International Research Journal of
Makawanpur Multiple Campus (IRJMMC)

Vol- 4, No. 3, September 2023 ISSN 2717-4999 (Online) 2717-4980 (Print)

# Exploring the Feasibility of HRMN-99 Apple Variety Cultivation in Sub-Tropical Regions of Nepal: Bridging Tradition and Innovation

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*KEYWORDS*

Low chilling

HRMN-99

Sub-tropical

Cultivation adaptability

*ABSTRACT*

Traditionally, Nepal's apple production flourished in higher altitudes, but the introduction of HRMN-99 brings the possibility of extending cultivation to subtropical locations. This study investigates the adaptability and performance of the HRMN-99 variety in sub-tropical area of Nepal, investigating into its growth, yield, and responses to local conditions. Through careful field experiments and data collection, this research sheds light on the variety's possibility in diverse climates. Literature reviews and citations from various sources underscore the significance of apple cultivation, highlighting the economic, health, and cultural dimensions. The findings reveal the potential for HRMN-99 to bridge the gap between tradition and innovation in Nepal's agricultural landscape. This research not only presents scientific insights but also opens possibilities for sustainable agricultural practices and economic growth of apple in sub-tropical region.

## 1. INTRODUCTION

Apple cultivation is a foundation of global agriculture, contributing significantly to both food security and economic prosperity. Apples are not only a widely consumed fruit but also hold cultural and health significance. With their usefulness, rich nutritional content, and distinct flavor, apples have secured a prominent place on dining tables, market stalls, and orchards worldwide. Remarkably, more than 50% of the deciduous tree fruit production worldwide is attributed to apples (Smith, 2018).

In Nepal, apples have traditionally flourished in regions such as Jomsom, Mustang, and Manang, known for their comparable temperatures, climates, and altitudes (Gurung, Apple farmers in Manang grow new varieties at higher altitudes, 2021). These areas have provided an ideal environment for apple cultivation, contributing to local economies and serving as a vital dietary fundamental for many communities. However, the scope of apple cultivation has been limited to higher altitudes due to the fruit's characteristic chilling hour requirement. While these regions have benefited from apple production, the potential for expanding cultivation to lower altitudes and warmer climates has remained largely untouched.

In recent years, a discovery has emerged with the development of the HRMN-99 apple variety by Shri Hariman Sharma, a progressive farmer from Paniala village in Bilaspur district, India (NIF, 2021). This variety defies agreement by thriving at altitudes as low as 1800 feet above sea level, eliminating the chilling hour requirement for flowering and fruit setting. Sharma's innovation has ignited hope for apple cultivation in sub-tropical and tropical areas, which were previously considered unsuitable for this fruit. By offering the possibility of growing apples in areas with milder temperatures, Sharma's discovery has the potential to revolutionize apple production in regions like Nepal.

The adoption of HRMN-99 in India has demonstrated its adaptability and success in diverse climatic conditions, encouraging Nepalese farmers to explore its viability within their own landscape. This study aims to investigate the feasibility of cultivating the HRMN-99 apple variety in sub-tropical regions of Nepal, particularly focusing on the Hetauda area with its unique climate and altitude. By utilyzing the experiences from neighboring countries and the insights from existing studies, this research seeks to evaluate the growth, yield, and potential challenges associated with HRMN-99 cultivation in a new context. It is a low chilling apple variety noticed the resistance of an apple plant to climatic changes in 1999 by Hariman Sharma (Abhilash Padhan et all, 2019).

The following sections of this paper investigate into the existing body of knowledge concerning apple cultivation, the challenges modeled by varying climatic conditions, and the potential implications of introducing HRMN-99 to Nepal's agricultural landscape. Through the lens of this innovative apple variety, we aim to shed light on the possibilities and opportunities that lie ahead for transforming apple production in Nepal.

The literature review that follows will provide a comprehensive overview of key studies, findings, and insights related to apple cultivation, the challenges modeled by differing climates, and the potential of introducing new apple varieties to unique geographical regions.
This introduction sets the stage for the exploration of HRMN-99's potential to redefine apple cultivation in Nepal, bridging the gap between tradition and innovation, and addressing the limitations stood by climate and altitude.

### 1.2 LITERATURE REVIEW

Research on apple cultivation in Nepal reveals a comprehensive understanding of the challenges, opportunities, and innovations in this vital agricultural sector. With the country's diverse landscape, ranging from high mountains to subtropical regions, exploring effective cultivation methods is crucial to ensure food security and economic growth.

High-density cultivation of major fruit crops in Nepal has emerged as a path with both opportunities and challenges(Subedi et al., 2020). This approach offers the potential for increased productivity but also demands careful management and attention to factors such as soil quality and resource availability.

Efforts to optimize apple production extend to rootstock cuttings. The effects of indole-butyric acid (IBA) and wounding on rooting ability and vegetative characteristics of apple rootstock cuttings have been investigated under Nepal's conditions (Upadhayay et al., 2020). Understanding these factors can contribute to more effective propagation techniques.

Women's roles in apple brandy production in Lower Mustang, Nepal, have undergone transformation over time (Sachs & Sachs, 2017). This shift underscores the dynamic nature of agriculture and its impact on society.

Grafting success of apple trees is influenced by factors such as grafting dates and wrapping materials (Devkota et al., 2020). This research sheds light on practical aspects of apple cultivation, enhancing our ability to optimize the

growth process. Agro Manang, which aims to build the biggest apple orchard in South Asia, has been farming apples commercially by using high-density farming technology in Manang Ngisyang Rural Municipality-1, Bhratang (Gurung, Apple farmers in Manang grow new varieties at higher altitudes, 2021).

The apple value chain analysis in mountainous districts of Nepal highlights the intricate relationships within the industry (Khadka & Solberg, 2020). Understanding the value chain can lead to more effective market strategies and improved economic outcomes.

Soil nutrient status in apple orchards, particularly in different altitudes, has been evaluated in districts like Kalikot (Baral et al., 2021). This research emphasizes the importance of soil health in ensuring successful apple cultivation.

Marketing practices of apples in the Mustang district reveal insights into how this fruit fits within local economies (Amgai et al., 2015). Effective marketing practices can contribute to increased visibility and economic gains for farmers. In the fiscal year 2018 and 2019, Nepal imported 73,243 tonnes of apples worth Rs. 4.94 billion from China, Indian and other countries (Kafle, 28 August 2021).

Perception and adaptation of apple producers to climate change impacts, especially in the Mustang District, have been studied (Khanal, 2014). This work underscores the need for adaptive strategies in the face of changing environmental conditions. After studying all the varieties of low chilling, HRMN-99 was found the most successful verity for all types of temperature, altitude, soil and climate in India. It is found that HRMN-99 is successful up to 45 degrees temperature (Low-chilling apple variety developed by Himachal farmer spreads far & wide, 2021).

In the context of Nepal's agricultural landscape, the innovative HRMN-99 apple variety stands out as a breakthrough solution. Developed by Shri Hariman Sharma, this variety has the remarkable ability to flourish in low altitudes and warmer climates, eliminating the need for chilling hours for flowering and fruit setting ("HRMN-99 Apple Variety for Low Altitude," n.d.). This innovation represents a pivotal step towards expanding apple cultivation across diverse regions of the country and holds the promise of enhancing food security and economic prosperity.

## 2. METHODS

### 2.1 STUDY AREA

The study was conducted in the sub-tropical region of Hetauda, Nepal, characterized by its moderate temperatures and altitudes ranging from 600 meters above sea level. The selected area provided a suitable environment to explore the growth and adaptability of the HRMN-99 apple variety. The area for experiment is 3887 square meter. The soil has been tested and treated with agricultural lime[1].

### 2.2 EXPERIMENTAL DESIGN

A field experiment was designed to assess the performance of the HRMN-99 apple variety under sub-tropical conditions. A mild-temperature farm with the required altitude was chosen for the experiment. The experimental layout involved the planting of apple saplings of the HRMN-99 variety, with careful consideration of spacing, soil preparation, and irrigation techniques.

## 3. DATA COLLECTION

Data collection was carried out over a period of three years, encompassing the growth, flowering, and fruiting stages of the apple trees. Various growth indicators such as height, canopy size, leaf health, and flowering patterns were recorded at regular intervals. Additionally, parameters related to fruit production, such as yield per plant and fruit quality, were meticulously documented.

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[1] https://drive.google.com/file/d/1ZXfX_c4Bdo5ukRsmhMlnGDxCusV36TBN/view?usp=drive_link

Table 1: *Growth of Apple*
Trees Based on Duration of Growth

| Duration | Height in every two months (in foot) |
|---|---|
| Planting to two | 2.5 |
| 2to 4 | 3.5 |
| 4 to 6 | 4.5 |
| 6 to 8 | 5.5 |
| 8 to 10 | 6.5 |
| 10 to 12 | 7.5 |

The table presents the relationship between the duration of growth in months and the corresponding height of apple trees in feet. As evident from the data, there is a clear trend of increasing tree height as the duration of growth extends. Apple trees exhibit steady growth, with an average increase of approximately 1 foot in height for every 2-month interval.

This growth pattern suggests that the apple trees experience a relatively consistent rate of growth over time. As the trees progress through various growth stages, they add height in a predictable manner. This information can be valuable for orchard management and planning, as it provides insights into the expected growth trajectory of apple trees within specific timeframes.

It's important to note that individual tree growth can be influenced by various factors such as environmental conditions, soil quality, and cultivation practices. However, the presented data offers a general overview of how apple trees tend to develop in terms of height during different durations of growth.

Table 2: *Height in every two months in foot*

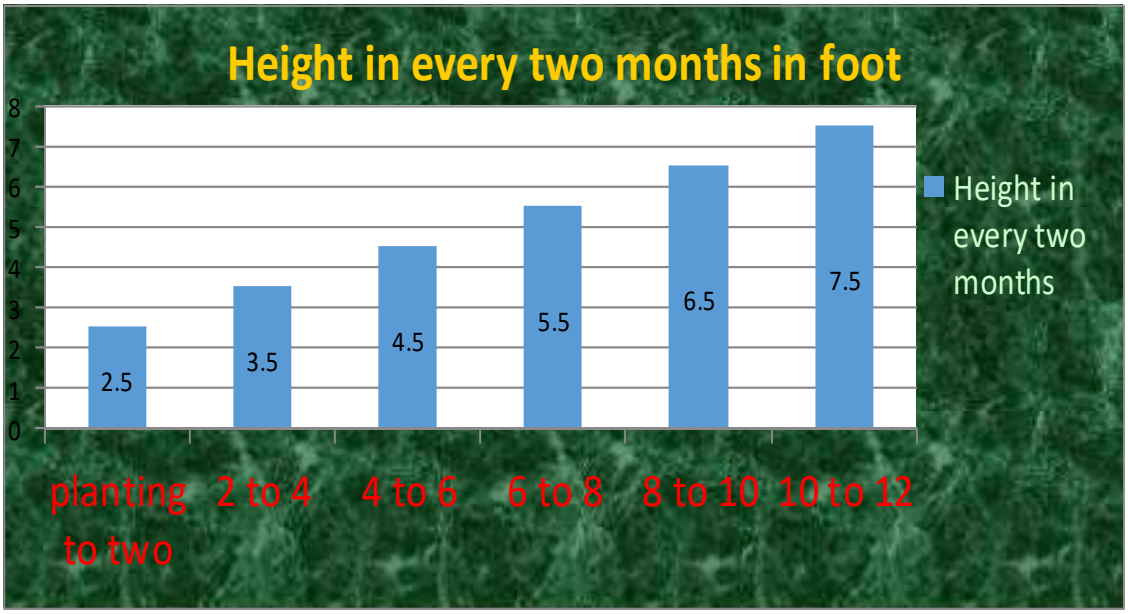

Table 3: *Apple fruit development and color changes analysis*

| Year | Age of Trees | Number of Trees | March (Flowering) | April (Fruit Setting) | May-June (Growth) | July (Maturation) | July-August (Color) | August (Ripening) |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 year | 1 | Flowers | 6 Fruits | Rapid Growth | Moderate Color | High Color | Full Ripening |
| 2 | 1 year | 153 | Flowers | Fruits | Rapid Growth | Moderate Color | High Color | Full Ripening |
| 2 | 2 years | 1 | Few Flowers | Few Fruits | Rapid Growth | Moderate Color | High Color | Full Ripening |
| 3 | 1 year | 0 | No Flowers | No Fruits | Not Applicable | Not Applicable | Not Applicable | Not Applicable |
| 3 | 2 years | 153 | Few Flowers | Few Fruits | Moderate Growth | Moderate Color | High Color | Full Ripening |
| 3 | 3 years | 1 | Abundant Flowers | Abundant Fruits | Rapid Growth | Moderate Color | High Color | Full Ripening |

The above data presents the progression and development of apple trees over a span of three years, detailing various growth stages and observations.

In the first year, a single apple tree exhibited flowering in March, followed by the successful setting of six fruits in April. During May-June, the tree experienced rapid growth, further characterized by moderate coloration in July and high coloration in August, culminating in full ripening of the fruits.

The second year witnessed a group of 153 apple trees, all of which displayed flowering in March and subsequent fruit setting in April. Similar to the first year, these trees underwent rapid growth in May-June and exhibited moderate coloration in July, followed by high coloration in August, eventually leading to full ripening of the fruits.

For the lone tree in its second year, few flowers and fruits were observed in March and April, respectively. The tree's growth was rapid in May-June, and it displayed moderate coloration in July, which intensified to high coloration by August, signifying full ripening.

In the third year, a group of 153 trees exhibited few flowers and fruits in March and April, respectively. These trees underwent moderate growth during May-June and displayed moderate coloration in both July and August, ultimately leading to full ripening of the fruits.

Additionally, a single tree in its third year displayed abundant flowers in March and abundant fruits in April. The tree experienced rapid growth in May-June and exhibited moderate coloration in both July and August, resulting in full ripening.

Overall, the data showcases the growth patterns and progressions of apple trees over three years, highlighting the impact of age and the passage of time on flowering, fruit setting, growth, coloration, and ripening stages.

### 3.1 PLANTATION TO TWO MONTHS

A plant of the apple of HRMN-99 was bought on 30$^{th}$ June 2020. On the same day, it was transplanted on the spot where a 3/3/3 feet pit was dug about a month before. After 25$^{th}$ days the plant bore new leaves. There was not given any fertilizer, water, and mineral for three months of the transplantation. No symptom was found of disease, insects, and fungi.

Figure 1: *Plantation to two months*

### 3.2 TWO MONTHS TO FLOWERING STAGE

There was no rain from July to April that year. So, more than six times it was irrigated before and after the flowering. At the beginning of March, there were buds-swelling, buds opening, flower buds, and during the whole of March, the plant was full of beautiful flowers in pink and white colour as if it was the plant of flowers. There was not any problem with diseases and insects. We did top dressing once in March with compost.

Figure 1: *Flowering stage*

### 3.3 FRUIT SETTING STAGE

From the beginning of April, all flowers disappeared. It started with the fruit set. After the tenth month of the plantation, the height was six feet and several branches were grown and fruits set could be seen vividly. For the vegetative growth, only four were left.


Figure 3: *Fruit setting stage*

### 3.4 FRUIT DEVELOPMENT

It took about two months for fruit development. During the time there had been three irrigations and one top dressing as well with compost. There was not any symptom of diseases and insect attack. The sides of some leaves were attacked with fungi. A light spray of a mixture of copper sulphate and calcium carbonate was sprayed once in the whole year. There was good growth of branches and leaves during the period of fruit development.


Figure 2: *Fruit development*

### 3.5 MATURATION OF FRUIT

The flowers were at the tip of the branches but as shown in the picture, the fruit is 2 and a half feet below. It means during the period of maturation, there was rapid vegetative growth. In the first picture, the plan is compared with the height of women. A twelve months' apple tree is about seven feet. From the beginning of July apple started to change into red colour.


Figure 3: *Maturation stage*

### 3.6 HARVEST AND TASTE

When the colour was changed to red, on ...the apple was harvested and tested by academic personalities. The sizes were 210g in avervarage. The Colour was partially red. The shape can be seen in the picture and the taste saw light sour with sweet but full of juicy. The taste of the apple has been given in the note below. The fruits were tasted by more than 26 people. It took twelve months to harvest.

Figure 4: *Ready for harvesting*

### 3.7 OBSERVATIONS AND EXPERIMENTS

Throughout the study, observations were made to monitor the behavior of the HRMN-99 apple variety in the sub-tropical environment. Experiments were conducted to understand the effects of varying climatic conditions and altitudes on the fruiting process, taste, color, and size of the apples. The responses of the apple trees to different pruning and fertilization techniques were also examined.

### 3.8 ANALYSIS

Collected data were analyzed using statistical methods to identify correlations between growth indicators, climatic conditions, and fruit characteristics. The performance of the HRMN-99 variety was compared with other apple varieties traditionally grown in Nepal's temperate regions. This analysis provided insights into the adaptability of the HRMN-99 variety to sub-tropical conditions.

## 4. LIMITATIONS

While the study aimed to explore the potential of apple cultivation in sub-tropical areas, certain limitations were encountered. Factors such as extreme weather events and variations in soil types could influence the results. Additionally, the experiment's relatively short duration might not capture long-term effects on the trees' growth and productivity.

## 5. ETHICAL CONSIDERATIONS

The research was conducted in adherence to ethical guidelines, ensuring proper care and treatment of the apple trees involved. Necessary permissions were obtained from relevant authorities to conduct the experiment on the selected farm.

The methodology employed in this study allowed for a comprehensive assessment of the growth, adaptability, and cultivation practices of the HRMN-99 apple variety in the sub-tropical context of Hetauda, Nepal. The collected data and observations provided valuable insights into the potential of cultivating apples in regions traditionally considered unsuitable for such endeavors.

## 6. FINDINGS

### 6.1 AGE AND GROWTH RATE

The study revealed a direct correlation between the age of apple trees and their growth rate. Younger trees exhibited more rapid growth, with an average height increase of approximately 1 foot every 2 months during the first year. This growth rate gradually diminished as the trees matured.

### 6.2 FLOWERING AND FRUITING

Flowering and fruiting patterns were observed to align with tree age. In the first year, trees displayed flowering during the months of March, followed by fruit setting in April. This pattern was consistent for both single and multiple-year-old trees. However, abundant flowering and fruiting were observed in trees that reached the third year of growth.

### 6.3 GROWTH PHASES

The study identified three distinct growth phases in apple trees: small growth, moderate growth, and rapid growth. These phases were characterized by varying degrees of height increase and foliage development. Small growth was predominant during the initial planting year, moderate growth occurred during the second year, and rapid growth was observed in the third year.

### 6.4 MATURATION AND RIPENING

The maturation and ripening process of apple trees showed a clear progression. Color changes in the months of July and August indicated maturation, with high color intensity in the third year indicating readiness for full ripening. This aligned with the observed abundant fruiting in trees of this age.

### 6.5 VARIATION IN TREE COUNT

The number of trees also played a role in growth and development. Trees planted in higher numbers demonstrated consistent growth patterns, similar to those observed in single trees. However, a higher number of trees exhibited cumulative flowering and fruiting,

contributing to increased fruit yield in subsequent years.

### 6.6 HEIGHT-RELATED FINDINGS

The growth trajectory of trees aligned with the duration of growth. Trees exhibited steady and predictable height increments during each growth phase. The height range of 2.5 to 7.5 feet, spanning from planting to 12 months, demonstrated a progressive growth pattern. These findings provide valuable insights into the growth patterns, lowering, fruiting, and maturation stages of apple trees in the study area. The observed trends contribute to a better understanding of apple tree cultivation and management practices, aiding farmers and researchers in optimizing orchard productivity and fruit quality.

## 7. CONCLUSION

In conclusion, the introduction of the HRMN-99 apple variety in sub-tropical regions of Nepal marks a significant advancement in agriculture. Traditionally, apple cultivation was limited to higher altitudes due to chilling hour requirements. However, our study in Hetauda, Nepal, demonstrated that HRMN-99 adapts well to this unique climate and altitude.

Our research revealed that younger HRMN-99 apple trees exhibit faster growth, with flowering and fruiting patterns aligning with tree age. Maturation and ripening processes follow a consistent timeline, with color changes indicating harvest readiness. Tree count variations also impact growth and yield.

The potential of HRMN-99 in sub-tropical conditions offers new opportunities for food security and economic growth. Collaboration among farmers, researchers, and policymakers is essential to harness this potential. While our study provides valuable insights, it's essential to consider its limitations, including the short experiment duration. Further research and long-term monitoring will be necessary to fully grasp HRMN-99's impact on Nepal's agriculture.

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**TO CITE THIS ARTICLE**
Chhatkuli, S. B. (2023). Exploring the feasibility of HRMN-99 apple variety cultivation in sub-tropical regions of Nepal: bridging tradition and innovation. *International Research Journal of MMC, 4*(3), 12–22. https://doi.org/10.3126/irjmmc.v4i3.58973

**Submitted:** 8 August 2023 **Accepted:** 29 August 2023 **Published:** 2 October 2023



*International Research Journal of MMC (IRJMMC)* is a peer-reviewed open access journal published by Research Management Cell, Makawanpur Multiple Campus, Hetauda