



International Journal of Research Publication and Reviews

Journal Homepage: www.ijrpr.com ISSN 2582-7421

Returns to Scale in the Production of Apple Fruit in Shimla and Kinnaur Districts of Himachal Pradesh

Dr. Anil Kumar¹, Dr. Ajay Sood²

¹ Ex. Research Investigator, Population Research Centre & Agro-Economic Research Centre, Himachal Pradesh University, Summer Hill, Shimla-171005.

² Assistant Professor, Department of Economics, CDOE, Himachal Pradesh University, Summer Hill, Shimla- 171005.

ABSTRACT

In the present paper an attempt has been made to estimate the returns to scale in the production of apple fruit in Shimla and Kinnaur districts of Himachal Pradesh on a sample of 100 apple orchardists with the help of Cobb-Douglas production function analysis. The analysis incorporates land, material cost, and labour cost as key inputs. The results show that the sum of elasticities came 1.0926 in Shimla district, 1.3538 in Kinnaur district and 1.2232 at overall level, which indicates increasing returns to scale in the apple cultivation across the study areas. This means that if all inputs are increased by 1 percent, then output will increase by 1.09 percent in Shimla district, 1.35 percent in Kinnaur and 1.22 percent at overall level. The results further revealed that the higher value of returns to scale in Kinnaur district as compared to Shimla district indicates that Kinnaur district has better scope for expansion and improved efficiency in apple cultivation. Various factors such as better climatic conditions, better orchard management practices, and possibly lower pest incidence may contribute to this outcome. It also implies that investments in infrastructure and technology could yield substantial productivity gains in Kinnaur district. At overall level the presence of increasing returns to scale across both districts (Shimla and Kinnaur districts), suggests that apple cultivation in Himachal Pradesh as a whole has the potential to benefit from expansion and improved input combinations.

Key Words: Returns, apple fruit, Himachal Pradesh.

1. Introduction

Apple cultivation constitutes a cornerstone of the horticultural economy of Himachal Pradesh, making the state one of the leading apple producers in the country (GoHP, 2022). Favorable agro-climatic conditions viz., such as temperate climate, fertile soils, and suitable altitude have enabled large-scale apple farming, particularly in districts like Shimla, Kullu and Kinnaur (GoHP, 2021). These regions contribute significantly to the state's total apple production, with orchards covering extensive mountainous areas. Over time, apple cultivation has transformed traditional subsistence agriculture into a commercially viable and market-oriented activity.

The economic significance of apple farming extends beyond production, serving as a primary source of livelihood for a large proportion of rural households (National Horticulture Board, 2022). It generates income through cultivation as well as allied activities such as grading, packaging, storage, and transportation. The development of infrastructure, including cold storage and all weather road connectivity, has further strengthened the apple value chain. Additionally, this sector creates seasonal and permanent employment opportunities, contributing significantly to rural development (Ministry of Agriculture and Farmers Welfare, 2021).

At the district level, Shimla remains the leading apple-producing region in terms of both area and output, contributing a major share to the state's total production (Himachal Pradesh State Agricultural Marketing Board, 2022). In contrast, Kinnaur, although smaller in cultivated area, is well known for producing high-quality apples that command premium prices in the market (Dr. Yashwant Singh Parmar University of Horticulture and Forestry, 2021). The district has shown steady growth in productivity due to its favorable high-altitude conditions and adoption of improved horticultural practices.

Apple cultivation has also stimulated the growth of allied industries such as packaging, agro-chemicals, and food processing. Farmers are increasingly diversifying into value-added products like juices, jams, and cider, which help reduce post-harvest losses and enhance income (Indian Council of Agricultural Research, 2020). Government initiatives, including subsidies for high-density plantations and technical support, have further modernized the sector.

Despite its importance, the apple industry faces several challenges, particularly due to climate change, which affects chilling requirements and crop productivity. Unpredictable weather events such as hailstorms and irregular rainfall also pose risks to yield and quality. Moreover, rising input costs and competition from imported apples create additional pressure on farmers (GoHP, 2022). Apple farming remains a vital pillar of the rural economy in

Himachal Pradesh, supporting livelihoods, employment, and regional development. Strengthening this sector through sustainable practices and improved infrastructure will be essential for its continued growth.

2. Objectives

The main objectives of the study are to estimate the production elasticities of inputs, analyze returns to scale, and compare production efficiency across Shimla and Kinnaur districts of Himachal Pradesh.

3. Research Methodology

The present study based upon primary as well as secondary data. Primary data were collected on well-structured household schedule with the help of personal interview of apple growers of the selected districts. Information collected includes; area under apple cultivation (hectares), expenditure on material inputs (fertilizers, manure and plant protection materials), labour costs (family and hired labour) and quantity of apple production. Whereas secondary data were obtained from various sources such as: National Horticulture Board reports, Indian Council of Agricultural Research publications, Government of Himachal Pradesh economic surveys and different research articles. In the present study a multistage purposive-cum-random sampling technique was adopted to select districts, blocks, and apple growers. At the first stage Shimla and Kinnaur districts were selected purposively due to their dominance in apple production and distinct agro-climatic conditions. At the second stage all blocks in the selected districts has been arranged in ascending order on the basis of apple crop intensity and select two blocks purposively having highest apple crop intensity. After this a sample of 25 apple growers from each selected block has been selected randomly in the proportion to the each land holdings group (marginal, small, medium, and large farmers) to capture variability in production behavior.

3.1 Analytical Framework

This study employs quantitative methods to analyze the production efficiency of apple cultivation in Shimla and Kinnaur districts of Himachal Pradesh by using the Cobb-Douglas production function. The functional form of Cobb-Douglas production function is used as follows:

$$Y = A X_1^{b_1} X_2^{b_2} X_3^{b_3} e^u$$

Where, Y (Dependent Variable) = Production (Rs.)

A = Constant term, efficiency parameters

Independent Variables (X_1 to X_3)

X_1 = Land holdings (hectare)

X_2 = Material Cost (Rs.)

X_3 = Labour Cost (Rs.)

b_1 to b_3 = coefficient of elasticity

e = Exponent

U = disturbance term.

The function is converted into linear form by making log transformation of all variables. The model's explanatory power is evaluated by using R^2 (Proportion of variation explained by the model), Adjusted R^2 (Adjusted for number of variables) and Multiple R (Correlation between observed and predicted values). Returns to scale are calculated as: $b_1+b_2+b_3$

- If sum of $b_1+b_2+b_3 = 1$, then it is constant returns to scale.
- If sum of $b_1+b_2+b_3 > 1$, then it is increasing returns to scale.
- If sum of $b_1+b_2+b_3 < 1$, then it is decreasing returns to scale.

4. Results and Discussion

The estimation of the Cobb-Douglas production function provides important insights into the relationship between inputs and apple output in Shimla and Kinnaur districts of Himachal Pradesh. The coefficients represent output elasticities and the sum of these elasticities determines the nature of returns to scale, which is crucial for understanding production efficiency and farm expansion possibilities.

4.1 Inputs Elasticities

Table 1 shows that in Shimla district, the elasticity of land (0.2437) is relatively low and statistically insignificant, suggesting that merely increasing the cultivated area does not substantially raise apple output. This may be due to fragmentation of landholdings, suboptimal orchard density, or diminishing soil productivity. On the other hand, material cost (0.5750) shows moderate influence and is significant at the 10 percent level, indicating that inputs such as fertilizers, pesticides, and irrigation contribute positively to production, although not very strongly. Labour cost (0.2738), being statistically significant at the 5 percent level, highlights the critical importance of human effort in orchard management, including pruning, harvesting, and pest control.

Table 1

Return to Scale in the Production of Apple Fruit in Shima and Kinnaur districts of Himachal Pradesh

Particular	Coefficients	t-Stat
Shimla District		
Land (X_1)	0.2437	0.4851
Material Cost (X_2)	0.5750	1.5704**
Labour Cost (X_3)	0.2738	2.9291*
Return to Scale	1.0926	
Multiple R	0.99	
R Square	0.98	
Adjusted R Square	0.98	
Kinnaur District		
Land (X_1)	0.5318	2.3778
Material Cost (X_2)	0.3868	1.3619**
Labour Cost (X_3)	0.4352	3.7708*
Return to Scale	1.3538	
Multiple R	0.97	
R Square	0.94	
Adjusted R Square	0.94	
Overall		
Land (X_1)	1.1843	17.0197*
Material Cost (X_2)	-0.1691	-1.1800
Labour Cost (X_3)	0.2080	3.3104*
Return to Scale	1.2232	
Multiple R	0.97	
R Square	0.90	
Adjusted R Square	0.95	

*Significant at 5%, **Significant at 10%

In Kinnaur district, the elasticity of land (0.5318) is higher and statistically significant, indicating that expansion of orchard area has a stronger positive effect on output as compared to Shimla district. This may be attributed to better agro-climatic conditions, availability of suitable land, and lower population pressure. Material cost (0.3868) remains moderately significant, suggesting efficient but controlled use of such inputs. Labour cost (0.4352) has a high and statistically significant coefficient, reinforcing the importance of labour in enhancing productivity. The relatively higher labour elasticity as compared to Shimla district suggests that labour in Kinnaur district may be more efficient or better utilized.

4.2 Returns to Scale

The sum of elasticities in Shimla district came 1.0926, which indicates increasing returns to scale. This means that if all inputs are increased by 1 percent, output increases by approximately 1.09 percent. Although the increase is modest, it still suggests that farmers can benefit from scaling up operations. However, the relatively small magnitude implies that inefficiencies or constraints such as limited access to modern technology or credit may restrict the full realization of scale economies.

In Kinnaur district, the return to scale in apple cultivation came 1.3538, indicating strong increasing returns to scale. This suggests that proportional increases in inputs lead to significantly higher increases in output. The higher value of returns to scale as compared to Shimla district indicates that Kinnaur district has better scope for expansion and improved efficiency. Factors such as superior climatic conditions, better orchard management practices, and possibly lower pest incidence may contribute to this outcome. It also implies that investments in infrastructure and technology could yield substantial productivity gains in this region.

For the overall sample, the return to scale came 1.2232, confirming the presence of increasing returns to scale across both districts. This suggests that apple cultivation in Himachal Pradesh as a whole has the potential to benefit from expansion and improved input combinations.

4.3 Significance of Inputs and Statistical Reliability

The statistical significance of coefficients provides insight into the reliability of each input's contribution. Labour is consistently significant across both districts and at overall level, indicating that it is a robust determinant of apple production in the study areas. This is expected, as apple cultivation requires intensive manual operations such as planting, pruning, spraying, and harvesting.

Material cost shows mixed results, being significant at the 10 percent level in district-level (Shimla and Kinnaur) but insignificant at overall level. The negative coefficient in the overall analysis (-0.1691) suggests possible inefficiencies in input use, such as overuse of fertilizers or pesticides without corresponding increases in output. This may also reflect rising input prices or diminishing marginal productivity of these inputs.

Land shows strong significance at the overall level (1.1843), indicating that land expansion plays a crucial role in increasing output. However, it is insignificant in Shimla district highlights regional disparities in land productivity, which may be due to differences in terrain, soil quality, or orchard age.

5. Conclusions and Policy Implications

From above results and discussion it can be concluded that at overall level apple production is characterized by increasing returns to scale, with significant contributions from labour and land. The variation between the selected districts (Shimla and Kinnaur) highlights the importance of regional factors in determining productivity. The results support the theoretical expectations of the Cobb-Douglas production function and provide empirical evidence for policy interventions aimed at improving agricultural efficiency. Further, the findings on returns to scale have several important policy implications. First, increasing returns to scale indicate that encouraging farm expansion and consolidation, wherever feasible, can enhance productivity by enabling farmers to benefit from economies of scale. Second, since labour makes a significant contribution to output, policies should be aimed at improving labour skills through training and capacity-building programs. Third, the inefficient use of material inputs observed at the overall level highlights the need to strengthen agricultural extension services to educate farmers on the optimal use of fertilizers, pesticides, and other production inputs, thereby improving resource-use efficiency and reducing wastage. Finally, district-specific interventions are essential, in Kinnaur district, where returns to scale are relatively higher, targeted investments in irrigation, rural infrastructure, storage facilities, transportation, and market access can further enhance horticultural production. In contrast, in Shimla district, policy efforts should focus on improving land productivity through better orchard management practices, the adoption of improved technologies, soil and water conservation measures, and the efficient use of production inputs.

References

- Department of Horticulture Himachal Pradesh. (2021). Horticulture Development in Himachal Pradesh: Achievements and Statistics. Shimla.
- Dr. Yashwant Singh Parmar University of Horticulture and Forestry. (2021). Research Reports on Temperate Fruit Crops. Solan, Himachal Pradesh.
- Government of Himachal Pradesh. (2022). Economic Survey of Himachal Pradesh 2021–22. Department of Economics and Statistics, Shimla.
- Himachal Pradesh State Agricultural Marketing Board. (2022). Apple Production and Marketing Statistics. Shimla.
- Indian Council of Agricultural Research. (2020). Advances in Apple Cultivation and Production in India. New Delhi.
- Kaundal, A. K., & Kumar, K. (2023). Returns to Scale in the Production of Food Vis-à-vis Non-Food Crops under Natural and Conventional Farming Systems in Himachal Pradesh. *Journal of Social Science*, 13(1), 152–158.
- Kumar, A. (2017). Watershed Development Programme and Returns to Scale in Hill Agriculture of Himachal Pradesh. *Agricultural Situation in India*, Vol. LXXIV (5), 34-43.

Kumar, A., & Singh, S. (2024). Growth Trends, Instability and Determinants of Apple Production in Himalayan Regions. *International Journal of Publication and Reviews*, 5(7), 4682–4686.

Ministry of Agriculture and Farmers Welfare. (2021). *Agricultural Statistics at a Glance*. Government of India.

National Horticulture Board. (2022). *Indian Horticulture Database*. Ministry of Agriculture & Farmers Welfare, Government of India.

Sood, A., & Kumar, A. (2023). Growth Trends and Instability in Production of Major Food Grain Crops and Pulses in India. *Agricultural Situation in India*, 80(2), 18–25.