Evaluation of growth trends, regional variations and productivity metrics of apple cultivation in Himachal Pradesh

Abstract

In India, the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh are where apples are primarily farmed. Since a decade, India has seen a spatial escalation on apple growth, and therefore, fosteredcountry's economy and employment.Thus, we took secondary data on apple growth trend and its production from the different sources and analysed it through growth rate, decomposition analysis and instability index techniques.Our findings reported that between1973–1974 and 2021–2022, there was an increase in the global area, productivity, and production of apples in Asia and India. The output of apples worldwide has increased at a compound annual growth rate of 2.51%, whereas India has experienced a notable rise of 3.40 percent annually. The majority of the apple's area, output, and productivity came from the Asian region, with growth rates of 3.38, 5.97, and 2.59%, respectively. Furthermore, Worldwide scenario on apple cultivation reported that Poland had the highest relative instability in apple productivity (21.44%), followed by India (15.96%), China (12.53%), Turkey (11.18%)and USA (8.61%).In Himachal Pradesh, the area yield effect was used to explain the rise in apple output in Asia, however, area expansion was the primary cause of the increase in production in India. Zone III of Himachal Pradesh has the greatest average yearly productivity (4.78 %), followed by Zone II (3.35 %) and Zone IV (0.57 %). In zones III and IV, the expansion of area (96.93%) and yields (85.13%) was the reason for the increase in apple production, however, in zone II, the yield effect (102.05%) was the cause of the increase in production.

Keywords: Apple, agricultural production, economics, plant growth, hill fruits

Introduction

The importanceand promotion of horticulture in Himachal Pradesh is a national priority, because undulating physiographic of land in the hilly areas is more suitable for cultivation of horticulture crops and also playing a vital role in promoting environmental conservation. It has also proved that horticulture is significant for supplementing otherwise major income of the people of Himachal Pradesh (Attri and Rajendar, 2010). India is regarded as fruits &vegetable basket of the world. The horticulture sector encompasses a wide range of crops e.g., fruit crops, vegetables crops, potato and tuber crops, ornamental crops, medicinal and aromatic crops, spices and plantation crops. While the first few Five Year Plans assigned priority to achieving self sufficiency in food grain production, over the years, horticulture has emerged as an indispensable part of agriculture, offering a wide range of choices to the farmers for crop diversification. It also provides ample opportunities for sustaining large number of agro industries which generate substantial employment opportunities.

The importance of horticulture in improving the productivity of Land, generating employment, improving economic conditions of the farmers and entrepreneurs, enhancing exports and providing nutritional security to the people is widely acknowledged. Horticulture sector, which includes fruits, vegetables, species, floriculture and coconut among others, covered 159.7 million hectors of land 2013-14, accounting for 8.5 per cent of the gross cropped area of the country, with production of

283.36 million tonnes and contributed 30 per centof GDP from agriculture (Singh 2013). Trends in favour of diversification of horticulture as well as increase in proportion of such land in total cultivated land are sweeping across the country. Diversification in favour of horticulture crop is driven by hard economic factors characterised by high productivity of per unit area, much higher returns compared to agriculture return, higher potential for employment generation and exports, comparatively lower requirement of water and easilyadaptable to adverse soil and water land situation (Koul, 1997). India with its wide range of soil and climate conditions is ideal for growing large varieties of fruits, both indigenous and the ones introduced from abroad. India today is the largest producer of fruits.

Indian being a home of wide variety of fruits and vegetables holds a unique position in production figures among the countries. India is a country with a variety of climate and land conducive to cultivation of various types of horticulture crops. The cultivation of tropical fruits and vegetables are confined to plain and coastal regions ofIndia, whereas, sub-tropical horticulture crop find their place in the plains and foot hills of Indian mountains while the temperature fruits are the monopoly of hilly regions of India like Himachal Pradesh J&K and Uttaranchal (Azad,1998 and Sikka & Swarup, 1985). Horticulture is the prime mover of economic growth in Himachal Pradesh and the state has also craved and a niche a horticulture state and is also known as "*Fruit Bowl of Nation*" (APEDA). Himachal Pradesh as the Horticulture state of India has been recognized as the apple state of India for being adjudged as the best producer quality of apples.

In the state of Himachal Pradesh, farmers are encouraged to grow the world's finest and choicest variety of apple. The state department of Horticulture helps them in the economic upliftment of rural population and has also generated employment. The total area under fruits in Himachal Pradesh is about 2,26,799 hectares with a production of 9,28,829 MT of all kinds of fruits. Apple is the major fruit accounting 46per cent of total Area under fruits and 88 per cent of the total production (Economic Survey, 2016). Apple is a predominant fruit crop of Himachal Pradesh and in recent years it has emerged as the leading cash crop amongst fruit crops. Apple is the fourth major fruit crop of the country in terms of production after Mango, Citrus Fruit and banana. Apple is grown mainly in the state of Jammu and Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh. Himachal Pradesh is the second largest producer of apple in India, After the Jammu and Kashmir. Himachal Pradesh is known for the production of quality apples. The state has agro-climatic and geographical conditions favourable for apple cultivation. The major apple producing districts of Himachal Pradesh are Shimla,Kullu, Chamba, Sirmour, Lahaul and Spiti and Kinnaur. The apple fruit contributes more than 987 crore towards the gross domestic product. The production level has gradually touched to 540.30 MT with 5.6 T productivity (Kaur, 2002) the horticulture sector encompasses a wide range of crops e.g., fruit crops, vegetables crops, potato and tuber crops, ornamental crops, medicinal and aromatic crops, spices and plantation crops. Over the years, horticulture has emerged as an indispensable part of agriculture, offering a wide range of choices to the farmers for crop diversification. It also provides ample opportunities for sustaining large number of agro-industries which generate substantial employment opportunities. The study is taken with was focused on following objective "To study the compound growth rate in area, production and productivity of apple, to study the comparative analysis of apple productivity and to analyse the contribution of yield and area in the production of apple in various region of Himachal Pradesh"

Horticulture is an old in India as the people of themselves. The area and production under horticulture in India are rapidly increasing. As theimportance of horticulture crop is

felt over the world, India is also gradually finding its place on the fruit map of the world. In fruits India is the largest producer of mangoes and bananas and is among the first ten in the production of apples, papayas, oranges and grapes. Horticulture sector is the main component for the development in the state of Himachal Pradesh. It providesjob opportunities for more than one lakh masses directly or indirectly.

Materials and methods

To fulfil the mentioned objectives of the present manuscript "A Study on area, production and productivity of Apples in Himachal Pradesh from 1973-74 to 2021-22" the secondary source of the data has been availed from the reliable sources such as National Horticulture Board (NHB), Economic survey, Directorate of Economics and Statistics Himachal Pradesh, Directorate of Horticulture Himachal Pradesh government official records, Books, journals magazines websites and other active related agencies of the department of horticulture in the state etc. The period of analysis ranged from 1973-74 to 2021-22. In this study simple statistical tools like Annual Compound Growth Rate (ACGR), instability index and decomposition analysis were used.

Compound growth rate (CGR)

The compound growth rates for different variables were computed by fitting the exponential function to the figures of area, production and productivity of apple of Himachal Pradesh. The ordinary least square method was used to fit the power function of the following form $Y = ae^{bt}$. It was converted into log linear function with the help of logarithmic transformation as under:

$$\text{Ln } Y = \text{Ln } a + t\, b$$

Where,

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

t = Independent variable (time in a year).

Compound growth rate (CGR) was calculated by using the following formula:

CGR = b*100

Where, b = Slope co-efficient which represents the growth rate per period

For significance testing t value was calculated using formula:

$$t = \frac{CGR}{SE(CGR)}$$

Instability Index

The instability in area, production and productivity and export-import of apple was measured in relative terms by Cuddy-Della Valle index which has been used by a number of researchers as a measure of variability in time series data. The simple coefficient of variation overestimates the level of variability in the data, whereas, Cuddy-Della Valle corrects the coefficients of variation (Wasim, 2011).

$$\text{Instability index} = \text{CV X } \sqrt{1 - r^2}$$

Where,

CV: Coefficient of variation (%)

r^2: Coefficient of determination from a time-trend regression

Decomposition Analysis

Decomposition is a process of breaking up into constituents elements. To measure the relative contribution of area and yield to the total output change, component analysis model as given below was used. This model was given by Minhas and Vaidyanathan (1965) and developed by Sharma (1977).

$$P = A * Y$$
$$(P + \Delta P) = (A + \Delta A) *(Y + \Delta Y)$$
$$\Delta P = \Delta A\ Y + \Delta Y\ A + \Delta A\ \Delta Y$$

Change in production = Yield effect + Area effect + Interaction effect
$\Delta A\ Y$ = Area effect
$\Delta Y\ A$ = Yield effect
$\Delta A\ \Delta Y$ = Interaction effect
A_0 = Triennium average of area in base year
A_1 = Triennium average of area in Current year
Y_0 = Triennium average of yield in base year
Y_1 = Triennium average of yield in Current year
P_0 = Triennium average of production in base year
P_1 = Triennium average of production in base year

For estimates of contribution of area and yield towards change in production (positive/negative) for base years and current year were estimated using the above model as suggested.

Results and discussions

Trend analysis is an aspect of technical analysis that tries to explain the time-series behaviour of a particular crop in the past and to predict the future accordingly. In the present section, the results of trend analysis of area, production and productivity of apple have been discussed at international, national and state level.The World's apple production has been grown at a compound growth rate of 2.51 per cent per annum during 1973-74 to 2021-22. Moreover, Asian region contributed the major proportion in area, production and productivity of apple with a growth rate of 3.38, 5.97 and 2.59 per cent, respectively (Table 1 and Fig 1). Amongst the various Asian countries, China has the major growth engine in apple farming. During the period 1973-74 to 2021-22, apple production in India recorded a significant growth of 3.40 per cent per annum which was higher than World's growth rate but lower than the Asian growth rate in production. Similar study was found by Kireeti, 2013 and Dinesha and Sriramappa, 2015.

Table 1.Compound annual growth rate of area, production and productivity of apple in World, Asia and India (1973-74 to 2021-22)

Region	Area	Production	Productivity
World	1.01* (0.17)	2.51* (0.006)	1.50* (0.18)

Asia	3.38* (0.29)	5.97* (0.15)	2.59* (0.23)
India	2.33* (0.009)	3.40* (0.169)	1.07* (0.165)

**Significant at 1 per cent level of significance.* *(Source:Anonymous, 2021)*

Comparative analysis of apple productivity

Crucial appraisal of data in table 2 examined the average productivity and variability analysis of apple productivity and results showed that analysis of productivity is very important to examine the comparative pro and cons of apple production in different regions. Competitiveness between states, regions and nations in the long run is influenced by comparative advantages and ability to develop the comparative advantages. Therefore, estimates of productivities of major apple producing countries were used to study the comparative advantages in the apple production. The disparity in apple yields between the countries depends upon level of adoption and degree of adjustments of production system to the new technological advances and the climatic factors. The top 5 apple producing countries were selected because India ranked 5th in apple production during the study period.

The average annual yield per hectare during 1973-74 to 2021-22 was found highest (28.45 MT/ha) in USA followed by Turkey (16.09 MT/ha), Poland (12.79 MT/ha), China (9.88) and India (6.50 MT/ha) (Fig. 3). It is fascinating to note that though China is the leader in apple production but it stood forth in terms of productivity. In comparison with all other major countries, it is depressing to note that India was falling behind all of them with a meagre productivity of 6.50 MT/ha placing itself in a critical position amidst the apple industry. The table further reveals that apple productivity of the selected country was statistically significant as the critical difference was estimated 1.98. These international differences in apple productivity may be endorsed to different factors like land area, type of land, cultivars, technologies adopted, geographical conditions like slope, elevation and aspect, the irrigation facilities, managerial skills and risk bearing abilities of the farmers.

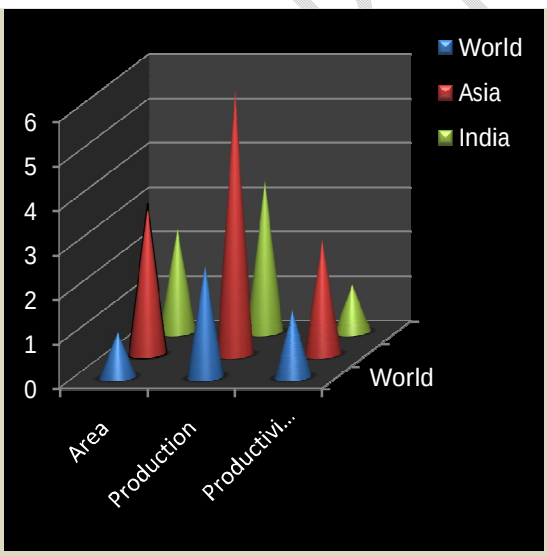

Fig.1: Compound annual growth rate of area, production and productivity of apple

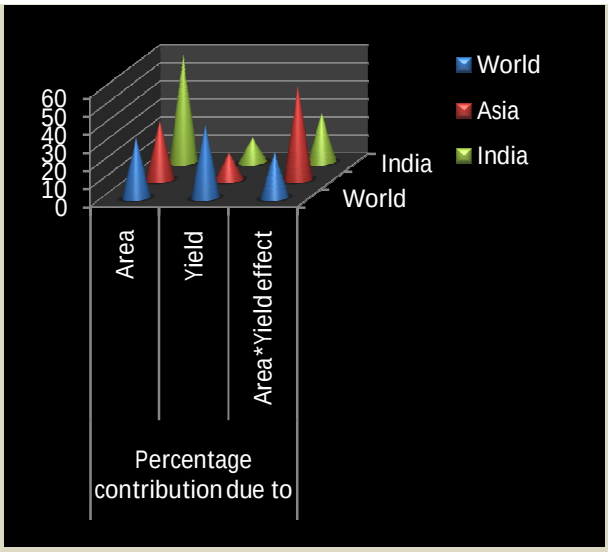

Fig.2: Contribution of yield and area in the production of apple

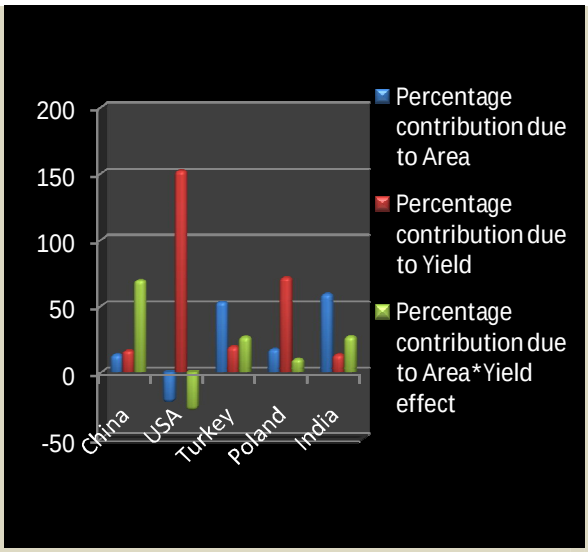

Fig. 3: Contribution of yield and area in the production of apple in top 5 apple producing countries

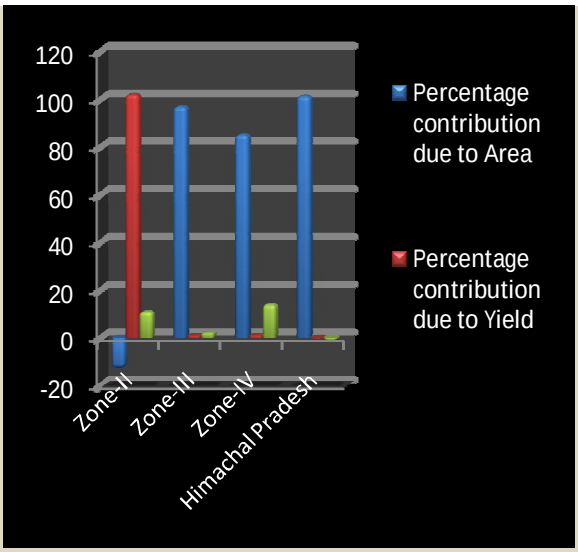

Fig. 4: Contribution of yield and area in the production of apple in different agro-climatic zones of Himachal Pradesh

Table 2.Comparative analysis of apple productivity of top 5 apple producing countries (1973-74 to 2021-22)

Country	Range	Productivity (MT/ha)	CDVI
China	2.62-18.64	9.88	12.53
USA	19.91-41.62	28.45	8.61
Turkey	12.30-20.01	16.09	11.18
Poland	5.92-20.34	12.79	21.44
India	4.56-10.34	6.50	15.96

**CDVI- Cuddy-Della Valle index; CD = 1.98* *(Source: FAO, 2021)*

The relative variability in apple productivity is very important for sustainable production and was measured in terms of Cuddy-Della Valle instability index. The relative instability in apple productivity was found highest (21.44%) in Poland followed by India (15.96%), China (12.53%), Turkey (11.18%) and USA (8.61%), respectively. Productivity variability was found lowest in USA and highest in Poland. Similar study was conducted by Sen, 1967; Bairwa and Sharma, 2012.

Effect of area and yield on apple production

The decomposition analysis was carried out to examine the various factors responsible for change in production of apple in various regions. Yield and area are considered important contributors in the production of apples. In order to visualize the contribution of each of them in the production, Narula and Sagar (1973) model was used and results have been presented in table 3 and fig 2.

Table 3.Contribution of yield and area in the production of apple in various regions (1973-74 to 2021-22)

Regions	Percentage contribution due to		
	Area	**Yield**	**Area×Yield effect**
World	33.35	41.19	25.46

Asia	32.84	15.14	52.02
India	59.26	13.52	27.22

(Source: Anonymous, 2021)

The results clearly showed that in world, the increase in apple production was explained due to area (33.35%) and yield (41.19%) expansion and interaction between area and yield (25.46%). However, in Asia, the increase in production was mainly because of area and yield effect as 52.02 per cent variation in apple production was due to area-yield effect. In India apple production mainly increased because of area expansion (59.26%). Thus it can be conclude that at world level apple production increased because of productivity whereas, in Asian region due to area-yield interaction. However, in India apple production increased only because of area expansion.

Table 4.Contribution of yield and area in the production of apple in top 5 apple producing countries (1973-74 to 2021-22)

Countries	Percentage contribution due to		
	Area	**Yield**	**Area × Yield effect**
China	13.51	16.75	69.74
USA	-23.24	152.28	-29.04
Turkey	53.35	19.69	26.96
Poland	17.75	71.82	10.43
India	59.26	13.52	27.22

(Source: Anonymous, 2021)

Decomposition analysis (Table 4 and Fig 3) at country level revealed that among 5 top apple producing countries production in USA and Poland increased mainly because of increase in yield as more than 152.28 and 71.82 per cent. However, in Turkey (53.35%) and India (59.26%) apple production mainly increased because of area expansion. Apple production in China increased because of the combined effect of area and yield which contributed 69.74 per cent increase in production.

Growth in export and import of apple in India

In view of increasing demand for Indian Horticulture produce, fresh and processed products in the International market, the export of horticultural crops at all India level has increased. The horticultural exports in India have increased after the implementation of NHM scheme. India is exporting horticultural crops mainly to Bangladesh, UK, UAE, Malaysia, Nepal, Saudi Arabia, Bahrain and Kuwait. India has emerged as an importer exporter of the fresh fruits as there has been a significant increase in export and import of the different fruits in the recent years. However, export of apple has not been successful from India that's why its contribution to the world apple export is negligible with a huge gap in total apple production and the annual average export and import volume in India.

The trends in export and import of the apple during 1973-74 to 2021-22 have been presented in table 5. The analysis has been carried out in pre and post liberalization periods. The analysis showed that apple export was significantly higher (8.70%) in first period as compared to the second period, while the overall export growth rate was 6.30 per cent per annum during 1973-2018. The percentage change in Indian apple export was found to be

higher (28.90%) in period 1973-1990. Indian apple import registered a growth of 23.56 per cent during 1990-2018.

Table 5. Compound growth of export and import of apple in India (1973-74 to 2021-22)

Particular	1973-1990	1990-2018	1973-2018
Export			
Compound growth rate	8.70* (1.59)	4.43* (2.75)	6.30* (0.79)
Percentage change	28.90	26.02	27.46
Import			
Compound growth rate	-	23.56* (1.78)	-
Percentage change	-	34.83	-

**Significant at 1 per cent level of significance(Source: Anonymous, 2021)*

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. The zone-wise growths in area, production and productivity of apple during 1973-74 to 2021-22 have been presented in table 6. The time series data have been divided into two periods: Period-I (1973-1990) and Period-II (1990-2018). The growth rate in productivity is an important determinant of agricultural transformation and considered as the engine of growth to the farm economy. The productivity growth is an indicator of use of farming knowledge, technology, infrastructural development, farm investments, and development of suitable price policy. The productivity growth allows farmers to break out of poverty and low-income equilibrium trap and contribute to overall economic growth. To achieve this, there is a need to strengthening the efforts for increasing production by maintaining or increasing productivity.Apple farming is the fastest growing economic activity of the state as it is being grown in 9 out of 12 districts. Due to varied agro-climatic conditions across the districts, there exist large variations in the area production and productivity of apple. Further these 9 districts fall in three agro-climatic zones*viz.* Zone-II (Solan, Sirmaur and Kangra), Zone-III (Shimla, Kullu, Mandi and Chamba) and Zone-IV (Kinnaur and Lahaul &Spiti).

Table 6 depicted the compound growth of area, production and productivity of the apple cultivation during 1973-74 to 2021-22. The perusal of the table reveals that, the area under apple cultivation has significantly increased at 6.06 per cent per annum in zone-IV followed by zone-III (2.79%) and zone-II (0.03%), respectively. The growth in the area has decreased in the second period as compared to the first period in all agro-climatic zones of Himachal Pradesh. The overall growth of apple area in Himachal has been significantly increased at 2.88 per cent per annum, respectively.The apple production has significantly increased at 7.59 per cent per annum in Zone- IV and Zone-III (3.70 %) while apple production in Zone-II has significantly decreased (2.39%). Growths in the apple production in Zone-IV and Zone-III have decreased in the second period but the growth in production in Zone-II has significantly increased (2.91%) during second period. The increase in production of apples has come mainly because of area expansion as the apple productivity is quite low as compared to advanced countries.

Table 6.Compound growth of area, production and productivity of apple in different agro-climatic zones of Himachal Pradesh (1973-74 to 2021-22)

Particular	1973-1990	1990-2018	1973-2018
Area			
Zone-II	2.98* (0.20)	-2.02* (0.20)	0.03* (0.21)
Zone-III	3.51* (0.006)	1.76* (0.11)	2.79* (0.009)
Zone-IV	9.70* (0.39)	4.85* (0.52)	6.06* (0.25)
Himachal Pradesh	3.76* (0.07)	1.89* (0.12)	2.88* (0.094)
Production			
Zone-II	-11.17* (2.33)	2.91* (1.15)	-2.39* (0.75)
Zone-III	7.78* (1.84)	4.68* (1.45)	3.70* (0.62)
Zone-IV	10.47* (2.52)	6.07* (0.53)	7.59* (0.45)
Himachal Pradesh	7.35* (1.78)	4.74* 1.28	3.84* (0.55)
Productivity			
Zone-II	-14.15* (2.44)	4.93* (1.24)	-2.42* (0.91)
Zone-III	4.27** (1.84)	2.92 1.50	0.90 (0.64)
Zone-IV	0.76 (2.40)	1.22** (0.57)	1.53* (0.42)
Himachal Pradesh	3.59 (1.78)	2.86** (1.33)	0.96 (0.58)

Significant at 1 per cent level of significance; **Significant at 5 per cent level of significance (Source:** Directorate of Horticulture, 2020)*

Growth in apple production has been decreased (7.33%) in second period as compared to first period (4.74%), whereas, the overall production during 1973 to 2018 increased significantly at 3.84 per cent per annum. Similar patterns were found in the productivity of apple in Himachal Pradesh. The rate of growth of productivity during 1973-1990 was 3.59 per cent per annum while during 1990-2018, 2.86 per cent per annum.

Comparison of apple productivity

Apple productivities in various agro-climatic zones of Himachal Pradesh were estimated and results have been presented in table 7. Average annual productivity was highest (4.78%) in zone-III followed by zone-II (3.35%)) and zone-IV (0.57%), respectively. This may be due to existence of niche advantages for the cultivation of apple in these zones.

Table 7. Inter-zones comparative analysis of apple productivity in Himachal Pradesh

Particular	Range	Productivity (MT/Ha)	CDVI
Zone-II	0.46-6.14	3.35	29.40
Zone-III	0.44-9.56	4.78	44.29

Zone-IV	0.04-4.53	0.57	138.78

**CDVI- Cuddy-Della Valle index; CD = 1.78 (Source: Directorate of Horticulture, Shimla)*

High productivity zones also exhibited high degrees of stability and productivity levels. In general, the low productivity zones were found to have higher instability in the yield levels. Results further shows that productivity in zone-III and zone-II was statistically at par.

Effect of Area and Yield on Production

Zone wise contribution of area and yield on the production of apple has been presented in the table 8 and fig 4. It was observed that increase in apple production was due to area (96.93%) and yield (85.13%) expansion in zone-III and zone-IV, respectively, whereas in zone-II the increase in production was due to yield effect (102.05%).

Table 8.Contribution of yield and area in the production of apple in different agro-climatic zones of Himachal Pradesh (1973-74 to 2021-22)

Particular	Percentage contribution due to		
	Area	**Yield**	**Area*yield effect**
Zone-II	-12.99	102.05	10.94
Zone-III	96.93	0.91	2.16
Zone-IV	85.13	0.98	13.89
Himachal Pradesh	101.32	-0.38	-0.94

(Source: Directorate of Horticulture, Shimla)

Combined effect of area and yield of apple has resulted 13.89 per cent increase in zone-IV, followed by Zone-II (10.94 %) and Zone-III (2.16%). Combined effect of area and production showed a decreasing (-0.94) effect on apple production in Himachal Pradesh, however, area effect on the apple production was 101.32 per cent, highlighting the fact that apple production in the state has increased due to expansion in area only.

Conclusions

There has been a rising trend in the area, production and productivity of apples in World, Asia and India from 1973-74 to 2021-22.The world's apple production has grown at a compound growth rate of 2.51 per cent per annum, whereas India recorded a significant growth of 3.40 per cent per annum. Asian region contributed the major proportion in area, production and productivity of apple with a growth rate of 3.38, 5.97 and 2.59 per cent, respectively.The relative instability in apple productivity was found highest (21.44%) in Poland followed by India (15.96%), China (12.53%), Turkey (11.18%) and USA (8.61%), respectively. It has been carried out in pre and post liberalization periods that the apple export was significantly higher (8.70%) in first period as compared to the second period, while the overall export growth rate was 6.30 per cent per annum during 1973-2018 while Indian apple import registered a growth of 23.56 per cent during 1990-2018.The study highlights that out of the various zones of Himachal Pradesh, zone-III was highest average annual productivity i.e., 4.78 per cent and increase in apple production in India was mainly due to area expansion.

References

Anonymous. 2020. Directorate of Horticulture, 2020. Status and position of apple crop in area, production and productivity in Himachal Pradesh. *Researchgate.net*.

Anonymous2021. APEDA- Agri Exchange https:// agriexchange.apeda.gov.in/indexp/Product_description.aspx?hscode=08081000.

Attri and Rajendra. 2010. "Horticulture" Himachal Pradesh: A Himalayan Dream Land. Shimla: (*Sarla Publication, 2010*) 332-340.

Azad K. 1998. Horticulture Development in Hill Areas. Mittal Publications, New Delhi, 309.

Bairwa KC, Sharma R and Kumar T. 2012. Economics of growths and instability: fruit crops of India. *Rajasthan Journal of Extension Education* 20:128-132.

Dinesha MV and Sriramappa KE. 2015. Growth in Area, Production and Productivity of Vegetables and Fruits in India with Special Reference to Karnataka. *International Journal of Applied Research*8: 288-293.

Economic Survey. 2016. Economic and Statistic Department, Government of Himachal Pradesh. (PDF) Status and position of apple crop in area, production and productivity in Himachal Pradesh *Researchgate.net*.

Food and Agricultural Organization. 2021. Apple productivity of top 5 apple producing countries. https://openknowledge.fao.org/server/api/core/bitstreams/001d5e02-62b8-4506-9ee5-01f011f357d8/content.

Kaul GL.1997. Horticulture in India: organisation of production marketing and processing, *Indian Journal of Agricultural economics* 52(3): 561.

Kaur N. 2002. Spatial diffusion of orchardists in Himachal Pradesh. Thesis, (Ph.D. Department of Geography, Punjab University, Chandigarh, 2002).

Kirtee K. 2013. Productivity analysis of apple orchards in Shimla district of Himachal Pradesh. Thesis (Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, India, 2013).

Minhas BS and Vaidyanathan A. 1965. Growth of crop output in India 1951-54 to 1958-61: an analysis by component element. *Journal of the Indian Society of Agricultural Statistics* 17: 230-252.

Narula SS and Sagar V. 1973. Methodology for working out contribution of area and yield in increase in production. Agricultural Situation in India 28 (7): 473-477.

Sen SR. 1967. Measurement of the effects to area, yield and process in the increase of crop output in India. *Agricultural situation in India*32: 348-350.

Sharma KL. 1977. Measurement of the effect of area, yield and prices in the increase of value of crop output in India. *Agricultural Situation in India*32: 348-250.

Sikka B and Swarup R. 1985. Growth rates and cropping pattern changes in agriculture in Himachal Pradesh. *Agriculture station in India* 39(2): 843-846.

Singh HR. 2013. Agriculture Economics and Development, Sagar Publishers, Jaipur, 144-145.

Wasim MP. 2011. Agricultural growth and instability in major crop production: a province-wise analysis in Pakistan. *Asian Economic Review*43: 294-314.