



Review

Himalayan Horticulture Produce Supply Chain Disruptions and Sustainable Business Solution—A Case Study on Kiwi Fruit in Uttarakhand

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Abstract: Uttarakhand, a state in the northern region of India which is traversed by the Himalayas, grows a variety of horticultural crops (e.g., fruits, vegetables, spices, and flowers) and is experienced with large-scale horticulture production at the national and/or international levels. Due to the wide variation in the climatic conditions and growing patterns, its pattern varies from harvest to harvest and from one province to another in terms of range, production, and yield. One of the most lucrative industries in Uttarakhand's hilly areas is horticultural cultivation. It substitutes for the neighborhood economy and helps farmers make a living. According to the literature, no work on the supply chain management of fruits in the hilly areas of Uttarakhand has yet been documented to analyze the growth of horticulture cultivation. Thus, the primary objective of this paper is to focus on the supply chain management of kiwi fruit, a type of major growing fruit in Uttarakhand's Bageshwar area. Additionally, this paper will offer a business plan for small-scale farmers to boost employment, economic development, and benefits. This study contributes to the discussion of the problems with the Himalayan fruit supply chain that is specific to the kiwi fruit and how a sustainable business model like horti-tourism can enable greater revenue generation for farmers while also resolving the problems with the Himalayan produce supply chain.

Keywords: Himalayan fruits; value chain; sustainable agribusiness; kiwi; sustainable business model



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1. Introduction

The production of fruits and vegetables (F&V) revitalises Indian agriculture. Though India's share of the world market is still less than 1%, the country's agricultural goods are becoming more popular [1]. With an increasing share of high-value commodities in agricultural production and the potential for advancement, this segment is projected to drive agricultural growth in the coming years [2]. In the 1980s, the government of India realized the need for reform in the horticulture sector by focusing investments in this sector. Currently, horticulture has proven its dependability in increasing revenue through higher productivity, job creation, and striking export potential [3]. Horticulture has progressed from a rural to a profitable industry. Horticulture output now accounts for 33% of agricultural output [4]. Under the scope of agriculture and related activities, the portion of the plan outlay for horticulture increased from 3.9% in the IX Plan to 4.6% in the XII Plan [5]. Several commercially important horticultural crops are grown in India, where they account for 30% of the country's GDP and roughly 37.1% of all agricultural commodity exports [6]. The horticulture sector has emerged as a crucial driver of agricultural evolution [7]. Structured trade and private label infiltration, demand for functional food, and increased spending on healthy food are the primary drivers of this sector's economic growth [8]. In recent years, India's horticulture production has grown. The area under horticulture increased by 2.6% annually during the previous ten years, and

in 2017–2018, annual production increased by 4.8% [5]. Fruit production increased from 50.9 million tonnes (Mt) in 2004–2005 to 97.35 Mt in 2017–2018 [5].

Growing horticultural produce is, in general, much more dynamic and profitable. The sector receives special attention, specifically after the primer of the Horticulture Mission for North-East and Himalayan States (HMNEH) and the National Horticulture Mission (NHM) in the 11 Plan, which has yielded rich fruit [9]. The plan has been to focus on boosting production through dense farming and high-value product plantations, protected cultivation, micro irrigation, good planting material, updating old orchards, emphasising post-harvest management, and marketing products for higher price realisation [10,11]. India has seen the transition from food grain to horticulture crops from 2012–2013 to 2017–2018 [5]. The production of horticulture crops has outperformed the production of food grain since 2012–2013 [5]. According to data gathered from the Horticulture Statistics Report, the total fruit production in the year 2018 was highest in the case of Andhra Pradesh (152.15 Lakh Tones), followed by Maharashtra (117.28 Lakh Tones) [5]. As can be observed, Uttarakhand is not currently a significant producing state in India, but it has vast opportunity regions due to its nice weather for horticulture development. Fruit production is one of the most important economic factors in Uttarakhand [10].

The hilly region fruits are burdened with major supply chain issues, post-harvest losses, and wastages due to various factors. Unlike in other states, such as Himachal Pradesh, Kashmir, or Arunachal Pradesh, where farmers/growers are rich, farmers and growers in Uttarakhand are not saving money and are not financially stable due to small landholdings per farmer. Further, these fruits have a relatively short shelf life and are easily perishable [12]. Commercial farming households in Kashmir (apples) and Himachal Pradesh (vegetables and fruits) earn three times more than subsistence hill farmers in annual earnings. Not only do they spend more but also save more after necessary annual expenses. Food, health, and education are the most important household expenditures in these cash-cropping villages, followed by social affairs. There is a wide disparity in the annual incomes of Himalayan farming families. Farmers with larger orchards earned INR 1.5 million to INR 2 million (USD 30,000 to USD 3000). The data indicated that economic opportunities have also widened the range of economic disparity among the villagers, viz., from USD 1000 to USD 32,000 per annum [12].

India imports approximately 75% of the total kiwi demand in the country [13]. As per the Ministry of Commerce, Government of India data, the import of kiwi fruit in India has grown from 49,483 Mt to 64,779 Mt in 2021–2022 [14]. Kiwi is one of the newly introduced horticulture crops in India, and Arunachal Pradesh is the largest Kiwi-producing state. In 2018, out of the total kiwi produced in India, approximately 56.5% was produced in Arunachal Pradesh [13]. The state's geographical features and climatic surroundings are conducive to large-scale production of moderate and semi-tropical fruit crops. Fruits like apple (*Malus Domestica*), pears (*Pyrus sp.*), peaches (*Prunus persica*), plums (*Prunus*), apricots (*Prunus armeniaca*), and walnuts (*Juglans*) are grown in hilly areas, whereas mango (*Mangifera indica*), litchi (*Litchi chinensis*), malta (*Citrus sinensis*), santra, lemon, guava (*Psidium guava*), and pomegranate (*Punica granatum*) are mostly grown in lower and valley areas [15]. Uttarakhand currently ranks first in the country in pear production (0.788 lakh Mt), followed by peach (0.579 lakh Mt), plum (0.362 lakh Mt), and apricot (0.282 lakh Mt). It ranks second in the country in walnut production (0.19 lakh Mt), followed by J and K (2.10 lakh Mt), and third in apple production (0.62 lakh Mt), followed by J and K (13.68 lakh Mt) and Himachal Pradesh (6.25 lakh Mt) [9].

Uttarakhand is divided into four agro-climatic zones, with six altitudinal farming approaches. There is potential to grow a wide variety of major crops such as kiwi and apples within the state. In Uttarakhand, six varieties of kiwi are grown: Abbot, Allison, Bruno, Hayward, Monty, and Tomuri. Fruit production is a significant contributor to the state of Uttarakhand's economy. However, the fruits of the hilly region are burdened with major supply chain issues, post-harvest losses, and surpluses due to a variety of factors. Color, texture, and morphological features are the most frequently used factors to

categorize diseases, maturity, and fruit class [16]. The kiwi fruit is a berry with many seeds embedded in fleshy and edible tissue. Kiwi fruit originated in China and has since spread throughout the world [17]. The identification of the glitches may overlay a pathway for the development and execution of an effective economic strategy.

The study discusses the issues in the value chain of fruits grown specifically in the western Himalayas and how a sustainable business model can help farmers increase their income. Fruits and vegetables have the highest overall perishable product wastage, according to the MOFPI (2018–2019) report. The main objective of this study is to increase the revenue of farmers by understanding the loopholes or issues in the value chain of Himalayan fruits, with specific cases of kiwi fruit in Uttarakhand. Furthermore, the study suggests a sustainable business model that generates economic benefits for farmers and the state. Understanding supply chain disruptions and developing a value chain to track horticultural farming development in Uttarakhand's hilly regions will help achieve the aforementioned goals. Thus, by resolving issues in the value chain of Himalayan fruit, the efficiency of all the stakeholders can be enhanced, ultimately enhancing the economy of the farmers. The present study has been conducted with the following key objectives: (i) to recognize the issues linked to the kiwi value chain in Uttarakhand, India; (ii) to identify the influence of issues on revenue and price realization for farmers; and (iii) to offer sustainable solutions with a focus on increasing revenue for farmers and providing an additional sustainable business model as part of horti-tourism. This study talks about a project undertaken and its results in real-time. For Uttarakhand farmers, the current returns are not viable and are not economically stable as the landholdings per farmer are negligible. Furthermore, these fruits have a very short life and are easily perishable. The author's objective is to showcase an increase in the revenue of farmers, which can be achieved by understanding the loopholes in the value chain of the Himalayan fruits and thus creating a sustainable business model, fruit vineyards, and horti-tourism setup with this specific case of kiwi fruit in Uttarakhand.

According to the literature-based gap analysis, current research has concentrated on the following topics:

- Studies have considered either supply chain in general or F&V. There is a lack of studies considering kiwi fruit in the Himalayan region.
- Frameworks or models have concentrated more on the performance of the supply chain but not kiwi specific to the region of the Uttarakhand Himalayas.
- Studies have been either carried out on supply chain performance, or on issues in supply chain or barriers to performance, or on the role of IT in enhancing performance; however, there are hardly any studies done that analyze the issues specific to perishable seed fruits or the Himalayan kiwi fruit supply chain.
- There have been studies related to post-value addition for various produce. However, there is very limited research on how to maximize the returns for kiwi fruit from post-harvest products with the help of a business model.
- There is limited research on the fruits supply chain specifically focusing on the kiwi value chain, overcoming issues and its pragmatic solutions in the hilly region to ease the life of farmers and help increase their revenue.
- There is a lack of a revenue-generating model in the Himalayan region specific to high-value fruit such as the kiwi.

2. Literature Review

This study discusses various literature on and related to the fruit and vegetable supply chain. Furthermore, it focuses on explaining the complications encountered in the supply chain of fruits in the hilly region as a real-time case of kiwi fruit value chain analysis in Bageshwar District, Uttarakhand. The proposed solution is in the form of a business model. Literature has been alienated into numerous themes as a result of supply chain disruptions. We attempted to capture an overview of the fresh fruit supply chain using a specific case [18,19]. The issues in the fruit value chain that have been extensively

covered in the literature [10,17] and are also specific to kiwi fruit have been focused on [18]. Departments such as State Horticulture, Central Horticulture, Watershed Department, etc. have tried to establish statistics and data on the production of different fruits and its scope of increase in the production in the state. Plummeting food waste has been projected to save about 90 Gigatons of CO₂, between 2020 and 2050 [20]. Solutions as part of the post-harvest management of kiwi fruit have been covered at different levels [21]. Horticulture as a sustainable business model is the best and optimum outcome in the fruit value chain [22]. The potential of vineyards to increase tourism and the income of farmers has been highlighted [18,23].

The problems in the fruit supply chain in the hilly area have been investigated, and efforts have been made to identify the factors that are causing this problem. Real-time fieldwork was conducted in the Bageshwar District for the kiwi supply chain, and real-time data collection was followed by solution provision. All of the data has been used as a case study. Furthermore, evocative research was used for this study. This study also gathered data from secondary sources—the State Directorate of Horticulture, Dehradun on the outline and growth of horticulture.

2.1. Issues and Challenges in Kiwi Supply Chain

In the early years, Kiwi cultivation necessitates a significant investment. It was observed that the downstream supply chain is insufficiently competent, and a farmer in the cluster faces various problems. Many research studies have been conducted on the supply chain of fruits and vegetables segments across the countries. The research on the fruit and vegetable supply chain has focused on both developed and emerging countries. For instance, Swinnen and Maertens [24] studied the consequence of globalization on the agri-fresh produce supply chain in emerging countries. Fearne and Hughes [25] and Vorst and Beulens [26] have directed a study on the fruits and vegetables supply chain in the framework of economically developed countries. Also, there is substantiation of fruits and vegetables supply chain studies in emerging countries. Joshi et al. [27] and Sagheer et al. [28] have performed their studies in the Indian framework, whereas Perera et al. [29] conducted the study in the context of Sri Lanka.

Recently, there is a considerable boost in globalization-linked problems in the fruits and vegetables supply chain. Therefore, study work to these extents by Matopoulos et al. [30], Dunne [31], Mikkola [32], and Van Donk et al. [33] are also established in the literature. There are numerous issues such as quality and technology application [34] addressed in the literature to comprehend problems and challenges in the fruits and vegetables supply chain.

A range of problems have been observed in the research that can be largely grouped into the following factors: poor infrastructure, poor transportation arrangements, absence of market information, inadequate knowledge of farmers, lack of technology, a huge number of intermediaries, etc. [8], a highlighted lack of adequate infrastructure for processing, cold-storage, and transportation in developing countries such as India, are the foremost tribulations in the success of agribusiness. Road connectivity and the systems are also one of the main challenges in this sector [35,36]. Meager and insufficient transportation amenities contribute more to this problem [35–39].

Real-time information flow is critical in the supply chain to ensure the smooth flow of functions. It is critical in the fresh produce supply chain, especially for seasonal Himalayan fruits that have a short shelf life and are perishable. Kader [35] talked about the absence of information as one of the socioeconomic factors causing post-harvest losses. Buyukbay, Uzunoğlu, and Bal [40] also recognized the absence of information as one of the key reasons for waste.

2.2. Production Issues

The worldwide kiwi production (Table 1) amounted to about 4.41 million metric tons in 2020, more than double the global production volume of 1.87 million metric tons in

2000 [41]. For the previous few years, Italy and New Zealand have been contending for the spot of the world's prime exporter of kiwi fruit, and presently New Zealand is a little ahead [21]. Similarly, top kiwi fruit-producing states in India during 2021–2022 have been given in Table 2.

Table 1. Top kiwi fruit-producing countries in 2020 (Source: Statista).

| Region | Countries | Production (in Thousand Metric Tonnes) |
|--------|-----------------|---|
| World | China, mainland | 2230.01 |
| | New Zealand | 624.94 |
| | Italy | 521.53 |
| | Greece | 307.44 |
| | Iran | 289.61 |

Table 2. Top kiwi fruit-producing states in 2021–2022 (Source: APEDA).

| Region | State | Production (in Thousand Metric Tonnes) | Production Share (%) |
|--------|-------------------|---|----------------------|
| India | Arunachal Pradesh | 7.4 | 44.71 |
| | Manipur | 3.01 | 18.11 |
| | Sikkim | 2.16 | 13.00 |
| | Nagaland | 1.80 | 10.83 |
| | Himachal Pradesh | 1.16 | 6.98 |
| | Mizoram | 1.03 | 6.20 |
| | Jammu and Kashmir | 0.03 | 0.18 |

India imports 75% of its local demand for fresh kiwis. Also, Arunachal Pradesh produces approximately 56.5% of the total 8.5 thousand tons of kiwi fruit produced in the country in 2018. As a result, there is a huge opportunity to expand kiwi plantations in hilly states in general, and Arunachal Pradesh in particular [42,43].

In Uttarakhand, kiwi fruit ripens between October and December, depending on the variety and the climate. Many times, kiwi is harvested at an early stage so that it can be transported over long distances in lower-quality packaging materials to save money. This practice restricts the produce from being of the highest quality and size, resulting in lower market prices. As mentioned in the KVCA report [42], a well-managed plant can give an average fruit yield that varies from 80–90 kg/plant.

Poor orchard maintenance results in a low kiwifruit yield. Training and pruning unwanted twigs in the off-season are important agronomical practices for a good harvest. Kiwi fruit vines typically grow 2–4 m per year and become congested and uncontrollable if not pruned. Similarly, thinning is important to reduce the number of fruits in a bunch so that the fruits grow to a consistent size [42].

Similarly, one of the studies talks about how the partial utilization of agro-wastes by mushrooms results in the generation of a significant quantity of spent mushroom substrates (SMS) that have continued to become an environmental problem. Shiitake mushrooms, in particular, can be grown on various types of agro-wastes while producing a significant amount of SMS.

2.3. Infrastructure Issues

An effective and efficient infrastructure helps farmers and owners of agribusinesses run their operations smoothly and makes it possible to deliver the product at the appropriate time under the right conditions. A significant proportion of India's northern and

eastern regions are covered in hilly terrain and are major sources of seasonal and seed fruits. The road infrastructure in such areas is extremely poor. It takes a long time to transport fresh and easily perishable fruit products to market, and the quality and condition of the produce deteriorate, which results in waste.

Uttarakhand state's villages, farms, and markets, which are mostly in the hilly region, are not well connected to the market. The farmers must gather their harvests on the nearby road in order to transport them, which increases the amount of produce that is wasted [44]. Kiwi fruits that are intended for sale within 3–4 months are warehoused under normal atmospheres [21]. Infrastructure is one of the main obstacles in the supply chain of farmed products in Uttarakhand, resulting in massive losses.

2.4. Transportation Issues

The logistics of moving a fresh harvest are very intricate. Other factors such as packaging, temperature, and humidity must be taken into account to ensure the produce stays fresh and intact. Transportation has a very vital role in the supply chain. Numerous studies have found that 33% of food is lost or wasted in transit. Fresh produce spends approximately half of its shelf life in transit [45]. This food loss is mainly due to spoilage of the product while it is being transported, as well as damage that the fruits and vegetables endure that prevents them from being able to be sold. Without proper transportation, farm produce cannot be delivered to the end consumer on time and in good condition. Fruits and vegetables, for example, have a short shelf life, are highly perishable, and must be stored at a controlled temperature. In India, infrastructure is the main barrier in the supply chain of agricultural products, resulting in a large number of losses [10]. In the food supply chain, sustainability emphasizes waste reduction or minimizing food losses. It is considered that the extreme amount of food lost in the food supply chain is due to quality issues [46].

Proper stacking and cushioning are critical to avoid sudden impacts. In some products, refrigeration is essential during transportation [47]. There are various transportation-related issues in the state because of a lack of good connectivity, poor road systems, the absence of temperature-controlled vehicles for transporting goods, and so on [48–52]. Transportation-related challenges in the state have been identified. Farmers typically carry fruit packs on their backs or heads to the nearest drop point. These are then transported by small local vehicles to nearby local markets, and then by trucks or shared vehicles to larger markets [53,54].

2.5. Marketing Issues

Accurate information is the foundation of a competent supply chain; otherwise, it leads to the grapevine. Without correct information about market demand, the supply chain cannot run effectively. In India, farmers lack information about the prices in the market, demand, food processing units, etc. Inadequate information leads to poor price realization, massive losses, late delivery of goods in the marketplace, and so on [10]. In Uttarakhand, farmers are not well informed about market prices, consumer demand, food processing facilities, etc. There is a lack of organized markets and post-harvest infrastructure. [42].

2.6. Post-Harvest Losses Issues

Poor post-harvest management is supposed to be a major problem in the supply chain of the fresh fruit and vegetable segment in our country. Various authors have talked about post-harvest issues in fresh vegetables such as tomatoes and cranberries [48,49]. There have been studies on the control of post-harvest diseases, as well as old issues and new approaches [55]. Also, researchers such as Rolle [56] have talked about post-harvest management and marketing in the Asia-Pacific Region. Several studies on post-harvest mismanagement in the fresh fruits and vegetables sector, food safety, and health issues have been conducted in India [57,58]. Similar problems were identified across the New Zealand horticulture sector. This greenhouse tomato grower's total food loss was 16.9% of marketed yield, consisting of 13.9% unharvested tomatoes, 2.8% rejected at the glasshouse, and 0.3%

rejected at the packhouse. The tomato loss suffered by the grower was primarily due to commercial factors such as market price, competitor activity, and supply and demand. Commercial factors, in particular, are difficult to address, and collaboration across the supply chain will be needed to assist growers in reducing food losses [59].

There are huge losses in the supply chain of perishable food in the process of reaching the main market or processing units, etc. It is estimated that more than 40% of the total food produced in India is wasted in transit. Massive losses occur during the transportation and storage of fresh food products. There are significant post-harvest losses in Uttarakhand due to a lack of cold chain facilities, poor logistics connectivity in hilly areas, and other factors [10].

3. Case Analysis

3.1. Project and Site Description

Uttarakhand, located in the Himalayan foothills, is notable for its diverse topographical features, which range from snow-capped mountain peaks to forests. It is divided into two regions: the western region (Garhwal Mandal) and the eastern region (Kumaon Mandal). It is divided into 13 districts, each with 95 blocks. The state has a total geographical area of 5.35 million ha, of which 4.6 million ha (86%) is hilly and 0.74 million ha (14%) is plain [9]. Only about 14% of the geographical region is cultivable [9]. The state's location and diverse climate provide unique compensations for the advancement of horticulture, agriculture processing industries, organic farming, off-season vegetable farming, and other cultivation that can be profitably explored.

Our case study focuses on Sama village, which is located at an elevation of 2500 m above sea level in Kapkot Tehsil of Bageshwar district in Uttarakhand, India (m asl). The main occupation of these localities is agriculture. The average plot size of Kiwi growers in Liti and Sama villages is around 2.25 hectares, and the plot sizes range from 0.5 to 4 hectares. Total produce is grown on 10 hectares of land in Sama village. Produced in the Bageshwar district of Uttarakhand, kiwi can be categorized into three grades (grades as A, B, C, and D) based on weight, quality, color, and texture (Table 3). Grade 'A' and Grade 'B' kiwi produced is majorly sold in the market, and Grade 'C' and Grade 'D' Kiwi are majorly processed for producing candy, squash, jam, and sauce.

Table 3. Grading of kiwi fruits based on quality, color, and texture.

| Code | Weight per Fruit | % of Crop | Price per Kg | Quality | Colour | Texture |
|---------|------------------|-----------|--------------|---------|--------|---------|
| Grade A | >100 gm | 25% | Rs. 150–120 | ★★★★ | ★★★★ | ★★★★ |
| Grade B | 60–80 gm | 35% | Rs. 80–70 | ★★★ | ★★★ | ★★ |
| Grade C | 50–60 gm | 40% | Rs. 40 | ★★ | ★★ | ★ |
| Grade D | < 50 gm | | Rs. 30 | ★ | ★ | ★ |

The maximum ★ stars indicate parameters for best quality, maximum color, and great texture. The format of fruit product grading is an important process for farmers and growers because it affects fruit quality assessment in the domestic and international export markets. Grading and sorting are time-consuming, labor-intensive, error-prone, and tedious processes. As a result, an efficient fruit grading system is required.

Temperature is a major constraint for kiwi plantations. The kiwi plant cannot survive temperatures below -15°C , but kiwi berry plants can survive temperatures as low as -30°C . Soils must be well-drained. Soil nutrient conditions are not assessed by the farmers. The farmers practice non-organic cultivation. This may lead to nutrient deficiency in the plants, which may lead to health issues, etc. Moreover, the amount of manure provided to plants varied across farmers, which shows that some farmers do not have enough knowledge regarding cultivation practices. As mentioned earlier, nearly 70% of the

kiwi fruit yield is of B, C, and D grades (with C and D grades covering about 40% of the production). This leads to lower price comprehension for kiwi growers. Farmers themselves buy and prepare farmyard manure (FYM) without any support from the department. The FYM is either bought from local markets or prepared by the farmers by using cow dung, poultry, and piggery wastes, etc. This often leads to a shortage of manure.

3.2. Steps Involved in Setting up the Project

Step 1: There are 2322 farmer interest groups (FIGs) in the study area of Bageshwar District, with 140 cultivating kiwi. Sama village has approximately 213 houses. These farmers are the primary beneficiaries of the project. Farmers in the Bageshwar district are currently growing kiwi on their own or leased land. We focused our project research on these 140 farmers' supply chain activities.

Step 2: It is important to note that the project used the medium of these farmers to strengthen the household economy. Furthermore, the focus was on repairing supply chain disruptions by identifying loops in the process, from farmland to the product reaching the end customer, with the goal of increasing farmer revenue, offering real-time solutions, and implementing them within 180 days.

Step 3: Focus on minimizing the waste generated by low-quality fruits in the supply chain. Follow the strategy of intensification and diversification of revenue by using processed fruit products and growth centers. Also, add products with a longer shelf life for value creation to C and D grade products for maximum profits.

Step 4: To focus on a sustainable business model for horti-tourism as a part of the post-harvest strategy. Horticulture tourism aims to support the farmers and create an optimum value chain for the fruits grown in the hilly regions.

Step 5: Identification of technology intervention for higher crop productivity, decreased use of water as the hilly region has a scarcity of water, efficient working of farmers, and ease of market connections.

The following section highlights the major inefficiencies observed in the different stages from production to marketing systems and the issues identified during the span of the project. Figure 1 depicts the value chain in the village cluster based on real-time fieldwork.

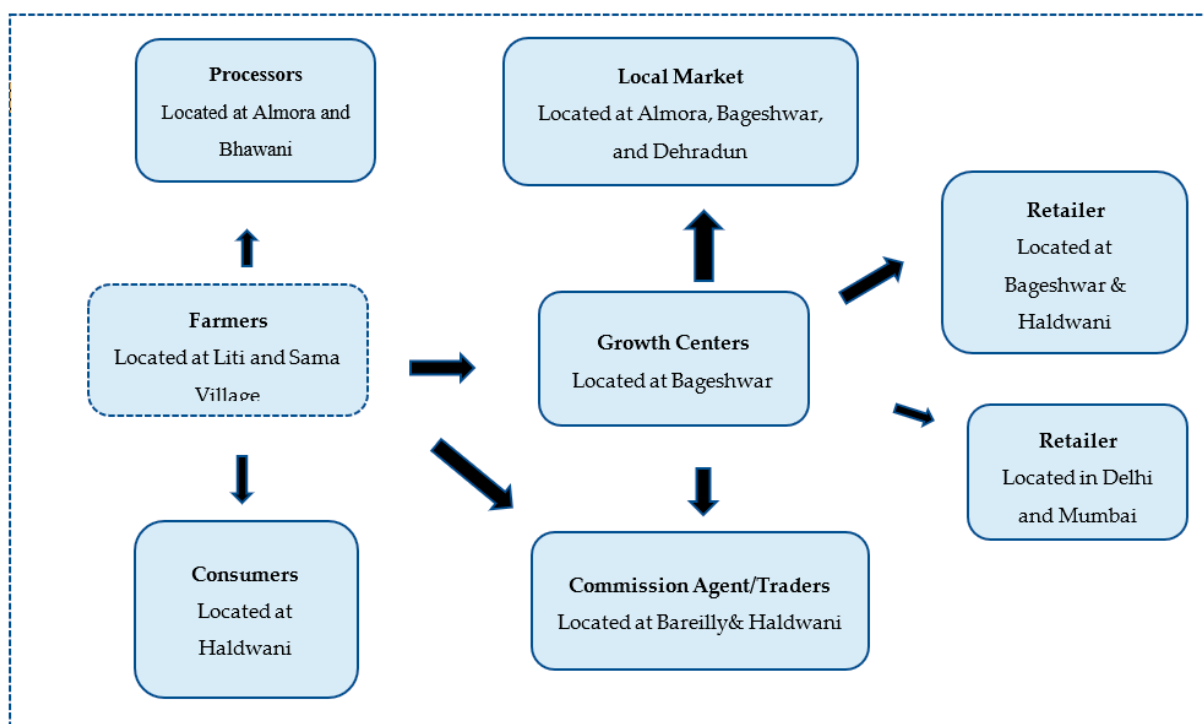


Figure 1. Schematic diagram showing the traditional kiwi value chain in Bageshwar District.

3.3. Case Scenario

3.3.1. Supply and Demand of Kiwi

The farmers are unable to fetch the best prices for their produce. The prices of kiwi fruit are highest during August and September when their demand is at its maximum. However, the fruit is harvested in the state from October to December. Reduced demand for the fruit at harvest time results in comparatively lower prices for the fruit obtained by the farmer. In general, one of the primary issues in the initial stages was a lack of saplings for distribution to farmers. This is due to the state's limited nursery capacity for growing kiwi saplings. Furthermore, the department's cap of INR 80 for acquiring saplings from private nurseries is much lower than the actual market price of saplings, which is INR 220 per plant. The high cost of kiwi saplings makes them unaffordable for farmers, limiting their ability to cultivate the kiwi. Farmers prefer Monty, Alison, and Bruno because they produce more. However, the market preference is for Heyward as it fetches a better price. As Heyward gives fruit every alternate year, the farmers have a loss and low returns. This leads to the low-level production of high-grade crops. Compiled production issues in kiwi value chain in Bageshwar District and their strategies and solutions implemented has been discussed in Table 4.

Table 4. Compiled production issues in kiwi value chain in Bageshwar District and their strategies and solutions implemented.

| Issues | Highlights | Ref. |
|--------------------------------------|--|------------|
| Production | <ul style="list-style-type: none"> ✓ Limited planting material ✓ Early or premature harvesting ✓ Producing fruit variety that has lower market rates and low acceptance. | [18,59,60] |
| Strategies and Solutions Implemented | | |
| ✓ | Setting up of nursery-cum-demonstration plot for kiwi. With the support of farmers, we were able to set up an in-house nursery in Sama village that provides plants and seeds for farmland to a larger number of farmers. Where a single plant produces 30–40 kgs of kiwi on average. | |
| ✓ | On marketable plantations, a T-bar or pergola was used to back the solid canopy of vegetation and fruit. As kiwi plants are dioicous, for eight female plants, one male vine is established. Drip irrigation systems are used for irrigating the field with the irrigation source streaming to enrich the kiwi with Himalayan mineral water, and underground water that is diverted and stored in geo tanks and concrete tanks. Only seven plants of kiwi can be grown in one Nali (0.05 acres). For better-drained soil and health, it also increased production. Most of the installations come under subsidy. | |
| ✓ | Focused on the development of model farms at the farmer's level for front-line demonstration. | |
| ✓ | Development of knowledge material and technical training: Besides setting up the farms, additional support was extended under the initiative for the growers which include technical training from Solan Horticulture University, Himachal. Also, field day handouts on best practice advice, orchard monitoring, trial reports were conducted, etc. | |
| ✓ | International Collaborations: tie-ups were initiated with international technical consultants/exporters to gain the necessary skills and expertise for export quality cultivation of kiwi to tap the international market, focusing on the Iran and New Zealand market. | |

3.3.2. Cold Storage

The Indian kiwi fruit is only available for two months, from November to December. However, the demand for kiwi is throughout the entire year. Kiwi fruits can be stored for up to six months if picked at the proper maturity and stored in optimal storage conditions such as temperature, gas composition, and relative humidity. The need for cold chain infrastructure to increase shelf life and reduce waste is critical to expanding the trade window for local produce. Better cold chain infrastructure for imports results in higher fruit quality standards in the country, as well as less dormant fruit.

Major produce, because of a lack of appropriate cold storage, was mostly spoiled. Currently, the harvested produce is sold locally and to regional markets in neighboring towns. Appropriate storage facilities with cold chain infrastructure will also open the distant market, resulting in less wastage and higher price realization for farmers. Farmers may need to store their produce at the cold storage facility in Bareilly until it is completely sold at the Bareilly APMC. However, the cold storage center at Bareilly is not suitable for

storing kiwis. The reason is that the kiwi needs to be stored at a low temperature with the presence of moisture. However, the cold storage center at Bareli stores the product in a dry environment.

Also, farmers needed to store near Sama Village; then they would store in Bageshwar Market's local ice cream parlors, and that would spoil the entire produce. Farmers do not have specialization in handling products that need to be maintained at a certain temperature after harvest to increase the shelf life of the fruit. The kiwi fruit can be kept without a refrigerator for two months. It can be stored at -0.6°C to 0°C for four to six months. Compiled cold storage issues in kiwi in Bageshwar District and strategies and solutions implemented has been discussed in Table 5.

Table 5. Compiled cold storage issues in kiwi in Bageshwar District and strategies and solutions implemented.

| Issues | Highlights | Ref. |
|--------------------------------------|---|---------|
| Cold Chain Facilities | ✓ Insufficient cold chain capacities and warehouses to aid the needs for stoned and seasonal fruits in the cold chain network in the hilly areas. | [10,38] |
| | ✓ Set-up in terms of cold storage, and cooling shed. | |
| Strategies and Solutions Implemented | | |
| ✓ | Capacity is proposed to be installed. Cold Store/Cold Room: Assuming per day handling capacity of 10 tonnes, a small cold store of 20 tonnes. | |
| ✓ | Capacity is also suggested to be installed at the center to facilitate short-term/long/temporary storage of the produce, particularly during the peak production period. It is noticed that the farmers in the district are also into other crop cultivation. The facility created may thus be put to multiple crop use during the kiwi off-season. | |
| ✓ | Refrigerated Vans: tie up with logistics partner in Rudrapur Industrial area; to smoothen the flow of graded and packaged produce; Sama village center was equipped with at least one reefer van to be used for procurement as well as distribution of produce to consumption markets in Delhi, Mumbai and other states. | |

3.3.3. Packaging

Prior to the intervention, the region's kiwi growers did not adhere to the recommended set of practices. The packaging was not up to market standards. The quality was poor, and 2ply corrugated boxes were used, which were easily damaged. One box can hold up to 3.5 kg of Kiwi. The cost per box was INR 40, which was prohibitively expensive for the farmers. Accumulated packaging issues in the value chain of kiwi in Bageshwar District and strategies and solutions implemented has been discussed in Table 6.

Table 6. Accumulated packaging issues in the value chain of kiwi in Bageshwar District and strategies and solutions implemented. [Ref to supplementary sheet for Figures S1 and S2].

| Issues | Highlights | Ref. |
|--------------------------------------|--|------------|
| ✓ Packaging Material | ✓ High cost of packaging material. ✓ 2ply corrugated boxes used that are damage-prone material and have lower quality standards. | [10,18,38] |
| Strategies and Solutions Implemented | | |
| ✓ | To minimize the damage and sell the products at good rates in Pan India, it was important to uplift the looks and quality standard of the product. The current market needed premium packaged goods that help to get better rates for farmers. | |
| ✓ | State Government department tied up with the packing material vendors. | |
| ✓ | Packaging for farm fruits was upgraded to 3ply-4ply corrugated boxes with trays that could carry 30 pieces in one box. The boxes had brand stickers on them as brand identification. | |
| ✓ | These boxes helped in reducing the in-transit damage to 90% as compared to the previous year. | |
| ✓ | Next Suggested Plan: The packaging unit is to be set up by federations which will offer employment prospects to the local people. | |

3.3.4. Transportation Issue

The district is situated in a remote location, and the road conditions are not good. Sama village is almost 2 h from the main Bageshwar market. Transportation infrastructure in the villages is a major concern [61,62]. Because of the region's heavy rainfall and snowfall, the roads are prone to landslides. This discourages farmers from selling kiwi in distant markets. Moreover, sales in distant markets require higher transportation costs and proper packaging for longer shelf life. Due to this, the farmers do not want to take the burden of selling it to distant markets even though there is a demand. Furthermore, traders from outside are deterred from visiting the cluster to buy kiwis due to its isolation and challenging road conditions.

For transportation to metro cities, a vehicle has to be booked, which requires a full truckload. So, if the stock has to be sent in a limited quantity, it is expensive. The cost from Sama village to Haldwani mandi in a shared vehicle was noted at INR 700 for 1 quintal, which is approximately INR 9 per kg. The cost from Sama village to Bareilly, in a pickup vehicle without box packaging, if the fruits are loaded in crate, was noted to be INR 10 per Kg. From Sama village to Haldwani it would cost a farmer approx. between INR 9 to INR 11 as per 217 Kms. Due to the high cost of transportation of produce to the market, the farmers are unable to sell their produce in markets located far from their farms. Compiled transportation problems in the value chain of kiwi in Bageshwar District and strategies and solutions implemented has been discussed in Table 7.

Table 7. Compiled transportation problems in the value chain of kiwi in Bageshwar District and strategies and solutions implemented.

| Issues | Highlights | Ref. |
|--------------------------------------|---|---------------|
| Transportation facilities | <ul style="list-style-type: none"> ✓ Lack of full truckload due to small quantities produced by farmers. ✓ Lack of suitable transportation mode. ✓ Incompetent and expensive transportation for the movement of seasonal perishable fruits. ✓ Absence of refrigerated vehicles for the transportation of delicate perishable seed fruits, in mountainous and rural areas. | [38,44,63–68] |
| Strategies and Solutions on the case | | |
| ✓ | Keeping these inefficiencies in mind, the agriculture value chain was established in Bageshwar to address transportation issues and find buyers willing to pay a higher price for farmers' produce. | |
| ✓ | The State government's refrigerated transportation system was initiated to be set up for F&V transport. Refrigerated vans with less capacity were introduced in rural areas by a public–private partnership. Connect with a logistics partner in the Rudrapur Industrial Area; Sama village center should have at least one reefer van for procurement and distribution of produce to consumption markets in Delhi, Mumbai, and other states. | |
| ✓ | A hub and spoke model was implemented. Small farmers would collect their produce and load it into Mandi vehicles. Therefore, transportation costs are lower for farmers. As the Mandi vehicle has a regular visit to Bageshwar market, the load cost is shared. | |
| ✓ | The cost shifted from INR 9 to INR 5 per kg till Haldwani Mandi. | |

When compared to other states like Arunachal Pradesh and Himachal, the quantity produced is very small. Bulk fresh produce helps farmers to distribute transportation costs. When the produce is in bulk, retail brands frequently offer their logistics. When the produce is low, the farmers must arrange for transportation, and the cost per box is high.

3.3.5. Market Issues

There is a lack of permanent traders due to the remote location of the region. Farmers feel hesitant to sell in distant markets as they do not produce significant quantities. Lack of bargaining power and high variability of prices force them to sell it to the nearby market. Furthermore, there is no APMC-regulated Mandi for the crop in the nearby markets of Bageshwar, Almora, and Kausani. There are also no collection centers, pack houses, or other

related infrastructure in the cluster. Before the intervention, the A and B grade produce was sold in the Bageshwar district market which only fetches a moderate price for the product.

Farmers usually sell their produce to local small cart vendors on relationship terms in nearby towns like Haldwani and Almora. Farmers are currently marketing their own produce, and as a result, farmers frequently have limited bargaining power. Recently, a Farmer Producer Organization (FPO) was formed, with the goal of marketing kiwi for the members collectively in order to gain more bargaining power. More active marketing support is required in the cluster to tap the high-end distant markets. The produce, due to a lack of proper cold storage, was mostly spoiled. When the yield is higher and the gap between selling times is high, the C and D grade kiwi produce is sent to the processing unit. Products like jams, chutney, and squash are prepared. These products are sold in the local Bageshwar market. A total of 40 quintals of produce was processed and sold last year in the local market. Compiled market issues in the value chain of kiwi in Bageshwar District and strategies and solutions implemented has been discussed in Table 8.

Table 8. Compiled market issues in the value chain of kiwi in Bageshwar District and strategies and solutions implemented.

| Issues | Highlights | Ref. |
|---------------------------------|--|------------|
| Demand and Market information | <ul style="list-style-type: none"> ✓ Limited market demand knowledge. ✓ Limited knowledge about the intermediaries and target market ✓ Absence of market information to the farmers such as prices, smooth flow of the product, food processing unit, etc. | [10,18,44] |
| Strategies and Solutions | | |
| ✓ | Intervention: was to find the correct target market and buyers for the farmers. Intensive primary research was conducted to understand the best buyers and maximum benefit for the farmers. Based on primary research: With multiple buyers in different cities, it is known that supplying produce at this stage, where the production is in few tonnes, to Big Retail Brands is not cost-effective. It is interesting to see that Irani kiwi has a stronghold in the market and dominates the price due to its high quality and bulk availability. | |
| ✓ | Local Mandi such as Haldwani, Dehradun, and Bareilly is a more lucrative market for small farmers. As the quantity grown can be easily procured and the transportation cost is less. These Mandi buyers benefit from buying kiwi from Bageshwar than procuring from Delhi Market. The Mandi buyers were willing to sell Bageshwar kiwi produce at good rates when the packaging was upgraded. Usually, one such box is sold to end consumers for approx. INR 550 to INR 1000 depending on the quality, as per current market rate and demand. But this year due to COVID-19 situation, the market was hit by low demand and in return low prices for the farmers. Irrespective of such conditions our agro-marketing team helped to get INR 92 per kg for our farmers. | |
| ✓ | The boutique shops/sellers based in metro cities like Delhi are interested in buying Himalayan fruits in quantities like 100 to 150 kgs. Which is a good quantity for the farmers, as the quantities are small. Our farmer's produce was sold at INR 180 per kg to boutique buyers in Delhi. Whereas in the year 2020, due to COVID-19 the market was unstable and the market demand was low, and the Delhi market was not willing to pay more than INR 80 to INR 100 per kg. | |

The farmers are unable to fetch the best prices for their produce. The prices of kiwi are highest during August and September (when its demand is maximum); however, the fruit is harvested in the state from October to December. The reduced demand for the fruit at the time of harvesting results in comparatively lower prices for the fruit being fetched by the farmer.

4. Various Identified Markets and Challenges

4.1. Big Fruits and Vegetable Retail Brands

Big-buyer retail brands such as Big Bazaar, Reliance Fresh, and Big Basket ask for only A-grade quality fruit. They also have strict quality-standard requirements for procuring the produce from farmers. For example, produce should have a certain level of sweetness. The farmers should produce more than 100 quintals regularly for these brands to sign a contract with the farmers. Our farmers have to face very tough competition from imported kiwi (Iran and New Zealand), which is better quality and has a cheaper price as it is produced in bulk. These brands were contacted for tie-ups for the farmers' produce. These brands

have strict quality standards for the procurement of produce. The fruit sweetness should be 5–6 and the pressure before plucking should be between 14 and 15. They prefer a two- to three-year contract for the supply of produce. However, the price they offer to farmers is INR 70–80. Also, the transportation cost is only shared when the produce is in metric tonnes rather than in bulk quantity.

4.2. Individual Buyers in Metro City

These buyers offer better rates than big brands. The actual rates are only decided after the stock is received by them. Uncertainty about rates is there. The competition is high as they have a lot of varieties of kiwi imported from Iran, Australia, and New Zealand. The market is dominated by Iran kiwi as it is procured in bulk and at very cheap rates. The present purchase rate is INR 80. The cost of transportation to major cities is higher than in the local market.

4.3. Mandi Buyers in Small City

Mandi buyers in small cities like Haldwani, Dehradun, and Bareilly offer better rates to farmers, as the competition for imported fruits is less as compared to big cities. The transportation costs are lower for farmers if the produce is sold in Haldwani Mandi as the Mandi vehicle has regular visits to Bageshwar District. If the product is packed as per the market standards, the buyers are willing to pay a decent price as per the current market rates.

4.4. Boutique Shops/Sellers

These buyers can be found in upscale markets in major cities. Khan Market, Vasant Vihar, and GK in Delhi and Gurgaon. They pay farmers higher prices for their produce than the rest of the market. They specialise in organic and chemical-free products, as well as Himalayan produce. They are willing to pay INR 180–200 per kg for kiwis that meet their standards.

4.5. Post-Harvest Problems in the Value Chain of Kiwi

Kiwi is a premium fruit; value-added products such as jams, chutneys, and squash are sold on average at INR 150–200 per 500 gms. This in turn does not generate as much revenue and does not justify a premium for fruit output. Processing units are absent for kiwi in the cluster except for one small-scale wine unit. The low-grade fruits that could have been sold at fairer prices to these units are now either kept for feeding pigs, the preparation of homemade wine for self-consumption, or sold at very low prices in the market. Accumulated post-harvest problems in the value chain of kiwi in Bageshwar District and strategies and solutions implemented have been discussed in Table 9.

Table 9. Accumulated post-harvest problems in the value chain of kiwi in Bageshwar District and strategies and solutions implemented.

| Issues | Highlights | Ref. |
|-------------------------------|---|------------|
| Processing and Value Addition | ✓ Limited value addition because of lack of processing units and lower no-bulk produce. | [10,18,38] |
| | ✓ Poor infrastructure facilities connecting to processing units. | |
| | ✓ Shorter shelf life of the processed product | |
| Strategies and Solutions | | |
| ✓ | To get better returns from our farm produce products, the quality should be great. The structure of self-help groups (SHGs) was effectively leveraged to deliver training for the growth center workers to upgrade the quality of products, where the top processed food trainers shared standardized recipes for the product. Females from the village were given hands-on training on various products and employed on wages. | |
| ✓ | Further, the product line was expanded in the food category. Products that have a long shelf life and that have better returns in the market were added. Products like dehydrated or dried kiwi and kiwi candies come under the dry fruit category and fetch a better price in the market. | |
| ✓ | Organic farm produce stores as an initiative under the SHG were opened in major tourist areas that stock these farms processed goods like jams, chutneys, juices, squash, etc. | |
| ✓ | Semi-processing unit with a larger capacity was proposed to be established by Govt department close to the farms. | |

5. Results and Discussion

The projected model offers noteworthy advantages and has numerous benefits, such as improved economy, efficiency, quality, and resilience. Specifically, in terms of efficacy, it reduces the overall handling of traceability processes and overall operating costs. It also serves as a cost-effective and economical mechanism in the perishable fruit value chain. The self-execution of all the intervention steps leads to real-time synchronization of the parallel information.

Uttarakhand emerged as one of the economically emerging states of India, with vibrant agriculture, industry, and service sector [50]. The state's economic growth has been credited to the booming service sector, wherein tourism has emerged as a major contributor. Tourism has thus become a key sector of economic growth and development, both from the viewpoint of income generation and as a source of revenue for the state [51,68]. The mountain region of Uttarakhand, with its fragile ecosystem and inadequate socioeconomic environment, represents the specific context in which diversification is required. Mountain regions have been the focus of neo-tourism activities around the world due to their abundant and diverse resources. These regions offer natural, cultural, and social diversity, tapping tourists' values and needs for experiential tourism [52]. With a focus on meaningful and local experiences, the majority of the activities related to alternative tourism may take place in these regions. Agri-tourism, or horti-tourism, has vast potential in the state, as we are rich in orchards and gardens, with a variety of fruits [68]. There is a new initiative from the Uttarakhand government established to boost "agri-tourism", with the inspiration of European vineyard tourism and Japanese strawberry tourism, in the state. The development project will be focusing on the mountain districts of Uttarakhand, which produce fruits like apples, pears, peaches, plums, apricots, and walnuts [57].

The final intervention was to develop a sustainable horti-tourism business model as a high-return post-harvest strategy (Figure 2). A premium fruit like the kiwi can bring in a lot of money if post-harvest products are developed that provide growers with higher returns. With a growing number of farmers planting kiwi and willing to lease land for plantation purposes, there is a high scope for setting up a vineyard in the Kapkot-Bageshwar district. Kiwi wine is a premium-processed product. A single bottle is sold at a minimum cost of approx. INR 1000–INR 1500. The expected revenue returns are higher as compared to other processed products. The cost of establishing a basic vineyard begins at USD 50,000. Wine can be sold as a premium product, which will help farmers earn more revenue on a single product in a shorter period. The inferior grades (C and D) are usually used for processing. Subsequently, it is a small-capacity unit, so there should not be any major concern regarding obtaining kiwi as a raw material.

Wineries would guard fruit growers from the whims of unwanted calamities. If the weather conditions were unfavorable in the future and the fruit quality diminished, then large fruit sales may suffer, leading to less money for fruit. However, winery profits would never decline. The quality or texture of wine can be adjusted even if the fruit quality is poor. Even in the case of a hailstorm, the fruit can be processed into a transitional product that can be transformed into wine later.

There are similar models adopted in Indian states like Nasik and Arunachal Pradesh (AP). In AP, currently, there is only one processor in the cluster that has set up a kiwi wine unit at Hong Village near Ziro. It was established in 2019, with an overwhelming capacity of about 170 Mt of kiwi in a year, and is now opting for a larger capacity after the growth in the region [18]. Similarly, the wine and grape industry is an important part of the agronomic landscape in Ontario, Canada. It is a critical player in creating good jobs for the country's middle class. Vineyards have become an essential part of the Canadian economy [53].

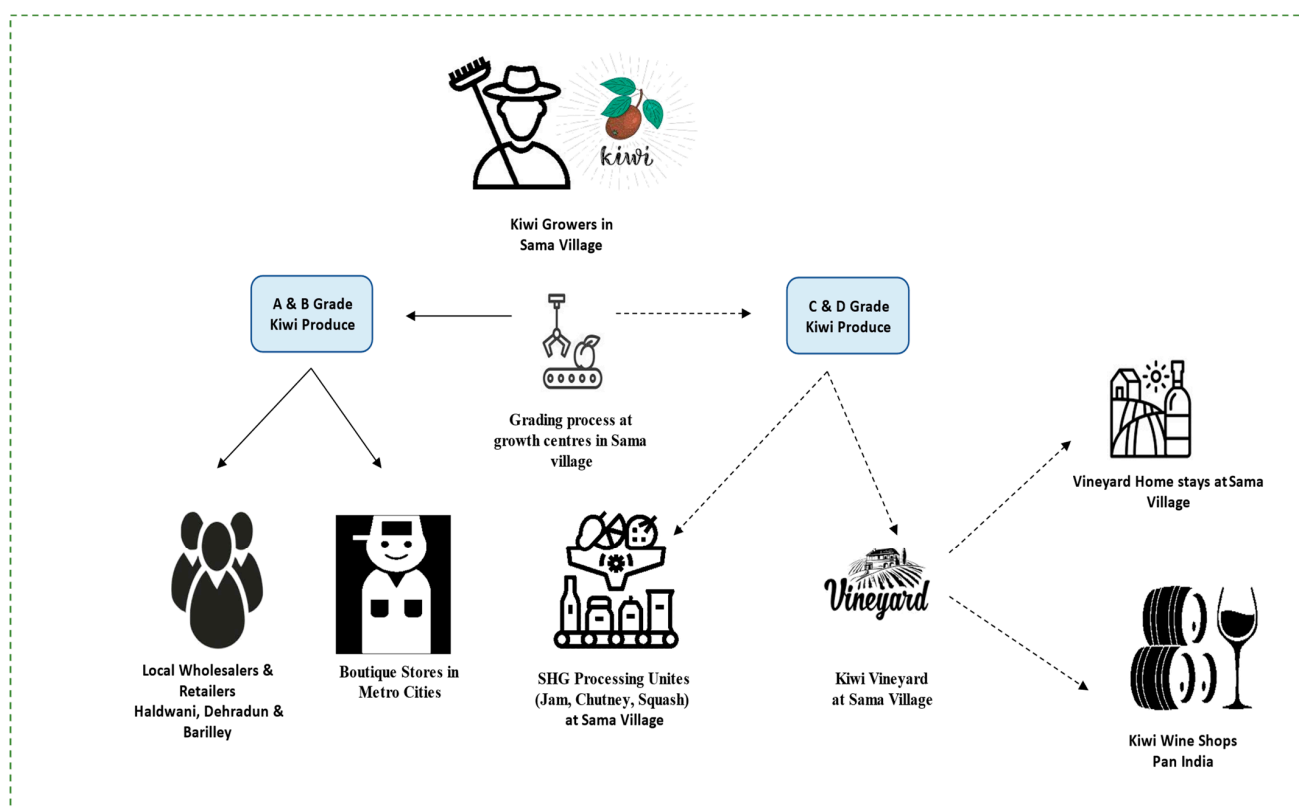


Figure 2. Model post-intervention.

It was experienced from the study that the absence of relevant post-harvest services for primary processing and the urgent need for optimally distributed cold chain infrastructure, including forwarding linkages through refrigerated transportation, hamper the quality of saleable excess produced in the state. The existing market infrastructure in the region is also minimal and basic. There are limitations on parts of critical infrastructure, such as storing, sorting, grading, and packaging facilities (Table 10). The limited interlinkages and price discovery mechanisms within the markets have further aggravated the loss of value to the farmers. Therefore, it is of utmost importance to augment post-harvest-related practices through sustainable development options. It is seen that such intrusions help in smoothening the supply chain, increasing the economic growth of the state, and improving value recognition at the farm level. Hundreds of farmers benefited from this case. More and more villagers are becoming interested in high-value fruit plantations and reducing post-harvest waste through a sustainable horti-tourism business model.

Table 10. Below is an interpretation of the before and after intervention in the case.

| | Before Intervention | After Intervention |
|-----------------------|--|--|
| Transportation | The transportation cost was INR 9–11 from Sama village to Halwani. | The farm produce was transported at INR 5 from Sama to Haldwani. |
| Packaging | The cost of packaging was INR 40 per box. [Ref to supplementary sheet for Figure S1] | The cost of packaging was INR 30 per box. With upgraded 3ply-4ply corrugated boxes. [Ref to supplementary sheet for Figure S2] |
| Sales | The produce was sold at INR 100–120 per kg in normal market conditions. | The produce was sold at INR 180–200 per kg in COVID-19 scenario market being unfavorable and in low demand. |

6. Limitations and Ways Forward

This study adds to the limited body of production and revenue loss data for Bageshwar District kiwi growers. The inclusion of a sustainable business model for improved price realization for farmers is a key strength of this study. Interviews with kiwi growers, middlemen like Mandis and transporters, as well as important players in the Uttarakhand horticulture industry, have been helpful in gathering information about the state's ongoing struggles to increase the income of its farmers through the sale of Himalayan fresh fruit [69–71]. Collectively, this information helps highlight the potential to prevent or valorize fresh fruit loss and operational disruptions in the supply chain.

There are some limitations to this study as well. The kiwi data was obtained from a small village in Uttarakhand's Bageshwar District on a single occasion and therefore does not represent production over a growing season or across the state. The mismanagement of kiwi produce is reported to increase near the end of the harvesting season. As the kiwi fruit audit for this research was conducted at the beginning of the harvest season, the results presented in this research may be underestimated. However, research with a larger number of Uttarakhand kiwi growers, throughout a growing season, would generate more accurate revenue data needed to support innovation to redirect or repurpose sustainable solutions in the supply chain. Also, the focus has only been on the kiwi fruit value chain in a small district in Uttarakhand and its challenges. The authors may consider other sectors like food processing units, cold-chain, and other perishable items such as meat, the dairy industry, chocolate, beverages, etc.

State Policy limitation: The solution suggested for post-harvest activities such as wine-making may require a strong and strict state policy to implement. As per the Uttarakhand State Mission report 2021, a Fruit Wine Policy incorporating various fiscal incentives has been promulgated to promote fruit-based wineries. However, the policy's passing and implementation will take time.

Ground constraints: Small groups of farmers are frequently hesitant to experiment with new solutions and implement anything innovative in the market. They are insecure and require encouragement from a group of successful entrepreneurs or government organizations. There are further limitations on parts of important infrastructure needs such as storing, sorting, grading, and packaging facilities. The markets have limited interconnections and price discovery mechanisms. Various agri-tech interventions can be implemented at different levels in the supply chain with the help of agri-tech start-ups. The issues identified may additionally be trial-and-error tested and validated on other fruits and vegetable supply chains in diverse states and geographical regions.

The contributing factors discussed by the grower, employees, and key stakeholders suggest that commercial factors are predominantly influencing low revenue levels across the Uttarakhand horticulture sector. Working independently, growers may have a limited ability to influence these drivers. As a result, a collaborative horticulture approach involving intermediaries throughout the Uttarakhand fresh fruit supply chain, politicians, food technologists, and research teams is required. Similar recommendations were made in recent publications [72–74], with examples including supply chain communication to minimize overproduction by growers and signal limited supply or cosmetic impairment to consumers, government policy that directs food loss disposal up the food waste hierarchy and infrastructure to shorten supply chains, improve access to secondary markets, and support the valorization of reject produce.

Growers, in particular, warned that efforts to reduce on-farm food losses must be economically viable in order to make it successful [75]. While some growers have focused on improving agricultural practices and technology to decrease on-farm food losses [35,75], others preferred efforts to focus on the creation of secondary markets and expand the food processing sector's ability to create products from imperfect produce [76–78]. The trend of sustainable business and upcycling of produce may provide growers and food processors an opportunity to innovate with surplus or unmarketable produce. Consumer response to the upcycled food trend has been positive, with 53% of Italian millennials willing to

buy upcycled food items, and 69% believing that the addition of upcycled ingredients has positive environmental benefits [79,80]. Similarly, experiential research in the supply chain of various related sectors, such as food processing units, the beverages industry, cold chain industry, and Himalayan F and V products such as peach, plum, apricot, mango, apple, litchi, tomato, berries, and so on, could be conducted [81,82].

7. Conclusions

This study suggests that there are high revenue-generating opportunities for farmers in the fresh-to-market and processed products in the kiwi supply chain. The supply chain conditions can be better controlled to reduce the impact of disruptions and operational drivers leading to food loss and lower revenue generation. Sustainable business drivers were identified as the most significant contributing factors for farmers' revenue generation for the wider Indian horticulture sector. Collaboration across the food supply chain and support from other agencies will be required to help growers utilize or valorize unmarketable produce and dispose of food loss in environmentally sustainable ways. A sustainable framework for the kiwi fruit value chain is represented. More precisely, a view of the traditional value chain is given. A real-world case scenario is described for defining the context and managerial requirements of local kiwi fruit growers in Uttarakhand's Bageshwar district. To provide an end-to-end traceability flow, operational details are provided by using examples from similar scenarios, as well as pre-and post-intervention details.

The fieldwork and study on the supply chain of kiwi fruit in Uttarakhand indicate a lack of supply chain management as well as a lack of cold chain infrastructure and food processing units, which are causing severe disruptions and resulting in fruit losses and waste in Uttarakhand and India as a whole. The entire fruit supply chain in Uttarakhand is burdened with problems such as post-harvest losses and wastages caused by a long and fragmented system, reliance on intermediaries, poor roads, an incompetent Mandi system, insufficient cold chain infrastructure facilities, high packaging costs, poor distribution quality, a weak link in the supply chain, and so on. This leads to poor price realization for growers on the one hand and a high price paid by consumers on the other. The Uttarakhand fruits segment is a rising sector. It grants a massive opportunity for agribusiness and the development of rural areas through setting up food processing units and a sustainable horti-tourism model in regions that are rich in orchards and fruit belts. The growth and development of the state of Uttarakhand, however, are being hampered by several supply chain-related challenges, as was previously mentioned.

The multi-stakeholder interaction in the model can involve the small farmers in the kiwi fruit supply chain. As a result, sustainable innovation can be framed in the form of interventions at various levels, such as production, supply chain, farming cluster, and market level, as well as reducing risks at both ends.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/horticulturae8111018/s1>, (Figures S1 and S2).

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