers from each village were drawn in the ratio of 5:3:2. A total of 50 growers from each village were drawn in the ratio of 5:3:2. A total of 50 growers from each block and 150 growers from each district are taken as final sample. Data were collected from the sample farmers with the help of a set of pre-tested schedule by personal interview method.

To compensate the objective of the study, both simple tabular analysis and functional analysis were done for interpretation of results.

a)Simple tabular analysis

The data collected were tabulated and analysed according to need of objective of the study. Simple statistical tools like percentage and averages were calculated where ever necessary

b) Functional analysis

The Cobb Douglas production function was used for examining the resource use efficiency in orange cultivation and the form of the production function fitted is as follows:

$$Y=aX_1^{b1}X_2^{b2}X_3^{b3}X_4^{b4}X_5^{b5}$$

Where, Y= Gross Income (Rs./ ha)

X_1= plant population (no. of plants/ha)

X_2= manure and fertilizer cost (Rs/ha)

X_3= human Labour cost (Rs/ha)

X_4=cost of plant protection chemical (Rs./ha)

X_5= miscellaneous expenditure (Rs./ha)

The regression co-efficient (b_i) in Cobb- Douglas production function directly indicates the elasticity of production which measures the percentage change in output for unit percentage change in the input (Bhowmick, 1975). The Cobb-Douglas (CD) type of production function was used in the agricultural research for its convenience for the comparison of the partial elasticity co-efficient (Prajneshu, 2008).

Conducting a 't' test for Non-Constant Returns to Scale

To perform a specific test for either increasing or decreasing returns to scale, here one-sided *t* test was used. In the case of increasing returns, following hypothesis and alternative hypothesis were tested;

$$H_0 : \sum_{i=1}^{n} bi = 1$$
$$H_1 : \sum_{i=1}^{n} bi > 1$$

In case of decreasing returns following hypothesis and alternatives were tested:

$$H_0: \sum_{i=1}^{n} bi = 1$$

$$H_1 : \sum_{i=1}^{n} bi < 1$$

The *t* statistic was constructed using the results such that

$$t\sum_{i=1}^{n} = \frac{\sum_{i=1}^{n} b_i - hypothesized\ value}{se(\sum_{i=1}^{n} b_i)}$$

Where, the standard error (se) of the parameter estimates, b1+b2 is computed as

$$\text{se (b1+b2+…)} = \sqrt{\text{var}(b1) + \text{var}(b_2) + ... + 2\,\text{cov}(b_1, b_2) + 2.\text{cov}(b_1, b_2)...}$$

The marginal value products (MVP) of all the inputs for each size group were computed to evaluate how efficiently the farmers of the sample population were using their resources. MVP was compared with the respective factor cost between different size categories of farms to see which categories of farms were utilising

different resources most efficiently. The ratio of the MVP to MFC was used to determine the resources use efficiency as shown in the following equation (Rahman and Lawal, 2003).

$$r = MVP/MFC$$

Where, r = Efficiency ratio (ratio of the MVP of an input and unit price of the input)

MVP = Marginal value product of a variable input.

MFC = Marginal factor cost(price per unit of input)

The marginal value product of a particular resource represents the expected addition to the gross return caused by an addition of one unit of that resource, while other inputs are held constant. The marginal value product of the factors were computed by multiplying the regression co-efficient of the given resource with the ratio of geometric mean of gross return to the geometric mean of the given resource which is then multiplied by unit price of the product. Here, all the variables of the regression model were measured in monetary value, therefore, the slope coefficient of those explanatory variables in the function represented the MVPs, calculated by multiplying the production coefficient of given resources with the ratio of geometric mean (GM) of net return to the GM of the given resources, that is,

$$\ln Y = \ln a + bi \ln Xi$$

Therefore, $dY/dXi = bi [\bar{Y}/ \bar{X}i]$ or, $MVP (Xi) = bi [\bar{Y}/ \bar{X}i]$

Where, $\bar{Y}$ = Geometric mean value of gross return in Rupees.

Xi = Geometric mean value of the ith variable input in Rupees.

As the MFC is price of input per unit, the MFCs of all the inputs will vary while calculating the ratio of MVP to MFC. However, the denominator will always be one, and therefore, the ratio will be equal to their respective MVP (Majumder *et al.*, 2009).

According to the conventional neo-classical test of economic efficiency, a production input is being used efficiently if the ratio of the MVP of an input and the unit price of the input equals unity. Thus,

a) If $r < 1$, it means the resource in question was over utilized hence decreasing the quantity used of that resource increases profit.

b) If $r > 1$, it shows that the resource was being under utilized and increasing the quantity of use will raise profit level.

c) If $r = 1$ it means resource was being efficiently utilized. MFC = Marginal factor cost (price per unit input)

Results and Analysis

Resource Productivity in Orange Cultivation

Results of the ordinary least square (OLS) estimates of the parameters for the sample orange farms shows **(Table 1)** that the regression co-efficient of plant population was positive and significant in all the size categories of farms. It varied from 0.4047in marginal farms to 0.1513 in small farms. Moreover, the coefficient was found significant at 1 per cent probability level in marginal farms and at 5 per cent probability level in small and medium farms. This indicates that in case of plant population, marginal farms had highest contribution towards gross income compared to the other two categories. There is still scope to increase plant population in all the size categories.

Table 1: Regression coefficients of factors influencing orange production across various size groups of sample orange growers(farms)

Sl. No.	Variables	Marginal n=75	Small n=45	Medium n=30	Pooled n=150
1	Plant population (no./ha)	0.4047*** (0.0915)	0.1513** (0.2650)	0.3242 ** (0.4849)	0.4664*** (0.0900)
2	Manure and Fertilizer cost (Rs./ha)	0.0716 *** (0.0150)	-0.0431 (0.0580)	0.4197*** (0.1136)	0.0409** (0.0168)
3	Human labour cost (Rs./ha)	0.1291*** (0.0298)	0.0619 (0.1049)	0.1955*** (0.0711)	0.2448*** (0.0324)
4	Expenditure on plant protection Chemical (Rs./ha)	0.2068*** (0.0340)	0.6623*** (0.1277)	0.0594 (0.0807)	0.1313*** (0.0266)
5	Misc expenditure (Rs./ha)	0.4007*** (0.0755)	0.2896* (0.1627)	0.2097 (0.2446)	0.5317*** (0.0873)
6	R^2	0.9908	0.9807	0.9707	0.9725
7	Returns to scale	1.2130	1.1219	1.2085	1.4150
8	t-value (testing significance of returns to scale)	0.2399	0.1247	0.2346	0.4118

*N.B.: ***Significant at 1 per cent probability level, ** significant at 5 % probability level,*
**significant at 10 % probability level*
Figures within parentheses indicate standard error

The regression co-efficient of manure and fertilizer was found positive and significant at 1 per cent probability level in marginal (0.0716) and medium farms(0.4197), whereas it was found negative in small farms(-0.0431). It implies that the small farmers utilised more amount of manure and fertilizer per hectare of orange plantation and there would have further decreased in gross return with increased expenditure on manure and fertilizer. On the other hand, the factor had contributed significantly to the gross return in marginal and medium farms and there is still scope for increasing expenditure on manure and fertilizer in these farm sizes.

The regression co-efficient of human labour was found positive in all the size categories of farms, whereas it was found significant at one per cent probability level in marginal and medium farms. This indicates that human labour contributed significantly to the gross return from orange plantation in marginal and medium farms and there is further scope for increasing expenditure on human labour in these size categories.

The regression co-efficient of plant protection chemical varied from 0.0594 in medium farms to 0.2068 in marginal farms which were found positive in all the farm sizes. The co-efficient was found significant at 1 per cent probability level in marginal and small farms showing significant contribution of plant protection chemical to gross income in these farm sizes and there is still scope for increasing the expenditure.

The value of regression co-efficient of miscellaneous expenditure (*viz.*, bamboo support, electricity etc.) ranged between 0.2097 in medium farms to 0.4007 in marginal farms showing positive contribution to gross income in all the size categories of farms and significant contribution in marginal and small farms. The regression co-efficient was statistically significant at 1 per cent probability level in marginal farms and at 10 per cent probability level in small farms This indicates the highest as well as significant contribution of miscellaneous expenditure of marginal farms towards gross income as compared to the other two categories of farms. There is still scope for increasing per hectare miscellaneous expenditure in marginal and small farms for increasing gross income.

Returns to scale in orange cultivation

It was observed from the **table 1** that the returns to scale in all size categories of farms were well above unity. It was estimated to be 1.2130, 1.1219 and 1.2085 in case of marginal, small and medium farms respectively indicating increasing returns to scale in all the size categories. However, it was not significant in all the farm sizes. The t values (table 1) calculated for testing the significance of returns to scale were less than the table values in all the size groups. Therefore, it can be concluded that returns to scale were not significantly increasing. Off course, return to scale was found highest in marginal farms. The results clearly indicated that one per cent increase in all the variable inputs at a time would increase production by 1.2130, 1.1219 and 1.2085 per cent in case of marginal, small and medium farms respectively. Therefore, there is scope for increasing gross income in all the size categories of farms.

Resource Use Efficiency in Orange Cultivation

All the variables of the regression model were measured in monetary value. Therefore, the slope co-efficient of those explanatory variables in the function are represented by the MVPs, which were calculated by multiplying the production coefficient of given resources with the ratio of geometric mean (GM) of gross return

to the GM of the given resources. The estimates of marginal value products (MVPs) and ratio of MVP to marginal factor cost are presented in **table 2.**

Table 2:Resources use efficiency of various inputs in orange cultivation across various size groups of sample orange growers of Tinsukia District

Sl. No.	Input factor	Geometric Mean of Xi	MVP in Rs.	Factor cost	Ratio of MVP to factor cost
Marginal					
1	Manure and Fertilizer cost (Rs./ha)	3515.24	2.3059	1	2.3059
2	Human labour cost (Rs./ha)	19,375.16	0.7542	1	0.7542
3	Expenditure on plant protection Chemical (Rs./ha)	1723.94	13.5726	1	13.5726
4	Misc expenditure (Rs./ha)	3234.72	14.0158	1	14.0158
Small					
1	Manure and Fertilizer cost (Rs./ha)	3038.10	-1.3516	1	-1.3516
2	Human labour cost (Rs./ha)	14,761.07	0.3991	1	0.3991
3	Expenditure on plant protection Chemical (Rs./ha)	1073.26	58.7501	1	58.7501
4	Misc expenditure (Rs./ha)	2904.94	9.4906	1	9.4906
Medium					
1	Manure and Fertilizer cost (Rs./ha)	5207.70	7.0397	1	7.0397
2	Human labour cost (Rs./ha)	12,877.68	1.3267	1	1.3267
3	Expenditure on plant protection Chemical (Rs./ha)	955.80	5.4311	1	5.4311
4	Misc expenditure (Rs./ha)	2684.01	6.8235	1	6.8235
All Farms					
1	Manure and Fertilizer cost (Rs./ha)	3639.88	1.1452	1	1.1452
2	Human labour cost (Rs./ha)	16,456.05	1.5174	1	1.5174
3	Expenditure on plant protection Chemical (Rs./ha)	1329.07	10.0791	1	10.0791
4	Misc. expenditure (Rs./ha)	3017.29	17.9754	1	17.9754

It was found that in marginal farms MVP of manure and fertilizer, human labour, plant protection chemical and miscellaneous expenditures were found 2.30, 0.75,13.57 and 14.01 which indicate that one unit increase in expenditure on manure and fertilizer, human labour, plant protection chemical and miscellaneous expenditure would have increased gross income by Rs. 2.30, Rs.0.75, Rs.13.57 and Rs.14.01.The ratio of MVP to factor cost was found more than one in case of manure and fertilizer, plant protection chemical and miscellaneous expenditure which implies that the marginal farmers had under utilised these resources in orange plantation and there is further scope for increasing per hectare output by using more amount of manure and fertilizer, plant protection chemical and miscellaneous expenditure. On the other hand, the ratio was found less than one in case of expenditure on human labour indicating over utilization of human labour in marginal farms. It indicates that there was no scope for spending more on human labour which otherwise might have decreased the profit.

In small farms MVP of manure and fertilizer, human labour, plant protection chemical and miscellaneous expenditures were found -1.3516,0.3991, 58.7501 and 9.4906 which indicate one unit increase in human labour, plant protection chemical and miscellaneous expenditure would have increased gross income by Rs. 0.3991, Rs.58.75 and Rs.9.49;whereas increase in one rupee in manure and fertilizer would have decreased gross income by Rs.1.35.The results further reveals **(Table 2)** that the ratio of the MVP to the MFC was greater than unity for plant protection chemical and miscellaneous expenditure .This implies that plant protection chemical and miscellaneous expenses were underutilised and there is still scope for increasing gross return by increasing expenditure on these resources. On other hand, the ratio is less than unity in case of human labour indicating over utilisation and the small farmers should limit the use of human labour. Whereas negative values of the ratio for manure and fertilizer demonstrated grossly in-efficient utilisation. It means that gross return from orange plantation were likely to increase, if more of inputs like plant protection chemical and miscellaneous expenses were used.

In medium farms the MVP of manure and fertilizer, human labour, plant protection chemical and miscellaneous expenditures were found 7.0397, 1.3267, 5.4311 and 6.8235 indicating positive increase in gross income by Rs. 7.04, Rs.1.33, Rs.5.43 and Rs.6.82 when there is one unit increase in the expenditure of these variables. The ratio of MVP to factor cost is more than unity in case of all the resources which implies that the medium farmers are underutilizing these resources. There is opportunity for increasing gross income by increasing expenses on these resources.

Conclusion

It is clear from the above analysis that the marginal farmers has underutilised the resources like manure and fertilizer, plant protection chemical and miscellaneous expenditure in orange plantation and there is further scope for increasing per hectare output by using more amount of these resources. On the other hand, the ratio of MVP to factor cost was found less than one in case of expenditure on human labour indicating over utilization of human labour in marginal and small farms. It indicates that there was no scope for spending more on human labour which otherwise might have decreased the profit. Whereas in case of small farms plant protection chemical and miscellaneous expenses were underutilised and there is still scope for increasing gross return by increasing expenditure on these resources. In case of medium farms, the ratio of MVP to factor cost is more than

unity in case of all the resources which implies that the medium farmers are underutilizing these resources. There is opportunity for increasing gross income by increasing expenses on these resources.

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