

# Growth Trends and Instability in Area, Production and Productivity of Fruit Crops in Himachal Pradesh

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## Abstract

The study was conducted with the aim to know the growth performance of fruits crops in Himachal Pradesh. The objectives of the study were to analyse the growth and instability of fruits crops in Himachal Pradesh and to estimate the decomposition analysis of fruits crops in Himachal Pradesh. To fulfill the objectives secondary data of 11 years was utilized for analysis using the statistical tools like Compound Annual Growth Rates (CAGR), Coefficient of Variation (CV), Cuddy Della Valle's Instability Index (CDVI) and Decomposition Analysis model. The study revealed that the area, production and productivity For all the fruits crops together, the compound growth rate during the years 2010-11 to 2020-21 has been estimated at 1.06, -0.56 and -1.60 per cent per annum, respectively. The coefficient of variation in the area, production and productivity far all fruits crops during the study period has been estimated at 3.53, 29.22 and 30.68 percent, respectively. The value of CDVI (0.73%) came in the range of 0-15 percent which confirm low level of instability in the area under all crops. The value of CDVI (30.74 and 31.85%) came in the range of 30 percent and above which confirm high level of instability in the production and productivity under all crops. There was low level of instability in the growth rates of area and high level instability in production and productivity during all the study periods. Area effect played the key role in the differentiation of fruit production in Himachal Pradesh.

**Keywords:** Fruit, Cuddy Della Valle Index, growth, instability index, decomposition

## 1. Introduction

Horticulture sector in India has emerged as an important sector for diversification of agriculture. India is the second largest producer of fruits in the world. Country has made good progress in fruit production with a total production of 110207 thousand MT from an area of 7025 thousand ha in 2022-23. Horticulture sector has a significant impact on the growth of the country's economy and it is expected that in future also it can make significant contribution toward accelerating the agricultural growth and contribution in GDP.

Himachal Pradesh is having the advantage of varied climate ranging from sub-tropical to dry temperate. Horticulture sector in the state has made remarkable contributions in the upliftment of socio-economic conditions of the farming community. The niche advantages for fruits have in the past been exploited by the growers wherever natural condition, socio-economic and institutional environment were favorable. As a result, the area, production, exports and its contribution to the GDP of agriculture has increased over the period of time.

In Himachal Pradesh, the area under Horticulture crops increased from 792 Hectares in 1950-51 to 2,36,466 hectares in 2022-23. The area under Horticulture in the state contributes 26 per cent of the total Agriculture area (8,91,926 hectares), whereas the sector contributes 22 per cent in terms of the value of the produce (Agriculture crops value Rs. 16,076 crore including vegetables, Horticulture crops value Rs. 4,476.64 crore, 2022-23). Between 2007-08 and 2021-22, the area under horticulture crops has seen a growth of 17.60 per cent. The overall fruit output in 2022-23 was 8.15 lakh tones, while the total fruit production in 2023-24 (up to 31st December 2023) was 5.84 lakh tones. Apple, Mango, Orange, Pear, Plum, Peach, Galgal and Apricot are the major horticulture crops in the state (Economic Survey of H.P, 2023-24).

Apple is the most important fruit crop of Himachal Pradesh, which constitutes about 48.78 per cent of the total area under fruit crops and about 81.2 per cent of the total fruit production during 2021-22 and area under apple fruits has seen a growth of 21.4 per cent. The area under other temperate fruits, nuts & dry fruits, citrus and other sub-tropical fruits have seen a growth of 6.0, -12.5, 22.1 and 21.5 per cent and about 7.0, 0.5, 4.3 and 7.0 percent of the total fruit production during 2021-22 respectively (Economic Survey of H.P, 2023-24).

Thus the present study is intended to examine the growth and instability in different fruits crops in Himachal Pradesh. These fruits crops are selected because these are utmost importance for the state.

### 1.1 Objectives of the study

1. To analyse the growth rate and instability in area, production and productivity of Fruits crops in Himachal Pradesh
2. To estimate the decomposition analysis of Fruits crops in Himachal Pradesh.

## 2. Data resources and methodology

The present paper is based on secondary data, which is collected for the year 2010-11 to 2020-21 from Directorate of Economics and Statistics and Directorate of Horticulture, Government of Himachal Pradesh on area, production and productivity of fruit crops. In order to achieve the objectives of the study, following statistical measures such as percentages, compound growth rates, standard deviation, coefficient of variation, instability index and decomposition analysis is applied;

### 2.1 Compound Growth Rate

Exponential Growth Function has been used to compute the compound growth rate of area, production and productivity;

$$Y = AB^t$$

Where Y = dependent variable, t = time

By taking logarithms of both sides of the equations it takes the form:  $\text{Log } Y = \text{Log } A + t \text{ Log } B$ .

If we put  $\text{Log } A = a$  and  $\text{Log } B = b$ , then equation becomes

$\text{Log } Y = a + bt$ , which is linear function with independent variable t and dependent variable Log Y. The compound growth rate calculate as  $(\text{antilog } b - 1) \times 100$  and represent uniform rate of change from year to year.

### 2.2 Instability Analysis

Instability in area, production, productivity of fruit crops has been estimated by using Coefficient of Variation and Cuddy-Della Valle Index. Although Coefficient of Variation (C.V) is the simplest measure of instability, it over-estimates the level of instability in time series data which are characterized by long-term trends. CV is calculated as follows:

$$CV = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

Cuddy-Della Valle Index (%) with an objective to know that, up to what extent risk is occurred in the selected variables. The Cuddy Della Valle Index de-trends shows the exact direction of the instability. Therefore, it is a better measure to capture instability in horticulture production. The Cuddy-Della Valle Index is calculated as follows:

$$\text{Cuddy-Della Valle Index} = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100 \times \sqrt{1 - R^2}$$

Where,

C.V. was the Coefficient of Variation in per cent, and  $R^2$  was the coefficient of determination from a time trend regression adjusted for its degrees of freedom.

A low value of this index indicates low instability in the selected variables. The ranges of CDVI are given as follows;

- Low instability = 0 to 15 (%)
- Medium instability = 15 to 30 (%)
- High instability = 30 and above (%)

## 2.3 Decomposition Analysis

To measure the relative contribution of area and yield and the interaction of both (area and yield) in the production change, the following decomposition analysis model is used which is given below.

Production = Yield effect + area effect + interaction effect

$$\text{Area Effect} = \frac{A_o \Delta Y}{\Delta P} \times 100$$

$$\text{Yield Effect} = \frac{Y_o \Delta A}{\Delta P} \times 100$$

$$\text{Interaction Effect} = \frac{\Delta A \Delta Y}{\Delta P} \times 100$$

Where,

$A_o$  = Area in base year

$A_n$  = Area in current year

$Y_o$  = Yield in base Year

$Y_n$  = Yield in Current year

$\Delta A$  = Change in area ( $A_n - A_o$ )

$\Delta Y$  = Change in yield ( $Y_n - Y_o$ )

$\Delta P$  = Change in Production

$P_n$  = Production in current Year

$P_o$  = Production in base year

Thus, the total change in production can be decomposed into yield effect, area effect and the interaction effect due to change in yield and area.

## 3. Results and discussion

### 3.1 Growth trends and instability in the area of fruits crops in Himachal Pradesh

The growth trends and instability in area of fruit crops is presented in Table 1. The table shows that in Himachal Pradesh during the year 2010-11 the area under apple fruit was 101.49 thousand hectares which increased to 114.65 thousand hectares in 2020-21 by registering a compound growth rate of 1.18

per cent, per annum. The mean value, coefficient of variance and CDVI has been worked out 109.63 thousand hectares, 3.97 per cent and 1.06 per cent respectively. The value of CDVI came in the range 0-15 percent which indicates that less instability and variability occurred in the area of apple.

The area under other temperate fruit crop during the year 2010-11 was 27.09 thousand hectares and it increased to 27.87 thousand hectare in 2020-21 with a compound growth rate of 0.31 per cent per annum. The coefficient of variance for these crops has been estimated at 1.37 per cent. The value of CDVI came in the range 0-15 percent which indicate low level of instability and inconsistency in the area under the other temperate fruit crops. The area under nuts and dry fruit crop was 11.02 thousand hectares which decreased to 10.03 thousand hectares in 2020-21 by registering with a Negative compound growth rate of (-) 1.05 per cent, per annum. The mean value, coefficient of variance and CDVI has been worked out 10.53 thousand hectares, 3.54 per cent and 0.46 per cent respectively. The value of CDVI came in the range 0-15 percent which indicates that less instability in the area of nuts and dry fruit crops.

**Table-1 Growth trends and instability in area of fruit crops in Himachal Pradesh**  
**Area (000 Hectare)**

Year	Apple	OTF	Nuts & Dry	Citrus	OSTF	All Fruits
2010-11	101.49	27.09	11.02	22.31	49.39	211.30
2011-12	103.64	27.47	11.04	22.40	50.02	214.57
2012-13	106.44	27.64	10.90	22.81	50.52	218.30
2013-14	107.69	27.79	10.82	23.11	51.30	220.71
2014-15	109.55	27.90	10.62	23.70	52.57	224.35
2015-16	110.68	27.91	10.49	24.06	53.66	226.80
2016-17	111.90	28.16	10.36	24.48	54.30	229.20
2017-18	112.63	28.37	10.30	24.65	54.90	230.85
2018-19	113.15	28.41	10.19	24.87	55.51	232.14
2019-20	114.14	27.96	10.07	25.05	56.08	233.30
2020-21	114.65	27.87	10.03	25.65	56.58	234.78
Mean	109.63	27.87	10.53	23.92	53.17	225.12
SD	4.35	0.38	0.37	1.14	2.55	7.94
CV	3.97	1.37	3.54	4.75	4.80	3.53
CDVI	1.06	0.90	0.46	0.66	0.65	0.73
CAGR	1.18	0.31	-1.05	1.44	1.45	1.06

*Source:* Directorate of Economics and Statistics and Directorate of Horticulture, Government of Himachal Pradesh, Shimla

**Note:** SD=Standard Deviation, CV=Coefficient of Variation, CDVI= Cuddy-Della Valle Index

The area under citrus fruit crop during the year 2010-11 was 22.31 thousand hectares and it increased to 25.65 thousand hectare in 2020-21 with a compound growth rate of 1.44 per cent per annum. The coefficient of variance for these crops has been estimated at 4.75 per cent. The value of CDVI came in the range 0-15 percent which indicate low level of instability in the area under the other temperate fruit crops. During the year 2010-11, in case of other sub-tropical fruits, the area was 49.39 thousand hectare and the same increase to 56.58 thousand hectares in 2020-21 with a compound growth rate of 1.45

percent per annum. The co-efficient of variation during the study period has been estimated at 4.80 percent. The value of CDVI (0.65%) confirms low level of instability in area under these crops.

For all the fruit crops together, the compound growth rate during the years 2010-11 to 2020-21 has been estimated at 1.06 per cent per annum. The coefficient of variation for all fruit crops during the study period has been estimated at 3.53 percent. The value of CDVI (0.73%) came in the range of 0-15 percent which confirm low level of instability in the area under all crops.

### 3.2 Growth trends and instability in the production of fruit crops in Himachal Pradesh

Growth trends and instability in production of fruit crops in Himachal Pradesh are presented in Table 2. The table shows that the production of apple fruit in Himachal Pradesh during the year 2010-11 was 892.11 thousand tonnes and in 2019-20 it decreased to 481.06 thousand tonnes with a negative compound growth rate of (-) 0.81 per cent, per annum. The average production of this fruit during the study period was 563.66 thousand tonnes. The co-efficient of variation in the production of this crop is 34.80 percent. The value of CDVI (36.58%) is in the range of 30 percent and above which indicates high level of instability and fluctuation in the production of apple crop during the study years viz.; 2010-11 to 2020-21.

**Table-2 Growth trends and instability in production of fruit crops in Himachal Pradesh**  
**Production (000 MT)**

Year	Apple	OTF	Nuts & Dry	Citrus	OSTF	All Fruits
2010-11	892.11	61.38	3.62	28.68	42.04	1027.82
2011-12	275.04	31.18	2.49	25.04	39.08	372.82
2012-13	412.40	55.03	2.81	24.32	61.16	555.71
2013-14	738.72	66.13	3.48	22.27	35.74	866.34
2014-15	625.20	43.61	2.41	22.17	58.55	751.94
2015-16	777.13	70.26	3.37	26.62	51.45	928.83
2016-17	468.13	51.50	2.99	28.05	61.21	611.88
2017-18	446.57	45.15	3.38	26.85	43.35	565.31
2018-19	368.60	37.15	3.65	29.34	56.62	495.36
2019-20	715.25	49.85	4.25	32.11	43.97	845.42
2020-21	481.06	40.65	4.69	33.29	64.80	624.49
Mean	563.66	50.17	3.38	27.16	50.72	695.08
SD	196.15	12.24	0.69	3.63	10.24	203.08
CV	34.80	24.40	20.53	13.37	20.19	29.22
CDVI	36.58	24.99	16.61	10.62	19.40	30.74
CAGR	-0.81	-1.77	4.05	2.69	2.61	-0.56

Source: Directorate of Economics and Statistics and Directorate of Horticulture, Government of Himachal Pradesh, Shimla

**Note:** SD=Standard Deviation, CV=Coefficient of Variation, CDVI= Cuddy-Della Valle Index

The production of other temperate fruit crops during the year 2010-11 was 61.38 thousand tones which decreased to 40.65 thousand tons in 2020-21 with a negative compound growth rate of (-) 1.77 percent per annum. The coefficient of variation in the production of these crops is estimated at 24.40 percent. The value of CDVI (24.99%) is in the range of 15-30 percent which confirms medium level of instability in the production of temperate fruit crops. The production of nuts & dry fruit crops during the year 2010-

11 was 3.62 thousand tonnes which increased to 4.69 thousand tonnes in 2020-21 with a compound growth rate of 4.05 percent per annum. The coefficient of variation is estimated at 20.53 percent. The value of CDVI (16.61%) indicates medium level of instability in production of temperate fruits crop as the value of this index is in the range of 15-30 percent.

The production of citrus fruit crops during the year 2010-11 was 28.68 thousand tonnes which increased to 33.29 thousand tons in 2020-21 with a compound growth rate of 2.69 percent per annum. The mean, standard deviation and coefficient of variation has been worked out to be 27.16 thousand tonnes, 3.63 percent and 13.37 percent, respectively. The values of CDVI (10.62%) fall into the range of 0-15 percent which confirms low level of instability and inconsistency in the production of citrus fruit in Himachal Pradesh. Further, the production of other sub-tropical fruit crops during the year 2010-11 was 42.04 thousand tonnes which increased to 64.80 thousand tons in 2020-21 with a compound growth rate of 2.61 percent per annum. The coefficient of variation in the production of these crops is estimated at 20.19 percent. The value of CDVI (19.40%) is in the range of 15-30 percent which confirms medium level of instability in the production of sub-tropical fruit crops.

For all the fruit crops together, the mean production came out to be 695.08 thousand tonnes. The production of all fruit crops was 1027.82 thousand tonnes during the year 2010-11 which decreased to 624.49 thousand tonnes in 2020-21 by registering with a Negative compound growth rate of (-) 0.56 per cent, per annum. The standard deviation and coefficient of variation for all fruit crops during the study period has been estimated at 203.08 and 29.22 percent, respectively. The value of CDVI (30.74%) fall in the range of 30 percent and above, which indicates high level of instability and fluctuation in the production of fruit crops during the study period.

### **3.3 Growth trends and instability in the productivity of fruit crops in Himachal Pradesh**

The per hectare productivity of apple during the year 2010-11 was 8.79 thousand tonnes which decreased to 4.20 thousand tonnes per hectare in 2020-21 with a negative compound growth rate of (-) 1.97 percent per annum. The mean productivity, standard deviation and coefficient of variation have been estimated 5.16 thousand tonnes per hectare, 1.90 percent and 36.72 percent, respectively. The value of CDVI (38.08%) ranges between 30 percent and above which confirm high level of instability in the productivity of apple crop in Himachal Pradesh.

The per hectare productivity of other temperate fruit crops during the year 2010-11 was 2.27 thousand tonnes which decreased to 1.46 thousand tonnes in 2020-21 with a negative compound growth rate of (-) 2.07 percent per annum. The mean productivity and standard deviation have been estimated 1.80 thousand tonnes per hectare, 0.45 percent, respectively. The coefficient of variation in the productivity of these crops is estimated at 24.86 percent. The value of CDVI (25.19%) is in the range of 15-30 percent which confirms medium level of instability in the production of temperate fruit crops. The per hectare productivity of nuts and dry fruit crops during the year 2010-11 to 2020-21 increased from 0.33 thousand tonnes per hectare to 0.47 thousand tonnes per hectare by registering a compound growth rate of 5.15 percent per annum. The mean productivity, standard deviation and coefficient of variation have been estimated 0.32 thousand tonnes per hectare, 0.07 percent and 23.21 percent, respectively. The value of CDVI (16.83%) ranges between 15-30 percent which confirm medium level of instability in the productivity of nuts and dry crops in Himachal Pradesh.



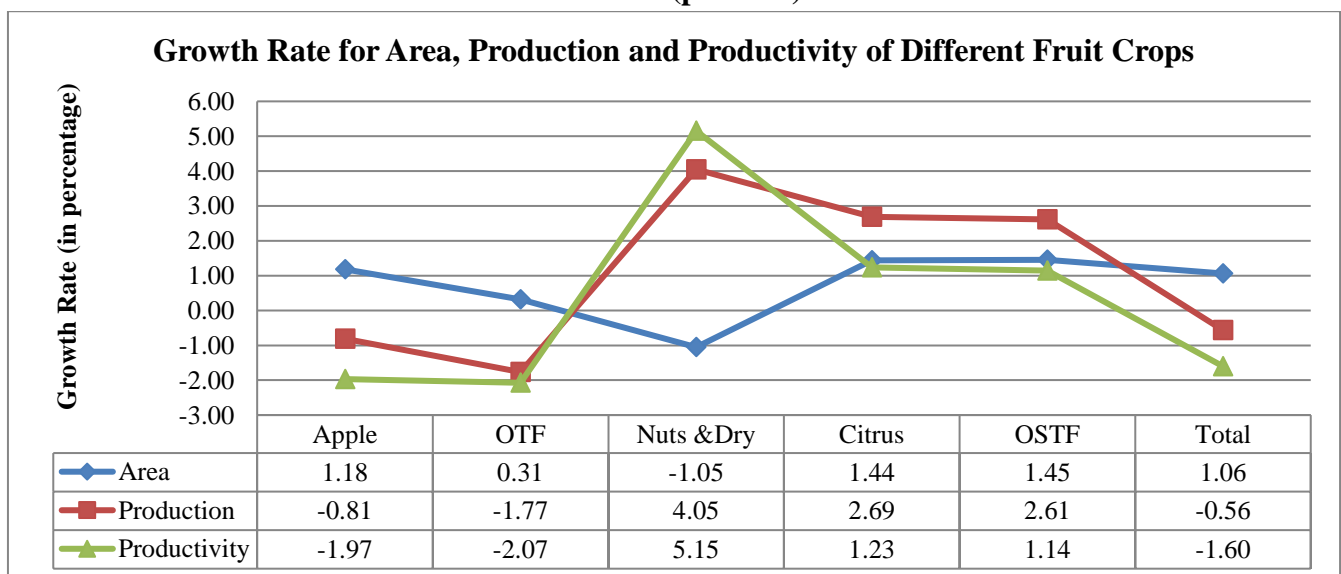
**Table-3 Growth trends and instability in productivity of fruit crops in Himachal Pradesh**  
**Productivity (000 MT/ Hectare)**

Year	Apple	OTF	Nuts & Dry	Citrus	OSTF	All Fruits
2010-11	8.79	2.27	0.33	1.29	0.85	4.86
2011-12	2.65	1.14	0.23	1.12	0.78	1.74
2012-13	3.87	1.99	0.26	1.07	1.21	2.55
2013-14	6.86	2.38	0.32	0.96	0.70	3.93
2014-15	5.71	1.56	0.23	0.94	1.11	3.35
2015-16	7.02	2.52	0.32	1.11	0.96	4.10
2016-17	4.18	1.83	0.29	1.15	1.13	2.67
2017-18	3.96	1.59	0.33	1.09	0.79	2.45
2018-19	3.26	1.31	0.36	1.18	1.02	2.13
2019-20	6.27	1.78	0.42	1.28	0.78	3.62
2020-21	4.20	1.46	0.47	1.30	1.15	2.66
Mean	5.16	1.80	0.32	1.13	0.95	3.10
SD	1.90	0.45	0.07	0.12	0.18	0.95
CV	36.72	24.86	23.21	10.81	18.92	30.68
CDVI	38.08	25.19	16.83	10.58	19.56	31.85
CAGR	-1.97	-2.07	5.15	1.23	1.14	-1.60

Source: Directorate of Economics and Statistics and Directorate of Horticulture, Government of Himachal Pradesh, Shimla

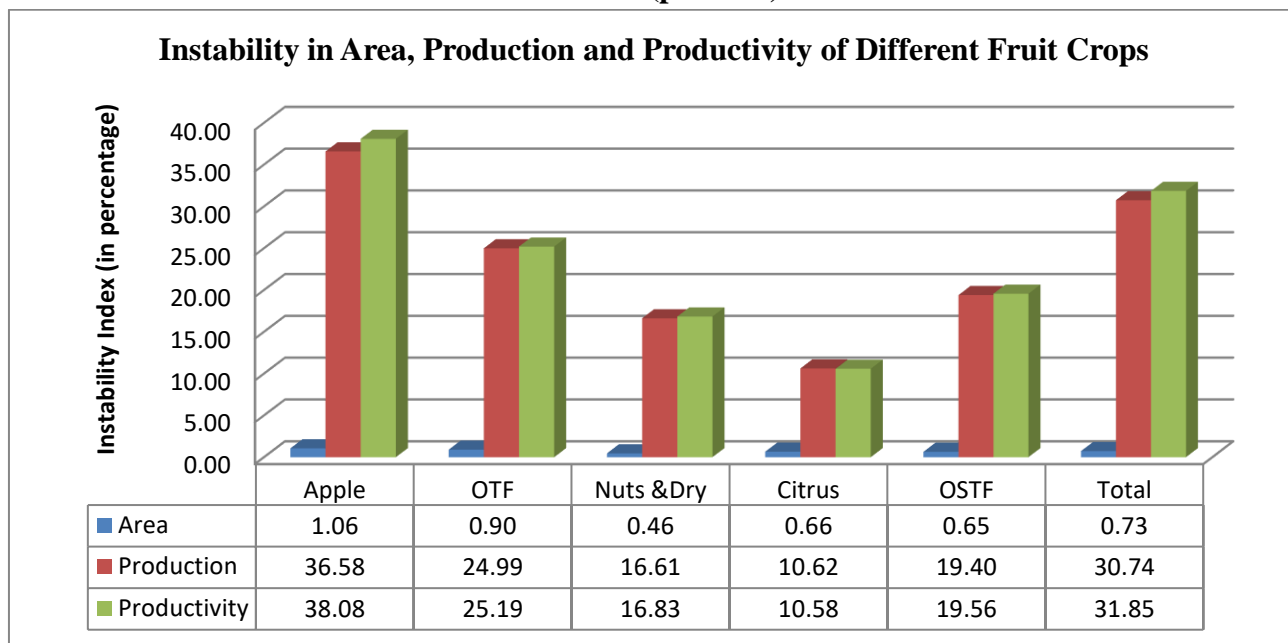
Note: SD=Standard Deviation, CV=Coefficient of Variation, CDVI= Cuddy-Della Valle Index

**Figure-1 Compound growth rates of area, production and productivity of fruit crops in Himachal Pradesh (per cent)**



Source: Data representation from Table-1, 2 and 3.

**Figure-2 Instability in Area, Production and Productivity of Different Fruit Crops in Himachal Pradesh (per cent)**



Source: Data representation from Table-1, 2 and 3.

The per hectare productivity of citrus fruit crops during the year 2010-11 was 1.29 thousand tonnes which increased to 1.30 thousand tonnes in 2020-21 with a compound growth rate of 1.23 percent per annum. The mean, standard deviation and coefficient of variation has been worked out to be 1.13 thousand tonnes per hectare, 0.12 percent and 10.81 percent, respectively. The values of CDVI (10.58%) fall into the range of 0-15 percent which confirms low level of instability in the productivity of citrus fruits. For other sub-tropical fruit crops, per hectare productivity registered a compound growth rate of 1.14 percent per annum during the study period. The mean, standard deviation and coefficient of variation has been worked out to be 0.95 thousand tonnes per hectare, 0.18 percent and 18.92 percent, respectively. The values of CDVI (19.56%) fall into the range of 15-30 percent which confirms medium level of instability in the productivity of sub-tropical fruit crops.

Among all the fruit crops together, per hectare productivity registered a negative compound growth rate of (-) 1.60 per cent per annum. The mean productivity and standard deviation is estimated at 3.10 thousand tonnes per hectare and 0.95 percent. The coefficient variation came out to be 30.68 percent. The value of instability index indicates high level of instability and inconsistency in the productivity of all fruit crops in Himachal Pradesh during the year 2010-11 to 2020-21.

### 3.4 Decomposition analysis

To determine how contribution of area, yield and their interaction are responsible for the overall growth of fruit crops production in Himachal Pradesh during the study period, decomposition analysis was carried out. The decomposition analysis of fruit crops production in area, yield and interaction effect was presented in Table 4. In this analysis attempt has been made to identify the contribution of area and productivity for change in production of fruit crops. The Table 4 Indicates that, the area effect is highest in case of nuts and dry fruits (143.56%), followed by apple (113.43%), other temperate fruit (105.48%), other sub-tropical fruit (63.84%), and minimum in case of citrus fruit it is 5.86 percent. For all the fruit crops, area effect was the most responsible factor for change in production of fruits in Himachal



Pradesh. While during the study period yield effect for citrus fruit was found to be most responsible for change in production of fruit in Himachal Pradesh.

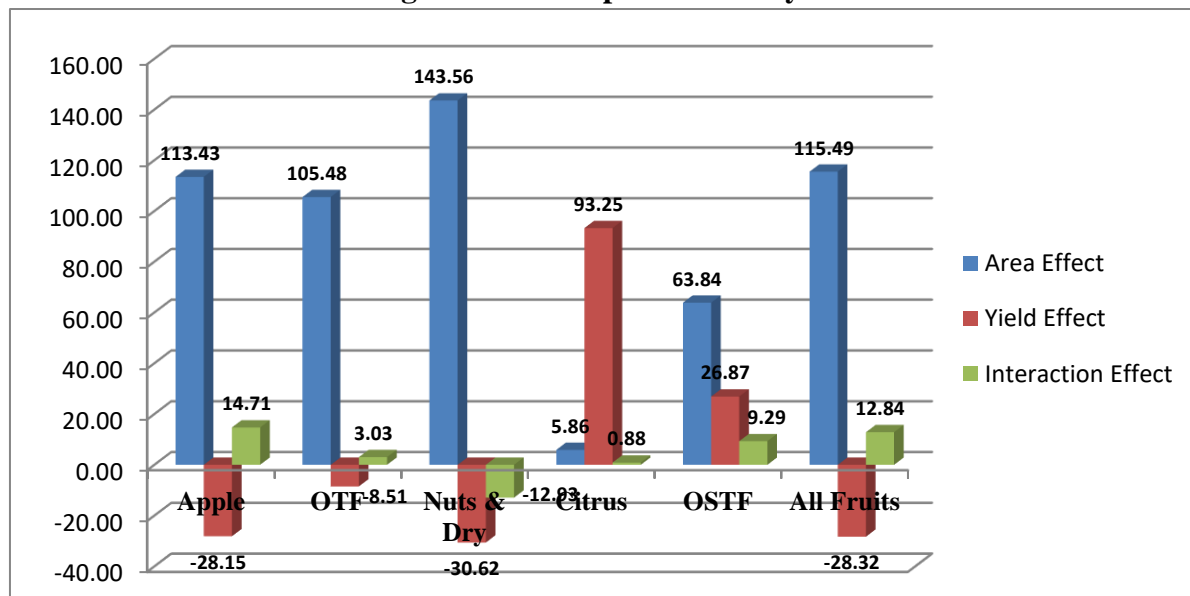
**Table-4 Decomposition analysis of Fruits production in Himachal Pradesh, 2010-11 to 2020-21**

Crops	Area Effect	Yield Effect	Interaction Effect
Apple	113.43	-28.15	14.71
Other Temperate Fruits	105.48	-8.51	3.03
Nuts & Dry Fruits	143.56	-30.62	-12.93
Citrus Fruit	5.86	93.25	0.88
Other Sub-tropical Fruits	63.84	26.87	9.29
All Fruits	115.49	-28.32	12.84

Source: Calculated by author

The highest yield effect was observed during the study period i.e., 93.25 per cent with area effect i.e. 5.86 per cent and interaction effect i.e. 0.88 per cent in case of citrus fruits. The yield effect have been found negative in case of apple (-28.15%), other temperate fruits (-8.51%) and nuts & dry fruits (-30.62%) due to adverse climatic condition and others factors during the study period. While for the other sub-tropical fruits crops, yield effects were (26.87 %) with area effect (63.84%) and interaction effect (9.29%). For all the crops together, the area effect was observed during the study period i.e., 115.49 per cent with negative yield effect i.e. (-) 28.32 per cent and interaction effect i.e. 12.84 per cent.

**Figure-3: Decomposition Analysis**



Source: Data representation from Table-4.

## 4. Conclusions

The study concludes that, the area under fruit crops had increasing growth in a decreasing rate during the study periods. The growth rates of production and productivity of fruit crops in Himachal had a fluctuating trend during the study periods. Also, the area, production and productivity of fruit crops in

Himachal Pradesh had instability and variability during the study periods. The area effect was a driving force for the change in production of fruit crops in Himachal Pradesh during the study periods. The negative yields effect in agriculture is a critical issue. In a nutshell it can be suggested that to combat these negative yield effects and improve productivity, it requires integrated pest management, sustainable soil management practices, efficient water use, adoption of climate-resilient plant varieties, and improved horticultural techniques. These measures can help maintain or increased yield despite the challenges posed by environmental and biotic stressors.

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