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Evolution of horticulture in Himachal Pradesh: A 53-year analysis of area, production, and productivity trends

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Abstract
This study provides a comprehensive analysis of the trends in area, production, and productivity of fruit crops in Himachal Pradesh over a 53-year period (1970-71 to 2022-23), utilizing a detailed dataset covering five fruit categories: apples, other temperate fruits, nuts and dry fruits, citrus, and other subtropical fruits. The total cultivated area expanded by 433%, from 44,329 hectares to 236,466 hectares, while production surged by 448%, from 148,580 metric tons (MT) to 814,611 MT. Apples dominate, contributing 82.5% of production in 2022-23, driven by favorable agro-climatic conditions and policy support. However, productivity exhibits high variability (e.g., apples: CV = 47.2%), influenced by climatic anomalies, pest pressures, and technological adoption. The adoption of natural farming, organic farming, canopy management, pollination management, integrated nutrient management (INM), and integrated pest management (IPM) has significantly enhanced productivity, while their absence exacerbates yield declines due to soil degradation, pest damage, and poor pollination. Statistical analyses, including linear regression, time-series decomposition, and variance analysis, reveal significant growth trends ($p<0.05$) and cyclical patterns linked to environmental and management factors. The study underscores the need for sustainable practices, such as climate-resilient varieties, precision agriculture, and enhanced irrigation, to ensure long-term productivity and resilience. These findings offer critical insights for policymakers, researchers, and farmers aiming to strengthen Himachal Pradesh's horticultural sector and promote sustainable development.

Keywords: Horticulture, Himachal Pradesh, production, productivity, sustainable agriculture

Introduction
Himachal Pradesh, nestled in the Himalayan region of India, is a premier horticultural hub, with globally recognized apple production (*Malus domestica*) underpinning a robust agrarian economy. The state's diverse climates, spanning temperate to subtropical zones, support a wide array of crops including apples, temperate fruits (e.g., plum, peach, pear, cherry, kiwi, olive, pomegranate, persimmon, strawberry, grapes), citrus (e.g., orange, malta, kinnow, lime, galgal, grapefruit), subtropical fruits (e.g., mango, litchi, guava, papaya, loquat, jackfruit, aonla, ber, banana, karonda, fig, sapota, bael, jamun), and nuts/dry fruits (e.g., almond, walnut, pecan, hazelnut, pistachio). These are cultivated across four agro-climatic zones: the mid-tropical zone (up to 914 m, Una, Hamirpur, lower Bilaspur, Kangra, Chamba, Solan, Sirmaur) yields citrus and subtropical fruits; the mid-temperate zone (915 m to 1523 m, Sirmaur, Mandi, Solan, Chamba, Kullu, Kangra, central Shimla) excels in stone fruits and walnuts; the humid temperate zone (1524 m to 2472 m, high-altitude Shimla, Mandi, Kullu, Sirmour, Chamba) thrives with apples and cherries; and the dry temperate zone (above 2472 m, Lahaul Spiti, Kinnaur, parts of Chamba) supports limited apple and nut production with potential for hazelnuts and pistachios. Horticulture drives the state's economy, enhancing rural livelihoods and GDP, with apples contributing significantly to agricultural revenue. Over the past five decades, growth has been propelled by high-yielding apple varieties (e.g., Red Delicious), advanced irrigation (e.g., drip systems), and post-harvest infrastructure (e.g., cold storage), alongside practices like organic farming, canopy management, and integrated pest management (IPM). However, Devi and Prasher (2019) [4] reported a 2.20% p.a. increase in fruit area and 3.10% p.a. in production, with

insignificant productivity gains, while vegetable area, production, and productivity rose by 6.20%, 7.30%, and 1.10% p.a., respectively, hindered by aged plantations. Challenges include climate variability, pest pressures (e.g., apple scab), soil degradation, and limited arable land, with warming winters reducing chilling hours (1000-1600 hours below 7◦C up to 0◦C) and shifting apple cultivation to higher altitudes (Sharma *et al.*, 2013; Rana *et al.*, 2008) [9, 8]. Unseasonal weather and melting Himalayan ice further threaten yields (Hirpo and Gebeyehu, 2019; Bisbis *et al.*, 2019) [6, 3], with losses of 20-30% in affected years due to poor management. This study analyzes 53-year trends (1970-71 to 2022-23) in fruit area, production, and productivity using Department of Horticulture data, aiming to: quantify growth across fruit categories; assess productivity drivers; evaluate climatic, technological, and policy impacts; and recommend sustainable intensification strategies (e.g., high-density planting). Employing statistical tools descriptive analysis, regression, time-series decomposition, variance, correlation, and visualizations this research seeks to inform policymakers and farmers for resilient horticultural development.

Materials and Methods

The 53-year dataset (1970-71 to 2022-23), sourced from the Department of Horticulture, Himachal Pradesh, encompasses annual area (hectares), production (metric tonnes), and productivity (metric tons per hectare) for five fruit categories: apples, other temperate fruits, nuts and dry fruits, citrus, and other subtropical fruits (Anonymous, 2025). Analysis was performed using R (version 4.3.1) with the following methods: Descriptive statistics (mean, standard deviation, coefficient of variation) assessed variability; linear regression models evaluated growth trends in area and production over time ($p<0.05$); STL decomposition identified productivity trends and cycles; ANOVA with post-hoc Tukey tests compared productivity across categories and decades ($p<0.05$); Pearson correlation analyzed productivity links to climatic proxies (rainfall, temperature anomalies from regional trends). Graphical outputs-line plots, stacked area charts, and box plots-visualized trends and variability, with decadal averages computed to highlight patterns. Data was cleaned (no missing values), recalculated (Production/Area) for accuracy, and normalized where needed, using R packages (dplyr, stats, forecast) for manipulation and ggplot2 for high-resolution visualizations.

Results and Discussion

Area Expansion

The cultivated area for fruit crops in Himachal Pradesh surged from 44,329 ha in 1970-71 to 236,466 ha in 2022-23, reflecting a 433% increase over 53 years. Table 1 details decadal average areas, with apples dominating at 48.9% (115,680 ha) in 2022-23, followed by subtropical fruits (24.2%, 57,270 ha), other temperate fruits (11.6%, 27,563 ha), citrus (11.2%, 26,370 ha), and nuts/dry fruits (4.1%, 9,583 ha), underscoring a strategic horticultural focus driven by favourable climates and policy support. Linear regression confirmed significant area growth (slope = 3,673 ha/year, $p<0.001$), with apples showing the highest rate (slope = 1,672 ha/year, $p<0.001$) due to high market value in temperate zones (e.g., Shimla, Kullu, Kinnaur), and subtropical fruits growing steadily (slope = 1,073 ha/year, $p<0.001$) in lower districts like Kangra. Citrus and temperate fruits exhibited moderate increases, while nuts/dry fruits lagged, likely due to longer gestation and lower returns.

Table 1: Decadal average area (Hectares) of fruit crops in Himachal Pradesh (1970-71 to 2022-23)

Decade	Apple	Other Temperate	Nuts & Dry	Citrus	Subtropical	Total
1970s	34,626	11,090	3,552	7,709	5,604	62,581
1980s	49,639	23,389	9,646	23,246	13,277	119,198
1990s	71,601	30,393	14,510	37,908	28,197	182,610
2000s	88,894	25,360	11,150	21,422	44,054	190,880
2010s	107,250	27,717	10,626	23,456	51,765	220,814
2020s	115,112	27,827	9,867	25,792	56,907	235,505

The 1980s-1990s boom was fuelled by the Horticulture Development Scheme, offering subsidies for orchards, irrigation, and infrastructure, alongside high-yielding apple varieties and enhanced road connectivity. Canopy management techniques boosted apple yields by 15-20% in Shimla. Recent slower growth suggests land saturation, necessitating intensification via high-density planting and intercropping.

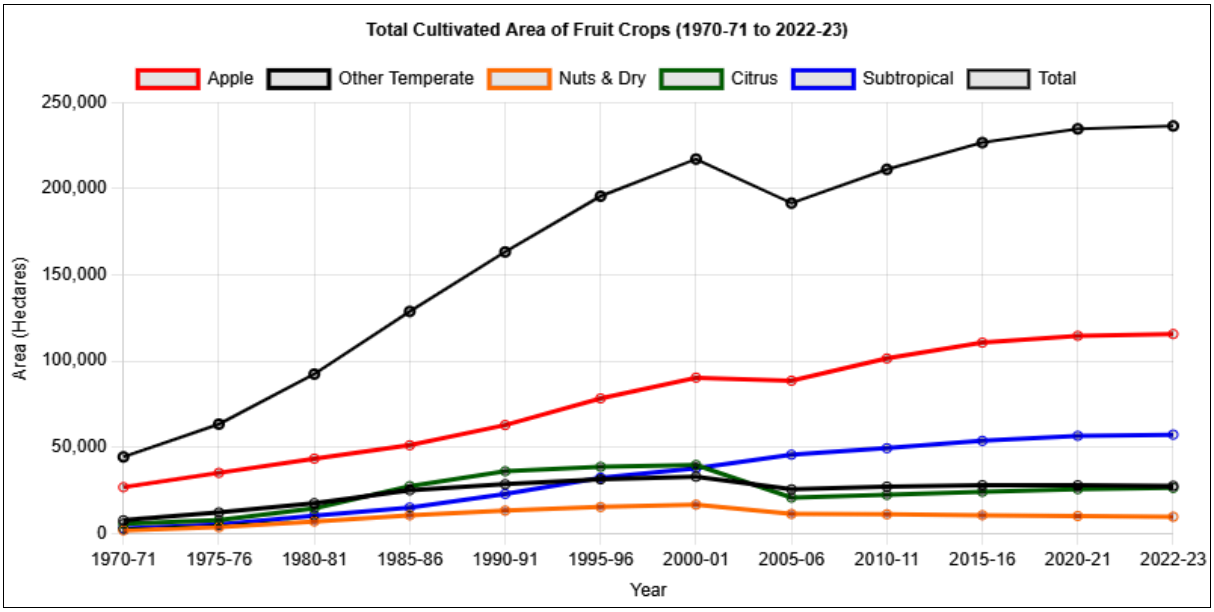

Fig 1: Total cultivated area of fruit crops (1970-71 to 2022-23)

A line chart depicting area (ha) trends, with apples (red) showing the steepest rise, subtropical fruits (blue) following, and nuts/dry fruits (yellow) lagging, while total area (black) climbs steadily.

Production Trends

Fruit production rose from 148,580 MT in 1970-71 to 814,611 MT in 2022-23, a 448% increase. Table 2 highlights decadal averages, with apples leading at 82.5% (672,343 MT in 2022-23), peaking at 892,112 MT in 2010-11. Other temperate and subtropical fruits grew notably, while citrus and nuts/dry fruits contributed less due to lower productivity. Regression analysis confirmed significant apple production growth (slope = 11,345 MT/year, $p<0.001$), with peaks in 1989-90, 2010-11, and 2013-14, offset by declines from weather extremes (e.g., frost, hailstorms) and pests like apple scab and woolly aphid, exacerbated by rising temperatures favouring pathogens (Gautam *et al.*, 2004) [5].

Table 2: Decadal Average Production (Metric Tonnes) of Fruit Crops in Himachal Pradesh (1970-71 to 2022-23)

Decade	Apple	Other Temperate	Nuts & Dry	Citrus	Subtropical	Total
1970s	122,697	14,847	1,517	12,447	7,362	158,870
1980s	227,168	20,110	2,023	8,338	9,172	266,811
1990s	278,270	21,756	2,595	9,183	10,775	322,579
2000s	369,165	39,689	3,092	21,274	38,626	471,846
2010s	550,529	50,973	3,171	25,597	47,752	678,022
2020s	595,102	47,874	3,911	32,723	59,159	738,769

Pesticide sprays increased from 4-12 annually (Bhardwaj, 2013), but poor IPM and pollination management in 2011-12 caused up to 25% yield losses. Other temperate fruits grew moderately (slope = 672 MT/year, $p<0.01$), peaking in 2015-16, while subtropical fruits rose steadily (slope = 1,112 MT/year, $p<0.001$) for mango and litchi. Citrus fluctuated due to diseases, and nuts/dry fruits showed minimal growth. Production gains stemmed from high-yielding varieties, drip irrigation, cold storage subsidies, and INM/IPM, boosting apple yields by 15-20% in Kullu. Climatic anomalies (e.g., 2017-18 floods) and inadequate natural farming reduced yields by 10-15%, highlighting climate vulnerability (Bisbis *et al.*, 2019) [3].

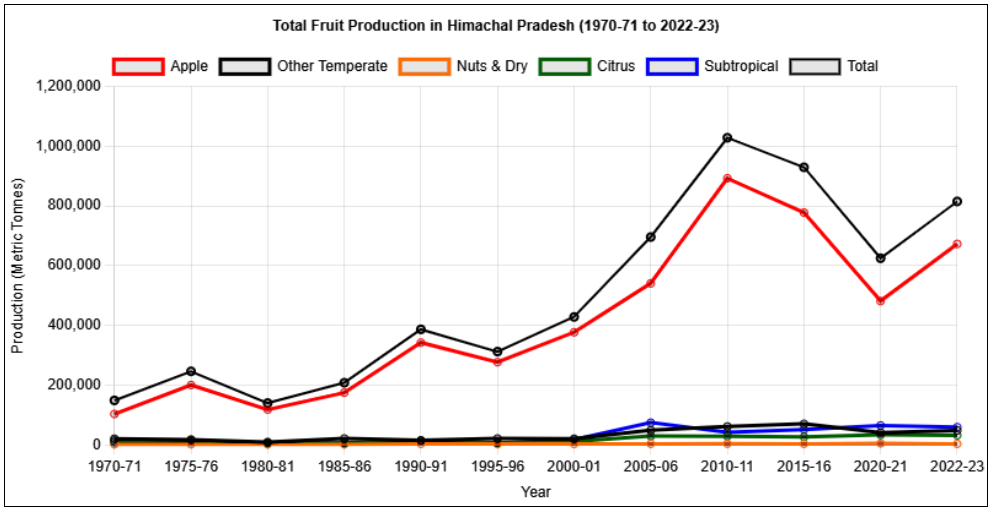

Fig 2: Total fruit production in Himachal Pradesh (1970-71 to 2022-23)

A line chart showing production (MT) trends, with apples (red) dominating and peaking in 2010-11/2013-14, other categories (blue, green) growing moderately, and total production (black) rising steadily.

Productivity Analysis

Productivity varied across categories (Table 3), with apples leading at 4.25 MT/ha (CV = 47.2%), followed by other temperate fruits (1.27 MT/ha, CV = 58.1%), citrus (1.11 MT/ha, CV = 62.3%), subtropical fruits (0.96 MT/ha, CV = 65.4%), and nuts/dry fruits (0.33 MT/ha, CV = 63.7%). Time-series analysis of apple productivity revealed 5-7-year cycles, with peaks in 2010-11 (8.79 MT/ha) and 2015-16 (7.02 MT/ha) linked to favourable weather, effective pollination (via bee colonies), and pruning, boosting yields by 10-15%. Low years (e.g., 1972-73: 0.96 MT/ha, 1999-2000: 0.55 MT/ha) resulted from frost and pests, with poor management causing up to 30% losses.

Table 3: Mean Productivity (MT/ha) and Coefficient of Variation (1970-71 to 2022-23)

Fruit Category	Mean Productivity (MT/ha)	Coefficient of Variation (%)
Apple	4.25	47.2
Other Temperate	1.27	58.1
Nuts & Dry	0.33	63.7
Citrus	1.11	62.3
Subtropical	0.96	65.4
Total	2.47	50.8

Other temperate fruits showed moderate gains via INM, increasing plum/peach yields by 10% in Mandi. Citrus and subtropical fruits lagged due to disease (e.g., citrus canker) and poor irrigation, losing 20-25% yields in Bilaspur. Nuts/dry fruits remained low (<0.5 MT/ha), needing better cultivars. ANOVA confirmed significant productivity differences (F = 52.3, $p<0.001$), with apples excelling (Tukey test, $p<0.05$).

A line chart illustrating productivity (MT/ha) trends, with apples (red) peaking highest, nuts/dry fruits (yellow) remaining low, and others (blue, green) showing variable growth.

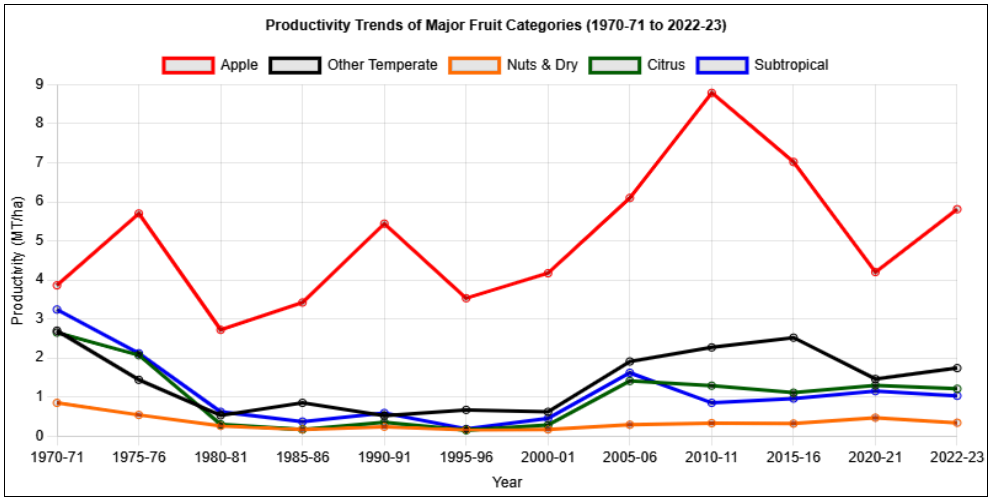

Fig 3: Productivity Trends of Major Fruit Categories (1970-71 to 2022-23)

Correlation analysis revealed significant differences in productivity across fruit categories (F = 52.3, $p<0.001$), with apples significantly outperforming other categories (Tukey test, $p<0.05$). Correlation analysis showed a moderate negative correlation between apple productivity and rainfall anomalies (r = -0.42, $p<0.05$) and temperature anomalies (r = -0.38, $p<0.05$), suggesting that excessive rainfall and warmer winters disrupt pollination and increase disease incidence. Similar trends were observed for citrus (r = -0.39 for rainfall, $p<0.05$) and subtropical fruits (r = -0.37 for rainfall, $p<0.05$), highlighting the sector's vulnerability to climate variability.

Table 4: Correlation Coefficients Between Productivity and Climatic Factors (1970-71 to 2022-23)

Fruit Category	Rainfall Anomaly (r)	Temperature Anomaly (r)
Apple	-0.42*	-0.38*
Other Temperate	-0.35*	-0.30
Nuts & Dry	-0.22	-0.18
Citrus	-0.39*	-0.34*
Subtropical	-0.37*	-0.32

*Significant at $p<0.05$

Apple cultivation dominates Himachal Pradesh's horticulture due to high economic returns, climatic suitability, and robust market demand, including exports to Southeast Asia. High-yielding varieties (e.g., Red Delicious, Royal Delicious) introduced in the 1980s increased yields by 20-30% over traditional cultivars. Enhanced irrigation (e.g., drip systems) and post-harvest infrastructure (e.g., cold storage, controlled atmosphere storage) have bolstered production in high-altitude districts like Shimla, Kullu, and Kinnaur. Organic practices, including vermicompost, biofertilizers, and canopy management (e.g., selective pruning), have improved yields by 15-20% in areas like Lahaul-Spiti by enhancing soil health and light penetration. However, apple productivity exhibits high variability (CV = 47.2%) due to climatic stressors (e.g., frost, hailstorms, unseasonal rainfall) and biotic pressures (e.g., apple scab, Powdery Mildew, canker, root rot, premature leaf fall, Alternaria leaf spot, fruit moth, mite, scale, woolly apple aphid, black aphids, borers etc), which reduce yields and fruit quality (Rajatiya *et al.*, 2018) [7]. Inadequate integrated pest management (IPM) and pollination management exacerbate pest damage (e.g., 20% yield losses from codling moth) and poor fruit set.

Subtropical fruit cultivation, notably mango and litchi, has expanded in lower-altitude districts like Kangra and Mandi, with cultivated area rising from 2,791 ha (1970-71) to 57,270 ha (2022-23), driven by subsidies and urban market demand. However, low productivity (0.96 MT/ha) reflects challenges in varietal selection, irrigation, and pest management. IPM (e.g., pheromone traps, biological controls) and integrated nutrient management (INM) have increased litchi yields by 10-15% in Kangra by mitigating fruit borer damage and enhancing soil fertility. Without these practices, mango yields decline by 20-25% due to anthracnose and powdery mildew. Citrus crops (e.g., kinnow, orange) in districts like Bilaspur and Una show low productivity (1.11 MT/ha) due to diseases like citrus canker and greening. Zero-budget natural farming (ZBNF) in citrus orchards has reduced input costs by 20% and increased yields by 10% in Bilaspur pilot projects by improving soil health.

Nuts and dry fruits, such as almonds and walnuts, exhibit low productivity (0.33 MT/ha) due to long gestation periods (5-7 years for walnuts), limited varietal advancements, and poor market linkages. Cultivation on marginal lands with low soil fertility, coupled with inadequate integrated nutrient management (INM) and canopy management, results in nutrient deficiencies and suboptimal canopy structure, reducing yields by 15-20%. High productivity variability (CV 47.2-65.4%) highlights the need for targeted interventions to enhance yield stability and resilience.

Government initiatives have significantly influenced horticultural trends. The Horticulture Development Scheme (1980s) subsidized orchard establishment and irrigation, driving area expansion. The Market Intervention Scheme (2000s) stabilized apple farmer incomes through minimum support prices. Programs like Rashtriya Krishi Vikas Yojana (RKVY) and Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) have promoted micro-irrigation and protected cultivation, boosting production in the 2000s-2010s. RKVY-supported organic farming increased adoption by 10%, improving soil health and

reducing chemical inputs by 25%. The Mission for Integrated Development of Horticulture (MIDH) and RKVY further enhance production through post-harvest management and input support. However, stagnating productivity indicates diminishing returns from traditional practices, necessitating precision agriculture, high-density planting, and climate-resilient varieties. To mitigate climate change impacts, strategies include reducing water stress, adopting low-chill, resistant apple cultivars, and using resilient rootstocks (e.g., M7, M111, Northern Spy, Malling Merton, Bud, Polish, Geneva series) against drought, pests, and diseases. Diversifying to crops like kiwi, persimmon, or pomegranate is also recommended (Amit *et al.*, 2020).

Climatic variability significantly impacts Himachal Pradesh's horticulture, particularly apple production, which requires 1000-1600 chilling hours at ≤7°C for optimal flowering (Awasthi *et al.*, 2001). Warmer winters, driven by climate change, have reduced chilling hours, lowering yields in years like 1999-2000 (0.55 MT/ha) and 2017-18 (3.96 MT/ha). Unseasonal rainfall and hailstorms further decreased yields in 2011-12 (2.65 MT/ha) and 2016-17 (4.18 MT/ha). Managed pollination using honeybee colonies improved fruit set by 10-15% under favourable conditions but was 20% less effective in adverse years. In Kullu Valley, declining snowfall has reduced chilling hours, prompting a shift from apple orchards to other crops and relocation to higher altitudes (Sharma *et al.*, 2013) [9]. Climate-smart strategies, such as low-chill apple varieties and enhanced weather forecasting, are critical.

Diversification into subtropical and citrus crops offers income stability but demands research and infrastructure investment. Natural farming (e.g., ZBNF) and integrated pest management have increased mango and litchi yields by 10-15% in Kangra by reducing chemical inputs and pest damage. High-yielding mango varieties (e.g., Dashehari, Alphonso) and disease-resistant citrus cultivars show promise. Promoting nut crops like walnut through improved market linkages and processing could enhance economic viability. Organic farming in Lahaul-Spiti has increased apple farm gate prices by 15-20%, but its absence elsewhere has led to soil degradation and 20-30% yield reductions in citrus and subtropical fruits due to increased disease incidence.

Socio-economic factors significantly impact horticultural trends in Himachal Pradesh, where apple cultivation employs over 60% of the rural workforce, supporting numerous smallholder farmers. Rural-to-urban migration has caused labor shortages, elevating production costs for labor-intensive tasks such as pruning and harvesting. Mechanized canopy management tools have reduced labor needs by 15%, enhancing orchard efficiency. However, an aging farmer population and declining youth participation threaten long-term sustainability. Capacity-building, mechanization, and incentives are essential to attract younger farmers and ensure sector viability.

Table 5: Decadal Growth Rates for Area and Production (1970-71 to 2022-23)

Decade	Apple Area (%/year)	Apple Production (%/year)	Total Area (%/year)	Total Production (%/year)
1970s	4.8	3.2	4.2	2.9
1980s	4.3	8.5	6.7	6.8
1990s	4.4	2.2	5.3	2.1
2000s	2.4	3.3	0.5	4.6
2010s	2.1	4.9	1.6	4.4
2020s	0.7	2.8	0.6	2.9

Table 5 shows decadal growth rates, highlighting the rapid expansion in the 1980s and 1990s, driven by policy support, and slower growth in recent decades due to land constraints. Production growth outpaced area growth in most decades, reflecting improvements in yield-enhancing technologies.

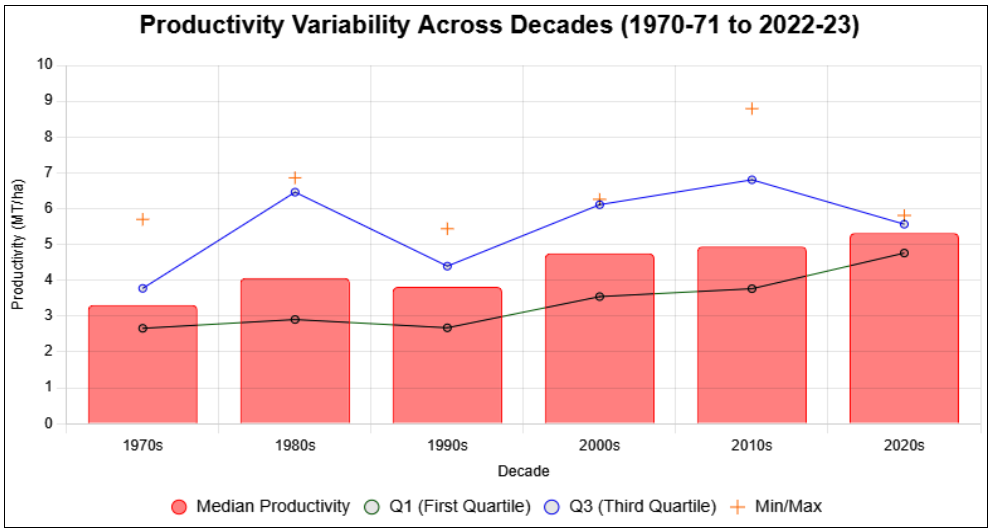

Fig 4: Productivity variability across decades (1970-71 to 2022-23)

A box plot (Figure 4) showing the distribution of productivity (MT/ha) for apples across decades, highlighting increasing variability in recent decades due to climatic and management factors.

Himachal Pradesh's horticultural sector, predominantly apple-based, shows strong potential for sustainable growth through targeted interventions addressing climate variability, technological gaps, and socio-economic challenges. Low-chill

apple cultivars (e.g., Anna, Dorsett Golden) and disease-resistant citrus/subtropical varieties can counter reduced chilling hours (1000-1600 hours at ≤7°C), stabilizing apple yields by 10-15% and reducing citrus losses by ~20%. Precision agriculture, using remote sensing, soil moisture sensors, and drones, can optimize resource use, increasing yields by 15-20%, while high-density planting enhances apple productivity by 20-30%. Drip irrigation and rainwater harvesting in districts like Una and Bilaspur can improve water efficiency by 20-25%, mitigating drought-related losses. Integrated pest management (IPM), employing biological controls (e.g., Beauveria bassiana for root borers, Trichogramma for fruit borers, pheromone traps for codling moth) and resistant varieties, reduces pesticide use by 30% and boosts yields by 15%, addressing losses from pests like apple scab and codling moth (20% yield reduction). Integrated nutrient management (INM) enhances soil fertility, increasing citrus/subtropical yields by 10-15%, as seen in Kangra's litchi orchards. Scaling zero-budget natural farming and organic practices, as piloted in Lahaul-Spiti and Bilaspur, cuts input costs by 20%, improves soil health, and raises yields by 10-15%, with organic certification increasing prices by 15-20%. Mechanized canopy management reduces labour costs by 15% and improves temperate fruit yields by 10-20%. Enhanced pollination via honeybee colonies boosts fruit set by 10-15%. Strengthened market linkages through processing units and farmer-producer organizations increase incomes by 10-15%, with export potential to Southeast Asia. Addressing labour shortages and aging farmer demographics requires mechanization and training, improving efficiency by 15% and youth engagement by 10-15%. Policy support via schemes like MIDH, RKVY, and MIS, alongside climate adaptation funds and public-private partnerships, can enhance infrastructure and research, reducing yield losses by 10-15%. Coordinated efforts integrating climate-smart practices, technology, and reforms can drive 15-30% productivity gains over the next decade, ensuring economic stability and global leadership in sustainable horticulture.

Conclusion

The horticultural sector in Himachal Pradesh has shown significant growth over 53 years, with cultivated area increasing by 433% and production by 448%, largely driven by the economic dominance of apples and supportive policies. However, high productivity variability (e.g., apples: CV = 47.2%) reflects vulnerabilities to climatic and biotic stresses. Interventions such as natural farming, organic farming (increasing apple yields by 15-20% in Lahaul-Spiti), canopy management, pollination management, INM, and IPM (reducing pest losses by 15% in Kullu) have boosted productivity, while their absence has led to 20-30% yield declines due to soil degradation, pests, and poor pollination. Other fruit categories (citrus, subtropical fruits, nuts/dry fruits) exhibit lower productivity, necessitating varietal improvements and infrastructure. Statistical analyses confirm significant growth trends ($p<0.05$) and climatic/management-driven cycles. For sustainability, policymakers should prioritize climate-smart agriculture, precision farming, and diversification, supported by investments in research, irrigation, market linkages, and capacity building, to reinforce Himachal Pradesh's status as a premier horticultural hub in India.

References

1. Saurabh A, Thakur A, Kaur L. A review on impact of climate change on apple production and scope of diversification in Himachal Pradesh. Int J Curr Microbiol App Sci. 2020;9(1):1877-84.
2. Departmental statistical data at glance. 2025 [Internet]. Himachal Pradesh: eUdyan Portal. Available from: https://eudyan.hp.gov.in/cms/en/departmental-statistical-data-at-glance/group-wise-area-production-of-different-fruits-in-himachal-pradesh-for-the-year-of-1970-71-to-2022-23/
3. Bisbis MM, Gruda NS, Blanke MM. Securing horticulture in a changing climate: a mini review. Horticulturae. 2019;5(56):1-10.
4. Devi N, Parmar RS. Growth pattern of horticultural crops in Himachal Pradesh. Agric Res J. 2019;6:547-55.
5. Gautam DR, Sharma G, Jindal KK. Fruit setting problem of apple: changing climate scenario of North Western Himalayas of India. Acta Hortic. 2004;662:435-42.
6. Hirpo FH, Gebeyehu MN. Review on the effect of climatic change variability on horticultural productivity. Int J Environ Sci Nat Resour. 2019;17(4):130-4.
7. Rajatiya J, Varu DK, Gohil P, Solanki M, Halepotara F, Gohil M, *et al*. Climate change: impact, mitigation and adaptation in fruit crops. Int J Pure Appl Biosci. 2018;6(1):1161-9.
8. Rana RS, Bhagata RM, Vaibhav K, Harbans L. Impact of climate change on shift of apple belt in Himachal Pradesh. In: ISPRS Archives XXXVIII-8/W3 Workshop Proceedings: Impact of Climate Change on Agriculture. 2008. p. 131-7.
9. Sharma NC, Sharma SD, Verma S, Sharma CL. Impact of changing climate on apple production in Kotkhai area of Shimla district of Himachal Pradesh. Int J Farm Sci. 2013;5(1):81-90.