

“Apple Cultivation in Rohru and Kinnour: A Comparative Study of Agro-Climatic Conditions, Farmer Practices Conditions, Farmer Practices, and Productivity Trends”

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Abstract: *Apple cultivation is a key economic activity in Himachal Pradesh, particularly in the regions of Rohru (Shimla district) and Kinnaur district, which are renowned for producing high-quality apples. This study presents a **comparative analysis** of the two regions by examining **agro-climatic factors, farmer cultivation practices, and trends in productivity.***

*The research is based on a combination of primary **data collected through structured interviews and field surveys**, along with **secondary data** from government and institutional sources. It investigates how differences in **altitude, temperature, rainfall patterns, and soil composition** affect apple growth, flowering, and harvesting cycles. The study also compares the **agricultural techniques and inputs** used by farmers in both areas, including irrigation methods, pesticide and fertilizer application, and the adoption of modern practices such as high-density plantation and drip irrigation.*

The findings reveal significant contrasts: Rohru, with its relatively moderate climate, supports early flowering and harvesting, while Kinnaur's higher altitude and cooler temperatures result in late flowering but better fruit quality and shelf life. Despite better climate suitability, farmers in Kinnaur face limitations in transportation and market access. Conversely, Rohru farmers benefit from better infrastructure but are more affected by climate variability and disease outbreaks.

*This comparative study highlights the **need for region-specific strategies** to improve productivity and sustainability. It suggests targeted policy interventions, improved extension services, and greater technological support to address the distinct challenges faced by apple growers in both regions.*

1. Introduction Apple cultivation is a vital pillar of the rural economy in Himachal Pradesh, contributing significantly to income generation, employment, and regional development. With over 90% of the state's fruit production being apples, the crop has transformed the economic landscape of several districts, including Shimla and Kinnaur. The Rohru region of Shimla district and the Kinnaur district are two of the most prominent apple-producing zones, known for their high-quality fruit and strong dependence on horticulture. Despite their shared significance, these two regions differ considerably in altitude, climate, soil type, infrastructure, and farming practices. While Rohru benefits from early flowering and proximity to major markets, Kinnaur enjoys ideal climatic conditions that enhance fruit color, sweetness, and shelf life. However, both regions are increasingly vulnerable to climate variability, pest outbreaks, and market-related risks, which affect apple yield and farmer incomes.

This research investigates these contrasting factors by undertaking a comparative study of the two regions, focusing on agro-climatic conditions, cultivation practices, and productivity trends. The goal is to highlight regional strengths and challenges and to recommend strategies that can improve sustainability and productivity in apple farming.

Existing Evidence / Literature Survey

The apple industry in Himachal Pradesh has been widely studied from the perspectives of horticultural development, climate sensitivity, marketing, and productivity. However, much of the literature is fragmented, with limited comparative analysis between different regions such as Rohru (Shimla district) and Kinnaur. This section outlines the key existing evidence relevant to the themes of this study.

Apple Production Trends in Himachal Pradesh

Several researchers, including **Sharma and Verma (2021)** and **Rana and Thakur (2020)**, have documented the rise of apple cultivation as a commercial enterprise in Himachal Pradesh. The area under apple cultivation has expanded steadily over the last few decades, particularly in districts like Shimla, Kinnaur, and Mandi. However, **yield fluctuations** due to changing climate and varying input use remain a persistent concern.

The Department of Horticulture, Himachal Pradesh (2022) reports that while Shimla remains the leading apple-producing district in terms of volume, Kinnaur apples are highly valued in premium markets due to their superior color, texture, and shelf life.

Agro-Climatic Influences on Apple Cultivation

Research by **Chauhan and Negi (2021)** emphasized the influence of temperature, rainfall, and chilling hours on apple flowering and fruiting. It was found that high-altitude regions like Kinnaur are better suited for high-color apple varieties due to longer chilling periods, whereas mid-altitude zones like Rohru allow for early harvesting and access to early-season markets.

IMD (2023) data also confirms shifting snowfall and rainfall patterns in both districts, influencing disease incidence and flowering cycles.

Traditional vs. Modern Farming Practices

Singh and Dogra (2019) compared traditional apple orchards to high-density plantation (HDP) systems in Rohru and concluded that HDP significantly increases yield per hectare, but requires higher inputs, technical knowledge, and water availability. Conversely, **Yadav and Bhardwaj (2020)** highlighted the prevalence of low-input, organic-oriented practices in Kinnaur, which are more sustainable but less productive.

Marketing and Post-Harvest Infrastructure

Sharma and Katoch (2019) identified market linkages and infrastructure as key constraints for apple growers in remote regions. Rohru benefits from better road connectivity and early-season access to mandis, while farmers in Kinnaur face delays due to limited transportation and storage facilities.

Thakur and Sharma (2018) recommended expanding cold storage and grading units in tribal areas to reduce post-harvest losses.

Climate Change and Adaptation

Recent studies such as Kaushal and Thakur (2020) show that apple belts in Himachal Pradesh are shifting upward due to global warming. Farmers in lower elevations like parts of Rohru are already experiencing declines in yield, while Kinnaur is gaining in suitability. However, adaptation strategies remain poorly adopted due to lack of localized research, awareness, and policy support.

Raina and Mehta (2018) emphasized the need for integrating climate forecasting and insurance schemes into horticultural planning, especially in vulnerable districts.

Gaps in Literature

Although there is ample research on apple production in Himachal Pradesh, the literature tends to:

- Focus on either one region at a time,
- Overlook farmer-specific constraints,
- Understudy the interaction of climate and socio-economic conditions, and
- Rarely offer a side-by-side comparison of modern vs. traditional practices across districts like Rohru and Kinnaur.

Conclusion of Literature Survey

The reviewed literature establishes a foundation for understanding the agro-economic and climatic dynamics of apple farming in Himachal Pradesh. However, this study adds value by offering a comparative, location-specific, and farmer-centered perspective that is currently underrepresented in academic and policy discourse. It aims to bridge this gap by combining field data, climate analysis, and farmer interviews to draw regionally relevant conclusions.

Background of the Research

Apple farming in Himachal Pradesh has its roots in the early 20th century when Samuel Stokes introduced the fruit in Kotgarh. Since then, it has evolved from a subsistence activity to a commercially important sector. The Rohru and Kinnaur regions have traditionally led apple production due to their favorable growing conditions.

However, over the years, apple farming has been affected by shifting climatic patterns, changing farmer behavior, and technological advancements. Farmers are now experimenting with high-density plantations, drip irrigation, and integrated pest management, but the rate of adoption and success differs between regions due to factors like accessibility, awareness, affordability, and local agro-ecology.

This research attempts to bridge the information gap by examining both regions through a comparative lens. It builds upon existing literature but focuses more deeply on the interplay between environment, practice, and productivity at the micro-level in Rohru and Kinnaur.

Research Gap

Despite the substantial body of research on horticultural development in Himachal Pradesh, including the cultivation of apples as a major cash crop, there remain several important gaps in the current literature and regional understanding:

Lack of Comparative Regional Studies

Most existing studies focus either on Shimla or Kinnaur district in isolation. Very few comparative studies have been conducted to examine how apple cultivation varies between these two distinct agro-climatic zones, particularly in terms of:

- Climate adaptability,
- Cultivation techniques,
- Input use, and
- Productivity outcomes.

Inadequate Integration of Agro-Climatic and Socioeconomic Factors

While some research explores climatic trends or productivity, there is a noticeable absence of studies that **integrate agro-climatic data with farmer behavior, technology adoption, and market accessibility**. This limits the understanding of how different factors interact to affect apple output in marginal and tribal areas like Kinnaur versus more connected areas like Rohru.

Insufficient Focus on Climate Change and Sustainability

Climate change is beginning to significantly influence apple belts in Himachal Pradesh, shifting altitudinal suitability and impacting flowering and fruiting patterns. However, research analyzing **climate variability, pest dynamics, and farmer adaptation strategies at the micro-level** (such as specific blocks like Rohru or tribal villages in Kinnaur) is limited.

Technological Adoption vs. Traditional Practices

Although high-density plantation (HDP) and scientific orchard management have gained popularity in Shimla district, **few studies assess their comparative benefits or drawbacks against traditional systems** in high-altitude areas like Kinnaur, where ecological sustainability and organic practices are more common.

Lack of Ground-Level Data and Farmer Perspectives

Much of the existing data is derived from government reports or secondary statistics. There is a **shortage of field-based primary data** that captures local farmer experiences, constraints, and preferences regarding apple cultivation techniques, market access, or climate-related challenges.

Conclusion of the Gap

Given these gaps, this study aims to provide a **comprehensive, comparative, and ground-level analysis** of apple cultivation in Rohru and Kinnaur. By doing so, it contributes to a more nuanced understanding of:

- Regional disparities in horticulture,
- Practical challenges faced by farmers,
- Sustainability concerns in apple production, and
- The need for tailored policy interventions.

Research Objectives

The primary objective of this study is to conduct a comparative analysis of apple cultivation in the Rohru and Kinnaur regions of Himachal Pradesh, focusing on environmental and human dimensions of production.

Specific Objectives:

1. To analyze and compare the agro-climatic conditions affecting apple cultivation in Rohru and Kinnaur.
2. To examine the differences in farmer practices, including traditional methods and the adoption of modern techniques.
3. To study the productivity trends of apple farming in both regions over the past decade.
4. To identify the challenges and constraints faced by apple growers, including climate impacts, pests, and market access.
5. To suggest region-specific recommendations for improving apple productivity, sustainability, and farmer livelihoods.

1. Scope of the Study

This study is focused on the Rohru block in Shimla district and selected villages in Kinnaur district, both located in the hill state of Himachal Pradesh.

1. The scope includes:

- Assessment of climatic, topographical, and soil factors affecting apple growth.
- Study of apple cultivation techniques, both traditional and modern.
- Evaluation of yield data and trends over recent years.
- Survey and interviews with local farmers, horticulture officials, and experts.
- Comparative analysis to identify key differences and commonalities in cultivation outcomes.

2. Limitations (Outside the Scope):

- This study does not include the processing or export sectors of apple trade.
- It does not extend to other horticultural crops.
- Financial data is limited to production costs and farmer income, excluding broader trade dynamics.

2. Material and Methods of the Study

The present study adopts a comparative and descriptive research design to analyze apple cultivation in the Rohru region of Shimla district and Kinnaur district of Himachal Pradesh. It combines both primary and secondary data sources to explore the agro-climatic conditions, farming practices, and productivity trends in the selected regions.

Study Area

The study focuses on two major apple-producing regions:

- 1) Rohru Block (Shimla District): Located in the southeastern part of Shimla, Rohru is known for early-season apple varieties, relatively moderate altitude (1,500–2,500 meters), and good access to roads and markets.
- 2) Kinnaur District: Located at a higher altitude (2,200–3,500 meters), Kinnaur produces high-quality apples with excellent color and shelf life due to cooler temperatures and late flowering seasons. The region is more remote and has different climatic and logistical challenges.

Research Design

This study uses a comparative case study approach, combining qualitative and quantitative methods to understand regional differences and commonalities in apple farming systems.

Data Collection Methods

a) Primary Data Collection

- Field Surveys and Structured Questionnaires were administered to a random sample of 60 apple farmers (30 from Rohru and 30 from Kinnaur).
- Interviews were conducted with:
 - Horticulture department officials,
 - Local agricultural extension workers,
 - Village elders and experienced orchardists.
- Field Observations were made regarding orchard layout, irrigation systems, pest control methods, and post-harvest handling.

b) Secondary Data Collection

- Reports from the Department of Horticulture, Himachal Pradesh.
- Past census and agricultural statistics.
- Research papers, government documents, and meteorological data from the
- Indian Meteorological Department (IMD) and HP Agricultural University.
- Historical productivity and weather data (last 10–15 years).

Sampling Technique

- Purposive sampling was used to select key apple-growing villages in each region.
- Within each village, random sampling was employed to select farmers across
- various age groups, landholding sizes, and experience levels.

Data Analysis Techniques

- Quantitative data (e.g., yield trends, costs, input usage) were analyzed using:
 - Averages, percentages, and growth rates.
 - Comparative tables and graphs to show trends and differences.
- Qualitative data from interviews and observations were analyzed through
 - thematic analysis, focusing on:
 - Climatic challenges,
 - Technology adoption,
 - Farmer perceptions,
 - Sustainability issues.

Time Frame of the Study

The study was conducted over a period of 6 months, covering:

- Pre-harvest and post-harvest periods,
- Different stages of orchard management,
- Retrospective yield and climate data from 2010 to 2023 for long-term analysis.

4. Results and Discussion

This section presents the key findings of the study based on primary and secondary data collected from apple farmers in Rohru (Shimla district) and Kinnaur district. The results are discussed under the following main themes:

Agro-Climatic Conditions

The study reveals substantial differences in agro-climatic conditions between Rohru and Kinnaur:

- a. **Altitude and Temperature:** Rohru lies at an altitude of 1,500–2,500 meters, with a relatively moderate temperature range, leading to early flowering and early harvesting. Kinnaur lies at a higher altitude (2,200–3,500 meters), resulting in late flowering, better fruit coloring, and longer shelf life.
- b. **Rainfall and Snowfall Patterns:** Kinnaur receives less rainfall but more consistent winter snowfall, which is crucial for chilling hour requirements in apple trees. Rohru has more erratic rainfall, increasing the risk of scab, canker, and pest infestations.
- c. **Climate Change Impact:** Farmers in both regions reported increased unpredictability of weather—late snowfall, sudden hailstorms, and drought spells. However, Kinnaur farmers noted lower disease incidence due to the cooler climate.

Farming Practices

I. Traditional vs. Modern Practices:

In Rohru, over 65% of farmers had adopted high-density plantation (HDP), drip irrigation, and chemical fertilizers, supported by better market access and government schemes. In contrast, Kinnaur farmers largely rely on traditional planting methods, organic manure, and low chemical input, which helps in maintaining soil health but limits productivity.

II. Orchard Management:

Rohru orchards are more intensively managed, with higher use of pesticides and growth regulators, whereas Kinnaur relies more on natural pollination, minimal pruning, and low-input cultivation, contributing to the perception of “naturally grown” apples.

Productivity Trends

1. Yield Comparison:

Average yield in Rohru is higher, at approximately 18–20 metric tonnes/ha, compared to 12–14 metric tonnes/ha in Kinnaur. However, per apple quality and pricing is often better in Kinnaur, where premium markets value the aesthetic and storage quality of the fruit.

2. Year-wise Productivity Trends (2010–2023):

Rohru showed greater fluctuations in yield due to weather extremes and disease, while Kinnaur had more stable but moderate yields. Adoption of HDP in Rohru contributed to short-term productivity spikes, though long-term sustainability concerns were raised.

Marketing and Infrastructure

3. Market Access:

Farmers in Rohru benefit from closer proximity to APMCs (Agricultural Produce Market Committees) and better road connectivity. In contrast, farmers in Kinnaur face difficulties in transporting produce due to limited and weather-dependent roads.

4. **Cold Storage and Grading:** Cold storage facilities are more available in Shimla district, while Kinnaur lacks access to modern grading and packaging infrastructure, affecting post-harvest handling and losses.

Challenges Faced by Farmers

Challenges	Rohru	Kinnaur
Climate Change	Frequent hailstorms, dry spells	Delayed snowfall, erratic frost
Pest & Disease	High pesticide use	Lower incidence but rising slowly
Market Access	Strong network, early entry Remote,	late-season market entry
Labour Shortage	Major issue during harvest	Lesser due to smaller orchards

Farmer Perspectives

Farmers in both regions emphasized the need for:

1. Improved forecasting and crop insurance,
2. Training in climate-resilient practices,
3. Better support for organic certification (in Kinnaur) and HDP management (Rohru),
4. Expansion of cold chains and transportation infrastructure.

Discussion Summary

The comparative analysis highlights that Rohru is ahead in terms of volume and technology, but faces greater climate vulnerability and sustainability risks. Kinnaur, while less intensive, produces high-quality apples valued in niche markets, though challenged by remoteness and limited infrastructure.

Both regions require tailored interventions—Rohru needs sustainability measures and pest control reforms, while Kinnaur would benefit from infrastructure development and improved access to markets and technology.

5. Conclusion

The study titled “Apple Cultivation in Rohru and Kinnaur: A Comparative Study of Agro-Climatic Conditions, Farmer Practices, and Productivity Trends” set out to explore and compare the major factors influencing apple production in two prominent apple-growing regions of Himachal Pradesh—Rohru in Shimla

district and Kinnaur district. The primary objectives included analyzing agro-climatic differences, evaluating traditional and modern farming practices, examining productivity trends, and identifying region-specific challenges.

Summary of Objectives Achieved

1. Agro-climatic comparison revealed clear ecological distinctions, with Rohru characterized by moderate altitudes and early harvests, while Kinnaur benefits from high altitudes and superior fruit quality.
2. A detailed assessment of farmer practices showed that Rohru farmers are more inclined toward modern, input-intensive methods, while Kinnaur farmers rely more on traditional, low-input systems.
3. Analysis of productivity trends highlighted that Rohru achieves higher yields but with increased input costs and environmental risks, while Kinnaur's organic-leaning practices result in more stable but lower yields.
4. Region-specific constraints and challenges were identified, such as climate stress in Rohru and infrastructure bottlenecks in Kinnaur.

Insights from the Literature Review

The literature revealed that while many studies have explored apple production in Himachal Pradesh, most of them focused either on economic outputs or climate change effects in isolation. Very few have attempted a comparative, location-based, and farmer-focused approach, especially between Rohru and Kinnaur. This study fills that gap by linking environmental, technical, and socio-economic factors at the micro-regional level.

Key Findings

- 1) Climate impacts are increasingly affecting both regions, though in different ways—unseasonal rains and hail in Rohru, and delayed snowfall in Kinnaur.
- 2) Rohru's high-density orchards and better infrastructure lead to greater output but also greater input dependency.
- 3) Kinnaur's natural farming approach enhances fruit quality and market value but limits yield due to poor connectivity and lack of cold chains.
- 4) Both regions show growing interest in sustainable agriculture, though levels of awareness and access to government schemes vary.

Recommendations for Future Policy and Research

- a. Region-specific interventions: Rohru needs climate-resilient farming models and improved pest control strategies, while Kinnaur requires investment in cold storage, road connectivity, and organic certification support.
- b. Capacity building: Farmers in both areas would benefit from regular training in sustainable practices, soil health, weather forecasting, and market intelligence.
- c. Technology adaptation: Promote customized use of modern tools like drip irrigation, weather-resistant varieties, and mobile advisory services, especially in remote areas.
- d. Further research: Future studies should explore the impact of climate change models, carbon footprint of different cultivation systems, and the potential for diversification into allied horticultural crops.

In conclusion, while both Rohru and Kinnaur play vital roles in Himachal Pradesh's apple economy, a differentiated and inclusive development approach is necessary to ensure sustainable and equitable growth of the sector in the face of climatic and economic challenges.

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सेब उत्पादन पर सर्वेक्षण प्रश्नावली (किसानों के लिए)

भाग 1: सामान्य जानकारी

1. किसान का नाम: _____
2. उम्र: ____ वर्ष
3. लिंग: ☐ पुरुष ☐ महिला ☐ अन्य
4. शिक्षा स्तर: ☐ निरक्षर ☐ प्राथमिक ☐ माध्यमिक ☐ स्नातक ☐ अन्य
5. गांव / पंचायत का नाम: _____
6. जिला: ☐ रोहड़ू (शिमला) ☐ किन्नौर
7. खेती का कुल क्षेत्रफल (बीघा/हेक्टेयर): _____
8. सेब की खेती का क्षेत्रफल: _____

भाग 2: कृषि प्रथाएँ (कृषि तकनीक और प्रक्रिया)

9. सेब की कौन-कौन सी किस्में उगाई जाती हैं?
 - ☐ रेड डिलीशियस
 - ☐ रॉयल डिलीशियस
 - ☐ गाला
 - ☐ ग्रैनी स्मिथ
 - ☐ अन्य: _____

10. आप किस प्रकार की खेती करते हैं?
- ☐ पारंपरिक (Traditional)
 - ☐ आधुनिक / हाई डेंसिटी (Modern / High Density)
 - ☐ मिश्रित
11. सिंचाई की कौन-सी विधि अपनाते हैं?
- ☐ नहर
 - ☐ वर्षा पर निर्भर
 - ☐ ड्रिप / स्प्रिंकलर
 - ☐ अन्य: _____
12. खाद और उर्वरक का उपयोग:
- ☐ रासायनिक
 - ☐ जैविक / कम्पोस्ट
 - ☐ दोनों
13. कीट एवं रोग नियंत्रण के लिए कौन-सी विधियाँ अपनाते हैं?
- ☐ कीटनाशक दवा
 - ☐ जैविक उपचार
 - ☐ कोई नहीं

भाग 3: जलवायु और पर्यावरण प्रभाव

14. क्या पिछले 5 वर्षों में जलवायु में कोई परिवर्तन महसूस किया है?
- ☐ हाँ ☐ नहीं

यदि हाँ, तो कैसे?

- ☐ कम बर्फबारी
- ☐ असमय वर्षा/ओलावृष्टि
- ☐ तापमान में वृद्धि
- ☐ अन्य: _____

15. जलवायु परिवर्तन से उत्पादन पर क्या असर पड़ा है?
- ☐ उत्पादन में कमी

- ☐ फलों की गुणवत्ता में गिरावट
- ☐ रोग और कीट बढ़ें
- ☐ कोई असर नहीं

भाग 4: विपणन और सरकारी सहायता

16. आप अपने सेब कहाँ बेचते हैं?
- ☐ स्थानीय मंडी
 - ☐ बाहर की मंडी
 - ☐ बिचौलियों के माध्यम से
 - ☐ ठेकेदार को सीधे
17. क्या आप सरकार की किसी योजना (जैसे सब्सिडी, प्रशिक्षण आदि) से लाभान्वित हुए हैं?
- ☐ हाँ ☐ नहीं

यदि हाँ, तो कौन-सी योजना: _____

18. क्या आपको सेब भंडारण/कोल्ड स्टोरेज की सुविधा उपलब्ध है?
- ☐ हाँ
 - ☐ नहीं
 - ☐ आंशिक रूप से

भाग 5: सुझाव और विचार

19. आपकी सबसे बड़ी समस्या क्या है?
- ☐ जलवायु परिवर्तन
 - ☐ कीट एवं रोग
 - ☐ बाजार तक पहुंच
 - ☐ सरकारी सहयोग की कमी
 - ☐ श्रमिकों की कमी

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