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Resource use efficiency of lemon cultivation in Jammu region of J&K state

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ABSTRACT *The present study made an indepth analysis of lemon being an important citrus crop by studying its resource use efficiency. The analysis of data on lemon indicated the overall values of regression coefficients as 0.451, 1.257, -0.011, -0.002 and -0.023 for human labour, manures + fertilizers, irrigation, plant protection and training/ pruning, respectively, out of which human labour and manures + fertilizers were statistically significant, indicating that one per cent increase of expenditures on these two inputs could increase the returns to the extent of 0.45 per cent and 1.26 per cent, respectively, while as in case of irrigation, plant protection and training/ pruning one per cent additional investment could decrease the production by 0.011 per cent, 0.002 per cent and 0.023 per cent, respectively. The marginal value productivities of human labour and manures + fertilizers were positive with their values at 0.111 and 0.882, respectively whereas that of irrigation (-0.020), plant protection (-59.710) and training/ pruning (-0.039) were negative thereby indicating that with an additional one rupee spent on these inputs could reduce the total returns and hence should be checked.*

Introduction

Globalization of economies and liberalization of trade has led an urgent need for prioritizing the potential areas for investment in order to earn handsome amount of income. Even the entrepreneurs, small as well as marginal farmers aspire to take advantage of global opportunity. Diversification to horticultural crops has been found to be best option as they make more profit, generate additional employment for rural masses and conserve natural resources. Agriculture continues to be core sector of the Indian economy, on which more than 60 per cent of our population is dependent for their livelihood (Anonymous, 2010). Among the citrus fruit crops, lemon is one of the major commercial fruit crop widely consumed as juice. Its global demand is attributed to its high vitamin C content and its antioxidant potential (Gorinstein *et al.*, 2001). It is rich in folic acid, a good source of fiber, fat free, sodium free and cholesterol free with additional quality of containing potassium, calcium, folate, thiamin, niacin, vitamin B_6, phosphorus, magnesium and copper. It may help to reduce the risk of heart diseases and some types of cancer and is also helpful to reduce the risk of pregnant women to have children with birth diseases (Economos *et al.*, 1999). Lemon juice is widely known as a diuretic, antiscorbutic, astringent, and febrifuge. In Italy, the sweetened juice is given to relieve gingivitis, stomatitis, and inflammation of the tongue. Lemon juice in hot water has been widely advocated as a daily laxative and preventive of the common cold, but daily doses have been found to erode the enamel of the teeth. Prolonged use will reduce the teeth to the level of the gums. Lemon juice and honey, or lemon juice with salt or ginger, is taken when needed as a cold remedy (https://aggie-horticulture.tamu.edu/**citrus/lemons**.htm).

J&K State is well known for its horticultural produce both in India and abroad. The state offers good scope for cultivation of horticultural crops, covering a variety of temperate fruits like apple, pear, peach, plum, apricot, almond, cherry and sub tropical fruits like mango, guava, citrus litchi, phalsa and Berete. Besides, medicinal and aromatic plants, floriculture, mushroom, plantation crops and vegetables are cultivated in the state. Apart from this, well known spices like saffron and black Zeera are also cultivated in some pockets of the state. Horticulture is gaining momentum in the state as its contribution to GSDP remains around 7-8 percent over the past few years. There are around 6 lakh families comprising of about 30 lakh people which are directly or indirectly associated with horticulture. Horticulture development is one of the thrust areas in agriculture and a number of programmes have been implemented in the past, resulting in the generation of higher incomes in the rural areas, thereby improving the quality of life in villages. An income of `4100 crore has been generated from fruit production during 2011-12 which includes an amount of `495 crore from dry fruits (J&K Economic Survey, 2012-13). Among the various fruit crops, growing of citrus has vast potential in Jammu region of Jammu and Kashmir state as it comprises highest area under its cultivation (11762 hectares) which is 99.62 per cent of total area of citrus in J&K, whereas its production has been realized to (19202 metric tonnes) which is 99.96 per cent of the total production of J&K (Anonymous, 2009). In Jammu region, the districts mainly Rajouri, Kathua, Jammu, Udhampur, Samba and Reasi are the prominent areas where it is grown. Keeping in view the importance of the lemon fruit and the facts described above, a study was undertaken with the following objectives: to estimate resource use efficiency of lemon in respect of important factor inputs.

Materials and Methods

A multi stage sampling was adopted for the selection of samples, with districts, blocks, villages and lemon growers as the first, second, third and fourth stage sampling units. Kathua district of Jammu region was selected because it covered the maximum area under its cultivation. Then three blocks from each district were selected on the basis of area under lemon

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cultivation and from each block two villages were selected. The ultimate units, that is, lemon growers were selected randomly from each village from the whole area under study.

The primary data from lemon growers was selected by survey method, using well-designed schedule. Collection of data was done by the personal interview method. The schedule was pre-tested before using for actual data collection.

Production function analysis:
In order to study the relationship between output and various inputs used, Cobb- Douglas production function was used. This function is used extensively in agricultural production function analysis. The functional form applies is given as under:

$$Y_t = \beta_0 \left(\prod_{i=1}^{n} X_i \beta i \right) u_t \quad (i = 1,2,3, \ldots, n)$$

Where Y and X_i (i=1,2,3, ..., n) are the output and levels of inputs. The constant β_0 and β_i's (i-1,2,3, ..., n) represent the efficiency parameters and the production elasticities of the respective input variables for the given population at a particular period, t.

The fitted Cobb-Douglas production may be written for the present case with five input variables as:

$$Y = a_0 x_1^{b1} x_2^{b2} x_3^{b3} x_4^{b4} x_5^{b5}$$

On log transformation, the above function can be transformed to a linear form as:

$$\text{Log } y = \log a_0 + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5$$

Or $\log y = \log a_0 + b_i$
Where

Y = Output of citrus in quintals as dependent variables

x_1 = Human labour in man days

x_2 = Manure and fertilizers (kg/acre)

x_3 = Expenditure on plant protection (`/acre)

x_4 = Expenditure on irrigation (`/acre)

x_5 = Expenditure on training and pruning (`/acre)

a_0 = 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.

$$MVP = \hat{bi} \frac{GM(Y)}{GM(xi)} \times P_y$$

Where,

MVP (x_i) = marginal value productivity of i_{th} resource

= regression coefficient (estimated)

GM (Y) = geometric mean of output

GM (x_i) = geometric mean of inputs

P_y = price of output

Results and discussion
Resource use efficiency
The regression function result and marginal value productivity of lemon from 5th – 9th year is given in Table 1. The output of lemon orchards was regressed against human labour, (manures + fertilizers), irrigation, plant protection and training/ pruning. The perusal of the data revealed that production function from 5th – 9th year was statistically significant having R^2 value (0.729) meaning that 72.9 per cent of the total variations in the production function for lemon was explained by the explanatory variables under consideration. The functional analysis for lemon production revealed that human labour and irrigation were positively and negatively significant at 1 per cent level of probability, respectively with regression coefficients as 1.300 and -0.062, respectively whereas (manures + fertilizers) with negative non – significance had the regression coefficient as -0.845, plant protection and training/ pruning were positively non significant with their regression values as 0.012 and 0.020, respectively. The marginal value productivity of human labour, plant protection and training/ pruning was positive with their values at 0.103, 0.016 and 0.040, respectively, whereas (manures + fertilizers) and irrigation were negative with their values as -0.482 and -0.032, respectively. It could be seen from the Table that marginal value productivity of human labour, plant protection and training/ pruning were positive and showed that additional one rupee spent on these inputs, could add to gross returns by `0.10, `0.02 and `0.04, respectively and hence there was still a scope to invest more on these inputs. There was no need to invest more on irrigation and manures + fertilizers.

The regression function and marginal value productivity of lemon from 10th – 14th year is depicted in Table 2, wherein the output of lemon orchards was regressed against human labour, (manures + fertilizers), plant protection and training/ pruning. The production function with R^2 value as 0.830 was statistically significant meaning that 83.0 per cent of the variations in the production of lemon was explained by the explanatory variables under consideration. The table further indicated that the human labour with statistically positive significance at 1 per cent level of probability had the regression value of 1.543 whereas (manures + fertilizers) had the regression value of -0.096 and was negatively significant at 1 per cent level of probability. The marginal value productivity of human labour was positive while that of manures + fertilizers, plant protection and training/ pruning were negative hence indicating their excess use and should be avoided to check the fall of returns in the lemon orchards in the age of 10 – 14 years because they could reduce the output by `0.05, `0.01 and `0.05, respectively with one additional rupee spent on them. These findings are in close conformity with Iqbal (2009).

The regression function result and marginal value productivity of lemon from 15th – 19th year presented in Table 3 depicted that the output of lemon orchards was regressed against human labour, (manures + fertilizers) and plant protection and the production function used was statistically significant having R^2 value as high as 0.950 meaning that 95.0 per cent of the total variation in the production for lemon was explained by these variables. The functional analysis for lemon production revealed that manures + fertilizers with significance at 1 per cent level of probability had regression coefficient as 0.972, whereas plant protection was found to be significant at 5 per cent level of probability with regression coefficient as -0.079 but human labour was non significant with value of regression coefficient as 0.053. All the regression coefficients were less than unity thereby indicating operation of diminishing returns. It could be seen from the Table that marginal value productivity of human labour and manures + fertilizers were positive while that of plant protection was negative, thereby indicating that with one additional one rupee spent on these inputs could increase the output by `0.07 and `0.08, respectively while as in case of plant protection output could reduce by `0.01.

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The regression function result and marginal value productivity of lemon orchards for the overall period presented in Table 4 depicted that the output of lemon orchards was regressed against human labour, (manures + fertilizers), irrigation, plant protection and training/ pruning. The production function used was statistically significant having R^2 value as 0.815 meaning that 81.5 per cent of the total variations in the production for lemon was explained by the explanatory variables under consideration. The functional analysis for lemon production revealed that human labour was found to be positively significant at 5 per cent level of probability with regression coefficient as 0.451 while (manures + fertilizers) was found to be positively significant at 1 per cent level of probability with regression coefficient as 1.257. Similar findings were those of Khushk *et al*. The variables like irrigation, plant protection and training/ pruning were found to be negative and non significant with regression coefficient as -0.011, -0.002 and -0.023, respectively. The MVP as shown in Table indicated that an additional one rupee spent on human labour and manures + fertilizers could add to gross returns by `0.11 and `0.88, respectively, hence there was scope of investing more on these inputs. The MVP of irrigation, plant protection and training/ pruning indicated that with an additional one rupee invested on them would have reduced the gross returns by `0.02, `59.71 and `0.04 and hence should be checked. These findings are in close conformity with Koujalagi *et al*. (1999).

Conclusion

Estimates of Cobb-Douglas production function indicated that human labour was significant and underutilized in all age groups expect in 15th – 19th year. The farm resources such as human labour and manures + fertilizers are underutilized. There is overutilization of other farm resources also. So rational allocation of these resources is necessary. Also growers must be convinced about the need and utility of application of manures + fertilizers.

Table 1: Estimated regression coefficients of various factors, their standard errors and MVP of lemon production (5th – 9th year)

Variables	Regression coefficients	Standard error	MVP
Constant	-0.083	1.262	
Manures + Fertilizers	-0.845	0.354	-0.482
Irrigation	-0.062*	0.015	-0.032
Plant Protection	0.012	0.011	0.016
Training/ Pruning	0.020	0.011	0.040
Human Labour	1.300*	0.338	0.103
F value	4.84		

Coefficient of determination (R^2) 0.729*

Note* Significant at 1% level of significance

Table 2: Estimated regression coefficients of various factors, their standard errors and MVP of lemon production (10th – 14th year)

Variables	Regression coefficients	Standard error	MVP
Constant	-2.670**	0.856	
Manures + Fertilizers	-0.096*	0.027	-0.054
Plant Protection	-0.029	0.015	-0.007
Training/ Pruning	-0.014	0.011	-0.046
Human Labour	1.543*	0.270	0.179
F value	12.16		

Coefficient of determination (R^2) 0.830*

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

Table 3: Estimated regression coefficients of various factors, their standard errors and MVP of lemon production (15th – 19th year)

Variables	Regression coefficients	Standard error	MVP
Constant	-0.450**	0.202	
Manures + Fertilizers	0.972*	0.051	0.075
Plant Protection	-0.079**	0.032	-0.005
Human Labour	0.053	0.044	0.066
F value	238.37		

Coefficient of determination (R^2) 0.950**

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 lemon production (overall)

Variables	Regression coefficients	Standard error	MVP
Constant	-2.744**	1.016	
Manures + Fertilizers	1.257*	0.330	0.882
Irrigation	- 0.011	0.016	-0.020
Plant Protection	-0.002	0.014	-59.710
Training/ Pruning	-0.023	0.011	-0.039
Human Labour	0.451**	0.194	0.111
F value	27.61		

Coefficient of determination (R^2) 0.815**

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