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An Analysis of the Factors Affecting the Apple Production and Productivity in Shimla

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Abstract

The present study entitled "An Analysis of the Factors Affecting the Apple Production and Productivity in Shimla" was undertaken with a vision to study the status of apple productivity in the western Himalayan state of Himachal Pradesh. Narkanda was selected randomly as the ultimate block of study from the Shimla district of Himachal Pradesh state. The objective was aimed at analyzing the apple cultivation and the factors affecting the apple production and productivity. The study sample was drawn using random sampling method in four stages making a total of 70 orchardist households from five altitudinal zones namely ≤ 1500 m, 1500-2000, 2000-2500, 2500 -3000 and above 3000 m msl respectively in the study area. General mathematical and statistical methods were utilized to perform the present study. Overall multiple regression analysis was carried to know the factors influencing the apple production and for evaluating the economic efficiency of resources which has indicated that there exist a scope to increase the apple productivity in the study block, by increasing the levels of the variables like FYM, Chemical fertilizers, human labour, fixed costs and also that it should stick to optimum no. of sprays for plant protection and by maintaining the plant density. The findings of the present study strongly recommend the optimum use of the resources in order to adapt to the adverse conditions and attain desired growth in apple cultivation and ultimately the productivity.

Keywords: Apple production, chemical fertilizers, human labour, fixed costs, plant protection

Apple gets hold of a major part of fruit production in a state like Himachal Pradesh. Considering the vital role that Apple has in the economy of Himachal Pradesh, there is a need to analyze the factors affecting the apple production and the productivity in an approach of producing the Indian favorite apples by the orchardists in the state.

An orchard is a long term investment and careful planning is essential to ensure economic success. Apple orchard is no exception in this regard (Marini, 1997). The gains in production have come essentially from increase in the acreage rather than through intensive cultivation practices. The situation calls for the intensive use of knowledge and skills based farming to realise potential productivity.

The vast technological gaps existing in apple crop, indicates the scope of increasing productivity rates by plugging these gaps through balanced use of modern inputs. The present study intends to assess the factors affecting the apple production and to know where we stand and what ought to be done to achieve the international standards in the productivity. Quantification of influence of the various factors in the apple production in the study area shall focus the need of proper and efficient allocation of the physical and financial resources in order to produce among the best apples in country will seriously bring this crucial aspect in limelight.

Materials and Methods

Managerial skill index

Managerial skill index was used to measure the management capability of different orchardists. The formula to calculate the managerial skill index (MSI) (Timothy, O and Krishnamurthy S, 1990) is given as under:

$$MSI = \frac{M_i}{\bar{M}} \times 100$$

Where,

$$M_i = \frac{1M_1 + 2M_2 + 3M_3}{6}$$

M_1 = Number of years of schooling

M_2 = Years of experience in farming

M_3 = Farm training undergone, if any

With,

M_1 = 0 If illiterate

1 If up to school/literate

3 If college/college drop out

M_2 = 0 If no experience of farming

1 If there is 1 to 10 years of experience in farming.

3 If there is more than 10 years of experience in farming.

M_3 = 0 If no farm training undergone.

1 If once trained

3 If trained more than once.

Managerial skill index of each orchardist was estimated and grouped.

Multiple regression analysis

Category-wise multiple regression analysis was carried out to know the factors influencing the apple productivity. Production function was estimated on per hectare basis of bearing apple plants to measure returns to various factors of production and to mitigate the effect of Multicolinearity. Thus, all the variables except management skill index, spray deviation from recommended Schedule and altitude were transformed into per hectare basis. Some of the non-strategic collinear variables were omitted from the analysis to improve the precision of regression parameter. The variables considered for explaining the level of production at the farmers end in regression equations, were same, between sampled categories. In sample farms, following variables were used.

Log linear equations

$$\text{Log } Y = \text{Log}_a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + b_7 \log X_7 + b_8 \log X_8.$$

Y = Productivity of Apple orchards in study area (MT/Ha)

X_1 = Quantity of FYM applied (Kg)

X_2 = Quantity of Fertilizers applied (Kg)

X_3 = Deviation from prescribed spray schedule

X_4 = Human labour days (No.)

X_5 = Expenditure on fixed capital (₹)

X_6 = Plant Density / Hectare

X_7 = Literacy Index

X_8 = Managerial Skill Index

u = Random term which follows normal distribution with zero mean and constant variance.

a = Intercept and b_1 to b_8 are the elasticity coefficients

Productivity (Y): The productivity has been defined as the average quantity of yield produced per hectare of land area in past three years (including the reference year).

Quantity of FYM applied (X_1): It is the physical quantity of the farm yard manure applied in terms of Kilograms.

Quantity of fertilizers applied (X_2): It is the physical quantity of the fertilizers applied in terms of Kilograms.

Deviation from prescribed spray schedule (X_3): The details of deviation of number of sprays from the spray schedule was assigned by the values 1.14, 1, 0.86 and 0.71 for 8, 7, 6 and 5 number of sprays.

Human labour (X_4): In this study human labour was measured in adult man days of eight hours. It included family labour, permanent and casually hired labour. The variation in the efficiency of labour was removed by converting the female and child labour days into adult man days. The difference in the efficiency of labour has been taken into account by considering one man day equivalent of one adult (18 years and above) working for 8 hours on day. One man day was considered equivalent to two minors (less than 18 years) and three women days were considered equivalent to two man days.

Expenditure on fixed capital (X_5): Fixed capital includes the sum of annual depreciation on farm implements, machinery, farm building, livestock and interest in on fixed capital, amortized establishment cost and rental value of land.

Plant Density/Hectare (X_6): It represents the number of plants per hectare of land area.

Literacy Index (X_7): Explained in Para 3.3

Managerial skill index (X_8): Management index was prepared on the basis education, experience and skill acquired by the orchardists. The procedure for computation of managerial skill index (MSI) has been outlined in section 3.3.5 of this chapter.

Criteria for selection of appropriate function

Two types of algebraic forms viz.; linear and cobb – Douglas were tried in the present study with the optimism that one of these would give best fit and confirm to the logic of signs and magnitude of the estimated parameters. The final choice of function was made on the basis of economic and statistical criteria such as value of R^2, sign and significance of regression coefficients of the function. Accordingly, Cobb–Douglas form of function turned out to be the best fit function, and hence used in functional analysis.

Returns to scale

The sum of elasticity coefficients in Cobb-Douglas indicates the returns to scale. The return to scale suggests the percentage increase in output when all the inputs are increased simultaneously by one per cent. The Sb_i was statistically tested by 'F' test as follows:

$$F\ (1, N\text{-}K)\ d.f. = \frac{\Sigma(b_i - 1)^2}{Var.\Sigma b_i / N - K}$$

Where,

N = Number of observations

K = Total number of parameters estimated

Σb_i = Summation of elasticity coefficients

Adjusted coefficient of multiple determination ($\bar{R}^2$)

The adjusted value of $\bar{R}^2$ is calculated as follows (Koutsoyiannis, 1987).

$$\bar{R}^2 = 1-(1-R^2)\frac{N-1}{K-K}$$

Where,

N = number of sample observations

K = number of parameters estimated.

R^2 = Unadjusted multiple correlation coefficient

Test for overall significance of regression

'F' test has been used to test the overall significance of explanatory variables whether they affect the dependent variable or not. The expression for the test is as under (Koutsoyiannis, 2002)

$$F\ (k-1, N-k)\ d.f. = \frac{\bar{R}^2}{1-\bar{R}^2} \times \frac{N-K}{K-1}$$

Where,

K = Number of parameters

N = Number of observations in the sample

R^2 = Coefficient of adjusted multiple determination

Marginal value products

In order to evaluate the economic rationale of resource use on different categories of farms, the marginal value productivities (MVPs) of different resources was calculated by multiplying regression coefficient of given resources with the ratio of geometric means of yield to the geometric mean of given resources. The marginal value product of a particular resource represents the expected addition to the gross returns caused by an addition of one unit of that resource while other inputs are held constant. For estimation of MVP_{xi} the computational steps followed are as under:

$$MVPx_i = (b_i)\frac{\bar{Y}}{\bar{X}_i}(P_y)$$

Where,

$\bar{Y}$ = Geometric mean of output

$\bar{X}_i$ = Geometric mean of input

b_i = regression coefficients

i = 1 , 2, ……n and

P_y = price of apple per unit (R)

Results and Discussion

Resource Use Efficiency in Apple Production

In the previous sections, we have attempted to work out the costs and returns of the apple cultivation, which

has not cast off adequate light on the productivity and efficiency of resource allocation. It merely provides general indication of overall productivity of apple orchards.

Therefore, in this section, we have tried to identify the factors affecting the apple production as a part of the study using high precision methods and measures of resource use with the help of production function analysis. The 'F' test applied to test the overall significance of the regression was found significant.

Input-output Relationship

One important area of agricultural research centers on the physical relationship between input used and output produced. Once this relationship has been defined, a basis exists for answering the questions about how productivity of a crop is affected by the changes in the size of various factors of production utilized in the production process. Productivity of apples depends upon a variety of factors, some of which are controllable while some factors may be uncontrollable represented by 'u'. In the present study, Farm Yard Manure, Chemical fertilizers, human labour, expenditure on fixed capital, management factor, literacy of orchardists, and deviation of the orchardists from the prescribed spray schedule and density of plantation were identified as the main factors affecting the productivity and production of apples in the study area. It was hypothesized that farm yard manure, chemical fertilizers, human labour, fixed costs, literacy rate and management skills of the orchardists has positive impact on the productivity of apple crop. The deviation from the prescribed number of sprays during production period, plant density was assumed to have negative impact on the apple yield. The regression analysis was carried out for all the sampled orchardists, the results of which are presented in Table 1.

Eighty five per cent of variation in the dependent variable was explained through the chosen variables on pooled orchard data in the selected study block. The adjusted coefficient of multiple determination that explains the explanatory power of the model was found to be 0.70.

The OLS parameter estimates with respect to FYM, chemical fertilizers, human labour and expenditure on fixed capital were positive as well as significant which indicated that one per cent increase in each of these variables, apple orchard productivity, on an average, would increase by 0.102, 0.385, 0.44 and 1.088% respectively. The signs and magnitude of the aforesaid variables were in accordance with the theory. In case of deviational variable, (when the orchardists are deviating from the prescribed schedule of spray) and that of the plant density/ha were examined, the results have revealed that one per cent change from the optimum would result 0.348 and 0.862% decrease in the productivity. This clearly indicated the irrational use of these practices by the orchardists in the study area. The elasticity coefficients of literacy index and management index were found negative albeit non-significant, hence cannot be commented upon.

The returns to scale (Σb_i) was also estimated , the values of non-significant variables have been excluded from its estimation, since their null hypothesis of ' b_i' equal to zero was accepted. The results indicate that returns to scale were less than one measuring thereby

Table: 1. Multiple Regression Analysis (Log linear Regression)

Variable	B	S E	t - value
Constant	- 9.96	6.50	-1.533
X1 = FYM applied (Kg)	0.102NS	0.111	0.924
X2 = Fertilizers applied (Kg)	0.385*	0.055	7.058
X3 = Deviation from prescribed Schedule	- 0.348*	0.135	- 2.568
X4 = Human labour days (No.)	0.444*	0.083	5.382
X5 = Expenditure on fixed capital (₹)	1.088**	0.619	1.759
X6 = Plant Density / Hectare	- 0.862*	0.223	- 3.856
X7 = Literacy Index	- 0.003NS	0.057	- 0.046
X8 = managerial Skill Index	- 0.008NS	0.027	-0.298

$\Sigma b_i = 0.71^{*}$, $R^2 = 0.70$, $R^2 = 0.85$, F Value = 20.084

Note: *** - Denotes significant at 10% level of significance

** - Denotes significant at 5% level of significance

* - Denotes significant at 1% level of significance

Table 2: Marginal Value Products ($MVPx_i$) and factor price ratios ($MVPx_i/Px_i$) on sampled orchards

Sl. No.	Variables	$MVPx_i$	$MVPxi/Px_i$
1	Farm Yard Manure (X_1)	945.49	2.70
2	Chemical Fertilizers (X_2)	241.36	17.24
3	Human Labour (X_4)	1160.36	4.64
4	Fixed Cost (X_5)	19.55	19.55
5	Plant Density (X_6)	- 1878.52	- 4.69

that decreasing returns to scale are thus operative. The decreasing returns to scale indicated that the orchardists are operating in rational zone of production in the study area.

MVP – MFC ratio analysis

The theory of economics justifiably asserts that the marginal value products must equalize the marginal factor cost. The ratio of the marginal value productivities of resources to their factor costs were computed for the apple farms of the study sample (Table 2).

The MVPs of the apple orchards in the study area pertaining to FYM, fertilizers, human labour, expenditure on fixed assets have symbolized a positive sign. It conveyed that there is ample amount of scope to raise the returns by an efficient usage of these resources. The ratios of the MVPs to their associated costs were found considerably greater than unity, which indicates that returns from apple farming could have been increased by increasing use of these three resources.

The analysis of data indicates that there exist more scope to augment the income by making more usage of chemical fertilizers, human labour, FYM and fixed costs. The inefficiency was noticed in the density of planting as the MFC ratio was negatively focussed. It depicts that for every rupee spent on one extra tree will result in to a loss of 4.69 rupees. The fixed cost has shown high MVP-Factor price ratio of 19.55, which indicates that the income of the growers through apple cultivation can be enhanced by investing more on better type of implements and machinery, livestock, storages, farm houses, irrigation structure etc. It also indicated that optimum strategy should be adopted as a whole in order to improve income through apple cultivation.

References

Braun, P. and Muller, M. 2012. Effects of climate change on fruit production in the state of Hesse. *INKLIM* 2012 Module II plus.

Koutsoyiannis, A. 2002. Theory of Econometerics. 2nd Edition. New Delhi. Replica Press Pvt. Ltd., Delhi: 129, 157.

Marini, R.P. 1997. Growing peaches and nectarines in Virginia, Virginia cooperative extension. Horticulture Publication, pp. 422–519.

Sharma, H.R. 2011. Crop diversification in Himachal Pradesh: patterns, determinants and challenges : policy options and investment priorities for accelerating agricultural productivity and development in India, IGIDR Proceedings/ Projects Series. India International Centre, New Delhi, p. 19.

Timothy, O. and Krishnamurthy S. 1990. Productivity variation and water use in farms of Madurankkan area of Changalpatu district of Tamil Nadu. *Indian Journal of Agricultural Economics* **45**(1): 60.