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RESEARCH PAPER

Resource use efficiency of kinnow production in North-Western Himalayas: An economic study from Himachal Pradesh

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Abstract : The Himalayan region extends all along the Northern boundary of India. Traditionally, agriculture on hills was practiced on a subsistence basis but, with the development of means of transport, storage facilities and other infrastructure, hill agriculture has become commercial in character. The present study has been carried out in Indora and Nurpur blocks of Kangra district of Himachal Pradesh which fall in North-Western Himalayan region of India. A sample of 100 kinnow growers was drawn for the present study using multistage sampling technique. The results of the study revealed that on overall farms,89 per cent of total variation in kinnow production was explained by independent variables. Human labour, FYM and fertilizer were under-utilized resources on overall farms and more use of these inputs will increase the output significantly. Among different categories of farms, the regression co-efficient for human labour was positive and significant on medium (0.621) and large farms (0.399) while fertilizerwas positively significant on all categories of farms. The regression co-efficient value for FYM was positively significant on small (0.445) and medium farms (0.474) and regression co-efficient for plant protection chemicals was found significant only on large category farms (0.158). The MVP value for human labour (1.327), FYM (3.526) and fertilizer (4.527) on overall farms revealed that by increasing the use of these inputs by 24.64, 71.63 and 77.91 per cent, respectively, the profit would be increased. The findings of the study clearly showed that these resources were underutilized by the farmers in the study area and optimum use of these resources would definitely increase the returns of kinnow growers in the study area.

Key Words : Agriculture, Multistage sampling, Regression co-efficient, Returns

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INTRODUCTION

Fruits in human nutrition make balanced diet, which tends to the development of sound health and happiness of human beings. Fruits provide vitamins, proteins, minerals like Ca, Fe and P, enzymes and organic acids and therefore, they are considered as protective food. India, with its wide variability of climate and soil, is highly favourable for growing a large number of fruit crops.

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India contributes about 12.6 per cent to the total world production of the fruits. In India, fruits are grown on an area of about 6.30 million hectares with an annual production of 92.84 million tonnes (Anonymous, 2017). Fruits and vegetables account for nearly 90 per cent of the total horticultural production in the country. India is the world's second largest producer of fruits with its projected value touching 98 million tonnes by the year 2020-2021 (Bhat *et al.*, 2011). Besides the nutritional value, the fruit production is labour-intensive and helps in generation of additional income and employment through on-farm packaging, processing and marketing of fresh produce and value-added processed products. Major orchard fruit crops in the country are mango, banana, citrus, apple, guava, pineapple, grape, pomegranate, ber etc.

India is the leading producer of citrus fruits after Mexico with an annual production of about 12.75 million tonnes from 1.06 million hectares area (Anonymous, 2017). India alone has contributed 24 per cent of the total world production of citrus fruits in the world (Anonymous, 2016). Among citrus crops, mandarin orange (Kinnow mandarin, Nagpur, Khasi, Darjling) covers largest area followed by sweet orange (Musambi, Pineapple, Blood Red and Jaffa) and Acid lime. Among these, Kinnow mandarinbears highest place in production, productivity, juice content and fruit quality. Kinnow is a hybrid between King mandarin (*Citrus* nobilis) and Willow leaf (*Citrus deliciosa*) mandarins developed by Dr. H.B. Frost at Citrus Experiment Station, California (USA) in 1915 (Sharma *et al.*, 2007 and Iqbal *et al.*, 2009). Kinnow has been proved promising because kinnow has wide adaptability to variable agro-climatic conditions andalso comparatively more resistant to insect pests and diseases. In India, the cultivation of kinnow has assumed a considerable significance during the recent years and it is being grown in Punjab, Himachal Pradesh, Rajasthan, Haryana, Jammu and Kashmir and Uttar Pradesh. Punjab is India's leading producer of kinnow with 29 per cent of total national production.

Himachal Pradesh, the north-western and Himalayan state of the country has been endowed with unique locational and climatic advantages which make it an ideal region for growing a large number of horticulture commodities like fruit crops, vegetables, flowers, mushroom, medicinal and aromatic plants etc. (Singh *et al.*, 2009). Due to comparative profitability of citrus fruit in sub-tropical region of the state, cultivation of citrus has increase over time and emerged as an important horticulture activity in lower altitudes of the state. This may be judged from the fact that the area under citrus fruit crops has been increased from 7552 hectare in 1975-76 to 24475 hectare in 2016-17. The production of citrus fruits has reached upto 28051 metric tonnes in 2016-17 (Anonymous, 2018). Among citrus fruits, kinnow mandarin has shown tremendous potential in the foothills of the state. It plays an important role in the socio-economic transformation of rural masses in the low-hill zone of the state. Progressive farmers prefer to grow kinnow because of its high yielding characteristics and its attractive quality that possesses the potential to give the lucrative return in the form of profit. Kinnow fruits are medium, oblate, with flattened base, deep orange yellow in colour and very juicy (Gangwar *et al.*, 2005) and have lot of market potential which can help in increasing the farm income (Verma *et al.*, 2015). Therefore, efforts must be made to boost the production of kinnow and in turn increase the returns of kinnow growers in the state. Keeping in view these facts, the present study was undertaken to study how efficiently the resources are utilized by kinnow growers in the study area.

MATERIAL AND METHODS

The present study was conducted during 2017-18 in Kangra district of Himachal Pradesh purposively because this district is the main kinnow growing belt of the state. A multistage sampling technique was adopted to select the sample size of 100 kinnow growers in total. At the first stage of sampling, two blocks namely Indora and Nurpur were selected purposively as these are major kinnow growing blocks of the Kangra district. At the second stage of sampling,ten villages from each selected block were selected randomly. Thereafter, alist of farmers growing kinnow in the selected villages was prepared and a sample of five kinnow growers from each village was selected randomly at the third stage of sampling. For the analysis of data, the selected farmers were further categorized using cumulative cube root frequency method into three categories according to the number of plants as given in Table A. Thus, the total sample of 100 farmers consisted of 46 small farmers, 39 medium farmers and 15 large farmers. Both primary as well as secondary data was used for the present study. The primary data was collected on well-designed pre tested schedule through survey method by interviewing

Table A : Distribution of sampled orchardist according to numbers of plants

Category of farmers	Numbers of plants	Numbers of farmers	Percentage
Small	<300	46	46.00
Medium	300-700	39	39.00
Large	>700	15	15.00
Total		100	100.00

the selected respondents directly. Thereafter, following analytical tools were used to meet out the objective of the present study:

Multiple regression analysis:

For evaluating the economic efficiency of resources use in kinnow production multiple regression analysis was carried out. Some of the non-strategic collinear variables were dropped from the analysis to improve the precision of regression parameter. Thereafter, Cobb-Douglas type of production function was used as:

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

Log eq.

$$\text{Log } Y = \text{Log } a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4$$

where,

Y = Gross returns per hundred plants (Rs.)

X_1 = Human labour expenditure (Rs.)

X_2 = Expenditure on farm yard manure (Rs.)

X_3 = Expenditure on fertilizers (Rs.)

X_4 = Expenditure on plant protection measures (Rs.)

a = Intercept

b_1 to b_4 are the elasticity co-efficients.

Marginal value productivity:

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 as:

$$MVP(X_i) = b_i \frac{Y(G.M.)}{X_i(G.M.)}$$

where,

MVP (X_i) is the marginal value productivity of i[th] resources

b_i is the regression co-efficient (estimated)

GM (Y) is the geometric mean of output (yield)

GM (X_i) is the geometric mean of i[th] resources.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Distribution of sampled households according to size of family:

The data in the Table 1 depicted the sampled households according to size of family. The results revealed that in the study area, the average size of the family was maximum on the medium farm category (4.97) followed by 4.67 and 4.53 on small and large categories, respectively. Under overall situation, family size was found to be 52.83 per cent males and 47.17 per cent females. The number of females per thousand of males was worked out to be 868, 904 and 944 for small, medium and large farm categories, respectively. Overall, the sex ratio was found to be 893 in the study area.

Land use pattern of sampled households:

Land is a basic resource in an agrarian economy. Land use pattern determine the type of farming system and attains a special status in determining the income generation opportunities, especially in rural areas. The land utilization pattern on different categories of farms in the study area has been summarized in Table 2 which revealed that the average size of holding of small, medium and large farmers was found to be 0.70, 2.44 and 4.21 hectares, respectively. The average size of land holdings on overall category was found to be 1.90 hectares.The

Table 1 : Distribution of sampled households according to size of family (Farm category wise)

Particulars	Small	Medium	Large	Overall
Average family size	4.67 (100)	4.97 (100)	4.53 (100)	4.77 (100)
Average numbers of males	2.50 (53.53)	2.61 (52.52)	2.33 (51.43)	2.52 (52.83)
Average numbers of females	2.17 (46.47)	2.36 (47.48)	2.20 (48.57)	2.25 (47.17)
Sex ratio	868	904	944	893

Figures in parenthesis are percentages to average family size results also showed that the area under orchard varied between 60.00 to 78.62 per cent of total land holding among the different categories of farm. Under over all scenario maximum percentage of area was found to be under orchard (74.74%) followed by food crops (20.53%), pasture land (2.10%), forest land (1.05%), land put to non– agricultural use (1.05%) and barren land (0.53%).

Resource use efficiency and marginal value productivity of kinnow production:

For the present study,in order toexplain the contribution of individual factor/input in the total output/ yield of kinnow in the study area, the resource use efficiency and marginal value productivity (MVP) has been worked out for small, medium, large and overall farms category.

Resource use efficiency and MVP of kinnow orchards on small farms:

In case of small farms (Table 3), the value of co-efficient of determination; R^2 (0.88) was estimated to be statistically highly significant which means that 88 per cent of total variation in kinnow production was explained by independent variables taken under consideration. FYM and fertilizer were statistically significant with positive values of 0.445 and 0.587 at 10 and 1 per cent level of significance, respectively, while human labour and plant protection were found to be non-significant but with positive regression co-efficient value 0.298 and 0.512, respectively. It was also found that, the marginal value productivity for explanatory variables *viz.*, human labour, FYM, fertilizers and plant protection chemicals was positive with its value of 1.286, 4.604, 5.016 and 3.053, respectively. The sum of elasticity co-efficients (Σb_i =1.03) was greater than unity, which shows increasing returns to scale on small farms. The positive value of MVP for significant variables *viz.*, FYM (4.604) and fertilizer (5.016) was greater than unity which means these inputs were under-utilized and by increasing FYM and fertilizer by 78.28 and 80.60 per cent, the profit would be increased. The MVP value of human labour (1.286)

Table 2 : Land use pattern of sample households (Farm category wise) **(in hectare)**

Sr. No.	Particulars	Small	Medium	Large	Overall
1.	Area under food crops	0.21 (30.00)	0.48 (19.67)	0.7 (16.63)	0.39 (20.53)
	Irrigated	0.14 (20.00)	0.35 (14.34)	0.58 (13.78)	0.29 (15.26)
	Un-irrigated	0.07 (10.00)	0.13 (5.33)	0.12 (2.85)	0.10 (5.26)
2.	Orchard area	0.42 (60.00)	1.87 (76.64)	3.31 (78.62)	1.42 (74.74)
	Irrigated	0.36 (51.43)	1.68 (68.85)	3.05 (72.45)	1.26 (66.32)
	Un-irrigated	0.06 (8.57)	0.19 (7.79)	0.26 (6.18)	0.16 (8.42)
3.	Forest land	0.02 (2.86)	0.02 (0.82)	0.04 (0.95)	0.02 (1.05)
4.	Pasture land	0.03 (4.29)	0.04 (1.64)	0.09 (2.14)	0.04 (2.10)
5.	Barren land	0.01 (1.43)	0.01 (0.41)	0.01 (0.24)	0.01 (0.53)
6.	Land put to non-agricultural use	0.01 (1.43)	0.02 (0.82)	0.06 (1.43)	0.02 (1.05)
7.	Total area	0.70 (100.00)	2.44 (100.00)	4.21 (100.00)	1.90 (100.00)

Figures in parenthesis are percentages of total area

Table 3 : Estimated regression co-efficients of various factors, their standard errors and marginal value productivity (MVP) of small farms for kinnow orchards

Variables	Regression co-efficients	Standard error	MVP	Percentage change
Constant (α)	3.668**	1.384	-	-
Human labour (X_1)	0.298	0.357	1.286	22.24
FYM (X_2)	0.445*	0.225	4.604	78.28
Fertilizer (X_3)	0.587***	0.132	5.016	80.06
Plant protection (X_4)	0.502	0.512	3.053	67.24
Co-efficient of determination (R^2) = 0.88***				
Σb_i = 1.03				
F-value = 27.24***				

*, **and *** indicate significance of values at P=0.01, 0.05 and 0.1, respectively

and plant protection (3.053) revealed that 22.24 and 67.24 per cent more use of these inputs could increase the profit.

Resource use efficiency and MVP of kinnow orchards on medium farms:

Resource use efficiency on medium farms (Table 4) revealed that regression coefficient value for human labour, FYM and fertilizer was significant with positive values of 0.621, 0.474 and 0.267 at 10, 1 and 5 per cent level of significance, respectively, while plant protection was found non-significant but with positive value of 0.143. The marginal value productivity for explanatory variables *viz.*, human labour, FYM, fertilizers and plant protection chemicals was found positive with its value of 1.134, 3.749, 5.824 and 4.224, respectively. The sum of elasticity co-efficients (Σb_i=1.36) was found to be greater than unity, which shows increasing returns to scale on medium farms.The value of co-efficient of determination (0.92) was found to be statistically significant means that 92 per cent of total variation in kinnow production was explained by independent or explanatory variables taken under consideration. The value of MVP for significant variables *viz.*, human labour (1.134), FYM (3.749) and fertilizer (5.824) was greater than unity which means these inputs were under-utilized and by increasing these inputs by 11.82, 73.32 and 82.82 per cent, respectively, the profit would be increased. The MVP value for plant protection (4.224) revealed that 76.33 per cent more use of this inputs could increase the profit.

Resource use efficiency and MVP of kinnow orchards on large farms:

The results in the Table 5 revealed that for large farms, co-efficient of determination with its value of 0.96 was statistically significant means that 96 per cent of total variation in kinnow production was explained by independent variables taken under consideration and it also revealed that fertilizer, human labour and plant protection was significant with positive values 0.648, 0.399 and 0.158 at 1, 5 and 10 per cent level of significance, respectively, while FYM was found to be

Table 4: Estimated regression co-efficients of various factors, their standard errors and marginal value productivity (MVP) of medium farms for kinnow orchards

Variables	Regression co-efficients	Standard error	MVP	Percentage change
Constant (α)	3.375	3.426	-	-
Human labour (X_1)	0.621*	0.324	1.134	11.82
FYM (X_2)	0.474***	0.135	3.749	73.32
Fertilizer (X_3)	0.267**	0.121	5.824	82.82
Plant protection (X_4)	0.413	0.539	4.224	76.33
Co-efficient of determination (R^2) = 0.92***				
Σb_i = 1.36				
F-value = 86.24***				

*, ** and *** indicate significance of values at P=0.01, 0.05 and 0.1, respectively

Table 5: Estimated regression co-efficients of various factors, their standard errors and marginal value productivity (MVP) of large farms for kinnow orchards

Variables	Regression co-efficients	Standard error	MVP	Percentage change
Constant (α)	5.305	3.543	-	-
Human labour (X_1)	0.399**	0.158	1.665	39.94
FYM (X_2)	0.946	0.582	3.374	70.36
Fertilizer (X_3)	0.648***	0.067	4.072	75.44
Plant protection (X_4)	0.158*	0.087	4.854	79.40
Co-efficient of determination (R^2) = 0.96***				
Σb_i = 1.05				
F-value = 45.24***				

*, ** and *** indicate significance of values at P=0.01, 0.05 and 0.1, respectively

non-significant but with positive value of 0.946. It was also found that, the marginal value productivity for explanatory variables *viz.*, human labour, FYM, fertilizers and plant protection chemicals was positive with its value of 1.665,3.374, 4.072 and 4.854, respectively. The sum of elasticity co-efficients (Σb_i=1.05) was estimated to be greater than unity, which shows increasing returns to scale on large farms for kinnow cultivation.The MVP value for significant variables *viz.*, human labour (1.665), fertilizer (4.072) and plant protection (4.854) was greater than unity which means these inputs were under-utilized and by increasing these inputs by 39.94, 75.44 and 79.40 per cent, respectively, the profit would be increased. The MVP value for FYM (3.374) revealed that 70.36 per cent more use of this inputs could increase the profit.

Resource use efficiency and MVP of kinnow orchards on overall farms:

The perusal of data in Table 6 revealed that for overall farms, co-efficient of determination with its value of 0.89 was statistically significant which means that 89 per cent of total variation in kinnow production was explained by independent variables taken under consideration. In overall farms,fertilizer was found to be statistically highly significant at 1per cent level of significance and human labour and FYM were statistically significant at 5 and 10 per cent level of significance, respectively. The regression co-efficient for human labour, FYM and *viz.*, human labour, FYM, fertilizers and plant protection chemicals was positive with its value of 1.327, 3.526, 4.527 and 3.689, respectively. The sum of elasticity co-efficients (Σb_i = 1.20) is greater than unity, which shows increasing returns to scale on overall farms under kinnow cultivation in the study area. The MVP value for significant variables *viz.*, human labour (1.327), FYM (3.526) and fertilizer (4.527) was greater than unity which means these inputs were under-utilized and by increasing the use of these inputs by 24.64, 71.63 and 77.91 per cent, respectively, the profit would be increased. The MVP value for plant protection (3.689) revealed that 72.89 per cent more use of this inputs could increase the profit.

Conclusion and policy implication:

In agriculture, the efforts are related to the use and allocation of scarce resources among alternative uses with a view to maximize profit. The results of the present study revealed increasing returns to scale under kinnow cultivation on all farm categories. On overall farms, human labour, FYM and fertilizer were found statistically significant which means if there will be one per cent change in human labour, FYM and fertilizer, the returns will be changed by 0.399, 0.381 and 0.418 per cent, respectively. The significant positive value of MVP for human labour, FYM and fertilizer on overall farms revealed that these inputs were under-utilized and increased the use of these inputs by 24.64, 71.63 and 77.91 per cent, respectively, would definitely increase the returns of the kinnow growers in the study area. It was found that resources were underutilized by the farmers in the study area. Therefore, balanced use of these inputs by the orchardists can enhance the kinnow productivity and economic viability to a large extent. Hence, the cultivators should adopt recommended package of practices which in turn would result in increasing the return by minimizing the costs. It is suggested to upgrade the kinnow growers skills and for this an intensive training programme is needed which can be imported by Horticulture university and Horticulture department of the state.

Table 6: Estimated regression co-efficients of various factors, their standard errors and marginal value productivity (MVP) of overall farms for kinnow orchards

Variables	Regression co-efficients	Standard error	MVP	Percentage change
Constant (α)	3.217	4.563	-	-
Human labour (X_1)	0.399**	0.184	1.327	24.64
FYM (X_2)	0.381*	0.213	3.526	71.63
Fertilizer (X_3)	0.418***	0.126	4.527	77.91
Plant protection (X_4)	0.143	0.091	3.689	72.89
Co-efficient of determination (R^2) = 0.89***				
Σb_i = 1.20				
F-value = 116.24***				

*, ** and *** indicate significance of values at P=0.01, 0.05 and 0.1, respectively

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