Growth and Decomposition Analysis of Apple Production in Himachal Pradesh

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Abstract

Apple farming is the fastest growing economic activity of the state and due to varied agro-climatic conditions across the districts, there exists a large variation in the area output growth of apple fruit crop. The study is based on secondary data and the study period is divided into three sub periods namely P-I (1987-88 to 1996-97), P-II (1997-98 to 2006-07) and P-III (2007-08 to 2016-17). Area under apple increased during the P-I with a positive and high significant rate but in P-II & III, there has been relatively more emphasis on plantation of other fruits because of which the proportionate share of apple area has come down. The decomposition analysis revealed that during the P- I&II, area under apple in the state was the major contributing factor causing the change in production but during the P-III, it was the yield of apple that played the central role.

Keywords: Apple, Decomposition, Growth rate, Himachal Pradesh, Instability

JEL Classification: Q15, Q20, Q24

Introduction

Horticulture sector has emerged as a dynamic force for agricultural development in India. The sector has emerged as the most profitable venture providing ample employment opportunities and subsequently increasing the income of the farming community in the country. Besides, the sector has tremendous potential to push overall agricultural growth above the country's target. The importance of horticulture in improving the productivity of land, perking up economic conditions of the farmers and entrepreneurs, enhancing exports and providing nutritional security to the people is widely acknowledged. The temperate fruits are the monopoly of hilly regions of India like Himachal Pradesh (H.P), Jammu and Kashmir, Uttaranchal etc. (Azad, 1998 and Chadda, 1987). Out of all the deciduous fruits, apple is the most important fruit crop in terms of extent of area and production. Area under apple cultivation in India has increased from 241.8 8 thousand hectares in 2001-02 to 306.0 thousand hectares in 2017-18 and

the production has increased, from 1158.4 thousand MTs in 2001-02 to 2371.0 thousand MTs in 2017-18 (NHB, 2018). Greater emphasis has been made on development initiatives of this sector in the country as a result of which, the country has registered itself as the second largest producer of fruits and vegetables in the world, next to China.

The importance and promotion of horticulture in Himachal Pradesh (H.P) is a national priority because undulating topography of land in the hill areas is more suitable for cultivation of horticulture crops and also plays a vital role in promoting environmental conservation. The crop diversification towards selective high value crops including fruits and vegetables, compatible with the comparative advantage of the region, is recommended as an effective strategy in raising incomes, generating employment opportunities and alleviating poverty among small and marginal households (Vyas, 1996 and Joshi *et al,* 2004).

Horticulture sector is substantial for supplementing major income of the people of H.P (Attri R, 2010). The

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state of H.P being primarily a temperate hilly state is known for the production of commercial temperate fruits crops that includes apple, peach, plum, apricot, walnut, strawberry and cherry etc. Among these, apple is grown at the largest area and most preferred among the fruit growers in the state (Kumar *et al,* 2007). In H.P, area under fruit crops has been found to be 230.85 thousand hectares with the total production of 565.31 thousand MT out of which apple crop covers the area of 111.90 thousand hectares with the production of 446.57 thousand MT (GOI, 2018). So present study was undertaken considering the economic as well as environmental benefits of apple cultivation in H.P with the objective to examine the performance of apple cultivation in state and see if there have been any noticeable changes during the last three decades.

Data Sources and Methodology

Secondary data pertaining to area, production and productivity of apple in H.P was recorded from the National Horticulture Board, respective revenue offices and Directorates of Land Records for the period of 30 years i.e. 1987-88 to 2016-17. For the analysis, the entire period was divided into three sub periods i.e. P-I (1987-88 to 1996-97), P-II (1997-98 to 2006-07) and P-III (2007-08 to 2016-17). Nine out of 12 major apple growing districts of H.P were selected for the study viz. Chamba, Kangra, Kinnaur, Kullu, Lahaul&Spiti, Mandi, Shimla, Solan and Sirmour .

Compound growth rates (CGR)

The compound growth rates were computed by fitting the power function to the figures of area, production and productivity of apple for the period of 1987-1988 to 2016-2017. The ordinary least square method was used to fit the power function of the following form $Y = ab^t$.

Where:

Y = Dependent variable (Area, production and productivity etc.)

t = Independent variable (time in a year)

Compound growth rates (CGRs) were calculated by using the following formula:

CGR = (Antilog b-1) × 100

$$\text{SE of CGR} = \frac{100\,b}{\text{Log}_e\,10} \times \text{SE Log } b$$

Cuddy-Della Valle Index

Variability in area, production and yield of apple is measured in relative terms by the Cuddy della valle index which is used as a measure of variability in time-series data (e.g. Singh and Byerlee, 1990 and Deb *et al,* 1999). The simple coefficient of variation over-estimates the level of instability in time-series data characterized by long-term trends whereas the Cuddy-Della Valle index corrects the coefficient of variation, by:

$$\text{CDI} = (\text{CV*}) \, (1 - R^2)^{0.5}$$

Where CDI is the Cuddy-Della Valle index, i.e., corrected coefficient of variation (CV). CV* is the simple estimate of the coefficient of variation (in per cent), and R^2 is the coefficient of determination from a time-trend regression adjusted by the number of degrees of freedom.

Decomposition analysis

Decomposition analysis is used to measure the relative contribution of area and yield towards the change in total production of apples in H.P. The change in production was taken as the effect of three factors such as yield effect, area effect and interaction effect.

Here, Ab= Area in base year, Yb = Yield in the base year, Yc = Yield in the current year, Ac = Area in the current year, $\Delta P = Ab^* \Delta Y + Yb \Delta A + \Delta A \Delta Y$, ΔP = Change in production, ΔA=Change in area (Ac-Ab), ΔY= Change in yield (Yc-Yb) and Change in production= Yield effect + Area effect + Interaction effect.

Results and Discussion

Trends in area, production and productivity of apple in Himachal Pradesh

Himachal Pradesh has undergone a revolution in the apple production during last few decades. Apple has been the fastest growing economic activity of the state and is being grown in 9 out of 12 districts. Himachal Pradesh is the second largest apple producing State in India that produces on large scale for commercial purposes and achieving a prestigious status "Apple State of India". Apple is the most important cash crop of the hill State and constitutes 85 percent of the total production and 45 percent of land under fruit cultivation. The apple fruit having an economy of around 3700 crore and is grown mainly in the districts of Shimla, Kinnaur, Mandi, Chamba, Lahaul &Spiti and some parts of Sirmour (Wani and Sangora 2018).

The district wise compound annual growth rate of area, production and productivity of apple crop during the sub period P-I, P-II and P- III has been summarized in table 1.The perusal of the table reveals that the area under the apple crop in the state has increased at a compound growth rate of 2.25 per cent per annum during the overall study period (1987-88 to 2016-2017). The annual growth rate of area under apple in H.P was found to be 4.46 per cent, 0.63 per cent and 1.31 per cent per annum in the three periods respectively. In the later years, there has been relatively more emphasis on planting of other fruit trees in the state as a consequence of which the proportionate share of apple area has come down. It can be seen from the table that area under apple has been showing a steady growth, though yield showed negative growth in majority of the districts in sub period P-I as the technological innovation during this period was very less which led to the decline in productivity of the apple crop. The lowest growth rate in area was seen in the Solan and Kangra districts whereas the area growth was found to be quite impressive and significant in the tribal districts of Lahaul and Spiti, Chamba and Kinnaur in all the three sub periods as these districts constitute backward tribal districts which has received the added attention in the recent past by the state government for augmenting the growth promotion in these untapped traditional areas. Moreover, climatic conditions are more favorable in these districts for the successful cultivation of apple.

Amongst all the fruits grown in the state, apple was found to be occupying the prime position in terms of production also, accounting for nearly 80 per cent of total fruit production in the state. Although there has been commendable stride in increasing the apple production, yet the incremental production has come mainly as result of area expansion and the productivity of this fruits has been low as compared to advanced countries (Sharma *et al,* 2018). It was observed that the production of apples has increased at compound growth rate of 3.68 per cent per annum during the complete study period. The perusal of the table reveals that production growth was found to be quite impressive in subs period P-II i.e., 10.56 per cent per annum. The production was significant in the tribal districts of Lahaul and Spiti (14.45, 14.22 per cent per annum in P- I&II respectively) and Kinnaur (10.47, 14.92 per cent per annum in P-I &II respectively).

Productivity in fruit farming has been assessed by measures of crop yield. The growth rates in productivity is an important determinant of agricultural transformation and have been considered as the engine of growth to the farm economy. Thus, it has been important to assess the fruit productivity; its growth, to know where we stand and what ought to be done to achieve the international standards in the productivity. In H.P the overall productivity of apple hovers around 4 tonnes per hectare as compared to 7 tonnes per hectare at all India level and is much below the international level of 30 tonnes per hectare. The district wise growth in the productivity of bearing plants in H.P has been given in table 1 which has shown that many districts of the state have exhibited the negative growth in productivity. Growth rate of productivity in H.P was found to be negative in P-I and was very less i.e., 0.38 per cent in P-III but it was recorded highly positive but non-significant during the P-II. Kangra district recorded negative growth rate in productivity because the climatic conditions in the district are not favorable for fruit farming. The major factors which causes decline in production in low lying areas of Himachal Pradesh were climatic conditions and apple-growing areas in lower altitudes have reduced by as much as 77 per cent between 1981 and 2007 (Negi *et al,* 2012). This dismal growth in yield may be attributed to predominance of old and senile orchards, development of apple industry in rain fed conditions, global warming, low density of plantation, lack of efficient use of irrigation water, quality seeds and planting material, pollination problems, site selection, imbalanced use of resources etc.

So, it was concluded from the above analysis that area under apple had increased during the P-I but production and subsequently productivity showed elevated growth in sub period P-II because of the adoption of high yielding varieties, modern orchard management practices, including improved moisture conservation and fertilizer application by the farmers

Variability in area, production and yield of apple in Himachal Pradesh

The level of instability in apple production is very important for sustainable production. Variability in area, production and yield of apple is measured by coefficient of variation and Cuddy-Della Valle index. The resuls of table 2 presents the relative variability in area, production, and yield of apple in different districts of H.P. The variation in area under apple in H.P. during the three sub periods was1.03, 4.53 and 5.86

Table 1. Compound annual growth rate in area, production and yield of major apple producing districts in Himachal Pradesh

Districts	Area	Production	Yield
P-I (1987-88 to 1996-97)			
Chamba	10.35***	-8.87	-17.43
Kangra	1.47***	13.24	11.59
Kinnaur	4.80***	10.47***	5.41*
Kullu	3.58***	-4.85	-8.14
Lahaul&Spiti	14.47***	14.45**	-0.01
Mandi	4.83***	-4.65	-9.05**
Shimla	4.23***	-0.63	-4.67
Solan	0.81***	-5.01	-5.78
Sirmour	1.75***	-4.43	-6.08
Himachal Pradesh	**4.46***	**-1.34**	**-5.56**
P-II (1997-98 to 2006-07)			
Chamba	3.10***	9.79	6.48
Kangra	-5.09***	13.64**	19.75***
Kinnaur	7.24***	10.01***	2.58
Kullu	1.57***	14.92	13.13
Lahaul&Spiti	5.06*	14.22**	8.71*
Mandi	1.56***	24.79***	22.87***
Shimla	-2.00**	7.72	9.92
Solan	-21.46***	-4.30	21.84*
Sirmour	-1.97***	5.82	7.95
Himachal Pradesh	**0.63**	**10.56**	**9.86**
P-III (2007-08 to 2016-17)			
Chamba	1.02***	15.43*	14.25*
Kangra	-1.08**	-5.90***	-4.87***
Kinnaur	2.27***	2.98	0.69
Kullu	1.52***	0.47	-1.03
Lahaul&Spiti	9.88***	-3.59	-7.14
Mandi	-1.87	9.07	12.37
Shimla	2.90***	0.51	-2.09
Solan	-7.86***	-8.60**	5.20
Sirmour	-3.40***	18.02**	22.18**
Himachal Pradesh	**1.31***	**1.68**	**0.38**

*Note: *,** and *** significant at 10, 5 and 1 per cent level of significance*

per cent respectively. So, it was concluded that P-III showed high instability in the area compared to P-I & II. During P-I, compared to P-II, all districts except Mandi experienced increase in variability in area under apple. The relative variability in apple production in Himachal Pradesh during the three sub periods were 32.61, 44.43 and 40.53 per cent, respectively, indicating an increase in production variability in the later period. The magnitude of relative variability in apple yield showed that productivity is highly instable (extent of

Table 2. Variability in area, production and yield of major apple producing districts in Himachal Pradesh

Districts	Co-efficient of Variation (CV)			Cuddy-Della Valle index (CDI)		
	Area	Production	Yield	Area	Production	Yield
P-I (1987-88 to 1996-97)						
Chamba	28.90	170.60	193.50	4.09	172.98	174.15
Kangra	4.98	57.98	57.98	2.63	53.11	54.42
Kinnaur	14.10	34.71	26.80	1.41	20.54	22.42
Kullu	10.65	42.97	47.54	1.07	43.27	43.98
Lahaul&Spiti	45.18	55.33	49.97	10.10	39.90	53.00
Mandi	14.06	35.05	40.62	2.44	33.00	29.29
Shimla	12.50	29.94	33.36	1.25	31.69	33.04
Solan	2.50	54.90	55.23	0.61	55.15	54.56
Sirmour	5.37	65.07	63.19	1.52	67.31	64.00
Himachal Pradesh	**13.10**	**30.94**	**35.92**	**1.03**	**32.61**	**34.29**
P-II (1997-98 to 2006-07)						
Chamba	10.79	40.23	36.77	6.29	36.43	36.21
Kangra	19.74	47.41	59.87	13.09	36.72	41.05
Kinnaur	26.01	35.41	22.99	12.47	22.11	23.02
Kullu	4.89	52.22	50.37	1.20	48.99	48.26
Lahaul&Spiti	23.77	51.71	43.83	19.89	38.35	37.45
Mandi	4.79	67.19	63.60	1.17	37.41	37.08
Shimla	9.63	52.85	56.53	7.94	54.11	56.92
Solan	70.00	115.16	68.34	37.04	119.84	58.79
Sirmour	9.22	38.85	41.14	7.49	39.65	40.98
Himachal Pradesh	**4.68**	**46.30**	**46.25**	**4.53**	**44.43**	**45.08**
P-III (2007-08 to 2016-17)						
Chamba	3.87	60.68	58.02	2.51	52.20	51.24
Kangra	5.03	22.01	19.03	4.09	13.02	12.91
Kinnaur	7.01	19.73	16.63	2.22	18.61	17.44
Kullu	4.60	48.72	49.35	0.65	51.68	52.23
Lahaul&Spiti	27.44	47.66	97.07	7.26	48.98	101.58
Mandi	20.48	35.08	87.97	21.31	31.22	85.83
Shimla	8.64	38.56	42.35	0.86	40.86	44.48
Solan	24.46	36.81	260.97	3.46	28.27	274.58
Sirmour	10.69	73.34	81.62	3.55	56.81	58.29
Himachal Pradesh	**6.77**	**38.48**	**38.46**	**5.86**	**40.53**	**40.78**

risks and variability is more) over the years, having a Cuddy-Della Valle Index of 34.29, 45.08 and 40.78 per cent in the three sub periods. So, it was concluded that sub period P-I showed low variability in apple area, production and productivity.

Decomposition analysis of apples in Himachal Pradesh

Decomposition analysis was carried out to estimate the percentage contribution of area effect, yield effect and interaction effect towards change in production.

Table 3. Decomposition analysis of apples in Himachal Pradesh, 1987-88 to 2016-17

Districts	Area effect	Yield effect	Interaction effect
P-I (1987-88 to 1996-97)			
Chamba	-381.63	214.40	267.23
Kangra	3.52	83.66	12.82
Kinnaur	37.70	40.34	21.96
Kullu	-265.46	266.87	98.59
Lahaul&Spiti	186.97	-24.74	-62.23
Mandi	-579.49	443.33	236.16
Shimla	239.93	-98.32	-41.61
Solan	-18.01	110.25	7.75
Sirmour	-31.96	112.44	19.52
Himachal Pradesh	**410.32**	**-212.11**	**-98.22**
P-II (1997-98 to 2006-07)			
Chamba	130.76	-21.36	-9.40
Kangra	-17.47	158.74	-41.27
Kinnaur	114.99	-8.86	-6.13
Kullu	42.35	49.00	8.64
Lahaul&Spiti	73.28	13.34	13.38
Mandi	2.26	84.07	13.66
Shimla	20.44	85.37	-5.82
Solan	-159.36	1273.65	-1014.29
Sirmour	29.88	76.33	-6.22
Himachal Pradesh	**78.09**	**19.67**	**2.24**
P-III (2007-08 to 2016-17)			
Chamba	130.76	-21.36	-9.40
Kangra	-17.47	158.74	-41.27
Kinnaur	114.99	-8.86	-6.13
Kullu	42.35	49.00	8.64
Lahaul&Spiti	73.28	13.34	13.38
Mandi	2.26	84.07	13.66
Shimla	20.44	85.37	-5.82
Solan	-159.36	1273.65	-1014.29
Sirmour	29.88	76.33	-6.22
Himachal Pradesh	**-72.30**	**146.25**	**26.05**

It was evident from the table 1 that production of apples in H.P was declining during the P-I where as in P- II and P-III it showed a positive trend. Therefore, to know the contribution of area and yield towards change in production of apple, decomposition analysis was undertaken. The perusal of the table 3 reveals that during sub period P-I, area effect was the only positive effect causing the change in production of apples in H.P. Further in P-II, area effect (78.09%) was more dominant, followed by yield effect (19.67%) and interaction effect (2.24%). Where as in case of P-III, yield effect is the leading effect but area effect was found to be negative. It was concluded from the above analysis that during the period of 1987-88 to 2006-07

i.e. P-I & II, area under apple in the state was the major contributing factor to cause change in production but during the P-III, it was the yield of apple that played the major role.

District wise analysis showed that during the P-I, seven out of nine districts were associated with yield and the interaction effect which leads to change in the production of apple. Lahaul & Spiti and Shimla were the only two districts where area effect was dominant. Similarly in case of the P- II and P-III, yield effect played the major role to cause change in production.

Conclusion and Policy Implications

Area and production of apple in the state increased in almost all the districts of Himachal except Kangra, Mandi, Sirmour and Solan, Therefore, there is a need to develop cultivars suitable to these areas because area expansion is not possible due to lack of land for further expansion. As per the decomposition analysis, in P-I&II, area under apple in the state was the major contributing factor to cause change in production but during the P-III, it was the yield of apple that played the central role. Thus, efforts should be made to improve the technology as well as extension of the technology to the farms through different research and extension agencies in the state. Government should prioritize high yielding varieties of apple, proper mechanization, techniques like rainwater harvesting for irrigation, training and capacity building with engagement of national and international experts for specific inputs on apple orchard management and establishment of knowledge cum recreational centre in order to raise apple productivity which is a cause of concern.

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