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Challenges and Prospects of Apple Cultivation in Himachal Pradesh

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Abstract

The present endeavour aims to ascertain the current status and recent challenges of apple cultivation in Kinnaur district, Himachal Pradesh and to explore the prospects by framing suitable strategies through quantitative SWOT (Strengths, Weaknesses, Opportunities, Threats) and QSPM (Quantitative Strategic Planning Matrix) analysis. A total of 32 factors encompassing 20 internal [10 Strengths (S) and 10 Weakness (W)] and 12 external [6 Opportunities (O) and 6 Threats (T)] factors have been identified through empiric investigation and interaction with the stakeholders. Internal Factor Evaluation (IFE) and External Factor Evaluation (EFE) matrices have revealed that favourable agro-climatic conditions (S1, 3.60) and prevalence of diseases of the plants (W5, 3.6) are the most prioritised internal strength and weaknesses. At the same time, the establishment of adequate cold storage facilities (O5, 3.6) and recent changes in the prevailing climate (T1, 2.25) comprise the most concerning external opportunities and threats in the area, respectively. The results further reveal that implementing a well-managed gardening system and developing of infrastructural facilities (WT1, 124.7) may become the qualified alternative action plan to cope with the negative determinants. The establishment and expansion of apple orchard-based food processing units and tourism activities (SO2, 95%) may be considered the most suitable positive (SO) strategy to ensure further prosperity of apple production, which has been supported by most of the respondents. Adapting such a strategy will enrich the horticulture economy and promote the sustainable development of apple farming in the district.

Keywords: Apple Orchard; Internal Factor Evaluation & External Factor Evaluation (IFE & EFE) Matrix; Horticulture; Quantitative Strategic Planning Matrix (QSPM); SWOT Analysis; Himachal Pradesh; India

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Introduction

Endowed with conducive agro-climatic and geographical attributes, the state of Himachal Pradesh, the 'fruit bowl of India', has appreciably produced nearly 34 varieties of tropical and temperate fruits (Kaur, 2019). Among them, the apple holds the most dominant position by occupying about 49% of the total agricultural area and 79% of the whole fruit production of the state (Negi, 2020). Hence, the state has been praised with the prestigious title of "The apple state of India" owing to the enormous production of different varieties of delicious apples in an extensive commercial manner (Wani & Songara, 2018).

About 12000 hectares (10.03%) of the state's agricultural land has been utilised for the commercial production of delicious apples. Apple-based horticultural practice is now considered the most effective utilisation of natural resources in the hilly tracts of the state (Planning Commission, 2001). Nearly 12.64% of the total State Gross Domestic Production (SGDP) of Himachal Pradesh in 2018-19 has come from the agriculture and allied sector, the lion's share of which has been contributed by apple-dominated horticultural activities (Government of Himachal Pradesh, 2019-2020). Nine out of the twelve districts of the state have practised apple farming as the prime source of livelihood since the 70s of the last century (Directorate of Economics & Statistics, 2019). A sizeable proportion of cultivated land in a few districts like Shimla, Kullu, Mandi, Chamba, and Kinnaur are engaged in apple cultivation, and their share in this sector has been enhanced consistently. Besides, these districts have also produced a huge quantity of good-quality apples with a remarkable yield rate (Negi, 2020). As apple farming has been more beneficial and employment-generating in comparison to the other crops grown in the area, a more significant proportion of the farmers have shifted to apple cultivation from traditional farming practices (Gosain, 2007). But, in the recent past, apple cultivation in the area has faced several challenges, especially related to the changing climatic attributes.

Thus, it has become necessary to understand the prevailing positive and negative determinants of apple cultivation for future prosperity, considering the upcoming natural and socio-economic adversities. In this context, the present study strives to assess the current status of apple orchards in the district along with the recent environmental as well as socio-economic challenges. Further, the study aims to evaluate the apt strategies for sustainable apple cultivation in the near future by examining existing and upcoming internal and external factors determined by empirical observation.

The present study begins with a vivid introduction encompassing the objectives, followed by a description of the study area. This follows a brief literature review discussing the relevance of the investigation and the methodology adopted. After an accurate analysis of the results obtained, and adequate discussion, the concluding remarks have been drawn.

The Study Area

Located in the northeast corner of Himachal Pradesh, the Kinnaur district lies in the southern part of the Trans Himalayan Zone. Extending from 31°03'50'' N to 32°05'15'' N latitude and 77°45'00'' E to 79°00'35'' E longitude, the district covers a total area of 6,401 sq. km. The district is bounded by Lahul-Spiti district in the north, Kullu district in the north-west, Shimla district in the west and the southwest, the state of Uttarakhand in the south, while Tibet (China) demarcates its eastern boundary (Figure 1). The district occupies 3rd position in terms of area, while in terms of population, the district ranks 11th among the twelve districts of the state by accommodating only 84,121 population with a meagre density of 13 persons/sq. km in 2011 (Census of India, 2011). Physiographically, the district constitutes part of the Garhwal Himalayan mountain ranges, characterized by rugged rocky terrain and drained by the river Sutlej (Himachal Pradesh District Gazetteers: Kinnaur, 1971). The study area shows breathtaking views of charming lush green orchards in the lap of majestic mountains covered with pure and dazzling white snow.

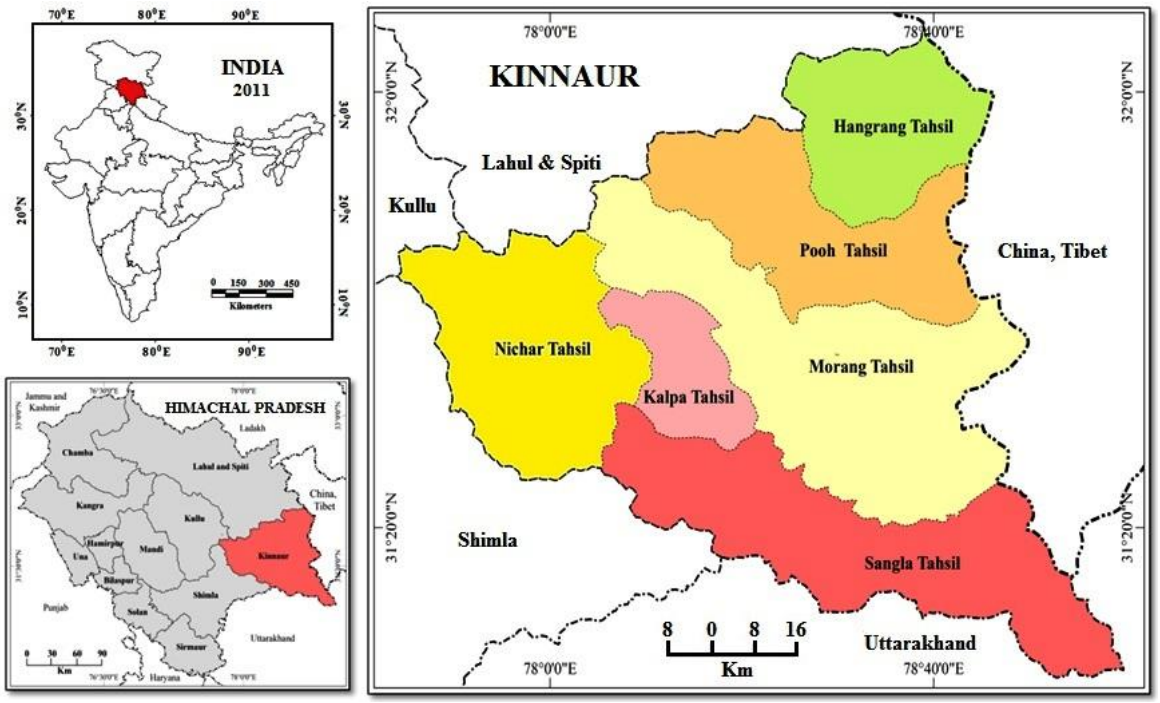

Figure 1: Location of the Study Area
Source: Census of India, 2011

Literature Review

Various studies have attempted to appraise different aspects of apple farming in the state (either district-wise or in totality), encompassing the diversified aspects like current status (Wani & Songara, 2018), spatio-temporal dynamism (Negi, 2020), cost-benefit analysis (Sharma et al., 2018), marketing efficiency (Wani & Songara, 2019), recent environmental troubles (Rana et al., 2011), qualitative SWOT analysis (Singh et al., 2015) etc.

Situated in the north-western Himalayas, the ecological appropriateness of the mountainous state of Himachal Pradesh with ridge-vale topography, temperate climate coupled with well-drained suitable soils provide an extensive ground for apple cultivation. Since the 1970s of the last century, apples have been the prime major horticultural crop of the state and occupied a place of pride in its economy. However, the initiation of apple cultivation in the state dates back to a century, when Captain R. C. Lee started a professionally managed orchard in 1870 in Bandrol in Kullu district for the first time (Panwar, 2011). Over a very brief period, apple farming has become the fastest growing economic activity of the state. Nine out of the 12 districts of the state started to produce apples in which Shimla, Kullu, Mandi, Chamba, and Kinnaur hold esteemed positions in terms of area, production and yield rate. At present, apple cultivation constitutes the backbone of the horticulture-based rural agricultural economy of the state and poses one of the primary sources of livelihood for its agrarian people, with an annual turnover of over INR 3500 crore (35000 million) and accounting for nearly 10% of the gross state domestic product (GSDP) (Negi, 2020). More than two lakhs (0.20 million) farmers' families are engaged in apple cultivation. The area under apple has increased substantially from a mere 400 hectares in 1950-51 to 113154 hectares in 2018-19. Similarly, the amount of production has escalated from 200 thousand metric tonnes in 1975-76 to 715.25 thousand metric tonnes in 2019-20 (Directorate of Economics & Statistics, 2019). The productivity of apple also increased from 5.70 MT/Ha to 6.26 MT/Ha during the aforesaid period.

However, over the last few decades, apple farming practices have faced several environmental threats especially due to the recent changes in the prevailing climatic regime.

The study of Kaur (2019) has highlighted the spatial diffusion pattern of orchards in the state from1950-1995, which depicts that the apple orchards have been shifted from low altitudinal areas to higher altitudes over the past decades. For example, in 1850, apples were grown at an altitude of 1200 - 1500 meters, but now (in 2014) apple orchards are developed at an elevation of more than 3500 meters. The northward relocation of apple orchards is certainly an outcome of increasing temperature as the region has experienced an increase of 0.5°C temperature from 2000 to 2014 (Sahu et al., 2020). Such climate-induced changes in apple farming practices have also influenced the life and livelihood of the farmers. The income of the cultivators in higher altitudinal districts like Lahul-Spiti, Kinnaur have increased over 10% from 1995, while the income of the farmers in lower altitudinal districts like Shimla, Kullu have notably decreased up to30% during the same phase (Rana et al., 2011). Under such circumstances, the districts like Kinnaur and Lahul-Spiti have emerged as important apple producers of the state for their relatively higher altitudinal location. Consequently, the relative share of Kinnaur has increased from 2.59% in 1971-72 to 10.03% in 2016-17, whereas the production share has also escalated from 2.50% to 12.86% during the stipulated period (Negi, 2020). During 2016-2017, the state depicts an average compound growth rate of 1.6%, where three districts, that is, Shimla (9.77%), Kinnaur (5.81%), Kullu (4.32%), have exhibited comparatively greater growth rates (Wani & Songara, 2018). In addition to recent climate change phenomena, few other factors like inadequate financial assistance, improper cold storage facilities, malpractices in markets, insufficient irrigation, and transport facilities etc have influenced the distribution, production, and productivity of apple cultivation. The apple cultivators and other stakeholders have also encountered several physical, socio-economic, and policy-oriented constraints (Wani & Songara, 2019). In 2015, a group of scholars tried to identify the major Strengths, Weaknesses, Opportunities, and Threats (SWOT) factors of apple farming practices in Himachal Pradesh (Singh et al., 2015). These scholars have analysed the SWOT factors qualitatively to assess the major concerning issues and suggested some systematic measures related to pre- and post-harvesting procedures, pest and diseases control and nursery managements etc. for sustainable growth of apple cultivation.

Further, the authors have recommended adopting appropriate people-centric approaches and area-specific development plans to ensure better performance of apple orchards in the state (Singh et al., 2015). Similarly, Bera (2015) has employed qualitative SWOT analysis to examine the instrumental factors of apple cultivation in the Kinnaur district. Contrary to the aforesaid studies, the present endeavour strives to explore the prospects of apple cultivation in the Kinnaur district by framing suitable measures through quantitative SWOT and QSPM analyses. The prime focus of the study is to find out the alternative ways to deal with the current vulnerabilities and threats by the existing positive factors for a prosperous future for the apple orchard, which may be regarded as the relevance and uniqueness of this assignment.

Methodology

Adapted Methods: SWOT-QSPM Analysis

The Integrated SWOT-QSPM model has been employed to understand the determinants and their interconnections and to appraise the strategies for sustainable development of apple farming. Introduced by Albert Humphrey during the 1960s (Nyarku & Agyapong, 2011), the SWOT model comprises an effective strategic management tool by analysing two internal factors [i.e., strengths (S) and weaknesses (W)], and two external factors [i.e., opportunities (O) and threats (T)] of any system, both by qualitative and quantitative ways (Gürel & Tat, 2017). Here, a quantitative (statistical) SWOT analysis technique is adopted, where weighted scores are assigned against the 10 strengths, 10 weaknesses, 6 opportunities and 6 threats factors (see, Tables 1 & 2), identified through field investigation and interaction with the respondents. Based on the stakeholder's perception, both the Rating Value (RV) and the Weighted Value (WV) of all the factors have

been computed. The weighted value of each factor ranges between 0.01 (not important) and 1.0 (very important). On the contrary, the rating value for measuring importance ranges from 1 (below average) to 4 (superior). Finally, the Weighted Score (WC) for each factor is calculated by multiplying the aforesaid components as shown below (David et al., 2009):

$$\boldsymbol{WC = RV \times WV}$$

These internal and external factors have been used to prepare the Internal Factor Evaluation Matrix (IFEM) and External Factor Evaluation Matrix (EFEM) to identify the crucial and irrelevant factors of apple cultivation in the area. These two matrices have been considered the fundamental framework of the Quantitative Strategic Planning Matrix (Shri et al., 2015).

A framework has been prepared for strategy formulation by linking the following two aspects:

- '**Strength-Opportunity**' (**SO**): SO strategy proposes using the strength factor to enhance the opportunities for further growth of apple farming practices. The respondents' opinions are collected through a rating scale, which is classified into three categories, that is, agree, disagree, and neutral. The strategy having the highest appreciation from respondents has been chosen as the best potential strategy for future development of apple production (Chakraborty & Chakma, 2020).
- **'Weakness-Threat' (WT**): WT strategy puts forward alternative action approaches to combat both the existing weakness and upcoming threats. SWOT analysis factors are linked with different WT strategies of the Quantitative Strategic Planning Matrix (QSPM) to ascertain the best policies for prosperous development. Computation of QSPM is done to mitigate the vulnerabilities of WT by using the Attractiveness Score (AS) and Total Attractiveness Score (TAS). The degree of attractiveness of each factor to each alternative strategy is determined by AS, with the spectrum from 1 (not attractive) to 4 (highly attractive). The weighted score of each factor in the IFE and EFE matrices have been multiplied with the Attractiveness Score (AS) to get the TAS of each WT strategy. Summing all TAS of each WT strategy gives the Sum Total Attractive Scores (STAS). Finally, the WT strategy with the highest STAS scores is regarded as the most appropriate measure to reduce weaknesses and threats (David et al., 2009).

Results and Discussion

Present Status of Apple Cultivation in Kinnaur District

The apple holds the most critical position among the diverse varieties of cultivated fruits as a cash crop, with significant district-wise spatio-temporal dynamics in terms of area, production, and productivity. In terms of area, the district of Kinnaur has occupied the 5th position, whereas, in terms of production, the district has ranked 3rd by producing 61673 tonnes of apples in 2020-21, which comprised nearly 12.86% of the state's total (Directorate of Economics & Statistics, 2019) (Figure 2).

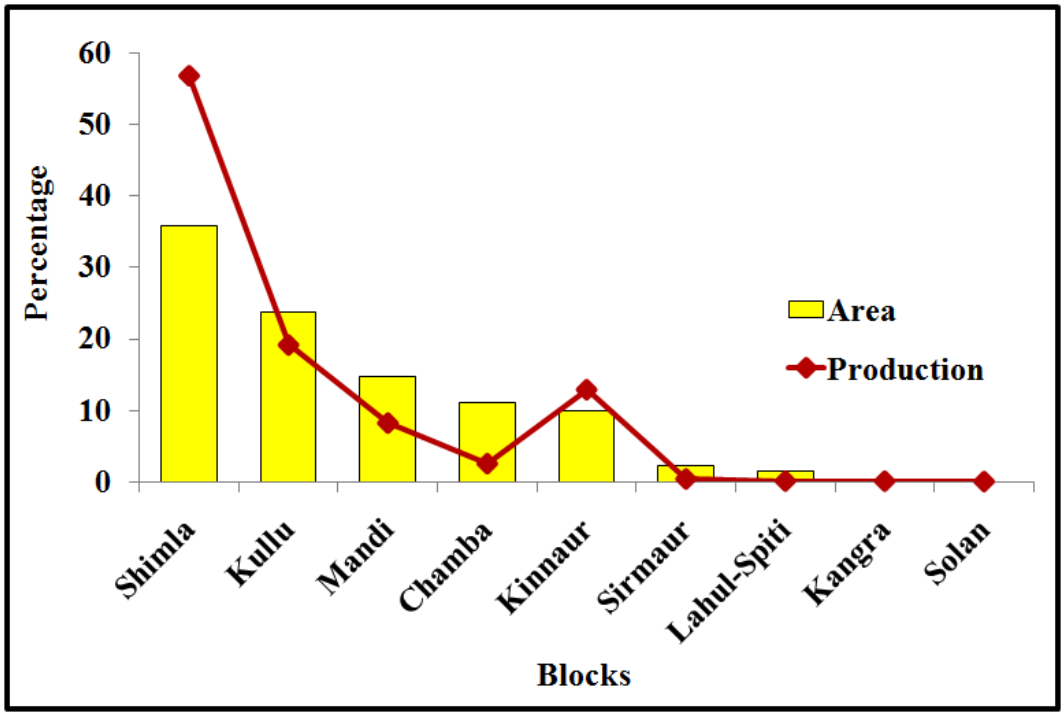

Figure 2: District-wise Area and production of Apple, Himachal Pradesh, 2018-19
Source: Directorate of Economics & Statistics, 2019

The district has recorded maximum positive growth in the area, production and productivity with a constant decline in instability. The area under apple farming in the district has enhanced substantially from 733 ha in 1970-71 to 11179 ha in 2018-19. The production figure has also been escalated from 3126 tonnes to 61673 tonnes, whereas the yield rate has augmented from 3.43 MT/Ha to 5.25 MT/Ha during the stipulated period. Despite notable decadal fluctuations, the district registers maximum positive growth in the area (R^2= 0.959) and production (R^2 = 0.657) since the initiation of apple farming in 1971 (Figure 3).

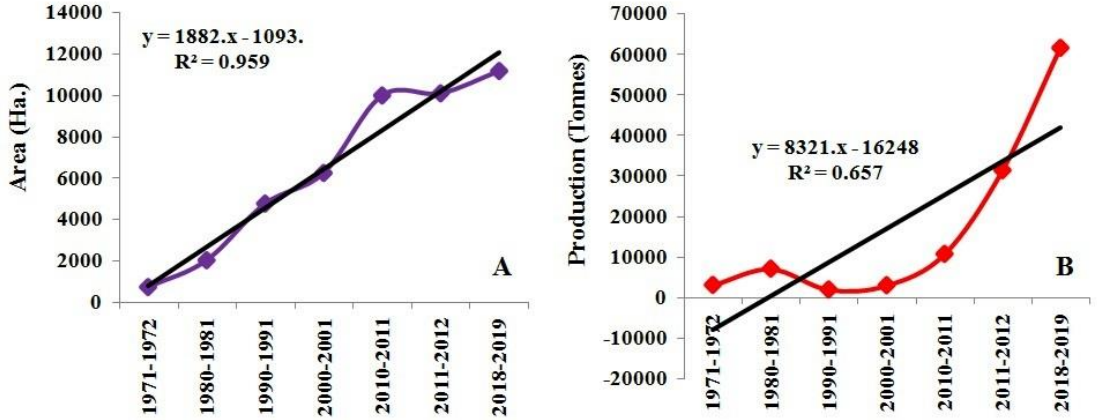

Figure 3: Temporal variation of (A) Area and (B) Production of Apple, Kinnaur
Sources: Government of India (Agricultural Situation in India), 2020

The relative share of apples of Kinnaur to the state's total has been increased from 2.59% to 10.03% for area and 2.5% to 12.86% for production during 1971-72 to 2018-19 Hence, with consistent development in apple cultivation, the district has become increasingly important in the horticulture-based economy of the state over time. Owing to the recent climatic

changes, the state's commercial apple farming has undergone some incredible changes, especially since the onset of the 21st century. The production and productivity of apples in the low altitudinal regions (districts) have experienced a steady decline. On the contrary, the changing climate has created wider scopes for apple cultivation in higher altitudes as conditions are getting more favourable (Sahu et al., 2020 and Basannagari & Kala, 2013). Consequently, the high altitudinal districts have revealed a progressive increase over time as the apple orchards are shifting towards the higher altitude areas of the state. The farmers show a positive attitude towards apple cultivation due to higher assured income than other crops (like potato, *rajma* or red kidney beans) and fruits (like plum). As a result, over the recent past, the apple orchards have expanded gradually in place of the traditional cropping fields or fruit gardens of the Kinnaur district. About 70% of the district's orchards are situated between the altitudes of 2000-3000m. More than half of apple plantation (54.4%) is located on slopes between 21°-40°. The majority of the orchards (78%) lie on a slope facing North-East and South-East (Figure 4). A bulk share of the working population (>85%) of youth to middle age, irrespective of gender, have got engaged in apple farming and allied activities. Such changes in the cropping pattern and livelihood strategies signify new socio-economic issues for the local farmers. The socio-economic lifestyle of the apple cultivators and traders has improved with the steady growth of apple orchards in the district.

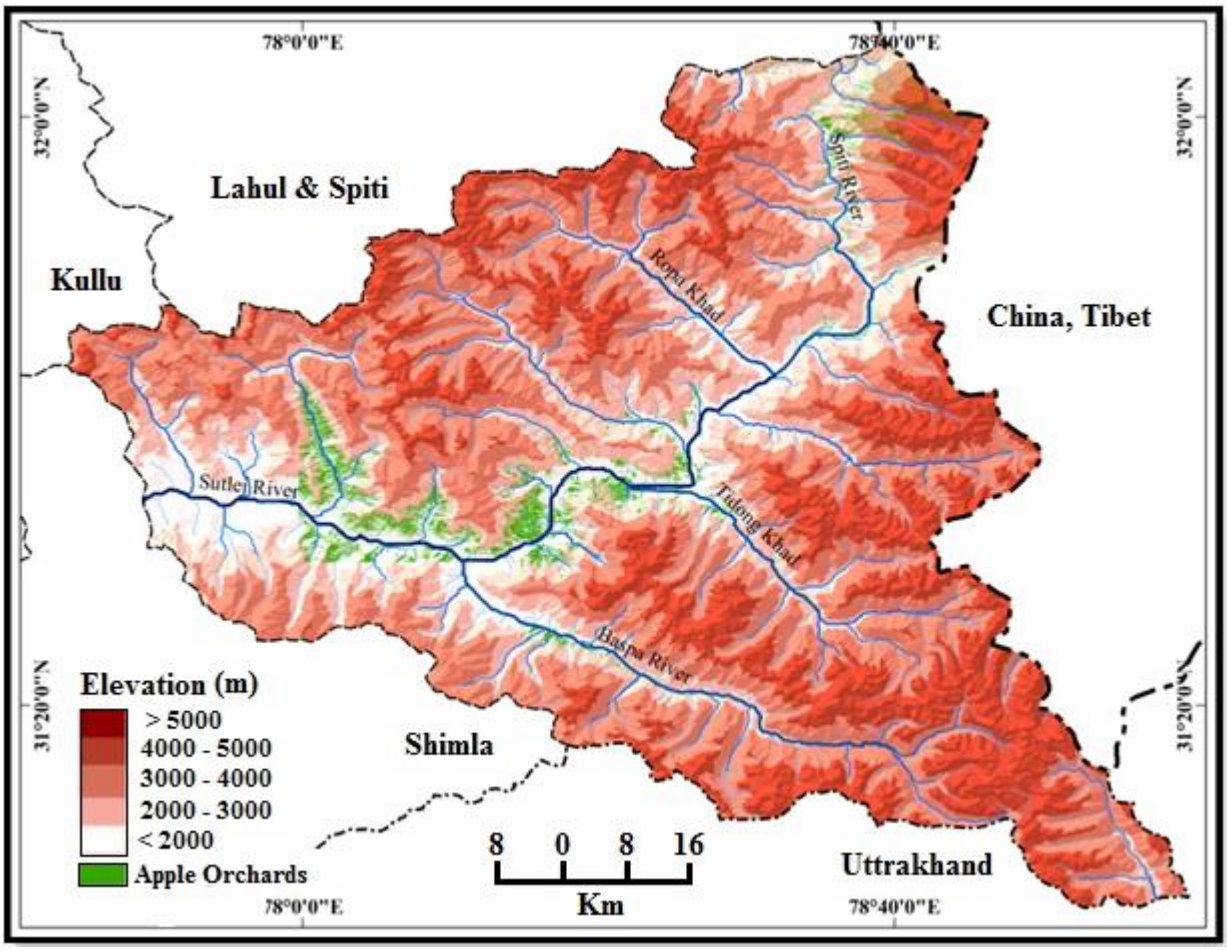

Figure 4: Spatial Distribution of Apple Orchards in relation to Relief and Drainage
Source: DEM and LISS-III Data 2018

Analyses of the Factors: Internal Factors Evaluation (IFE) Matrix and External Factors Evaluation (EFE) Matrix

Computation of IFE and EFE matrices has marked the area's prime and less important SWOT factors of apple production (Tables 1 and 2). IFE Matrix has shown favourable agro-climatic condition (S1, 3.60), high altitudinal location (S2, 3.40), and sufficient irrigation facility (S3, 2.40) comprises the three prime strengths factors of the prevailing apple farming practices. These results bear resonance to previous studies on apple cultivation in Himachal Pradesh. As evident from the study of Sahu et al., 2020, Sen et al., 2015, and Singh et al., 2016 the climate-induced shifting of apple belts towards the higher altitudes is one of the most potential strengths for apple production in the high altitudinal districts of Himachal Pradesh like Kinnaur, Kullu etc. On the contrary, the inroad of pest insects, fungal infections, and different diseases of apple trees (W5, 3.6), abnormal flowering due to declining chilling hours (W3, 3.4), and improper pre- and post-harvesting management (W8, 2.55) are considered as the most concerning internal weaknesses. Similar weaknesses of apple cultivation in the Kullu district of Himachal Pradesh have also been identified by Singh et al. (2015), wherein inappropriate orchard management, improper use of pesticides, insecticides, chemicals, and degradation and occurrences of different

diseases in apple gardens are marked as the major weaknesses.

In concerns to External Factors of Apple Cultivation, the EFE Matrix evaluates that the establishment of better cold storage facilities will encourage the production of apple cultivation (O5, 3.6), and the development of food processing industries (O4, 3.4) will enhance the demands for apple production. Conversely, the micro-climatic disturbances due to climate change (T1, 2.25) and the gradual shifting of apple orchards in higher altitudes due to global warming (T2, 2.21) have been predicted as the most vulnerable threats to apple cultivations in the district. The reduced periods of snowfall accompanied by a shorter duration of chilled period results in poor yielding both in terms of quantity and quality (Sahu et al., 2020). The gradual shifting from lower and mid-elevations to higher altitudes leads to the non-satisfaction with weather-specific requirements that have threatened apple productivity (Rana et al., 2011).

Table 1: Internal Factors Evaluation (IFE) Matrix					
Internal Factors			Weighted Value	Rating Value	Weighted Score
Strengths	S1	Favourable agro-climatic condition	0.9	4	3.6
	S2	High altitudinal (1500-2700m) location	0.85	4	3.4
	S3	Adequate irrigation facilities from local fountains (*Chasmepani* in local dialect)	0.8	3	2.4
	S4	Long experience of farming (>45 years) and good traditional knowledge of local cultivators	0.6	2	1.2
	S5	Varieties of apple species	0.75	3	2.25
	S6	Organic and eco-friendly cultivation method	0.65	2	1.3
	S7	Economically Profitable than other crops	0.85	3	2.55
	S8	An adequate supply of planting materials from organised nurseries	0.7	2	1.4
	S9	Presence of efficient contracting agents who assist in transportation and proper marketing	0.65	2	1.3
	S10	Rising demand in national and international market	0.7	3	2.1
Weaknesses	W1	Seasonal weather disturbances: vagaries in snowfall	0.7	3	2.1
	W2	Lack of accessibility due to undeveloped rail-road network	0.7	3	2.1
	W3	Abnormal flowering due to declining Chilling Hours	0.85	4	3.4
	W4	Apple Replant Disease (ARD) in replanted orchard sites	0.75	3	2.25
	W5	Fungal infections, pests attack, and diseases	0.9	4	3.6
	W6	Insufficient cold storage facilities	0.75	3	2.25
	W7	Labour intensive or manual grading and packaging system	0.7	2	1.4
	W8	Poor level of pre and post-harvesting management	0.85	3	2.55
	W9	Crisis of local labour and high wage rate of import labours	0.6	2	1.2
	W10	Declining productivity of old apple orchards	0.65	3	1.95
Source: Field Survey, 2019					

Table 2: External Factor Evaluation (EFE) Matrix					
External Factors			Weighted Value	Rating Value	Weighted Score
Opportunities	O1	Extension of organised and multi-operational marketing systems	0.7	3	2.1
	O2	Suitable governmental policies	0.6	2	1.2
	O3	Development of tourism along with the apple orchards	0.8	3	2.4
	O4	Establishments of food-processing industries	0.85	4	3.4
	O5	Adequate and organised cold storage: reducing the problem of overproduction and ensure a year-round supply	0.9	4	3.6
	O6	Eco-friendly horticulture practices enhance ecological sustainability, which sustains the production capacity in future	0.8	3	2.4
Threats	T1	Changes in the prevailing climate	0.75	3	2.25
	T2	The gradual shifting of apple belts in higher altitudes due to global warming	0.7	3	2.1
	T3	Occurrences of landslides	0.65	2	1.3
	T4	Problems of overproduction and switching to other crops	0.3	1	0.3
	T5	Ecological or biological disasters	0.2	2	0.4
	T6	Land encroachments in orchards sites	0.6	2	1.2
Source: Field Survey, 2019					

Strategy 1: Strength-Opportunity (SO) Factors

The combination of strength-opportunity (SO) factors has pointed out the following strategies for the prosperity of apple cultivation in the area:

- **SO1:** Ecological suitability combined with organised exporting systems will enhance the market area and satisfy the increasing demand in national and international markets.
- **SO2:** Growth of food processing industries encourages farmers to produce a large quantity of different varieties of apples.
- **SO3:** Use of green manures will augment production and productivity as well as maintain the ecological sustainability.
- **SO4:** Sufficient and well-managed cold storage facility will solve the problem of overproduction and confirm the uninterrupted supply throughout the year.
- **SO5:** The development of tourism industry will enhance the demand as well as the extent of the markets.

Respondents' opinions reveal that SO2 (95%) is highly appreciated by most of the respondents, followed by SO5 (92%) and SO4 (90%) (Figure 5) (Field Survey, 2019). Most of the respondents have advocated in favour of the development of food processing industries (SO2) in the region, which will create employment opportunities and alternative income generation for local people, reduce the cost of transportation, increase the demand of produced goods, and encourage the cultivators to produce a large quantity of good quality apples. It should be noted that the traditional way of preparing chips, jams, vinegar, and beverages from apples is a very popular

cottage-based activity in the hill villages of the district, which has been practised for a long time. However, no such large-scale apple-based food-processing industries have been set up as yet in the district. Concurrently, a significant proportion of the respondents express the desire for the simultaneous development of apple farming along with the tourism industry (SO5). This is because the beautiful apple orchards of the area naturally attract tourists. The inflow of tourists will create positive demand for (raw) apples and its bi-products (dried apples, jam, syrups etc.) in the market. Hence, the income may swell up not only from apple orchards but from other sources like hotels, restaurant businesses etc. Moreover, they may also become interested in developing infrastructure, especially the cold storages (SO4) to store the surplus production and help maintain the apple supply chain throughout the year.

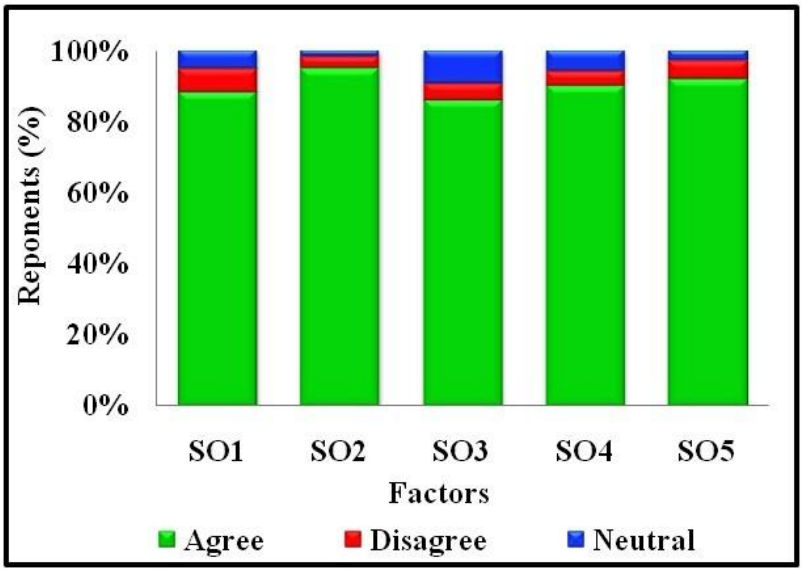

Figure 5: Perception of the respondents for SO factors
Source: Field Survey, 2019

Strategy 2: Weakness- Threat (WT) Factors

A combination of four WT strategies has been considered an effective measure to mitigate the relative weaknesses and threats of apple cultivation. This matrix measures the relative attractiveness of WT strategies with each internal-external factor of SWOT.

- **WT1:** The infestation from different pests and insects (like wooly apple aphids, apple thrips, and phytophagous mites, etc) and other diseases like leaf fall, powdery mildew, apple cankers, root rot, and collar rot, etc. hamper the optimal production of apple. Pest control and disease management strategies are strongly needed to combat these problems. Apple Replant Disease (ARD) is very predominant in young apple trees of replanted orchard sites, which reduces the production and yield rate of replanted orchards. To overcome this problem, soil fumigation, bio-control of soil biological activities, rootstock, and soil management treatments are adequately required. Also, establishing a soil nutrition monitoring system is highly recommended for healthy orchard management.
- **WT2:** Climatic disturbances like irregular snowfall and temperature fluctuations disrupt apple production. Excessive snowfall hinders the natural growth of apple orchards. Several cases of landslides are observed in rain-prone areas. These endangered apple orchards are needed to relocate to the safe zone. Proper pre- and post-disaster management strategies are also required to cope with the damages. Improper land use planning grasps the area of apple orchards by infrastructural

development. Proper land-use planning is needed to stop such encroachment on land.

- **WT3:** The production of apple cultivation suffers from a lack of pre- and post-harvesting management as most of the orchards do not have adequate infrastructures like cold storage facilities, proper grading, polishing and packaging systems, and proper transportation facilities. Our research observed that many apples rotted and were damaged due to improper storage and transport facility. Proper pre- and post-harvesting management are required in such a context. The establishment and up-gradation of new and conventional cold storage with low-cost value, infrastructural development in transportation systems with refrigerated trucks, and congenial warehouse establishment near the market area will improve the harvesting strategies.
- **WT4:** Nowadays, orchards are facing more climate change diseases like scrub diseases, premature defoliation, alternaria, and alternaria alternata, etc., and the consequences of global warming have declined the chilling hours. As a result, most of the apple belts in the lower altitudes are being shifted towards higher altitudes. Eco-friendly measures, pollution control strategies, and people's awareness of environmental sustainability is needed to maintain the natural balance of this ecosphere. Using more organic fertiliser, bio-compost fertiliser, and bio-pests would preserve the natural productivity of soil and cut the chain of bio-accumulation.

Table 3 titled Quantitative Strategic Planning Matrix (QSPM) is an analytical technique that identifies the magnitude of relative attractiveness of one strategy over another and reveals that WT 1 (124.7) is the highly prioritised strategy followed by WT 3 (117.45), WT 4 (111.15), and WT 2 (93.8) respectively for reducing the weakness and threats of apple cultivation in the area.

Table 3: Quantitative Strategic Planning Matrix									
Factors	Weighted	WT1		WT2		WT3		WT4	
	Score	AS	TAS	AS	TAS	AS	TAS	AS	TAS
S1	3.6	3	10.8	3	10.8	3	10.8	4	14.4
S2	3.4	3	10.2	3	10.2	3	10.2	4	13.6
S3	2.4	2	4.8	2	4.8	2	4.8	3	7.2
S4	1.2	3	3.6	2	2.4	2	2.4	2	2.4
S5	2.25	3	6.75	1	2.25	2	4.5	-	-
S6	1.3	1	1.3	-	-	-	-	4	5.2
S7	2.55	3	7.65	-	-	2	5.1	-	-
S8	1.4	2	2.8	1	1.4	1	1.4	-	-
S9	1.3	-	-	2	2.6	3	3.9	-	-
S10	2.1	2	4.2	1	2.1	2	4.2	1	2.1
W1	2.1	1	2.1	4	8.4	2	4.2	3	6.3
W2	2.1	-	-	-	-	2	4.2	-	-
W3	3.4	1	3.4	1	3.4	4	13.6	4	13.6
W4	2.25	4	9	-		-	-	-	-
W5	3.6	4	14.4	2	7.2	-	-	2	7.2
W6	2.25	-	-	-	-	-	-	-	-
W7	1.4	-	-	-	-	4	5.6	-	-
W8	2.55	-	-	-	-	4	10.2	-	-
W9	1.2	-	-	-	-	-	-	-	-
W10	1.95	4	7.8	-	-	1	1.95	1	1.95
O1	2.1	2	4.2	1	2.1	-	-	1	2.1
O2	1.2	1	1.2	2	2.4	2	2.4	1	1.2
O3	2.4	-	-	2	4.8	1	2.4	2	4.8
O4	3.4	2	6.8	1	3.4	2	6.8	-	-
O5	3.6	3	10.8	2	7.2	3	10.8	-	-
O6	2.4	3	7.2	-	-	3	7.2	4	9.6
T1	2.25	2	4.5	3	6.75	-	-	4	9
T2	2.1	-	-	-	-	-	-	4	8.4
T3	1.3	-	-	4	5.2	-	-	1	1.3
T4	0.3	-	-	-	-	-	-	-	-
T5	0.4	3	1.2	4	1.6	2	0.8	2	0.8
T6	1.2	-	-	4	4.8	-	-	-	-
STAS			124.7		93.8		117.45		111.15
Priority			1st		4th		2nd		3rd
Source: Field Survey, 2019									

Conclusion

The strategy formulation and its implementation are essential steps for the development of any system. This study examines apple cultivation's internal capabilities and external potentialities in Kinnaur district. Adaptation of the apple as the

prime cash crop brings apparent changes in the cropping pattern, the usual agricultural system as well as the rural economy of the area. At present, apple farming has become the prime source of occupation, income, and livelihood for the maximum proportion of district inhabitants, which have considerably influenced the stakeholders' socio-cultural life. So, it is important to establish the basic infrastructure in the district and provide basic training and extension services to apple producers.

The SWOT and QSPM analysis have revealed that the establishment of the food processing and tourism industry (SO2, 95%) along with apple orchards are the most appreciated SO strategies. Conversely, implementation of the proper gardening system (disease control system, pests and insects control mechanisms, soil nutrition monitoring strategy) and proper development of the infrastructural facilities (WT1, 124.7) are considered the best alternative WT strategies for improving the apple production in the district and enhancing the market area. These strategic tools are very useful in taking fundamental decisions for effective growth and sustainable farming practices. If the selected strategies are appropriately implemented, the apple cultivation of the Kinnaur district will achieve a better scope of development, which will significantly impact the economy of this hilly district.

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Conflict of Interest

The authors declare that they have no conflict of interest. This study received no financial aid from any persons/organisations by any of the authors. The datasets (questionnaires of the informants from the field survey) of this study are available from the corresponding author upon request.

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Author Contribution Statement

Benojir Yasmin (BY), Arindam Roy (AR), Mehedi Hasan Mandal (MHM), Giyasuddin Siddique (GS), and Subhendu Ghosh (SG) have collectively designed the study. BY, AR, MHM, and SG have collected the primary data through field investigation. BY and AR analyzed the data and wrote the first draft of the paper. MHM and SG have also help in analysis and writing. The guidance and supervision of GS has certainly improved the quality of the article and help to acquire the present shape of the manuscript. Finally, BY has reviewed, edited and prepared the final draft of the manuscript. All the authors have read and approved the final text. On behalf of the authors, the corresponding author declares that the above-mentioned statements are correct, and all authors agree on it.

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