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Trends in apple area, production and productivity: A detailed decomposition analysis for major apple producing states of India

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Abstract
Apple (*Malus domestica*) is a major temperate fruit crop of India. It forms a significant portion of the horticulture in north western and north eastern states of India. Jammu & Kashmir and Himachal Pradesh are the two major Apple producing states of India with a contribution of 75 per cent and 23 per cent, respectively. The study was conducted using secondary data of apple area, production and productivity for a period from 1993-94 to 2022-23. The period was further divided into sub-periods I (1993-94 to 2002-03), II (2003-04 to 2012-13) and III (2013-14 to 2022-23). The highest growth in area as well as production was observed in Jammu & Kashmir in Period II with Compound Annual Growth Rates (CAGR%) of 5.0 per cent and 5.1 per cent respectively. In case of production, Himachal Pradesh experienced a positive growth over entire study period as a whole (2.6%). The decomposition analysis showed that area was the major contributor to growth of apple production in the state of Jammu & Kashmir (78%), whereas in Himachal Pradesh yield was the major cause of growth in production with an effect of 55.83 per cent. The yield in case of Jammu & Kashmir was the highest, even higher than nation's average but it was somewhat stagnant during the study period, whereas the growth in terms of area was significant. The expansion of area under apple cultivation can be attributed to flat terrains availability for apple cultivation in Jammu & Kashmir, however are expansion in Himachal Pradesh is difficult due to hilly areas cultivation of apple in the state.

Keywords: Compound annual growth rate, decomposition, productivity, trend

Introduction
Horticulture has significantly improved agriculture by expanding its focus beyond traditional staple crops. Particularly in rural regions, it provides high-value fruits, vegetables, flowers, and medicinal plants, greatly boosting farmers' incomes and generating job opportunities. Horticulture also improves nutritional security by ensuring access to essential vitamins and minerals. Furthermore, it frequently employs more intensive and sustainable farming practices, which promote efficient land use and resource management, resulting in a more resilient and profitable agricultural sector overall. It is commonly acknowledged that horticulture plays a significant role in increasing land productivity, boosting exports, improving the financial circumstances of farmers and business owners, and ensuring people have access to nutritious food. (Sharma, 2021) [10]. Apple is regarded as an important fruit crop in temperate regions around the world, including India. It is extremely important in India's agricultural landscape, serving as the foundation for the economies of several northern and northeastern states. Apple cultivation is the backbone of the horticultural industry in India's northwestern Himalayan region, particularly in the states of Himachal Pradesh and Jammu Kashmir. These two states are recognized as the leading apple producers, accounting for 23 per cent (HP) and 75 per cent (J&K) of apple production in the country which is a significant portion of the total apple production. Apple cultivation provides a livelihood source for thousands of small and medium-sized farmers, contributing to rural prosperity and employment because apples are more profitable than agricultural crops like rice and wheat. In India, apples rank as the tenth most produced fruit crop. India's total apple crop production is 2589 thousand MT, covering an area

of 315.13 thousand ha. India is the world's fifth largest producer of Apple, accounting for approximately 2.70% of total global production. India's total domestic supply of Apple crop is 2723 thousand MT, ranking fifth in global Apple consumption. The two major states of apple production. In order to comprehend long-term trends and evaluate grower risks, this study first examines trends and instability in apple crop production in these two significant states. Following that, a comparative decomposition analysis is performed to separate the factors driving production growth, focusing on the contributions of area expansion and yield improvements. This combined strategy offers essential details to formulate centered policies and encouraging long-term expansion in the apple industry in the two strategically significant states.

Materials and Methods

The basis of the research was secondary data on the area, yield, and production of apple crops in Jammu & Kashmir, Himachal Pradesh and India. The data was collected from the India Stat website for a period from 1993-94 to 2022-23. To facilitate a better understanding and comparative analysis, the study period was divided into three time periods: Period I (1993-94 to 2002-03), Period II (2003-04 to 2012-13), and Period III (2013-14 to 2022-23).

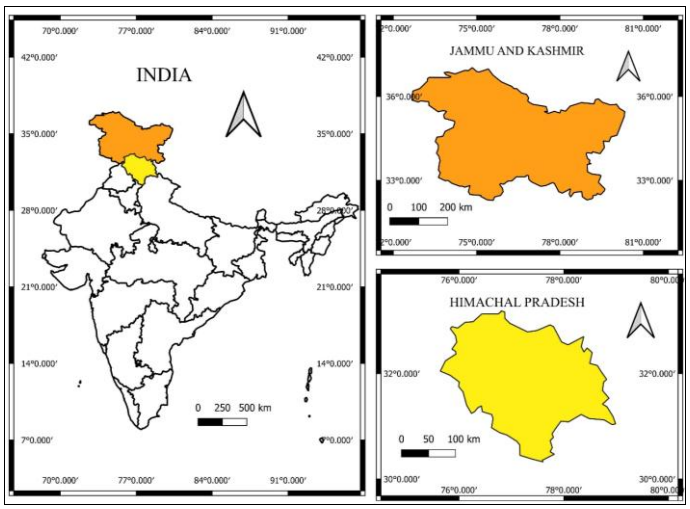


Fig 1: Representation of the study area using map.

Analytical Techniques

Growth Analysis

Compound growth rate analysis was used to evaluate apple growth in terms of area, production, and yield. Exponential function was fitted for the calculation. The compound growth function is defined as follows:

$$Y = ae^{bt}$$

$$\ln Y = \ln a + bt$$

$$CAGR\ (\%) = b \times 100$$

Where; Y is production and t is time period.

Instability Analysis

Instability analysis of apple area, production and yield was carried out using Cuddy -Della Valle index (CDVI%). (Cuddy and Valle, 1978) [4]. CV is a simpler measure of instability, but it cannot fully explain the variability in time series data due to the presence of trend component (Bansal, 2022) [6]. To address this issue, we used the Cuddy-Della-Vella instability index formula, which is expressed as:

$$CDVI(\%) = CV \times \sqrt{1 - R^2}$$

Where;

$$CV\ (\%) = \frac{\text{Standard deviation}}{\text{Mean}} \times 100$$

R^2: Coefficient of Determination

The ranges of CDVI are as following

- Low instability = 0 to 15
- Medium instability = 15 to 30
- High instability = 30 and above, (Sihmar, 2014) [5]

Decomposition Analysis

Decomposition is the process of splitting into constituent elements. To determine the relative contribution of area and yield to total production change, the component analysis model proposed by Minhas and Vaidyanathan (1965) [1] and developed by Sharma (1977) [3] was used. Interaction effect is the percentage share of area and yield (simultaneous variation) interaction towards total production.

$$\text{Decomposition Effect} = \frac{Y_0 \times \Delta A}{\Delta P} + \frac{A_0 \times \Delta Y}{\Delta P} + \frac{\Delta A \times \Delta Y}{\Delta P}$$

Decomposition Effect = Area Effect + Yield effect + Interaction Effect

Where; Y_0: Initial Yield

ΔY: Change in Yield

A_0: Initial Area

ΔA: Change in Area

ΔP: Change in Production

Results and Discussion

Jammu & Kashmir (J&K) and Himachal Pradesh (H.P.) are the major apple producing states in India. Jammu & Kashmir accounts for 75 per cent of the apple production in the country followed by Himachal Pradesh with 23 per cent apple production. Uttarakhand is also one of the significant apple producing state but its contribution is mere 2 per cent in country's total production. Figure 1 clearly shows the contribution of different states in nation's total apple crop production. It is quite evident that Jammu & Kashmir and Himachal Pradesh together accounts for more than 90 per cent of the total production in the country.

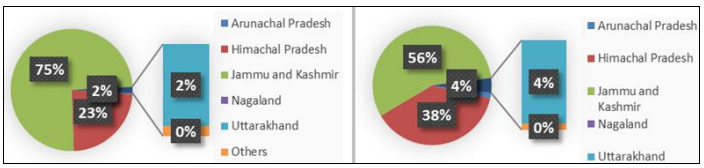


Fig 1: Share of major Apple producing states of India in total apple production (2022-23)

Table 1 depicts the growth and instability of apple crop's area production and productivity in India. It can be evidently inferred from the results that the area under apple cultivation in India has shown a significant positive growth during Period I *viz.*, 2.40 per cent and Period II, 3.90 per cent. The area has also shown a

positive significant growth of 1.70 during the entire study period as a whole *viz*., 1.70 per cent. In case of production, a positive growth was observed only in case of Period II (5.3%). The production also experienced a positive significant growth during 1993-94 to 2022-23 *viz*., 3.70 per cent. Yield/ Productivity only experienced positive growth as a whole for a time period from 1993-94 to 2022-23 *viz*., 1.30 per cent.

Table 1: Growth and instability of Area, Production and Productivity of apple crop in India from 1993-94 to 2022-23

Time Period	Area		Production		Yield	
	CAGR (%)	CDVI (%)	CAGR (%)	CDVI (%)	CAGR (%)	CDVI (%)
Period I	2.40***	2.11	-0.40	8.20	-2.80	7.03
Period II	3.90***	7.10	5.3***	13.63	1.40	16.00
Period III	0.10	4.05	2.00	9.45	1.80	11.59
1993-94 to 2022-23	1.70***	17.16	3.70***	30.95	1.30***	18.59

***means significant at 1 per cent level of significance
Period I: 1993-94 to 2002-03
Period II: 2003-04 to 2012-13
Period III: 2013-14 to 2022-23

The CDVI-based instability analysis reveals that Period I had the highest area stability and the lowest CDVI of 2.11 percent. In addition, Period I had the highest production stability, with an instability index of 8.20 percent. The Yield was also the most consistent during Period I. Period II demonstrated the least stability in terms of area, production, and productivity. Throughout all periods, area remained more stable than production and productivity. The production showed a high level of instability throughout the study period, with a CDVI of 30.95 percent.

Table 2 consists of comprehensive results of Compound Annual Growth Rate (CAGR%) and Cuddy Della Valle Index (CDVI%) of apple area, production and productivity in the states of Jammu & Kashmir and Himachal Pradesh. The analysis shows that in both the states, during entire study period, area showed a positive and significant growth. The highest growth in area was observed in Jammu & Kashmir in Period I with a growth rate of 5.0 per cent followed by growth rate of Jammu & Kashmir in Period I, *viz*., 2,7 per cent. As a whole, the growth in area was more in Jammu & Kashmir as compared to Himachal Pradesh. Only the state of Jammu & Kashmir has been observed to depict a positive significant growth if apple production during all the periods. The highest growth was observed in Period II, where production increased by 5.1 per cent. The apple production in Himachal Pradesh only showed significant positive growth for period 1993-94 to 2022-23 where production increased by 2.6 per cent. While considering the periods as separate, no significant growth was seen. The productivity on the other hand didn't show significant growth in either of the states during the entire study period. This shows that productivity of apple crop in the country has either been decreasing or not increasing significantly in the country. Apple productivity in India is low, with socioeconomic factors, credit, pests, and diseases being key contributors, and addressing these constraints is crucial for sustainable cultivation (Shah, 2022) [7].

Table 2: Growth and instability of Area, Production and Productivity of apple crop in Himachal Pradesh and Jammu & Kashmir from 1993-94 to 2022-23

Time Period		Area		Production		Yield	
		CAGR (%)	CDVI (%)	CAGR (%)	CDVI (%)	CAGR (%)	CDVI (%)
Period I	HP	1.5**	5.20	0.60	46.05	-0.90	44.30
	J & K	2.7***	0.94	2.6**	8.76	0.01	8.35
Period II	HP	2.60***	0.72	-1.83	41.65	-4.50	39.00
	J & K	5.0***	1.63	5.1***	11.89	0.1	11.68
Period III	HP	0.90***	0.76	-1.39	24.87	-2.30	25.15
	J & K	0.6***	0.76	3.0	14.34	2.4	14.53
1993-94 to 2022-23	HP	1.80***	16.75	3.70***	46.14	1.9	38.38
	J & K	2.7***	6.77	2.6**	12.48	0.01	11.73

** means significant at 5 per cent level of significance
*** means significant at 1 and 5 per cent level of significance

The instability analysis shows that area was more stable in both the states as compared to their respective production and yield. Himachal Pradesh showed a high variability in terms of production during the study period. It experienced a CDVI of 46.14 per cent considering entire study period as a whole.

For a more comprehensive visualization of the results figure 2, 3 and 4 were formed as trends of area, production and productivity, respectively. It can be clearly observed in the figure 2 that both Jammu & Kashmir and Himachal Pradesh experienced a growth in area under apple cultivation along with country as a whole. The growth in area was more stable in the states as compared to country as a whole. Up to the year 1998-99, the area under apple cultivation was almost same in Jammu & Kashmir and Himachal Pradesh, afterwards the state of Jammu & Kashmir experienced a significantly higher growth in area as compared to Himachal Pradesh.

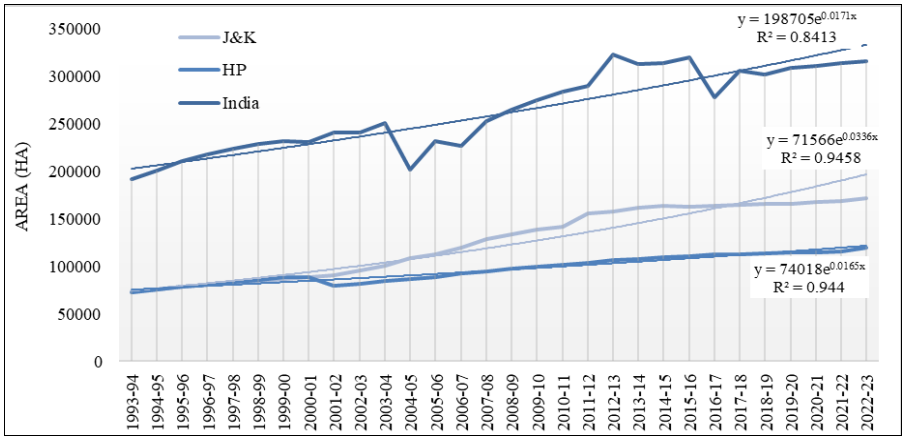


Fig 2: Trends in area under apple cultivation in India, Himachal Pradesh and Jammu & Kashmir from 1993-94 to 2022-23.

The yearly pattern of growth observed in production was almost similar in both the states as well as country. The production was lower in Himachal Pradesh as compared to Jammu & Kashmir. The growth was also higher in Jammu & Kashmir. Changing climatic patterns have a significant impact on apple production and productivity in Himachal Pradesh, with higher temperatures and lower rainfall negatively affecting both (Singh *et al*, 2016) [9].

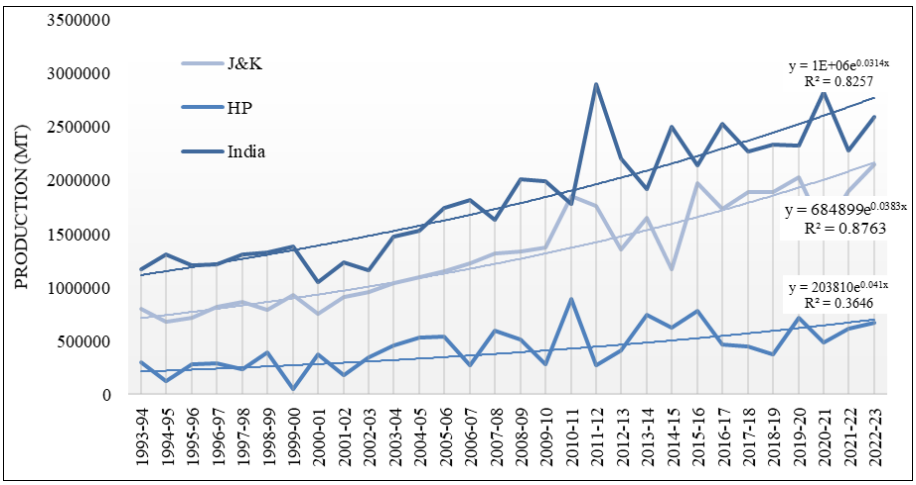


Fig 3: Trends in production of Apple crop in India, Himachal Pradesh and Jammu & Kashmir from 1993-94 to 2022-23.

The trends in the yield of apple in both the states as well as country as a whole are depicted in figure 4. It can be observed that yield was highly instable during the entire study period. The highest yield was observed in Jammu and Kashmir which was even higher than the country's average yield as a whole. The yield of apple has remained very low in Himachal Pradesh. Apple productivity has declined in elevations up to 1500 m amsl by 40-50 percent due to a lack of chilling requirement and the advancement of flowering as a result of warmer weather during winter (Chadda and Sharma, 2009) [8].

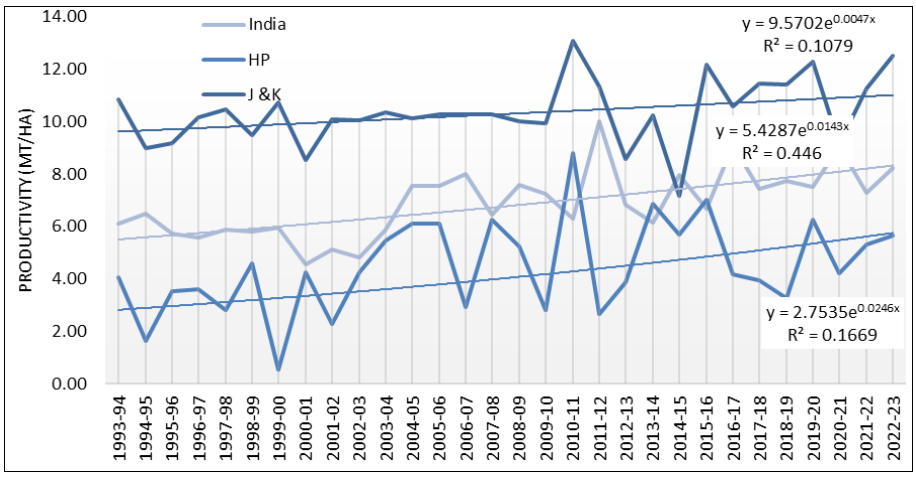


Fig 4: Trends in yield of Apple crop in India, Himachal Pradesh and Jammu & Kashmir from 1993-94 to 2022-23.

Farmers in both states have seen changes in the timing of blossoming, fruit-setting, yield, and increased incidents of pests and diseases as a result of changing climatic conditions. In order understand the factors driving the changes in apple production in these states, a comparative decomposition analysis of apple production into area and yield components was conducted.

As depicted in Table 1, production of apple crop in India had grown significantly in period II and it can be observed Table 3 that area effect was the major contributor (57.65%) in the rising production of crop in the country followed by yield effect (32.89%) and interaction effect (9.46%). During the entire study period as a whole, from 1993-94 to 2022-23, the positive growth in production was attributed to yield effect (52.08%) followed by area effect (29.46%).

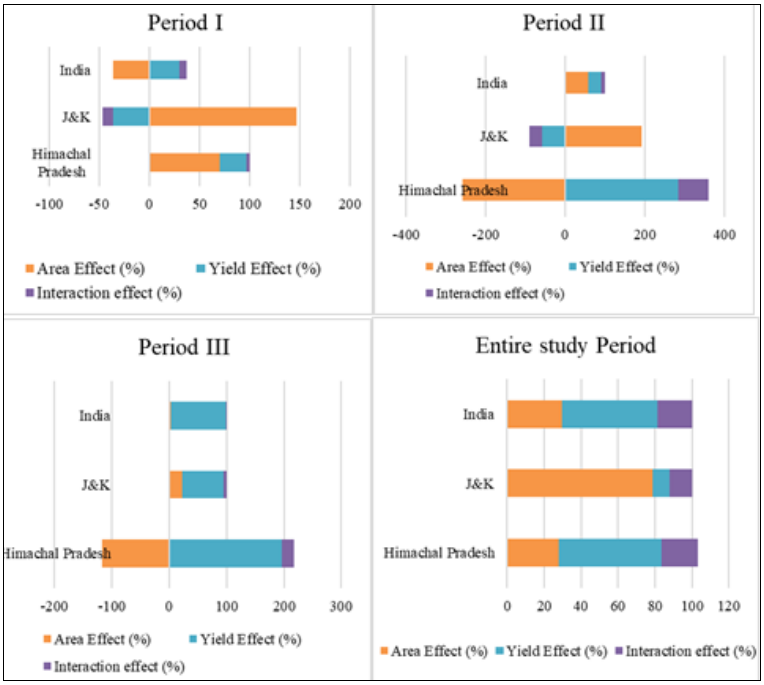
Table 3: Decomposition Analysis of Apple Production in India from 1993-94 to 2022-23

Time Period	Area Effect (%)	Yield Effect (%)	Interaction effect (%)
Period I	-36.08	29.55	7.53
Period II	57.65	32.89	9.46
Period III	2.73	96.34	0.93
1993-94 to 2022-23	29.46	52.08	18.46

Table 4 depicts the decomposition analysis of apple production in the major apple producing states Jammu & Kashmir and Himachal Pradesh. It was previously shown in growth analysis that production of apple in Jammu & Kashmir showed a significant growth in each sub- period, whereas Himachal Pradesh observed positive significant growth only in case of entire study period as a whole. It was observed that the contribution of area was highest in production growth of apple in Jammu and Kashmir with a share of 146.46 per cent, 190.85 per cent and 22.07 per cent in Period I, Period II and Period III respectively. The growth of production in Jammu & Kashmir as a whole from 1993-94 to 2022-23 was attributed to area effect (78.92%). Conversely, yield effect was found to be major contributor in production growth of apple in Himachal Pradesh. Area effect was 27.88 per cent whereas, the yield effect was 55.83 per cent. Hence, the growth in apple production in Himachal Pradesh was found to be due to yield effect.

Table 4: Decomposition Analysis of Apple Production in Himachal Pradesh and Jammu & Kashmir from 1993-94 to 2022-23

Time Period	Area Effect (%)		Yield Effect (%)		Interaction effect (%)	
	HP	J&K	HP	J&K	HP	J&K
Period I	70.11	146.46	26.51	-35.80	3.38	-10.66
Period II	-258.99	190.85	283.68	-58.17	75.30	-32.68
Period III	-117.53	22.07	196.75	73.05	20.78	4.88
1993-94 to 2022-23	27.88	78.92	55.83	8.98	19.48	12.10



Conclusions

This study, analyzing apple crop trends and decomposition in India's key apple-producing states (Jammu & Kashmir and Himachal Pradesh), reveals distinct growth patterns and contributing factors. Both states, and India as a whole, witnessed significant area expansion throughout the study period and sub-periods. However, production growth varied. Jammu & Kashmir experienced significant positive production growth across all periods, driven primarily by area expansion. In contrast, while Himachal Pradesh showed overall production growth over the entire study period, this wasn't consistently reflected in the sub-periods, with yield playing a more crucial role. The consistently higher yield in Jammu & Kashmir, often surpassing the national average, is noteworthy. However, the stagnant nature of this yield suggests that growth in Jammu & Kashmir has been largely achieved through expanding the land under cultivation

rather than increasing productivity per unit of land. This reliance on area expansion, while effective in the short term, might not be sustainable in the long run due to potential land constraints. Fortunately, Jammu & Kashmir possesses more readily available flat terrain with a suitable temperate climate for apple cultivation, making area expansion a more viable strategy compared to Himachal Pradesh. Himachal Pradesh, with its predominantly hilly terrain, faces greater limitations in expanding the area under apple cultivation. Consequently, its production growth has been more closely tied to yield improvements. This suggests that further research is needed to understand the factors influencing yield in both states. Identifying best practices, investing in research and development for improved varieties and cultivation techniques, and promoting sustainable farming methods are crucial for enhancing yield and ensuring long-term production growth, especially in Himachal Pradesh. From a policy perspective, interventions should be tailored to the specific needs of each state. In Jammu & Kashmir, while area expansion has fueled growth, policies should also focus on maintaining and improving yield to ensure sustainable growth. This could involve investments in irrigation infrastructure, soil health management, and pest and disease control. For Himachal Pradesh, given the constraints on area expansion, the focus should be on maximizing yield potential. This requires targeted investments in research for climate-resilient and high-yielding varieties, promoting integrated pest management, and providing farmers with access to modern technologies and training. Furthermore, policies should incentivize diversification within the horticultural sector of Himachal Pradesh, perhaps exploring alternative high-value crops suitable for the region, to mitigate risks associated with over-reliance on a single crop. By focusing on a combination of sustainable area expansion where feasible, targeted yield enhancement strategies, and diversification, both states can achieve sustainable growth in apple production and contribute to India's overall horticultural output.

References

1. Minhas BS, Vaidyanathan A. Growth of crop output in India, 1951-54 to 1958-61: Analysis by component elements. J Indian Soc Agric Stat. 1965;18(2):230-252.
2. Veena VM. Growth dimensions of horticulture in Karnataka: An econometric analysis [PhD thesis]. Dharwad (India): University of Agricultural Sciences; 1996.
3. Sharma KL. Measurement of the area, yield and prices in the increase value of crop output in India. Agric Situation India. 1977;32(6):349-351.
4. Cuddy JDA, Della Valle PA. Measuring the instability of time series data. Oxford Bull Econ Stat. 1978;40(1):79-84.
5. Sihmar R. Growth and instability in agricultural production in Haryana: A district level analysis. Int J Sci Res Publ. 2014;4(7):1-12.
6. Bansal R, Kumar M, Shaikh AS. Growth and export trends of major spices in India: An analytical study. Guj J Ext Educ. 2022;33(2):145-150.
7. Shah Z, Dar M, Dar E, Obianefo C, Bhat A, Ali M, *et al*. Sustainable fruit growing: An analysis of differences in apple productivity in the Indian state of Jammu and Kashmir. Sustainability. 2022;14:14544. doi:10.3390/su142114544
8. Chadda KL, Sharma NK. Climate change impacts on production of horticulture crops. In: Dhillon WS, Aulakh PS, editors. Impact of climate change on fruit crops. Delhi: Narendra Publishing House; 2009.
9. Singh N, Sharma DP, Chand H. Impact of climate change on apple production in India: A review. Curr World Environ. 2016;11(1):251-259.
10. Sharma I, Singh L. Growth and decomposition analysis of apple production in Himachal Pradesh. J Agric Dev Policy. 2021;31(2):239-246.