

Advancement of kiwifruit cultivation in Nepal: Top working techniques

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Received: 01 January 2024; Accepted: 23 February 2024; Published online: 29 February 2024

Abstract. In recent years, there have been notable advancements in the cultivation techniques of kiwifruit, a fruit that is both popular and economically important. One particular practice that has gained recognition is top-working, which involves grafting new scions onto existing rootstocks. This horticultural technique has shown promise in improving yield, disease resistance, and overall productivity in orchards. This comprehensive review paper examines the different methods used in top working for kiwifruit cultivation, explores the factors that influence its success, and discusses the benefits and challenges associated with this practice. This review provides an overview of various techniques used for the top-working kiwifruit plants in Nepal. The success of top-working depends on factors such as timing, compatibility between scion and rootstock, grafting materials, and proper grafting techniques. This review paper also ranges over the importance of kiwifruit cultivation for Nepalese farmers, problems faced by them, persistent constraints in the country, and the future promise that kiwifruit cultivation holds for the economic advancement of the nation.

Keywords: *Kiwifruit farming, kiwifruit farming opportunities, kiwifruit farming trend, Nepal and varieties*

Cite this as: Rai S. & Rai R. (2024). Advancement of kiwifruit cultivation in Nepal: Top working techniques. *J. Multidiscip. Sci.* 6(1), 11-16.

1. Introduction

The genus *Actinidia* is home to the famous Kiwifruit, which is well known for its exceptional taste and nutritional benefits. The fruit has a high vitamin C concentration and is abundant in dietary fiber, potassium, vitamin E, folate, antioxidants, and numerous other bioactive compounds (Chhetri & Subedi, 2019). *Actinidia deliciosa*, *Actinidia chinensis*, and *Actinidia arguta* are among the cultivated kiwifruit species (Sims, 2011). The global popularity of kiwifruit cultivation has soared due to its ability to thrive in various climates, its delectable fruits, early maturity, rich nutritional and medicinal properties, and lucrative economic benefits.

Mr. J.F. Messy, a road engineer involved in the SDC Project 1986 AD in Charikot, Dolakha, is credited with the initial introduction of kiwifruit (Atreya et al., 2020), which was transplanted in Charikot and Jiri Technical School. In 1987, the Hill fruit development project, funded by JICA Nepal, implemented the introduction of kiwifruit and established plantations in three different locations: the horticulture farm in Kirtipur, the horticulture farm in Daman, and the Kakani farm in Nuwakot (Atreya et al., 2020). The global and Nepalese production and consumption of kiwifruit have steadily risen each year. This growth can be attributed to the fruit's significant economic importance, as evidenced by the expansion of cultivation areas and increased production. Furthermore, the consumption of kiwifruit has also been on the rise due to its exceptional nutritional value and numerous health benefits. The kiwifruit covers a total area of 551 hectares, with a production volume of 719 metric tons (MoAD, 2017).

The primary focus for kiwifruit growers lies in the market. With its prolific fruiting behavior and significant economic value, the area and production of kiwifruit continue to expand each year, playing a crucial role in replacing imported fruits in Nepal. In order to keep up with the increasing worldwide demand for this exotic fruit, researchers and horticulturists have dedicated their

efforts to enhancing cultivation methods. Among these efforts, top-working has emerged as a promising technique to revitalize existing kiwifruit orchards, effectively tackling issues like reduced productivity and vulnerability to diseases.

Kiwifruit is highly nutritious, and various studies have demonstrated its numerous health benefits. Regular consumption of kiwifruit can help prevent diseases such as diabetes, heart-related conditions, colon health issues, muscular degeneration, obesity, and asthma. This fruit is suitable for people of all ages and is particularly advantageous for pregnant women. Due to its exceptional nutritional content, the price of kiwifruit is higher compared to other fruits.

2. Different varieties cultivated in Nepal

There are two primary types of kiwifruit that are cultivated globally: *Actinidia deliciosa* and *Actinidia chinensis*. *Actinidia deliciosa* encompasses varieties such as Hayward long, Hayward round, Abbott, Allison, Bruno, and Monty, whereas *Actinidia chinensis* comprises Red Kiwi, Hort 16, and Golden Kiwi (Dhakal, 2018; Sims, 2011).

Exclusively for Nepal, the important varieties suitable for cultivation are Hayward, Abbott, Allison, Bruno, Monty, and Soyou for the female line and Tomori, Matua, and Khohi for the male line (Atreya et al., 2020). Due to the broader adaptability of kiwifruit, these varieties can be found in the mid-hills of Nepal countrywide.

3. Top working technique in kiwifruit

Kiwifruit propagation can be effectively achieved through the asexual method, specifically by tongue grafting (Mohammadi & Abdi Senehkouhi, 1993). Kiwifruit cultivation often involves the technique of tongue grafting, which is a method used to propagate new plants. This process involves joining a piece of the desired kiwifruit variety, the scion, with a rootstock. The scion is carefully inserted into a slit made in the rootstock, ensuring that the cambium layers of both plants align. This allows for the successful fusion of the two plants, resulting in a new kiwifruit plant that inherits the desired traits of the scion. Tongue grafting is a common practice in kiwifruit cultivation, as it allows for the production of high-quality plants with improved characteristics.

However, in Kashmir conditions, the cleft grafting technique showed the best multiplication performance in the third week of March (Ashraf et al., 2020). Kiwifruit can be propagated by techniques such as tongue grafting, cleft grafting, whip grafting, etc., but different climatic conditions can affect the success and performance rate. Kiwifruit is grafted in the dormant season, when all the leaves of the vine fall out. Top work is done in February and March, as this is the best season for graft success, and these months are termed the dormant season. In Nepal, the cultivation of Red Kiwi for the early season, Bruno for the mid-season, and Hayward for the late season has been carefully chosen (Paudyal, 2013).

4. Factors influencing the success of kiwifruit top working

The achievement of successful top-level work in kiwifruit cultivation relies on several factors, such as the selection of rootstock, compatibility between scion and rootstock, appropriate timing, and favorable environmental conditions. The growth parameters and pomological traits of grafted plants, including height, leaves, growth habit of the tree, time of fruit maturity, and yield, are influenced by both the rootstock and the scion. After the grafting process, the graft union is secured to facilitate the healing process and prevent the drying of buds and stems. This can be accomplished using various methods (Hartmann & Kester, 1975). This section offers a comprehensive examination of these factors, providing valuable insights into the complexities involved in top working. Understanding the physiological and genetic compatibility between scions and rootstocks is essential for attaining the best possible results. The efficacy of grafting, a commonly employed method of propagation, is impacted by both the rootstock and the specific grafting technique utilized (Khanal et al., 2022).

4.1. Scion-rootstock variety

The success rate of grafting, a widely used propagation method, is influenced by both the rootstock and the type of grafting employed (Sedaghathoor & Noie, 2016). For rootstock, the Hayward variety is commonly used in Nepal. Common scion varieties here in Nepal are Hayward, Abbott, Allison, Bruno, Monty, and Soyou (Dhakal, 2018). Rootstock or scion selection from the older vine can generally hinder the scion-rootstock union, but no significant obstruction can hinder graft success (Cruz-Castillo et al., 1991).

4.2. Time of grafting

Kiwifruit is grafted in the dormant season, in the early spring of the year. In Nepal as well, grafting is done in the winter season. January, February, and March are essentially the best months for grafting on kiwi vines. At an altitude of 1800–1900 m, the best time for kiwifruit grafting is in the month of March (Ashraf et al., 2020).

4.3. Wrapping materials

Grafting tape, such as soft tying materials, serves to prevent the loss of humidity and drying of the scion. This, in turn, facilitates the production of wound tissue over the cut surface, allowing for easier healing and rapid cambial connectivity between the stock and scion (Zenginbal et al., 2006). The use of soft plastic wrapping materials and white raffia resulted in the highest bud-take. However, the graft success was reduced when paper tape was used. Hence, it is recommended to utilize soft, rubbery, or leathery polyethylene tapes for kiwifruit budding during the early spring season. Conventional wraps such as cannabis fiber, plastic string, cotton yarn, or paper tape are not suitable for kiwifruit budding (Zenginbal et al., 2006).

5. Benefits of top working

The top working technique is a tool used in fruit crops with the intention of improving production. Grafting involves utilizing a robust plant to substitute the root system of a cultivar that holds economic value but is vulnerable to one or multiple stressors (Gaion et al., 2018). The root system is termed a rootstock, and the upper fruiting body is called a scion. Some of the advantages of grafting include:

1. Grafting prevents biotic stress from Nematodes (Yin et al., 2015) infection and soil-borne fungi (Cohen et al., 2007).
2. The utilization of rootstocks that are resistant to soil pathogens offers a benefit in terms of minimizing the reliance on chemical agents (Rivero et al., 2003).
3. Wild varieties, commonly used as rootstock, are more tolerant to low soil temperatures and do not limit the growth of the scion or fruiting (Rivero et al., 2003).
4. The choice of rootstocks that either include or exclude ions has the potential to enhance resistance against elevated levels of salt in the soil (Rivero et al., 2003).
5. In grafted plants, there is an increased uptake of water and mineral nutrients, resulting in variations in the foliar concentration of these plants compared to ungrafted plants (Rivero et al., 2003).
6. Grafted vines have a faster fruit production rate. While it may take 7 years for a vine grown from kiwi seed to bear fruit, a grafted vine will only require 2–3 years.
7. A grafted tree will consistently produce fruit of the same high quality over an extended period of time.
8. Yield and productivity of the kiwi vine will drastically increase.

6. Constraints of kiwifruit farming in Nepal

Different constraints are shown in Table 1, selectively from Ilam and Sandakpur. Constraints are ranked according to the location in the table, and severity is shown in regard to these constraints (Giri et al., 2021). Input constraints include quality saplings and FYM usage in these locations. Technology constraints include a lack of male-female ratio maintenance, varietal selection, and the technical knowledge of the farmers. Post-harvest handling constraints include sorting and grading the fruit and a lack of cold storage for kiwifruit. Marketing constraints include transportation, poor road connectivity, and a lack of market intelligence. Disease constraints include nematode infestations. Financial constraints include investment scarcity and the benefit-cost ratio (Giri et al., 2021). Some constraints are described below:

1. Lack of quality saplings of kiwi plants: The cultivation of kiwifruits heavily relies on high-quality saplings as the main planting material. Unfortunately, due to the lack of an effective regulatory system for fruit nurseries, a majority of farmers reported to utilizing unauthorized kiwifruit saplings (Khatiwada et al., 2021).
2. Lack of technology adoption: Most farmers are still employing traditional techniques in kiwi farming, with a lack of knowledge regarding proper training, pruning practices, and girdling methods for kiwi plants (Khatiwada et al., 2021).
3. Nematodes associated with kiwifruit: There is occurrence and damage to kiwifruit due to nematodes (Chhetri & Subedi, 2019).

4. Post-harvest losses: Inadequate post-harvest handling methods in terms of sorting, grading, and packaging significantly contribute to growers' inability to obtain a favorable price for kiwifruit. Moreover, due to these practices, growers face challenges in producing various kiwifruit products such as jam, jelly, and pickle at their production sites ([Khatiwada et al., 2021](#)).

Table 1. Constraints associated with Kiwifruit with ranking in Ilam and Sandakpur

Production Constraints of Kiwi	Index Score		Rank	
	Ilam	Sandakpur	Ilam	Sandakpur
Financial Constraints	0.72	0.69	4	6
Input Constraints	0.86	0.84	2	3
Technical Constraints	0.91	0.91	1	2
Post-harvest handling and Processing Constraints	0.72	0.73	3	5
Marketing Constraints	0.66	0.74	5	4
Disease and Pest Constraints	0.62	1.41	6	1

7. Opportunities of kiwifruit cultivation in Nepal

The opportunity of kiwifruit cultivation in Nepal is considered based on the following conditions:

1. Climatic stability: The climate of Nepal is very suitable for kiwifruit cultivation. The area above the citrus zone and below the apple zone is best for kiwifruit cultivation.

2. Support of input and technical services: Different organizations, including PMAMP, TFRDC (Horticulture Farm of Boach), NGOs, cooperatives, and the agriculture section of the local municipality, offer production inputs and technical services to the farmers ([Khatiwada et al., 2021](#)).

3. Demand: The demand for kiwifruit is on the rise, which presents the potential for exporting to various regions.

8. Trend of kiwifruit cultivation in Nepal

The commercial potential of kiwifruit production in Nepal is evident, as there are potential markets within the country itself as well as in India and Bangladesh. Scientific literature from other countries also provides information on the climatic requirements for kiwifruit, which further supports the possibility of its production in Nepal's warm temperate climate ([Basnet et al., 2016](#)).

Farmers often encounter the challenge of low graft success, which results in significant losses for kiwifruit growers despite the increasing demand for saplings in commercial production. To achieve a higher success rate, it is crucial to identify suitable varieties for specific domains or areas and utilize appropriate wrapping materials to prevent moisture desiccation. Graft incompatibility resulting from poor varietal selection can lead to graft failure ([Pandey et al., 2019](#)).

Kiwifruit cultivation in Nepal spans 2116 hectares, with a productive area of 1167 hectares. The total production amounts to 4254 metric tons, yielding 3.65 metric tons per hectare ([MOALD, 2021](#)). However, the production of kiwifruit in Nepal is considered expensive due to the significant capital investment required for vines, trellises, and a permanent irrigation system. Additionally, it takes approximately three to four years for commercial fruit production to begin. Despite Nepal's immense potential for high-quality kiwifruit production, the industry must catch up due to market limitations, lack of awareness, and insufficient research on this crop. Nevertheless, Nepal has ample opportunities to enhance commercial kiwifruit production for local consumption and international export ([Khanal et al., 2022](#)).

A farmer has the capacity to cultivate 20 kiwi vines on 1 ropani land. The ideal areas for cultivation are those facing south and equipped with sufficient irrigation facilities. For the best results, loamy soil is highly recommended for kiwifruit plantations. After a period of five years, the kiwi vine reaches maturity and produces an annual yield of 50–80 kg of kiwifruits. These fruits can be sold for Rs. 400 to Rs. 800 per kilogram, depending on their quality and size. Consequently, the farmer can potentially earn around forty to forty-five thousand rupees per year from a single kiwi vine. Engaging in commercial kiwifruit farming can significantly improve the farmer's standard of living, which would otherwise be difficult to achieve through conventional farming and traditional animal husbandry practices.

Striving hands can achieve the impossible. Commercially, this endeavor benefits farmers and serves as a benchmark for boosting the nation's economy. The highly demanded Nepalese kiwifruit can be exported to the international market, creating employment opportunities for young individuals seeking jobs abroad. With proper training, access to technology, subsidies, and prior knowledge of fruit cultivation, Nepalese farmers have the potential to transform barren lands into bountiful ones.

9. Conclusions

Kiwifruit is a prominent agricultural commodity with great potential for export to the international market. Nepal possesses suitable topography, climate, and soil for the profitable production of kiwifruit, known for its unique taste, early maturity, and high nutritional and medicinal values. This study analyzes the production trend, exports, imports, current situation, and prospects of kiwifruit in Nepal. The findings indicate that kiwifruit production is on the rise. However, the commercialization of Nepalese kiwifruit is still in its early stages. Despite a decent presence in local and global markets, the country's kiwifruit production still needs to grow. The main challenges include a lack of scientific research on kiwifruit, limited adoption of improved technology, insufficient investment, poor-quality planting material, unstable prices and profit margins, and inadequate market channels. Therefore, to strengthen the kiwifruit subsector, it is recommended to focus on strategies such as enhancing productivity through conventional mechanization, adopting improved technology, intervening in pricing, gaining market recognition, establishing storage and processing centers, and fostering diplomatic relations for convenient global marketing.

Conflicts of interest. The authors mentioned that none of them have a conflict of interest when it comes to this article.

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