A COMPREHENSIVE VALUE CHAIN ANALYSIS OF MAJOR FRUITS IN MALAKAND DIVISION, KPK: CHALLENGES AND OPPORTUNITIES

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AUTHOR'S DECLARATION

I, **Jalal Ud Din**, declare that the thesis titled "**A Comprehensive Value Chain Analysis of Major Fruits Malakand Division, KPK: Challenges and Opportunities**", submitted to the Pakistan Institute of Development Economics (PIDE) in partial fulfillment of the requirements for the degree of M.Phil., is my own original work. It has not been submitted or published previously for any degree or qualification at any university or institution. All sources used have been properly cited, and I take full responsibility for the contents of this thesis.

Date: 05/22/2025

Jalal Ud Din

DEDICATION

This thesis is dedicated to my **parents**, whose love, prayers, and constant encouragement have been my greatest strength. A very special dedication goes to **my father and my uncle**, whose unwavering support, guidance, and belief in my abilities motivated me throughout this journey. I am also thankful to all my family members for their continuous support and encouragement. Without their presence and prayers, this achievement would not have been possible.

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LIST OF ABBREVIATIONS

AMIS	Agriculture Marketing Information System
CRS	Crop Reporting Service
CGR	Compound Growth Rate
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
ICT	Information and Communication Technology
ITC	International Trade Center
KPK	Khyber Pakhtunkhwa
KII	Key informant Interview
RCA	Revealed Comparative Advantage
SWOT	Strengths, Weaknesses, Opportunities, Threats
SPS	Sanitary and Phytosanitary
TDAP	Trade Development Authority of Pakistan
VCA	Value Chain Analysis
WTO	World Trade Organization

ABSTRACT

This thesis presents a detailed study of the fruit value chain in Malakand Division, Khyber Pakhtunkhwa (KPK) in Pakistan. Even though Malakand has a strategic position due to fruit production, the region is characterized by a set of inefficiencies at the system level, which causes huge post-harvest losses and underutilization of export opportunities. There are three key aims of this research. 1) It looks at the dynamics of the production of fruits in Malakand with time and how the trends translate to the performance of exports. 2) It quantifies the quantity of the fruits wasted post-harvest and determines the monetary cost of such losses throughout the value chain. 3) It examines the main issues that stakeholders, including farmers, traders, and exporters, encounter during the movement of fruits from the farms and the markets.

The mixed-methods research design, which will enable this study to focus on both the quantitative dynamics and the qualitative complexities of the fruit value chain in Malakand Division, is likely to include the following stages. The quantitative approach applies compound growth rate (CGR) and decomposition Analysis to a 19-year (2004-2023) multi-year data set. The paper presents significant changes in fruit productivity rates for Malakand Division, where apple fruit production decreases by 11.30 percent and peaches increase by 5.30 percent. The analysis of the decomposition indicates that peach growth is area-based (132.2%), whereas the persimmon growth is yield-based (79%). Estimates of post-harvest losses exceed PKR 851,183, with most of the losses incurred by farmers and wholesalers due to fruit fly infestations, physical damage, and power outages in cold storage. Based on the thematic analysis, four constraints are identified, namely price volatility, the lack of dedicated post-harvest infrastructure, the regulatory obstacles, and the lack of coordination of stakeholders. SWOT analysis has found opportunities in value-added processing and threats due to climate change and land-use transitions. The paper proposes electricity-run cold storage, pest management, and high-density planting training, and better certification and transportation- all measures that have the potential to reduce post-harvest losses by 40 percent and increase farmer incomes by 35%.

Key Words: Fruit Value Chain, Compound Growth Rate, Decomposition Analysis, Thematic Analysis, Post-Harvest Losses, Malakand Division

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Fruits are a significant contributor to Pakistan's agricultural economy, as the total share of fruits in the farm GDP is around 2.48 % (Government of Pakistan GOP, 2019), and they have large export potential (Pakistan Horticulture Development and Export Company PHDEC, 2017), but they face many challenges that limit their profitability, productivity, and exports. Pakistan produces around twenty-nine types of fruits annually, which have strong export potential; however, most of the production is either consumed domestically or lost to post-harvest waste, about 35%-40% (K. Ahmad et al., 2021). However, according to the International Trade Center (ITC, 2022) Trade Map, fruit exports have increased significantly; they reached USD 492 million in 2021. Pakistan exported 622.1 thousand tons of fruit in 2021–2022 (TDAP, 2022).

However, fruit production and exports are struggling with several challenges. On the production side, we are producing more than sufficient fruit; however, a significant share of the production is wasted due to inadequate storage facilities and a lack of awareness about potential value-added opportunities. The absence of suitable storage facilities for perishable crops, such as fruits, is one of the primary hurdles, causing significant post-harvest losses due to pests, rotting, incorrect handling, and challenges in exporting and proper marketing. In Pakistan, about 35–40% of fruits and vegetables are lost after harvest. Most post-harvest losses happen during the distribution, processing, storage, and transit phases. (K. Ahmad et al., 2021). Recent empirical literature indicates that exports of Pakistan are limited not only by distance, variations in the exchange rates, competitiveness of prices, but also by the quality control and poor adherence to international standards, which greatly diminish the volumes of exports and unit prices. (Hayat et al., 2024)

In Pakistan, Khyber Pakhtunkhwa (KPK) is one of the leading provinces in the production of fruits and vegetables. Specifically, in the context of fruit production, the province holds immense potential, producing high-quality fruits that have strong prospects for export to international markets. According to the Fruits, Vegetables, and Condiments report of Pakistan for 2022-23, the total fruit production in Khyber Pakhtunkhwa (KPK) amounted to 322,425 tons(Fruits, Vegetables

and Condiments Statistics of Pakistan, 2022-23). Among the major fruits cultivated in KPK, including Apple, Apricot, Persimmon, Peach, and Plum, these varieties collectively accounted for 59.52% of the total production. Notably, the Malakand Division emerged as one of the primary hubs for the cultivation of these fruits. (Fruits, Vegetables and Condiments Statistics of Pakistan, 2022-23).

The Malakand Division is a picturesque tourist destination located in the beautiful province of Khyber Pakhtunkhwa, Pakistan, renowned for its diverse produce and lush scenery. Malakand Division is also the finest fruit producer, and this includes Persimmon, Peach, plum, Apricot, Citrus fruits, and Apple, etc. Fruit growing and marketing are crucial to the local economy in this region and a significant source of livelihood for the locals. The understanding of the dynamics of the fruit value chain in the Malakand Division is taken to be of the essence in assessing the economic value of the sector, identifying growth and development opportunities, as well as addressing the challenges hindering it from achieving its potential.

The fruit value chain analysis of Malakand Division comprises an in-depth exploration of all the processes associated with the procedures involved in the production, clarification, delivery, and marketing of fruits in the Malakand Division, from a farm to a fork. This will bring on board a wide variety of stakeholders, as far as smallholder farmers, traders, processors, wholesalers, retailers, and consumers are concerned, each one of them providing at a different stage of the value chain. Factors affecting the fruit value chain in Malakand Division are numerous, i.e., Availability in the market, government policies, fertility of the soil, infrastructure, use of technology and climate, and socioeconomic forces. Additionally, the quality requirement, the dynamic market trends and demands, the consumer market, and environmental sustainability all determine the profitability and sustainability of the fruit industry within the region.

Several recent studies have studied the horticulture value chains in other parts of Pakistan, providing valuable sources of comparison in the Malakand context. Indicatively, in a study that mapped the apple value chain in Balochistan, Aurangzeb et al. (2024) discovered that there were high post-harvest inefficiencies, poor value processing, and imbalanced revenue distribution among the chain players. Correspondingly, Mazhar et al. (2022) analyzed the supply chains of mandarin in Punjab and indicated that the involvement of farmers in the modern supply chains

increased the profitability significantly, but several producers were left out because of quality and logistics. The Asian Development Bank (2021) states that the horticulture sector in Pakistan suffers as a result of systemic challenges that prevent its efficiency and competitiveness: a low yield, high post-harvest loss, inadequate infrastructure, and disjointed value chains, and that a thorough value chain analysis is necessary to develop effective interventions to address these issues. As Siddique and Garnevska (2017) surveyed the citrus industry, they reported the governance structures, margins, and export challenges, in which the structural inefficiencies remain even in well-established chains such as kinnow. Empirical research by Mehdi et al. (2017) on mango value chains showed that the returns of actors can be raised significantly with the help of better practices of handling and marketing, indicating the potential benefits of improving the value chain.

Value chain analysis is important to agriculture for an overall outlook of the whole chain from the farm to the fork. The breakdown of the entire process - production to consumption - can help identify areas of potential value addition, inefficiency, and places for development. In this framework of strategic review, processes can be optimized, and customer requests can be dealt with better. However, the fruit value chain is not fully utilized in Malakand Division, but marked challenges exist. On the other hand, though Khyber Pakhtunkhwa is one of the fruitiest regions of the country, there are certain issues concerning the proper harnessing of agricultural output from that region for export and economic growth. Rana et al. (2021) carried out a thorough evaluation of the situation in Khyber Pakhtunkhwa (KPK) and found that the gaps in storage facilities, transport networks, and market connections are key contributors to inefficiencies in horticultural value chains. Some of these difficult challenges associated with this are related to post-harvest losses, restricted access to proper storage facilities, poor infrastructure, unstable market conditions, and regulatory limitations. These challenges not only make the fruit value chain run as smoothly as it should be, but they also do not give the area's full potential since there are a lot of agricultural products available in the region.

It is necessary to examine the whole value chain of major fruits and identify the main constraints. If these are removed or diminished, then the scope for export growth and improvement in the Pakistani economy is worthwhile.

1.2 Value Chain Analysis

Value Chain Analysis (VCA) in agriculture is a strategic assessment framework that involves dissecting the sequential activities from production to consumption to identify value-adding steps, inefficiencies, and opportunities for improvement, optimize operations, and enhance efficiency in meeting customer demands. (Kaplinsky & Morris, 2000)

The study of value chains revolves around two key elements: “Value” and “Chain.” In VCA, the term ‘value’ means the added value, which is the worth that the product is accustomed to in the course of processing. As for the examples of agricultural products, this added value can also be effectively realized through product differentiation, including an increase in food safety and functional characteristics of the goods. Hence, the price of the final product is high to compensate for the higher value-added it provides. The “chain” symbolizes the supply chain, which includes all or most features of a particular product, with the assistance of many stakeholders and their processes from its creation to disposal. (Hawkes & Ruel, 2011). According to Kaplinsky & Morris, (2000), VCA is the examination of all the processes that are involved in taking a product or a service from its planning stage to its production, to delivery of a finished product to the consumer, and, finally, disposal of the product after consumption. Moving further, Sanogo (2010) builds on this by including the transfer of goods across stages and defining the key actors and firms, as well as the institutional support that can be obtained across the production flow.

The Malakand Division's fruit value chain analysis entails a thorough investigation of all the procedures involved in growing, preparing, distributing, and selling fruits, from farm to fork. A wide range of stakeholders will be included in this analysis, each of whom contributes at a distinct step of the value chain: smallholder farmers, traders, processors, wholesalers, retailers, and consumers. The fruit value chain in Malakand Division is influenced by several factors, including market accessibility, government regulations, soil fertility, infrastructure, technological adoption, climate, and socioeconomic dynamics. Furthermore, the quality standards, changing market trends, consumer preferences, and environmental sustainability all affect the fruit industry’s profitability and durability in the area.

The current research has used conceptual and theoretical frameworks to analyze the fruit value chain in Malakand Division in a systematic way. Conceptually, it follows the Value Chain

Analysis (VCA) approach to trace the flow of products, information, and value addition between producers and consumers with specialization in major stakeholders and processes that lead to efficiency and quality improvement. Theoretically, the research is based on the Value Chain Theory proposed by Porter (1985), modified by Kaplinsky and Morris (2001) as applied to the agricultural process, combining the primary activities (inbound logistics, operations, outbound logistics, marketing, and services) with the agricultural processes. The institutional and environmental factors are also included in modern extensions as exogenous factors influencing the performance of the value chain (Gereffi and Lee, 2016; UNIDO, 2020). It is an integrated system that will offer a systematic perspective on finding inefficiencies, value-adding opportunities, and policy entry points at various stages of the fruit value chain.

Value chain analysis is important to agriculture for an overall outlook of the whole chain from the farm to the fork. The breakdown of the entire process - production to consumption - can help identify areas of potential value addition, inefficiency, and places for development. In this framework of strategic review, processes can be optimized, and customer requests can be dealt with better. However, the fruit value chain is not fully utilized in Malakand Division, but marked challenges exist there. On the other hand, though Khyber Pakhtunkhwa is one of the fruitiest regions of the country, there are certain issues concerning the proper harnessing of agricultural output from that region for export and economic growth. Some of these difficult challenges associated with this are related to post-harvest losses, restricted access to proper storage facilities, poor infrastructure, unstable market conditions, and regulatory limitations. These challenges not only make the fruit value chain run less smoothly than it should be, but they also do not give the full potential of the area since there are a lot of agricultural products available in the region.

It is necessary to examine the whole value chain of major fruits and identify the main constraints. If these are removed or diminished, then the scope of export incrementation and betterment in the Pakistani economy is worthwhile.

1.3 Problem Statement

The Malakand Division, which is found in Khyber Pakhtunkhwa (KPK), forms one of the major fruit-producing areas in Pakistan, with a percentage contribution to the fruit production in the province amounting to 59 percent. It has a high relative advantage on certain fruits like peaches and persimmons that comprise 81% and 73% of the provincial production, respectively. In spite of this strategic potential, the region continues to be afflicted by the following challenges: low production efficiency, high post-harvest losses, ineffective value chain linkages, and poor access to export markets. The gap, in this case, has been critical, in that there is a lack of a clear data-driven policy framework, whereby the focus is on fruits with a comparative advantage. In addition, the gap between farmers and policymakers concerning the focus required on the fruit is rather significant, and each considers the priorities to be different, and the required interventions necessary to increase productivity and access to it as well. The lack of alignment means that investment and policy support are rather dispersed and not efficient. In order to respond to these concerns, it is critical to perform the value chain analysis that incorporates the main limitations, explains stakeholders' roles, and determines the weak points to be improved. This type of analysis can be used to inform specific activities and policy actions to minimize inefficiency, enhance coordination efforts, and drive value addition and exports. This would ultimately boost the economic value of the fruit industry in Malakand and also lead to an increased welfare of local farmers.

1.4 Significance of the Study

This study aims to reveal key issues in the value chain of fruits in Pakistan. The fruit sector is the most significant sector of agriculture and has been supporting Pakistan's economy for a prolonged period. This research elaborates, discovers, and observes some key constraints that can be optimized to enhance the efficiency and sustainability of fruit production and distribution. Enhancements in these processes can lead to more yield or greater productivity, higher-quality produce, and easier access to market-for the benefit of farmers, consumers, and the economy. The study's findings on each stage of the fruit value chain shall contribute to giving important input to policymakers, industry players, researchers, and the public. The research is based on a positivist

epistemological approach and a realist ontological approach that allows conducting an objective and evidence-based research regarding structural inefficiencies and the stakeholder dynamics of the fruit value chain at Malakand Division.

The research would identify the strengths and weaknesses, main challenges, and constraints of key industry stakeholders, including farmers, traders, processors, cold storage owners, and exporters, to point out their areas of improvement. This would include pointing out the areas where improvement is needed so that these stakeholders can strategize on how they can enhance their income and improve the quality of products going to more markets.

The findings from this study would be a positive contribution to the existing body of knowledge related to fruit value chains in developing countries. This evidence and analysis will form the basis of further research into areas such as sustainable agriculture, rural development, and food security.

The research will give policymakers valuable information to help create policies and actions that improve the fruit sector's productivity, profitability, and ability to compete in exports. Policymakers may facilitate the expansion of fruit operations by efficiently allocating resources, establishing helpful regulations, and investing in infrastructure by having a thorough grasp of the issues that various players confront.

1.5 Research Questions

- What are the production dynamics of major fruits in Malakand Division, including historical trends, contribution to the provincial and national indicators, and what are the key factors driving production, area, and yield?
- What is the value of waste at each stage of the fruit value chain, and what challenges, regulatory, market, and others, do key stakeholders face from production to export?

1.6 Research Objectives

- To analyze the historical trends of major fruits in the Malakand Division.

- To analyze fruit production dynamics using the Decomposition Analysis approach to examine the key contributing factors, such as area, production, and yield.
- To assess the value of waste at each stage of the value chain and quantify the total waste throughout the entire process.
- To examine the primary challenges faced by key stakeholders in the fruit value chains.

CHAPTER 2

LITERATURE REVIEW

2.1 Preamble

Fruits form an important part of the agricultural economy of Pakistan, being a significant source of GDP and with an immense potential to increase export earnings. Despite the increasing local and international demand, the fruit industry is riddled with inefficiency at various levels of the value chain, especially in post-harvest handling, storage, transportation, and marketing, which leads to massive wastages and losses to producers and traders. These structural and functional issues have been the subject of intensive literature with various analyses of the contributions of various stakeholders, market forces, and consumer behavior. The performance of fruit exports, the supply chain governance, and the opportunities of information and communication technologies (ICTs) to modernize the operations of the value chains have also been studied. Parallel to this, trend and decomposition analyses have been undertaken to get insight into the underlying factors that have contributed to growth in fruit production, disaggregated into area expansion, yield improvement, and improvement due to technological changes. The chapter is a critical review and synthesis of the existing literature in developing a clear concept of not only the value chain dynamics, but also the production trends, which will serve as the foundation of knowledge gaps as well as future policy and research directions in the fruit sector in Pakistan.

2.2 Trend and Decomposition Analysis

Decomposition analysis has become a common analytical tool that leads to insight into the components of agricultural (fruit production) growth. This method enables the researchers to break down the overall changes in output into contributions due to area expansion, yield improvement, and an interaction effect, which will give them a better idea about the mechanics of growth. Several researchers have used the approach in different geographic locations and fruit species.

Majumdar & Basu (2006) used the decomposition analysis to determine the growth trend of Indian horticulture. Their analysis disaggregated output growth into area and yield numbers and also concluded that the increase in fruit output in the early 2000s was mainly brought about by the widening of area and not by improvement in productivity. They stressed the importance of

investing in yield-enhancing technologies to realize sustainable agricultural growth. This research paper contends with the fact that Marks of the area expansion supersedes productivity enhancement in Indian horticulture and that technological investment is required. It gives my study a comparative base on which comparable productivity restraints can be seen in the Malakand fruit industry.

Shadmehri (2008) Performed the decomposition of crop production trends in Iran and evaluated the relative importance of area growth, yield growth, and interaction effects in the growth of output. Results of the study revealed that area expansion factors had a remarkable effect on production increase, though not all crops experienced a significant improvement. This was an indication of inefficiencies in practices adoption and transfer of technology. The results of the unequal yield advancement in Iran represent the general problem of ineffective technology spreading in horticulture. My research is similar to this issue because it focuses on the impact of low uptake of modern practices on the productivity of fruits in Malakand.

Rehman et al. (2011)Used the decomposition technique to investigate the role of the main factors of fruit production growth in Pakistan and found that the area growth was the leading factor in fruit production rate acceleration, and an increase in yields had a relatively minor effect. This implied that even in Pakistani fruit farming, they were yet to graduate to a level of more technology-driven farming as opposed to land-driven farming. As they analyze, the growth in fruit production in Pakistan is still an area-based and not a yield-based production, meaning that there is little technological change in the country. This observation is very similar to the argument made in my study about the necessity to modernize and increase the efficiency of inputs in the fruit production in Malakand.

Work by Ali et al. (2014) is an expansion of the framework to the case of wheat production in Pakistan through an improved multiplicative model. Through deconstruction, they broke down the growth of production into area effects, yield, and interaction effects as the years went by. Their methodology gave a systematic method of isolating the effect of each factor, and this study adopts it in the analysis of major fruit crops in Malakand Division. Through the improved productivity decomposition framework, this research presents a model for analyzing productivity drivers. My

study follows comparable analytical reasoning to decouple the structural and efficiency-related issues of the growth of fruit production in Malakand.

Pattnaik & Shah (2015) Decomposed agricultural growth in Gujarat with the inclusion of economic variables. They discovered that the price incentives had a big influence on stimulating area expansion and indirectly on productivity. They advised that, in policy support, another matching should be done through inputs to the market. Their contribution emphasizes the role played by economic motivation in the development of agricultural growth and productivity. This view enhances the knowledge of this study concerning the role of price cues and access to markets in determining the production of fruits in the Malakand Division.

The work by Shilpa et al. (2019) was devoted to the analysis of the apple production trends in the state of Himachal Pradesh, India. Decomposition analysis established that there has been a historical transition that was yield-led in place of area-led growth because of the adoption of high-density apple orchards and better input use. This change has brought in the importance of use of technology in improving productivity per unit area. The example of the shift to a yield-led instead of area-led growth in Himachal Pradesh explains how the adoption of technologies can change the efficiency of production. This transition is used in my research to propose similar technological interventions in the fruit orchards in Malakand.

Rohlupuii (2024)also considered the most important fruit crops- kinnow, guava, and mango, in the case of Pakistan, and represented the decomposition of production growth. According to the findings, the recent enhancement to yield, which was facilitated through the use of modernized inputs and improvement in the orchard management, was the major factor leading to output gains. The study also highlighted the existence of regional imbalances in growth patterns caused by unequal access, technology, and extension services. The fact that the yield increases in Pakistani fruits are now due to better management of the orchards is directly applicable within my field of interest. It strengthens the significance of reducing regional inequalities in access to technology as well as extension services in Malakand.

Together, these papers strengthen the effectiveness of decomposition analysis as a methodological tool in agricultural economics, particularly in breaking down complex production trends in fruit crops. They put forward the necessity to clarify whether the use of yield-increasing technologies

could support the increase in production, or if it were just the expansion of land that made it possible. This thesis implements the decomposition methodology proposed by Ali et al. (2014) in the case of fruit production in the Malakand Division. This allows the overall changes in production to be broken down into yield, area, and interaction effects, which can be used to provide insights into target policy and investment interventions. The literature gap identified regarding the study is that there is limited current and extensive research on growth and decomposition analysis, and specifically on fruit production. The available research is mostly narrow in scope, both in terms of methodology and regions. Accordingly, this thesis contributes to closing that gap by utilizing a more detailed and sophisticated trend and decomposition methodology, analyzing district, divisional, and provincial levels to produce more detailed and actionable knowledge about growth processes and production dynamics in the fruit sector.

2.3 Value Chain Analysis

Agriculture constitutes the most important sector of the Pakistani economy, and fruits form its important part both regarding local consumption and external export possibilities. Despite this importance, the fruit value chain (FVC) in Pakistan is dogged by inefficiencies, underdeveloped infrastructure, poor market connectivity, and insufficient policy support. To develop solutions for enhancing the fruit value chain, there is a need to analyze past research that touches on the various aspects of the value chain, such as production, distribution, marketing, and competitiveness of the fruits in the export markets. This literature review is an exploration of important studies in Pakistan and other similar developing nations to illuminate important findings, common limitations, and emerging approaches in fruit value chain management.

Umetaliev (2014) investigated how fruit is currently distributed, identified inefficiencies, and offers a strong distribution method that uses logistics concepts to increase growers' export potential. It offers a conceptual framework for rethinking the fruit value chain gradually, with an emphasis on developing a responsive and effective system. The main findings of the study include the need to follow the "seven rules" of logistics, the creation of a value chain for dried fruits that includes value addition, and particular logistical procedures. This all-encompassing strategy aims to close the gaps in the current fruit value chain's distribution system and boost its general effectiveness and responsiveness. This work offers an excellent background regarding the role of

logistics principles in enhancing the efficiency of fruit distribution. Its structure will justify my study as it underlines the responsiveness of the system and the necessity to incorporate contemporary logistics in fruit value chains, such as in the case of Malakand Division.

Shahwani et al. (2024) have performed a detailed value chain mapping of the apple industry in Mastung and Kalat districts of Baluchistan, including the opportunities of value addition and marketing. Their research found the key players in the apple value chain, which included suppliers of inputs, producers, intermediaries, processors, and retailers. The results indicated that value-added activities like grading, waxing, cold storage, and packaging were either underexploited or were not used at all at the farm level, resulting in low prices and constraining the expansion of the market. The authors highlighted that weak institutional support and market information asymmetry are limited by infrastructural gaps freezing storage and road network, which play a role in limiting the competitiveness of the Baluchistan apple industry. They suggested specific intervention measures, such as setting up processing units and building better producer associations, as well as incorporating farmers into formal marketing networks, as means of increasing profitability and minimizing post-harvest losses. The research is insightful and can also be applied to fruit value chains in the Malakand Division, where structural weaknesses dominate. This is very important and the latest study, and also very relevant to the focus area of our study. Findings of the research have a direct bearing on my study because the same gaps in infrastructure and poor institutional support are reflected in the fruit sector in Malakand. Their suggestions on the formal market linkages and farmer cooperatives guide potential policy actions in my research.

Badar et al. (2015) examine consumer preferences in the mango market in Pakistan to improve the industry's value chain procedures. By cluster analysis, the study was able to identify three unique consumer clusters by conducting five focus group talks and an intercept survey with 450 customers in four cities. These clusters exhibited significant differences in their priorities regarding search, experience, safety, and marketing attributes. The findings suggest that value chain actors can improve their operations to increase customer satisfaction and generate higher returns by understanding these diverse consumer preferences and anticipating changes in consumer behavior. This paper shows that consumer preferences determine value chain performance, a fact that we

should always remember when developing responsive marketing systems for marketing fruits. My work fills the gap by examining the supply-side inefficiencies on the consumer satisfaction level.

Mehdi et al. (2017) examined opportunities and limitations related to the enhancement of domestic mango value chains in Pakistan. Their study has found systemic vulnerabilities in dealing, transportation, storage, and market connection, and all of them lead to massive post-harvest losses and poor fruit quality. The authors highlighted that the majority of mango producers depended on the traditional intermediated value chain, and there was little value addition done at the farm level e.g., through grading or processing. The availability of markets was restricted in many cases by poor infrastructure and poor institutional provisions that restricted the response by producers to the changing consumer preferences and the quality standard. To enhance domestic value chains, the authors suggested an integrated strategy that included the formation of farmer co-operatives, investment in post-harvest infrastructure, and facilitation of quality certification programs. Their results highlight the role of the organized value chain development in enhancing efficiency and profitability- a concept applicable to the fruit value chains in Malakand Division. The mango chains they have worked with would demonstrate how the failure to manage post-harvest and lack of organization of the farmers restricts the value addition just like in Malakand. My study extends this by determining where in the chain of fruits such inefficiencies are most pronounced and what can be done.

Khan and Han (2017) provide insight into the present apple fruit Supply Chain Management system in Chitral for identifying the related environmental perspective of demand for fresh fruits in Pakistan, while considering environmental-related issues like financial constraints, natural disasters, market access, and technology. The findings state that small subsistence farming should be viewed as a business. The study employs an exploratory research design using secondary data, while reviewing up-to-date literature available. Moreover, it explains the factors that affect the supply chain of the Apple Fruit sector in Chitral, Northern Area of Pakistan. This paper supports the need to consider small-scale fruit farming as a commercial venture as opposed to subsistence farming. This opinion is reflected in my research as I discussed the potential of entrepreneurial strategies to improve profitability and sustainability in the fruit value chain of Malakand.

Gebre et al. (2020) Has examined the banana value chain in Ethiopia and highlighted the key entry-level barriers to marketing as well as on-farm productivity. They indicated in their work that inefficiency in postharvest management, inefficient market information, and inadequate input support systems contained the capacity of the entire chain. They concluded that the only means of enhancing the performance of a farmer and of the entire value chain is to solve its systemic issues with the help of strategies for sustainable development. Though the study mainly focuses on Ethiopia, the knowledge about the systemic inefficiencies and inefficient post-harvest management can be transferred. It reinforces my thesis that the only way to enhance the performance of the entire chain in emerging markets such as Malakand is to solve these structural barriers.

Badar et al. (2019) Examine mango value chains in Pakistan, with mango being the second-largest fruit crop after citrus fruit, which is of much importance to the socio-economic environment of Pakistan. Through 140 in-depth interviews with industry stakeholders, ranging from retailers to input suppliers, conducted across major mango-growing regions in Punjab and Sindh provinces, this paper presents findings from this examination. Thematic content analysis reveals the presence of three distinct value chains operating concurrently within the industry: traditional, modern, and export mango value chains. These chains vary in their dynamics, including product quality, financial mechanisms, inflow patterns, and chain governance structures. The study underscores the potential for enhancing chain performance through improved information dissemination and more effective governance mechanisms, emphasizing the importance of fostering collaborative relationships among stakeholders across various stages of mango value chains. o put their typology of traditional, modern and export mango value chains into a comparative perspective, their study offers an opportunity to my study. I use this framework as a way of explaining the variation in governance and coordination in Malakand fruit marketing networks.

B. Ahmad (2018) states that although the citrus crop is Pakistan's most dominant fruit crop and one of the country's major horticulture export crops, it still has issues with traditional marketing systems regarding price transparency. The issue of a lack of transparency heavily influences producers' ability to react to the demand as efficiently as possible. The study highlights that a general assessment of the citrus value chain needs to determine major factors having an impact on citrus exports from Pakistan. To determine the factors that influence the export performance of the

value chain, the study collected primary data using a convenience sample technique from exporter respondents in Sargodha and Bhalwal. Through ordinary least squares (OLS), major determinants are identified. Findings reveal that the citrus export sector is dominated by well-established exporters, focusing on a high-volume, low-margin business model. Kinnow is a kind of citrus fruit whose export is focused on low or middle-income countries because exporters have limited capacities to supply it to the developed countries, which demand very high quality as stipulated in the Sanitary and Phytosanitary (SPS) agreement of the World Trade Organization (WTO). The regression analysis demonstrates that marketing research and quality certification positively and significantly influence the improvement of Kinnow exports of Pakistan, which once again proves the need to invest in research and development and quality issues. The research also reminds us why post-harvest losses, yield per hectare, and seedless citrus varieties are being focused upon to increase the competitiveness of the Pakistani citrus exports further. This study highlights the importance of quality certification and transparency on export competitiveness. My research expands on this discussion by investigating the restriction of efficiency of domestic fruit marketing in Malakand Division by similar quality and information asymmetries.

Kassa et al. (2017) evaluated the market chain for bananas, avocados, and mangoes in the Bench Maji zone, analyzed the market's structure and performance variables, and described the responsibilities of primary and secondary actors. The study reveals that the fruit market functions as an oligopoly, with a small number of powerful dealers controlling the market and causing non-competitive circumstances. Ite study points out one sales channel that is especially effective, but it also draws attention to several other problems that affect market performance, such as seasonal variations, broker influence, absence of established market centers, and restricted access to market information. These results imply that resolving these inefficiencies and enhancing the infrastructure of the market may improve market performance.

Siddique and Garnevska (2018) investigate the citrus market in Pakistan, focusing on several key areas. The study looks at the different value chains, that is the citrus fruit undergoes from being farmed up to when they get to the consumers and thus identifies the most important stakeholders in the business, including farmers, traders, and retailers, and discovers the key findings: the study has uncovered that, the citrus value chains in Pakistan can be divided into processed and

unprocessed parts, that is citrus products such as, the concentrates and juices are a processed lot, while the fresh citrus fruits are sold directly on the market under an unprocessed category. The paper reveals how exporters, pre-harvest contractors, and citrus growers dominate these value chains. Citrus growers accept the farming of fruits; the pre-harvest contractors accept fruit management before harvesting, while exporters focus on marketing the citrus products abroad.

Waqar et al. (2018) Analyze the use of information and communication technology (ICT) along the citrus value chain in Pakistan and illustrate that a key challenge is filled with an extremely vast digital divide, as well as the need for ICT skills among the actors. Concluding, it is observed that although older age is a debilitation factor to the use of ICT in the production stage, education increases its use. A huge digital divide also exists among the different participants in the value chain, of whom some have far ends compared with other farmers, and value chain participants have better access to and use of ICT. All value chain participants must achieve a minimum level of awareness and competencies in ICT to enhance information use efficiency along the whole value chain. This finding agrees with numerous studies elaborating on the use of ICT within an agricultural value chain and indicating that better access to and education on ICT can lead to more competitive and efficient agricultural markets. The report further provides recommendations about policy aimed at improving the information availability in a sustainable manner, which is a basic aspect and of extreme importance for the all-around growth and development of Pakistan's citrus industry.

Tudor (2020) analyzes the problems and directions for improvement challenging Romania's fruit and vegetable industry, as well as its historical development, agricultural policies, health benefits, and statistical trends. Key conclusions reveal that the Common Agricultural Policy of the European Union has supported a shift toward market-oriented production. It is also noted that producer organizations are instrumental in supply and also align themselves with market demand. However, both total production and planting are witnessing a decline in industry. The report suggests that to revive Romania's fruit and vegetable industry, improvement of the whole production system, aligning with market demand, is required, but at the same time, upgrading facilities for processing and improving harvesting operations are also essential.

Mossie et al. (2020) Analyzed the factors that affect the involvement of smallholders in the fruit value chain in Ethiopia. Their study has indicated that the level of education of the farmers and their accessibility to the agricultural extension services were foremost concerning the success of their participation in value addition. As the paper has indicated, there is a very strong possibility of further knowledge and technical support that would help in embedding the smallholders in other, more lucrative segments of the chain. The research provides some useful information about the role that education and access to extension can play in defining smallholder involvement in value chains and emphasizing the role of capacity-building. On my side, it highlights the importance of the need to increase farmer knowledge systems and technical outreach in Malakand in order to make everyone more inclusive and add value.

Badar et al. (2021) Analyze the export competitiveness of Pakistan's major fruits and vegetables and identify fruits with a high potential for export using the revealed comparative advantage (RCA) indexes. Drawing from the statistics, the country has an optimum comparative advantage in the export of dates, citrus, and mangoes, implying that the commodities exported in these products are large. The study underscores the imperative to strategic investment in R&D, improvements in yields and quality, and better post-harvest management for these fruits and vegetables to achieve further export competitiveness. Such findings are consistent with several research outputs on agricultural export competitiveness that have indeed emphasized the role of innovation and quality improvement in maintaining and expanding market share in international trade. The conclusions of the study provide stakeholders and policymakers with the roadmap to exploit the inherent advantages in Pakistan by filling up the value chain gaps to enhance the nation's standing in global marketplaces. Their competitiveness of exports analysis of Pakistan offers an evidence-based insight of where the value chain investment is required the most. The viewpoint guides my research because it highlights the importance of innovation and post-harvest upgrade in the potential export of fruits in areas such as Malakand.

Maqbool et al. (2021) Used the multiple indices, including revealed comparative advantage (RCA), revealed symmetric comparative advantage (RSCA), relative import advantage (RMA), relative trade advantage (RTA), Trade Balance Index (TBI), and revealed competitiveness index (RC) to evaluate the global competitiveness of Pakistan's fruit exports during 2003-2019. The

empirical findings indicated that Pakistan had a relative and competitive advantage in fruit export during the research period, which in turn means a huge window of opportunity in the horticulture sector. Export of fruit can be one of the key sources of foreign exchange to Pakistan, provided the government provides it the right assistance and facilities. This is consistent with the existing studies, which have argued that government intervention and competitive advantage explain the disparity in the performance of exports of agricultural products. The multidimensional competitiveness test has provided the study with a strong quantitative basis in the study of the dynamics of fruit exports. This study forms the basis of my research, which qualitatively examines the ground realities that limit the ability of Malakand fruit producers to take advantage of such competitive advantages.

Rana et al. (2021) of the International Food Policy Research Institute (IFPRI) conducted an extensive evaluation of horticultural value chains in Khyber Pakhtunkhwa (including the Newly Merged Districts (former FATA)). Their research charted the most important actors, discussed cost and margin structure, and assessed infrastructural and policy limitations. They discovered that even with large volumes of production, in Khyber Pakhtunkhwa, the horticultural value chains are typified by dispassionate marketing structures, insufficient cold storage infrastructures, and value development. The paper highlighted the importance of policymakers and regulators in the development of value chains, especially in terms of investment in infrastructure, regulation of markets, and after-sales services. To enhance efficiency, Rana et al. suggested that farmer-trader linkages, collection centers, storage and processing facilities, and enablement regulatory structures should be promoted. The localized orientation and the policy suggestions they offer are a good starting point in placing the fruit value chain of Malakand Division in the greater provincial context. This IFPRI study has horticultural value chains in Khyber Pakhtunkhwa as its focus; hence, this can be considered a directly relevant provincial study in my research. It helps me prove that infrastructural shortages and poor institutional alignment are the key bottlenecks of the Malakand fruit value chain.

Wardhan et al. (2022) analyze the production dynamics, challenges, and growth opportunities of mango and banana value chains in India and make policy recommendations to improve them. The study emphasizes the fact that fruit crops represent an essential constituent of Indian agriculture.

In particular, tissue culture cultivars, including the Grand Nain variety, increased banana production, which, in turn, helped India become more competitive in exporting bananas. While mango production productivity and area under cultivation increased only marginally. This underscores the need for extended shelf-life mango varieties and improving transportation arrangements for perishable commodities to fully exploit the potential of the mango value chain. Results underscore the need for focused policy initiatives that promote expansion and productivity in such vital fruit industries. The results of India indicate that fruit industries could be changed using specific policy and technological interventions. This offers my research a good comparative view to show that the same strategy may be used to maximize productivity and export preparedness of the fruit industry in Malakand.

2.4 Conclusion and Research Gap

2.4.1 Research Gap

Existing literature provides valuable information about individual elements of fruit value chains such as export performance, logistics, and usage of information and communication technologies, but there is a major lack of extensive on-site studies that can accurately describe the experiences of various stakeholders in the Pakistani fruit industry. The majority of the studies concern specific fruits or restricted local environments, which makes it challenging to employ the research in a larger policy and development planning. Moreover, there is little application of advanced quantitative methods, in this case, the Compound Growth Rate and Decomposition Analysis used across various fruits and administrative levels to evaluate long- and short-term production patterns. The economic impacts of post-harvest losses are also poorly researched, and little work has been done on quantifying the financial drain that such losses present to farmers, traders, and other value chain players. Moreover, there is also an absence of connectivity between the empirical facts in the value chain and effective policy suggestions. There have been minimal qualitative thematic studies that have involved the opinions of farmers, wholesalers, exporters, and agricultural professionals, which could provide insight into the structural, behavioral, and institutional issues of the system.

This study aims to bridge these knowledge gaps by using a mixed-methods design, a combination of quantitative analysis and stakeholder-based qualitative thinking that would lead to more

comprehensive, evidence-based initiatives to enhance the productivity, profitability, and exportability of fruit value chains in Pakistan.

2.4.2 Conclusion

The value chain literature of fruits in developing nations, especially Pakistan, indicates the presence of numerous inefficiencies in production, distribution, and marketing phases, with the key issues being the oligopolistic market structure, lack of adequate infrastructure, low ICT usage, and lack of export competitiveness. Literature highlights the need to understand consumer preferences, increase the level of coordination among the stakeholders, and employ modern governance mechanisms to ameliorate the level of performance in the entire value chain. In parallel, analysis of growth and decomposition indicates that the trend of fruit production is determined by different shares of area expansion, yield enhancement, and technological advancement, and recent studies indicate yield-driven growth replacing land-driven growth. Nevertheless, the majority of the available research is crop-specific (e.g., citrus or mango), geographically restricted, or not refined in terms of methods. The thesis is filling these gaps by analyzing the structural and performance dimensions of fruit value chains as well as applying an adjusted decomposition model to major fruits of the Malakand Division to provide context-specific knowledge to guide policy and development interventions.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Preamble

This chapter discusses the detailed methodology utilized in this study to analyze and investigate the dynamics fruit value chain system of Malakand Division, Khyber Pakhtunkhwa (KPK).

3.2 Description of Study Site

Malakand Division, the largest administrative division in the Khyber Pakhtunkhwa province, governs seven districts, including Swat, Lower Dir, Upper Dir, Buner, Chitral, Malakand, and Shangla, which cover an area of about 29,872 km 2 (Government of Khyber Pakhtunkhwa, 2020). The region has an 8.2 million population (Pakistan Bureau of Statistics, 2023), and it is blessed with a variety of agro-ecological zones that include subtropical lowland (300m above sea level), alpine valleys (more than 4,000m above sea level) that have a variety of horticultural production. This division produces 42 % of all the fruit in Khyber Pakhtunkhwa, and it produces temperate fruits such as peaches 79 % of the provincial output, persimmons (73%), and apples (35%) (Khyber Pakhtunkhwa Bureau of Statistics, 2022). The single-handed production of peaches in the Swat district is 58 % and of persimmons in the Dir region is 68 % of all the production in the division (Agriculture Extension Department, 2021). These crops and their high-throughput management are possible due to the unique microclimates in the area where the average temperature is -2 °C in winter and 38 °C in summer (Pakistan Meteorological Department, 2022).

The region has massive development problems despite its significance as an agricultural area. Access to formalized irrigation exists in just 31 percent of agricultural lands (World Bank, 2021), with about 68 percent of farmers possessing less than 2 hectares of land (Food and Agriculture Organization, 2020). The land is logistically challenging, and only 41 percent of rural populations can access an all-year-round road (Khyber Pakhtunkhwa Planning & Development Department, 2022). The horticulture industry contributes about 57% to the number of jobs in the division and about 23 percent to the overall GDP in the region (Khyber Pakhtunkhwa Economic Survey, 2023). Nevertheless, the loss is expected to reach 35-40% after the harvesting because of poor storage and processing-related infrastructure (United Nations Development Program, 2021).

Malakand Division offers a critical case study of horticultural value chain analysis because of: agro-ecological variety that permits it to grow temperate (apple/peach) and subtropical (persimmon) fruits concurrently (FAO, 2020); concentrated production that has seen 72 percent of farmers practicing fruit farming as the primary livelihood (KP Agriculture Census, 2022); and (3) critical value chain failures that manifest in 38 percent wastage after harvest despite the high yield (UN The geographical limitations of the region (12 percent of lands are arable) combined with the overrepresentation in provincial fruit production (42 percent) forms the paradox that makes it an excellent location to ensure that interventions to increase the efficiency of horticulture are tested (World Bank, 2023). Moreover, its geographic location along the CPEC corridor gives it additional strategic value in terms of streamlining its agricultural value chains in the context of national food security and its export opportunities (Planning Commission Pakistan, 2022). These are geographic, economic, and infrastructural attributes that make the Malakand Division a very crucial case study to analyze the dynamics of the fruit value chain in mountainous agricultural systems.

3.3 Research Design

The current research used a mixed-methods research design to extensively study the dynamics of the fruit value chain within Malakand Division, Khyber Pakhtunkhwa (KPK). By integrating both quantitative and qualitative methodologies in this study, the goal was to get an all-around understanding of historical trends, roles of stakeholders, constraints, and strategies pertinent to fruit production and export in the region. The research in question epistemologically relies on the positivist position by being focused on objective measurement and systematic investigation of the research topic based on empirical observation and measurable evidence (Creswell, 2014). This is in line with the quantitative measures used in the performance of production and post-harvest losses, which are measured by using the Compound Growth Rate (CGR) and Decomposition Analysis. The study is ontologically based on a realist position where it is known that the fruit value chain is in operation in an objective reality that is influenced by institutional, structural, and market forces that are independent of human perception (Guba and Lincoln, 1994). This design combination guarantees a well-balanced, evidence-based, and context-driven study of the processes and limitations behind the fruit value chain within Malakand Division.

3.4 Conceptual and Theoretical Framework

Theoretical and Philosophical Foundation:

The current research assumes a positivist epistemological position and a realist ontological position that represents the belief in objective research and evidence-based knowledge about agricultural value chains. In the positivist perspective, social and economic events, including the production patterns, market coordination, and postharvest losses, can be perceived, quantified, and interpreted empirically to determine the patterns of causality (Creswell, 2014). This is supplemented by the realist ontology that presupposes that the fruit value chain is formed in a concrete and organized reality and is formed by institutional, infrastructural, and market forces that are independent of individual perceptions (Guba and Lincoln, 1994). This philosophical consistency would support the mixed-method design of the study, in which the quantitative scales of Compound Growth Rate (CGR) and Decomposition Analysis are used to assess production dynamics, and the qualitative approach is used to investigate the experiences and structural obstacles of the chain stakeholders.

This study is theoretically grounded using the Value Chain Theory of Porter (1985), though modified to the agri-food systems by Kaplinsky and Morris (2001). Although applications of these frameworks in industrial settings have been widely used, their application to regional horticultural systems is still emerging, especially in Pakistan. The available literature is dominated by studies on individual elements of value chains (e.g. export competitiveness or postharvest management) without taking the interactions between institutional and infrastructural deficiencies to determine their overall performance in terms of chain efficiency. This paper fills that gap, incorporating institutional and environmental factors into the classical model, as the recent conceptual literature in the agri-value chain sector follows (Gereffi and Lee, 2016; UNIDO, 2020). It enhances the applicability of the framework by putting it in the Malakand Division setting, where fragmented markets, poor logistics, and poor coordinating mechanisms exist despite the presence of good production potentials. This research hence provides a localized theoretical framework which connects value-creation with institutional ability, infrastructure, and stakeholder-interaction to provide not only empirical data but also theoretical development to the larger area of agricultural value chain study.

Conceptual Framework: Value Chain Analysis (VCA)

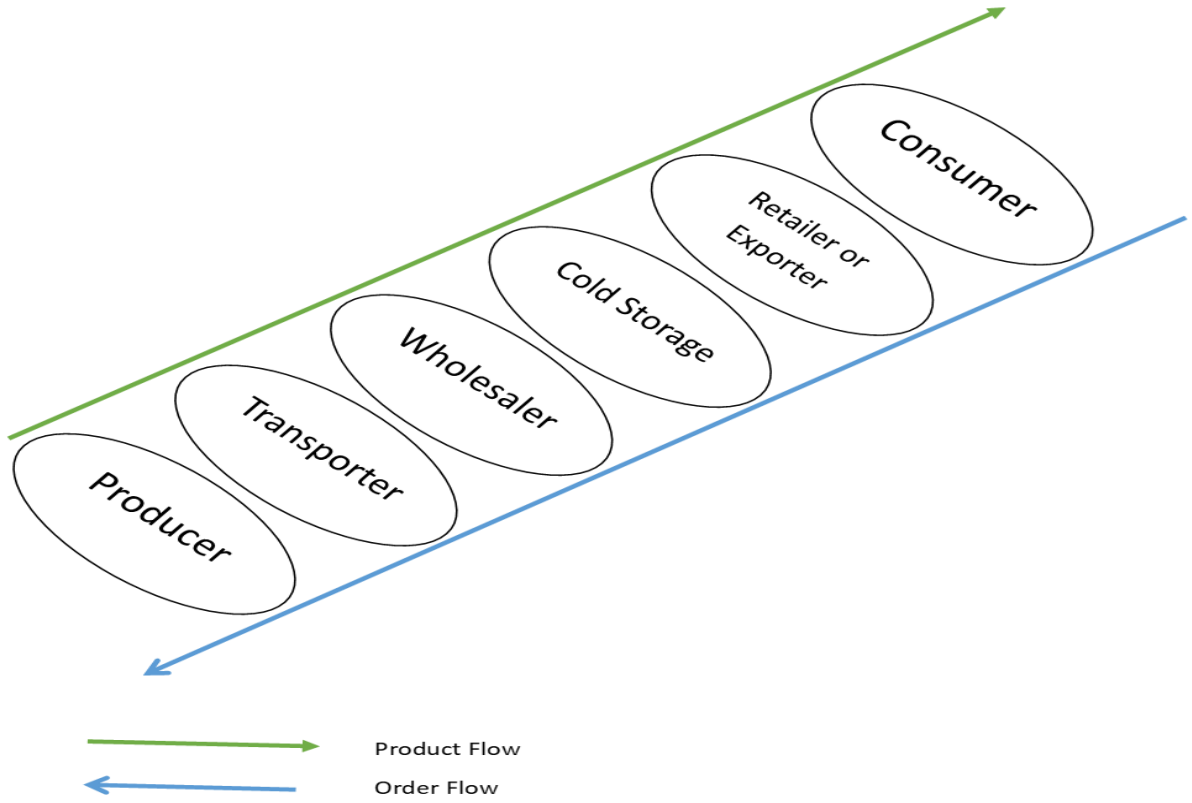


Figure 3. 1 Conceptual Framework of Value Chain

Value Chain Analysis (VCA) in agriculture is a strategic assessment framework that involves dissecting the sequential activities from production to consumption, aiming to identify value-adding steps, inefficiencies, and opportunities for improvement, optimizing operations, and enhancing efficiency in meeting customer demands.

This study is based on a conceptual framework showing how products move step by step through the value chain, from the producer (farmer) to the buyer. The value chain diagram explains that the participants include producers, transporters, wholesalers, operators of cold storage facilities, retailers or exporters, and consumers. Production technology, handling, and sales add value to the product at every development stage. The arrow with the green forward points shows how vegetables leave the farmer's farm, go through different intermediaries, and arrive at the

consumer's table. It represents the movement of information, feedback, and occasional payments that come from customers to the firm. A two-way exchange between agriculture and science improves productivity, guarantees quality, and cuts down post-harvest losses.

Also, the framework encompasses strategic and marketing aspects recognizing that the choices that the stakeholders make in terms of coordination, investment, and access to the market have a direct and direct impact on efficiency and profitability. Value creation is improved by strategic measures, like the creation of producer cooperatives, the setting up of processing units, or investing in cold storage. The marketing channels such as domestic and export channels, grading, branding and quality certification determine reach of products, consumer satisfaction and competitiveness in the export market. Combining these dimensions, the framework creates a holistic picture of interaction between operational, institutional, strategic, and marketing factor and how they influence the performance of the Malakand Division fruit value chain.

3.5 Theoretical Framework

The research is based on the Value Chain Theory by Porter (1985), which offers a systematic methodology of analyzing how constituent activities convert input to marketable outputs and generate competitive advantage. The theory was originally designed in manufacturing industries but adapting it to agricultural systems follows the adaptation done by Kaplinsky and Morris (2001), who reshape the primary activities of the theory described by Porter, which are inbound logistics, operations, outbound logistics, marketing/ sales, and service, into agri-food environments. The analytical power of the framework is that it has a two-prone effect as it focuses both on value-adding activities and on the support structure (technology, infrastructure and human resources) as such and it is especially applicable to study of the fruit sector within Malakand Division where systemic inefficiencies are realized at each of the stages of production, processing and distribution of fruits. The research furthers its classical version by adding institutional and environmental variables as exogenous factors influencing the performance of the value chain, which is based on the modern evidence of Agri-value chain literature (Gereffi & Lee, 2016; UNIDO, 2020), prioritizing cross-country adjustments to the developing economy.

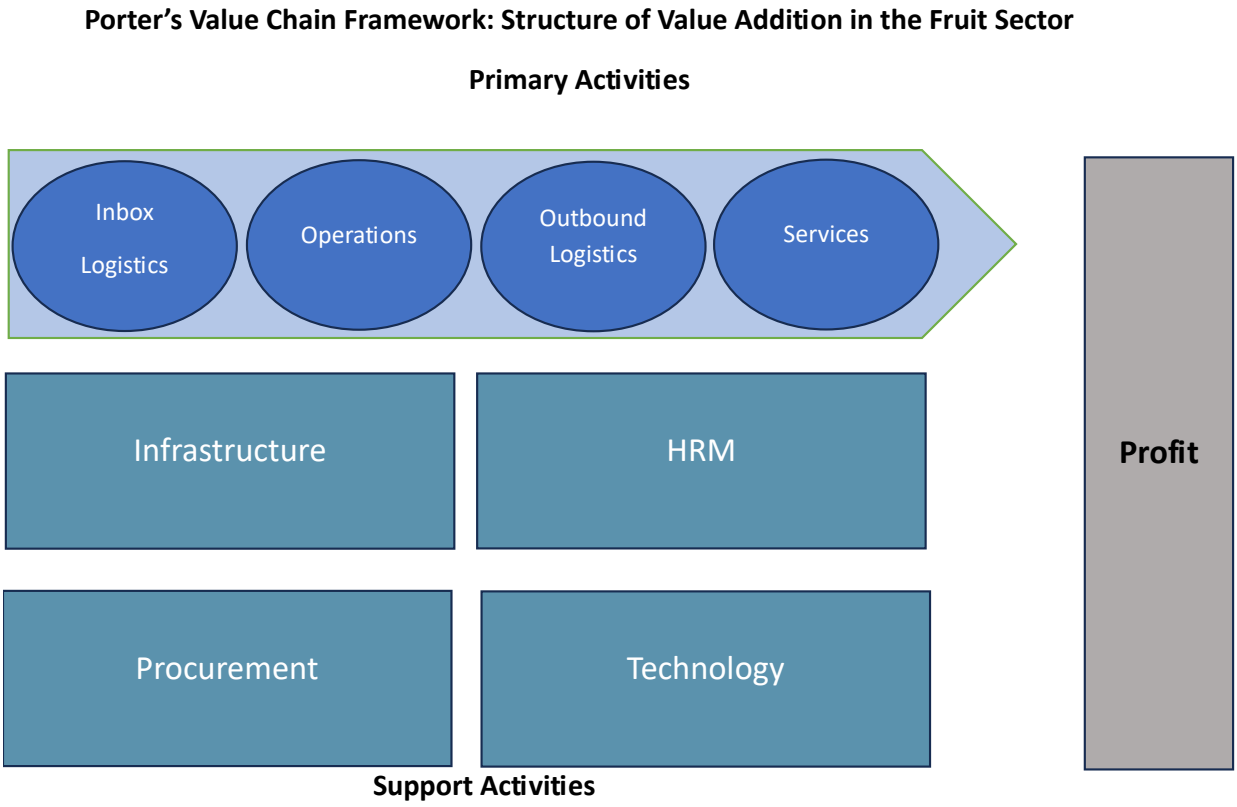


Figure 3.2 Porter's Value Chain Framework

The theoretical foundation of the visual conceptual model designed in the current study is based on the Value Chain Theory by Porter (1985), which is implemented in the setting of agricultural activity after Kaplinsky and Morris (2001). The main activities in this adaptation, which is inbound logistics, operations, outbound logistics, marketing and sales and services, depict the orderly stages in the chain of value of fruits at Malakand Division, whereas the support activities, namely, infrastructure, human resource management, technology-development and procurement, capture the enabling environment which determines value creation in each stage.

The given structure is directly related to the objectives of the study, which are: 1) Examine the production pattern and growth of marketing dynamics of key fruits. 2) Measure post-harvest and financial losses along the chain. 3) Determine barriers experienced by the stakeholders on the farm-to-market. These objectives are linked to the framework, so CGR and Decomposition Analysis deal with production and productivity changes at the operations stage, whereas the waste and loss analysis relates to inefficiencies in inbound logistics, operations, and outbound logistics. In the

thematic analysis of the interviews with stakeholders, barriers in the form of institutional, infrastructural, and market-related are captured in both primary and support activities of the scheme. The framework would be adopted methodologically as a tool to guide the data collection procedures with the Key Informant Interviews (KIIs) and the secondary statistics in order to capture every level within the chain systematically. The quantitative methods (CGR, Decomposition Analysis) were used to quantify the performance related to production stages, and qualitative thematic analysis was used to determine gaps, coordination breakages, and spaces to add value in line with the emphasis made by the framework in terms of inter-activity linkages.

The framework resolves the integration of theory and empirical research (as values are assigned to the levels of the value chain and are visually linked to values of the study), which makes the analysis organized and selective. This correlation enables a transition to a concrete proposal and to the need to reduce system inefficiency and find leverage points, including cold storage investment, better transport, quality certification, and farmer training, which also directly reacts to the priorities supported by the intervention proposed by the theory explained by Porter.

3.6 Sampling

Sampling means the procedure of picking a small sample of people, observations, or cases belonging to a larger population as a model in a research study. As it is inconvenient to study the whole population, because of a time or cost factor or a logistical problem, the sampling technique enables the researchers to generalize about the whole based on the data collected on the sample. A remarkable sampling strategy helps a sample to be representative, which reduces sample bias and increases research findings (Creswell & Creswell, 2018).

3.6.1. Population

The population for this study included farmers, traders, processors, cold storage owners, wholesalers, retailers, regulators, and other relevant stakeholders in the fruit value chain in Malakand Division.

3.6.2 Sampling Technique

This research used a mixed-method method of sampling method so that the stakeholders throughout the fruit value chain in Malakand Division were well represented. Because the study

was aimed at unearthing systemic inefficiencies, it involved the use of a purposive sampling technique to choose key informants (farmers, wholesalers, cold storage operators, and exporters) directly involved with peach and persimmon production and distribution, and the snowball sampling technique was used to carry out referrals (Palinkas et al., 2015).

3.6.3 Units of Data Collection (UDC)

UDC-1: Historical Statistical Data on Production and Area

This unit of data collection (UDC-1) was the historical record of fruits produced, areas cultivated, and yields in Malakand over the period. This data was used for both trend analysis and decomposition analysis.

UDC-2: Stakeholders for every stage of the whole value creation process

UDC-2 were actors of the fruit value chain in the Malakand division, encompassing farmers, processors, traders, exporters, and the owners of cold storage. Information was gathered from these stakeholders through KIIs.

3.7 Data Collection

3.7.1 Quantitative Data

The present study has been accomplished using 19 years of quantitative data from 2004 to 2023 on the area under cultivation and overall production of five major fruits, such as apple, apricot, peach, plum, and persimmon, in Khyber Pakhtunkhwa (KPK), and especially in Malakand Division. These fruits have been specifically chosen because they represent a considerable proportion of the overall fruit production in the province and play their role in the economy of local agricultural communities. The data has been sourced first-hand in the Directorate of Crop Reporting Services (CRS) of the Agriculture Department of KPK because CRS is the only official source of authenticated agricultural statistics of the province. The data set is not publicly available on the Internet, so data collection involved actual visits and official requests to the office of CRS. This dataset is best used to perform trend and decomposition analysis due to its consistency and long-term coverage, which will help in determining how fruit production dynamics change with time.

3.7.2 Qualitative Data

The primary data collected for this study were through 50 semi-structured Key Informant Interviews (KIIs) of stakeholders engaged in the fruit value chain of Malakand Division. The study was limited to peach and persimmon because the two fruits represent a significant %age of the total fruit output of the region and are most important in the dynamics of fruit production, distribution, and marketing in the area. The KIIs would have a guide to understand the amount and worth of the post-harvest losses and the key issues at the various levels of the value chain. Interviews were taken by a varied range of actors to give a multi-dimensional perspective of the system, farmers (52%), retailers (10%), agriculture experts (8%), consumers (8%), transportation agents (8%), stakeholders of the wholesale market (mandi) (8%), cold storage owners (4%), and exporters (2%). These interviews were an excellent qualitative source of information about systemic inefficiencies and infrastructural gaps, as well as the thoughts of the stakeholders about enhancing the fruit value chain performance in the area.

3.7.3 Ethical Considerations

During the process of data collection for this study, high ethical standards were followed with respect to the rights, dignity, and confidentiality of every participant. Key Informant Interviews (KIIs) were done with prior verbal informed consent of the respondents, who were either farmers, traders, cold room operators, or exporters. Participants also had clear information on why the study was being conducted, what the gathered information would be used for, and that they could leave before it was too late without any adverse effects. There were no personal identities registered, and all responses were handled with the highest degree of confidentiality to uphold the identity and privacy of stakeholders involved in the fruit value chain. Participants were not pressurized, and the study did not impose on local customs and cultural norms whenever interacting with the locals. Furthermore, results in an aggregated format were reported, and the traceability of individual responses could not be established. Such ethical conduct was because the qualitative and quantitative information obtained is not only reliable but also ethically obtained, making the research more valid and applicable in the sustainable agricultural growth of Malakand Division.

3.8 Data Analysis

3.8.1 Quantitative Analysis

This study focuses on analyzing the growth rate of fruit production and decomposing the growth factors contributing to the fruit value chain in KPK and particularly the Malakand Division over the last nineteen years, i.e., from 2004 to 2023. In order to have this, time-series data on fruit production, the area cultivated was obtained from the Provincial Crop Reporting Service (Agriculture Department KPK).

3.8.1.1 Trend Analysis or Compound Growth Analysis

In estimating the growth rates in fruit area under cultivation, production, and yield, a compound growth rate as adopted by Shadmehri (2008) and Ali et al. (2014) was adopted. The Compound growth rate was determined by using a semi-log trend equation as follows:

$$\mathbf{lnY = \alpha + \beta t}$$

Where:

- **Y** stands for the time-series data of current fruit area, production, and yield.
- **t is** the trend term.
- **α** is the constant coefficient.
- **β** is the slope coefficient of the line or the amount of change in Y per unit change of the value of the explanatory variable t.

Thus, in this manner, the relative change of Y was divided by 100 to determine the growth of Y to an absolute change of the values of the explanatory variable. Based on this methodology, the proposed study will identify the patterns and trends in the fruit value chain that can reveal the variables affecting productivity and growth during the proposed research.

The Compound Growth Rate (CGR) technique was chosen as opposed to simple absolute growth trend analysis due to the increased accuracy of reflecting the actual rate of change and direction of change of fruit area, production, and harvest within the span of study (2004-2023). In contrast to absolute changes, which merely indicate the raw differences of two points in time

and are susceptible to distortion in the short-term intra-year changes, CGR measures proportionate changes year on year and consequently gives a smooth and more reliable growth path. Within the research framework, where production and area data are affected by climatic shocks, market fluctuations, and policy changes, CGR is a superior gauge of long-term growth trends, as it reduces the impact of outlier years. This renders it very appropriate to compare the two fruits in terms of growth rates in various districts and the provincial trends, which perfectly align with the purpose of the study, which is to gauge competitiveness and dynamic developments in the fruit value chain in the Malakand Division.

3.8.1.2 Decomposition Analysis

The decomposition process of total changes in the fruit production has been used by some authors, such as Majumdar & Basu (2006), Shadmehri (2008), Rehman et al. (2011), and Ali et al. (2014). Therefore, in this study, the approach employed by Ali et al. (2014) was employed to determine the total change in the fruit production in the Malakand Division through the use of the total change in the Area under cultivation, Yield & Area * Yield. These elements could be broken down to understand how each contributes to production trends as follows:

$$\mathbf{\Delta P = \Delta A * Y + \Delta Y * A + \Delta A * \Delta Y}$$

Where:

ΔP represents the change in total fruit production,

ΔA * Y represents the area effect, indicating how changes in the area under cultivation influence production,

ΔY * A represents the yield effect, showing the impact of yield changes on production.

ΔA * ΔY represents the interaction effect, capturing the combined influence of changes in both area and yield.

With the help of this decomposition model, the study identified the temporal pattern of flow of major fruit areas and yield, which will help in identifying their contribution to the overall production pattern in Malakand Division for the last nineteen years. This method assists in

isolating areas that may be instrumental in the increase in production, then taking necessary measures to improve productivity in particular areas.

The Decomposition Analysis was used due to the fact that it is the only approach that can decompose the variations in fruit production into area effect, yield effect, and interaction effect, thus indicating every driver of observed trends. The method in the context of this research is possible because of the production dynamics that would be described by many interconnected factors, like climatic conditions, farmer practices, and access to the market, and thus, the impact of expanded cultivation could be distinguished easily through enhanced productivity. In comparison to other methods of analysis, no other method invokes this degree of detail of quantifying the relative weight of each factor in sequence. Such an ability is paramount to policy-based research as it allows the implementation of interventions that are tailored and specific, say, the emphasis on yield-raising policies compared to expansion policies.

3.8.1.3 Waste Analysis

The value of waste at each stage of VCA was also investigated, which helped in understanding the total waste quantity and value of waste in the complete value chain.

Through waste analysis, we will calculate the amount of fruit lost at each stage of the value chain. Fruit losses can be calculated through waste analysis as follows;

$$\textbf{Waste Value}_i = W_i * P_w$$

Whereas,

- W_i is the amount of waste at stage i
- P_w is the price per unit of wasted fruit

The total value of waste can be calculated as;

$$\boldsymbol{Total\ Waste} = \sum_{i=1}^{n} (w_i * P_w)$$

This would help to quantify economic loss due to the waste of fruit during each stage of VC and total waste across VC. Waste Analysis determines the physical and monetary measure of post-harvest losses at several levels of the value chain. With the study revolving around inefficiencies and revenue losses, this process enables accurate estimation of economic loss by the stakeholders and, in this case, by farmers and traders. The measurements give evidence-based reasons to invest in storage, handling, and transportation enhancements. Waste Analysis was done to determine the amount of post-harvest loss at every point in the fruit value chain of the Malakand Division peaches and persimmons. This is the first time that waste has been measured in a systematic way in the region and nor is there a standard way of analyzing it that accounts for the losses of farmers through to the consumers in a one financial analytical model. Hence, a straightforward but formulated method was established through the use of the primary information collected through the key informant interview and stakeholder surveys that registered quantity managed, quantity lost, and the reason(s) behind the loss, and disposal. This will give the opportunity to break down wastage in a stage-wise manner, thus identifying the highly critical loss points in the chain accurately. This particular approach is new to the extent that it covers all stakeholders and allows us to identify the volumes of losses with their roots, i.e., it is a feasible intervention tool that can be used to design customized loss-reduction interventions.

3.8.2 Qualitative Analysis

In this study, for qualitative data, Key Informant Interviews (KIIs) were conducted with relevant stakeholders or actors involved in the fruits value chain. After the data was collected, three methods were used to analyze the data, such as Waste analysis, Thematic analysis, and SWOT analysis.

3.8.2.1 Thematic Analysis

The Thematic Analysis Approach was used to analyze data and draw results. Thematic analysis is a method of analyzing and interpreting data to identify themes or patterns of meaning within that data. Braun & Clarke (2006) define thematic analysis as a method applicable at various stages of analyzing and reporting data after coding, which allows us to capture the patterns in the qualitative data. It is a technique whereby one gets familiar with the data, develops codes, looks for themes, refines and defines themes, and in the end produces narratives that respond to the research question. The main objective of this analysis is to identify key themes and patterns related to

constraints and opportunities in the fruit value chain within the Malakand division. Themes related to roles, constraints, opportunities, and strategies within the fruit value chain will be identified and synthesized.

Steps involved in the Thematic Analysis

The Thematic Analysis Approach involves various steps for analyzing data that is collected through interviews. According to Bryman & Burges, (1994) The following are steps for the thematic analysis approach.

1) **Familiarization with the data.** All interviews will be completely and precisely documented. After that, to completely understand the information, the written version will be read multiple times. To extract initial conclusions from the data, notes, and initial concepts, which will be documented throughout this process.
2) **Making a flow chart:** After understanding the primary data and information, a flow chart will be constructed based on the merging themes, interlinkages, and dynamics associated with these. This would give us a clear picture of the whole value chain and related factors.
3) **Searching or identifying key themes:** After familiarization with the data, the key notes identified in the documented data will be classified into broader themes so that specific information can be derived according to the research goal.
4) **Generating initial codes:** Each theme will be carefully reviewed again, and these themes will be manually coded to represent important ideas, trends, and problems associated with the study goals.
5) **Revision and summarization of themes**: The identified themes will then be revisited or reviewed again to make sure that the themes are correctly identified. Then the identified themes will be summarized properly so that they accurately reflect the data and make it easier to understand the key findings from the data.
6) **Connecting the dots**: Afterwards, all the dots within the fruit value chain will be connected from the data and ascertain how the whole chain operates and what factors can influence various parts of the chain.

7) **Using themes for interpretation of data/results:** In the last step of the analysis, the summarized themes will be combined into a clear narrative that directly aligns with research questions and objectives, and then meaningful results will be drawn from them.

Why Thematic Analysis?

Thematic analysis is particularly suitable for this study since it allows a rich understanding of qualitative information related to the fruit value chain. Because of the dissimilar roles and interactions of each stakeholder, closed-end interviews or standardized questionnaires will not be sufficient. Thus, open-ended interviews will be conducted using tailor-made questionnaires for each stakeholder. This methodology fosters the identification of dominant themes, strengths, weaknesses, opportunities, and threats inherently associated with the fruit value chain. With the help of the interview data and related documents, the research can be capable of handling major concerns including transport, market access, and regulatory bottlenecks. The thematic analysis will then reveal meaningful insights with regards to the interrelations and factors that influence the value chain. Therefore, practical solutions will be developed that will focus on improving productivity and export potential within the region.

3.8.2.2 SWOT Analysis

SWOT Analysis (Strengths, Weaknesses, Opportunities, Threats) was done in terms of examining the internal and external forces in the fruit value chain of Malakand Division. The method of analysis is useful in highlighting the most significant factors affecting the operation and abilities of a sector or system.(Gürel, 2017). The strengths and weaknesses are internal to the organization, i.e., the organization has high-quality products or is limited in its workforce, and the threats and opportunities are external, i.e., the organization is threatened by a factor like the trend in the market or the issue of climate. The SWOT was applied in the study of this study following the interview with the stakeholders and the analysis of the secondary data to reflect more of the entire value chain of the production of fruits, particularly peach and persimmon.

The SWOT Analysis was used to combine quantitative results with qualitative knowledge obtained by Key Informant Interview (KII). This tool summarizes strengths, weaknesses, opportunities and threats throughout the fruit value chain and gives a strategic overview of the same which will

directly advise the policy remarks. The SWOT can be used in the Malakand context to enable the connection of empirical appearance with care and marketing improvement, less loss, and competitiveness both in the domestic and export marketplaces.

CHAPTER4

RESULTS AND DISCUSSION

4.1 Preamble

This chapter discusses an in-depth analysis of the trends in fruit cultivation and production within the Malakand Division, Khyber Pakhtunkhwa (KPK). This chapter is divided into two sections, i.e., secondary data analysis and primary data analysis. Two distinct methods are applied in secondary data analysis: trend analysis and decomposition analysis. The former explores compounding growth rates in area and production of major fruits, while the latter dissects the contributing factors behind observed trends, enabling a better understanding of the dynamics in fruit production. The analysis is based on secondary data obtained from the Provincial Crop Reporting Service of KPK, covering a comprehensive 19-year period from 2004 to 2023. While in Primary data analysis, thematic analysis, Waste analysis, and SWOT analysis are applied to the data collected through KIIs from relevant stakeholders.

Malakand Division holds a pivotal role in the fruit economy of KPK due to its substantial contribution to the provincial fruit area and production. The region, with its diverse agro-ecological conditions, supports the cultivation of a variety of fruits, making it an essential area of focus for understanding the shifts in agricultural patterns. The selected fruitsapples, apricots, peaches, plums, and persimmonsare key contributors to the local and provincial economy, with Malakand Division consistently maintaining a dominant share in the provincial totals.

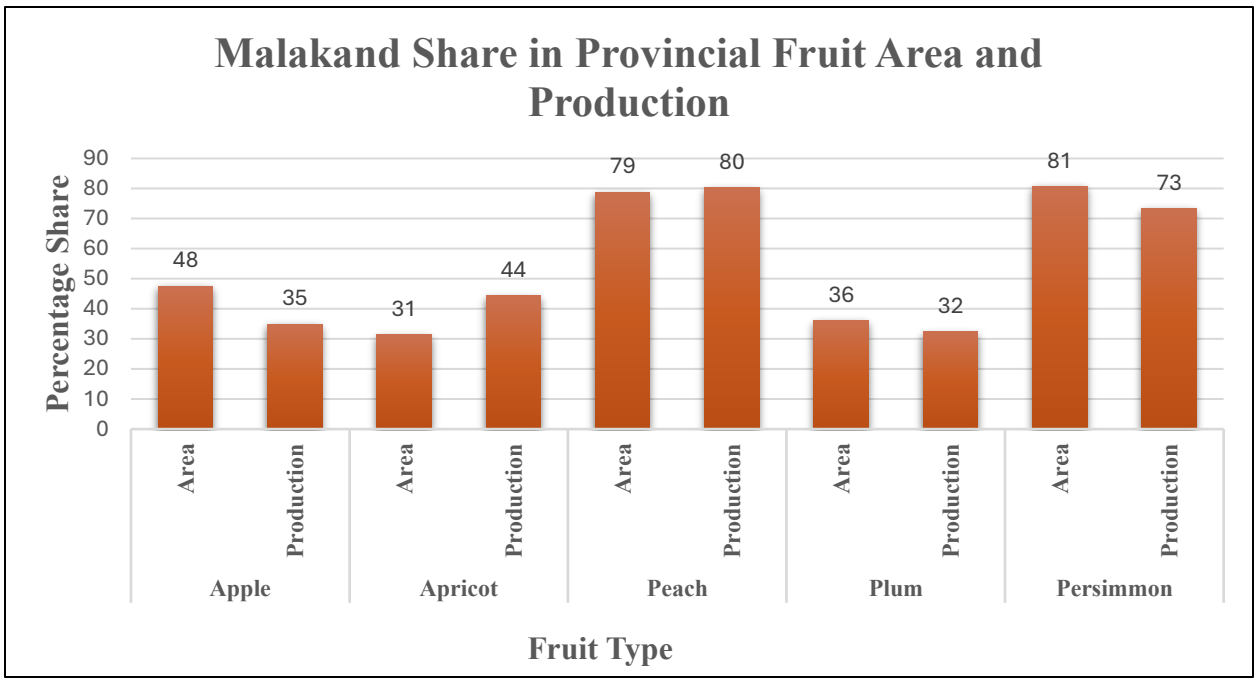


Figure 4. 1 Malakand's Share in Provincial Fruit Area and Production

Figure 4.1 demonstrates Malakand Division's percentage share in the provincial fruit area and production for five major fruits. The data underscores Malakand's significance as a leading fruit producer in KPK. Peaches and persimmons stand out as the most dominant fruits, with Malakand contributing an impressive 79% of the provincial area and 80% of production for peaches, and 81% of the area and 73% for persimmons. These figures highlight Malakand's comparative advantage in cultivating these high-yield crops, potentially due to favorable climatic conditions and soil suitability.

Apple cultivation, while showing lower relative shares compared to peaches and persimmons, still accounts for a significant 48% of the area and 35% of production in the province. However, the gap between area and production indicates potential challenges in productivity, which require further expansion. Similarly, apricots, though cultivated in 31% of the provincial area**,** contribute 44% to the production, signaling higher productivity in this fruit category. On the other hand, plums display a consistent share of 36% in area and 32% in production, reflecting moderate yet stable contributions to the provincial totals.

The statistics indicate that Malakand Division is a major producer of fruits in KPK, in line why this Division was chosen to conduct this research. The region is a leader in all five fruits evaluated, which makes it a model of fruit growing in a heterogeneous geographical region. High levels of peaches and persimmons in the areas and production emphasize the economic significance of the two crops in the region and present the potential to add value and expand into the market.

Simultaneously, the fact that the apples are less productive even despite vast areas under production is a cause of concern when it comes to the subject of efficiency and profitability, which leads to the conclusion that specific intervention steps are required in order to enhance the harvest. The productivity of apricots is high considering their cultivated area, which implies that there is an opportunity to increase production. The stability of plum trends depicts a leveled and well-balanced production system.

These findings point out the complex nature of forces that drive the cultivation of fruits in the Malakand Division, such as climatic provisions, market demand, and personal preferences. These dynamics are the focus of the study, aiming to offer useful insights that would facilitate the development of the policy to improve the sustainability of fruit production in the land.

Overall, the significance of Malakand Division to the production of fruit and its wide-ranging patterns of cultivation makes it a perfect object of study to learn the trend in agricultural patterns in a region. This research study will look at the trends and decompose the factors associated with the production of fruits with the view of providing viable recommendations meant to enhance the productivity and economic feasibility of fruit production in the area.

4.2 Secondary Data Analysis

Secondary data analysis makes use of the available compiled data so that the trends and knowledge about agricultural performance in the long term can be identified, providing the researcher with a picture of the long-term changes. In this regard, two major mechanisms are applied in the examination of the fruit production and cultivation region in Malakand Division, Khyber Pakhtunkhwa (KPK).

Growth Trend Analysis

This approach is concerned with the rate and direction of change with time of the area under cultivation and fruit production. Within the growth rates covering 19 years (2004 to 2023), a semi-log trend is used to predict the trends as being positive (growth), negative (decrease), or stagnant. The analysis is conducted for specific fruits such as apples, apricots, peaches, plums, and persimmons, comparing divisional (Malakand Division) and provincial (KPK) levels.

Decomposition Effect Analysis

This method disaggregates the observed changes in fruit production into distinct contributing factors, allowing for a more detailed understanding of the drivers behind the trends. It examines:

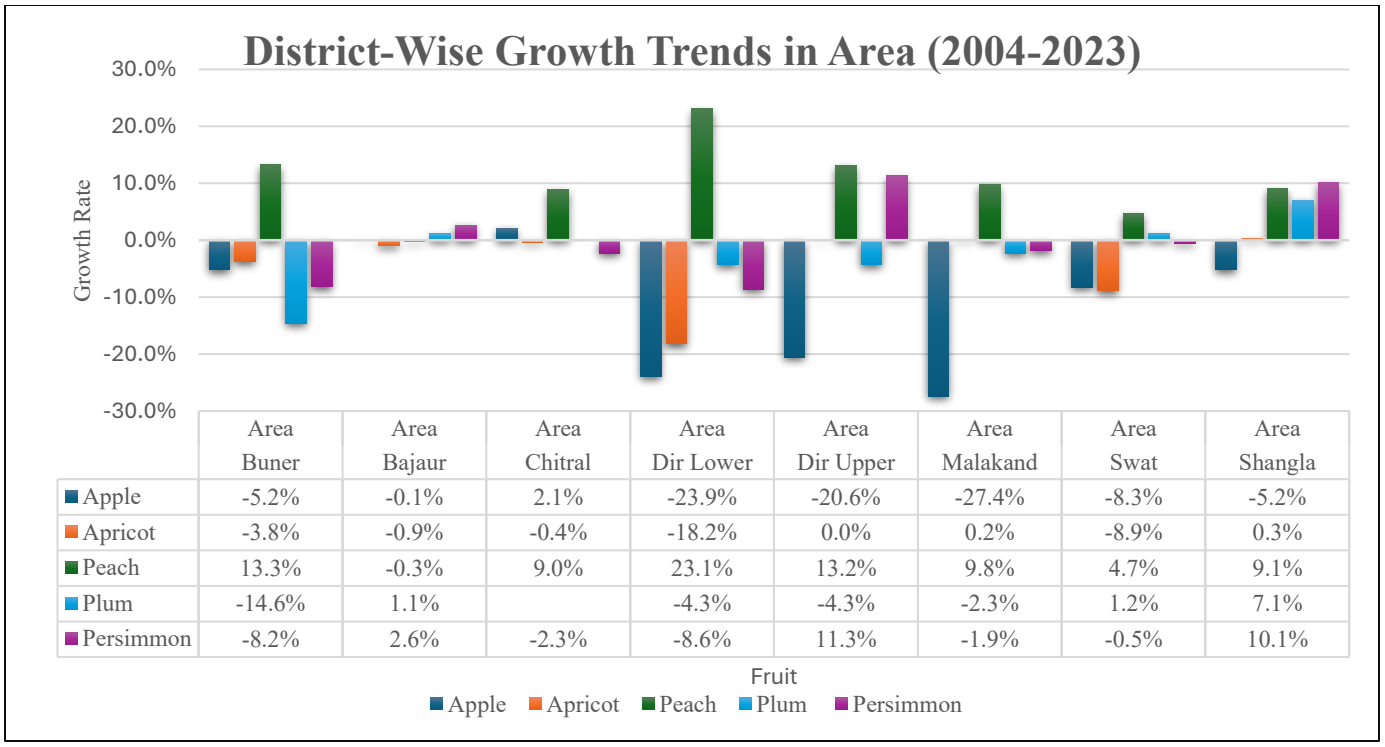
- Area Effect: The contribution of changes in the cultivated area to production trends.
- Yield Effect: The impact of variations in yield per unit area, which may result from factors like farming practices, seed quality, or climatic conditions.
- Interaction Effect: The combined influence of changes in both areas and yield.

This analysis is also conducted for specific fruits such as apples, apricots, peaches, plums, and persimmons, comparing divisional (Malakand Division) and provincial (KPK) levels.

4.2.1 Growth Trend Analysis

4.2.1.1 District-Wise Growth Rate of Area under Cultivation

This analysis examines the growth rate trends in the cultivated area (in acres) for various fruits across all districts of Malakand Division, Khyber Pakhtunkhwa, based on data obtained from the Provincial Crop Reporting Service KPK, spanning the last 19 years (2004–2023). The analysis provides insights into district-specific changes in cultivation patterns for apples, apricots, peaches, plums, and persimmons, highlighting regional and crop-specific trends that can inform agricultural policy and planning.



	Area Buner	Area Bajaur	Area Chitral	Area Dir Lower	Area Dir Upper	Area Malakand	Area Swat	Area Shangla
Apple	-5.2%	-0.1%	2.1%	-23.9%	-20.6%	-27.4%	-8.3%	-5.2%
Apricot	-3.8%	-0.9%	-0.4%	-18.2%	0.0%	0.2%	-8.9%	0.3%
Peach	13.3%	-0.3%	9.0%	23.1%	13.2%	9.8%	4.7%	9.1%
Plum	-14.6%	1.1%		-4.3%	-4.3%	-2.3%	1.2%	7.1%
Persimmon	-8.2%	2.6%	-2.3%	-8.6%	11.3%	-1.9%	-0.5%	10.1%

Figure 4. 2 District-Wise Area Trends

In comparing the growth rates of cultivated area in the major fruits within the districts of Malakand Division between 2004 and 2023, drastically different trends in crop development are observed, influenced by environmental changes, market forces, policy situations, and supply chain limitations. The entire eradication of apple farming in Buner (-100%) and Malakand (-27.4%) reflects both climatic vulnerability and inefficient governmental interventions in orchard rehabilitation, consistent with Rohlupuii (2024), who highlighted regional imbalances in fruit production due to unequal access to modern inputs and extension services. Dir Lower (-23.9%) and Dir Upper (-20.6%) also show sharp decreases in apple cultivation, driven by deteriorating profitability, pest attacks, and limited extension support, echoing findings from Khan and Han (2017) in Chitral, who identified similar supply chain and environmental constraints in northern apple production.

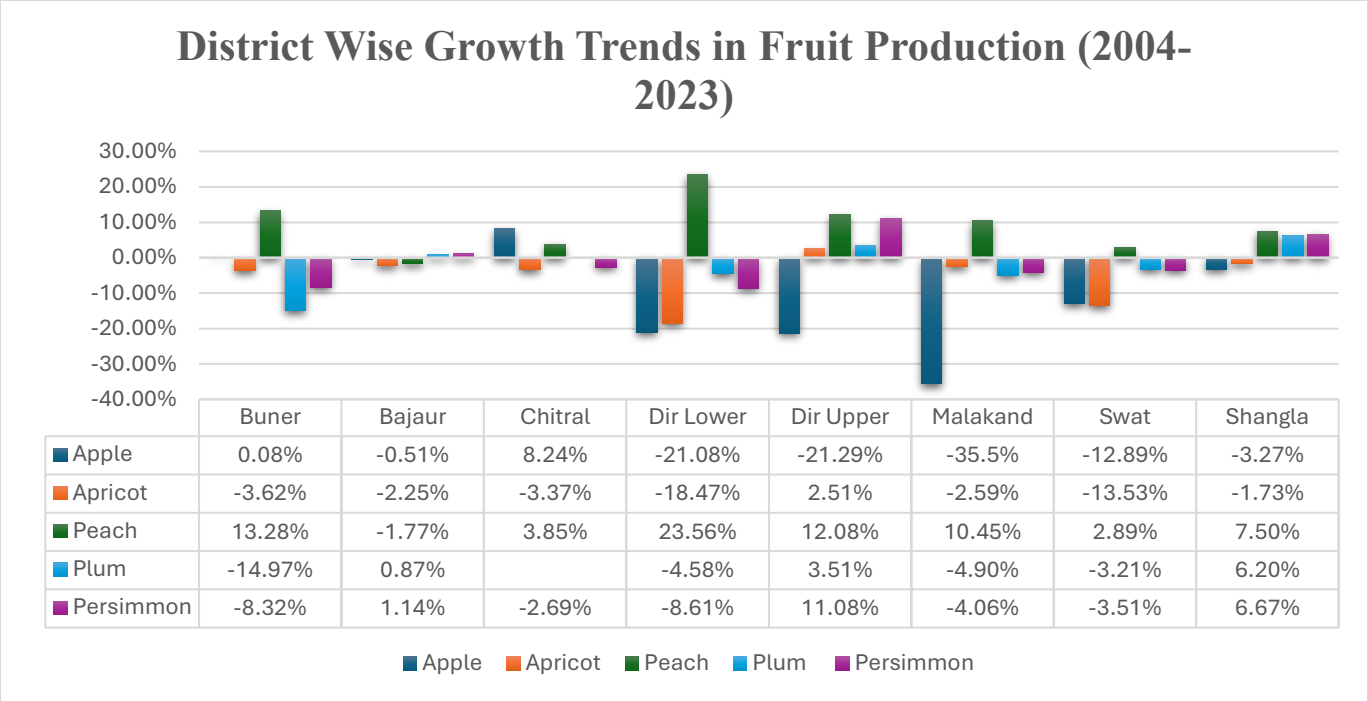
Conversely, peach cultivation expanded strongly in Dir Lower (+23.1%), Buner (+13.3%), and Dir Upper (+13.2%), suggesting greater adaptability and shorter-term harvesting cycles that yield higher returns. This aligns with Mehdi et al. (2017), who emphasized the advantage of fruits with

higher resilience and faster market turnover in domestic value chains. Persimmon area growth was notable in Dir Upper (+11.3%) and Shangla (+10.1%), while remaining relatively stable in Swat (-0.5%) and Bajaur (+2.6%), reflecting crop-specific climate resilience highlighted by Rana et al. (2021) in Khyber Pakhtunkhwa's horticultural chains. Apricot and plum trends were generally stable, though Dir Lower saw a decline in apricot (-18.2%) and Shangla showed growth in plum (+7.1%), underscoring the importance of local research, post-harvest operations, and market connectivity for optimizing crop potential (Aurangzaib et al., 2024; Shahwani et al., 2024).

Chitral and Bajaur show relative stability in fruit production, suggesting either environmental steadiness or a lack of modernization focus, while Shangla demonstrates strong growth in peaches (+9.1%) and persimmons (+10.1%), indicating its potential to become a horticultural development hub. These district-level trends emphasize the need for targeted policy interventions, including the promotion of climate-resilient varieties, subsidized modern orchard management techniques, and improved market infrastructure. Addressing supply chain bottlenecks, particularly cold storage, transportation, grading, and packaging facilities, can enhance competitiveness for high-performing fruits, especially in declining apple regions. Additionally, strengthening agricultural extension services, market linkages, and climate-smart farming practices can help mitigate losses in underperforming districts like Dir Lower and Malakand while supporting continued growth in districts such as Shangla and Dir Upper (Rana et al., 2021; Mehdi et al., 2017; Khan & Han, 2017).

4.2.1.2 District-Wise Growth Rate of Production

The analysis provides an insight into growth rate patterns in the production of fruits within the districts of the Malakand Division of Khyber Pakhtunkhwa using 19 years of data (2004-2023) provided by the Provincial Crop Reporting Service KPK. The trends indicate that there are differences in the production of apples, apricots, peaches, plums, and persimmons across all the districts, depending on the changes in cultivation practices, market dynamics, and environmental influence. Such observations can inform policies that help in realizing sustainable agricultural expansion in the region.



	Buner	Bajaur	Chitral	Dir Lower	Dir Upper	Malakand	Swat	Shangla
Apple	0.08%	-0.51%	8.24%	-21.08%	-21.29%	-35.5%	-12.89%	-3.27%
Apricot	-3.62%	-2.25%	-3.37%	-18.47%	2.51%	-2.59%	-13.53%	-1.73%
Peach	13.28%	-1.77%	3.85%	23.56%	12.08%	10.45%	2.89%	7.50%
Plum	-14.97%	0.87%		-4.58%	3.51%	-4.90%	-3.21%	6.20%
Persimmon	-8.32%	1.14%	-2.69%	-8.61%	11.08%	-4.06%	-3.51%	6.67%

Figure 4. 3 District-Wise Production Trends

Apple production has declined most sharply in Malakand (-35.5%), primarily due to cessation of cultivation over the past nine years. Field interviews indicate that frequent pest attacks, hailstorms, and limited government support for disease-resistant varieties are the main causes. Declines in Dir Lower and Dir Upper (-21.1% and -21.3%, respectively) reflect aging orchards and farmer shifts toward more profitable crops. These findings align with Rohlupuii (2024) and Khan & Han (2017), who highlight climate vulnerability, poor orchard management, and weak institutional support as key determinants of declining apple production in northern Pakistan.

Apricot production also declined significantly in Dir Lower (-18.5%) and Malakand (-13.5%), influenced by low market demand, limited value-added opportunities, and poor storability, consistent with Mehdi et al. (2017) and Badar et al. (2015), who emphasize post-harvest losses and infrastructure limitations as major constraints in fruit value chains. Persimmon and plum production trends similarly reflect infrastructure deficiencies and limited market access, with reductions in Buner (-8.3% for persimmon; -15.0% for plum) highlighting the impact of transportation bottlenecks and inadequate storage (Rana et al., 2021; Shahwani et al., 2024).

Conversely, peach production registered high positive growth in Dir Lower (+23.6%), Buner (+13.3%), and Dir Upper (+12.1%), supported by favorable agro-climatic conditions, increasing domestic demand, and relatively stable prices. Shangla consistently shows rising production for peaches (+7.5%), persimmons (+6.7%), and plums (+6.2%), reflecting reduced pest pressure, cooler temperatures, and improving market linkages. Chitral has reported moderate gains in apples (+8.2%) and peaches (+3.9%), attributed to natural cold storage conditions and lower pest prevalence, though limited market access remains a constraint. Bajaur remained largely stable across fruit categories, indicating some resilience but low adoption of modern practices.

Overall, these district-level production trends highlight that declines are typically driven by climate variability, lack of varietal improvement programs, low infrastructure, and limited integration of the value chain, whereas the growth of peaches and persimmons points to opportunities for targeted investments in cold storage, farmer training, and transport infrastructure. These observations align with prior studies on Pakistan's horticultural value chains (Mehdi et al., 2017; Rana et al., 2021; Rohlupuii, 2024), underscoring the need for coordinated interventions to enhance productivity and market competitiveness.

4.2.2 Provincial and Divisional-Wise CGR Analysis

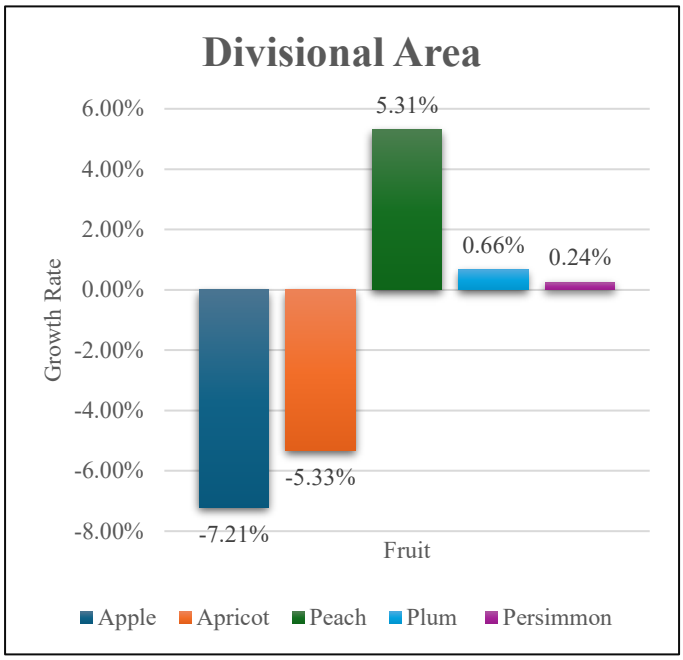


Figure 4. 4 Divisional Area Trends

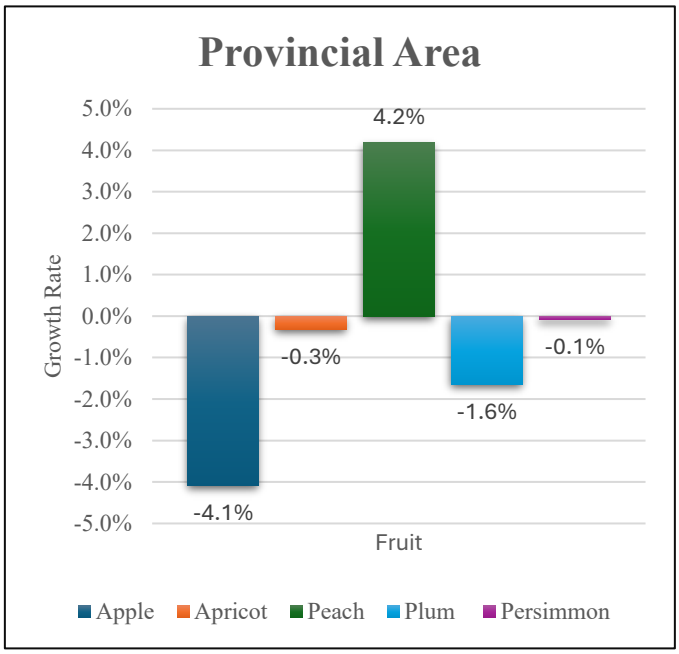


Figure 4. 5 Provincial Area Trends

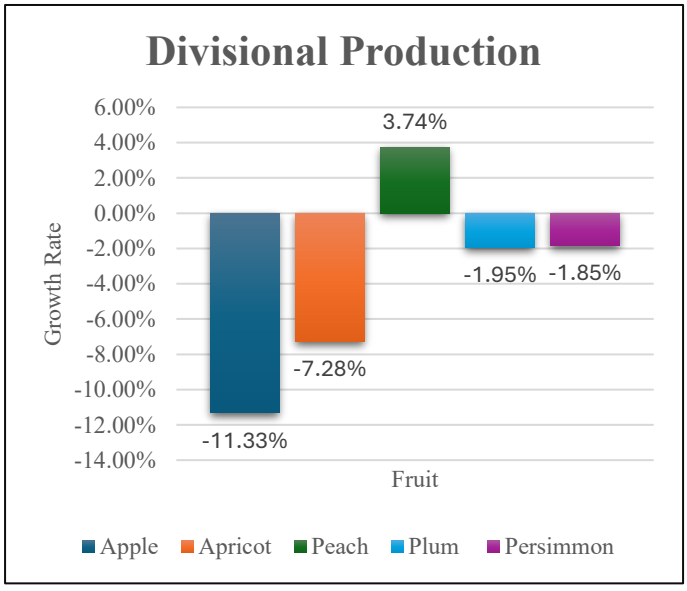


Figure 4. 6 Divisional Production Trends

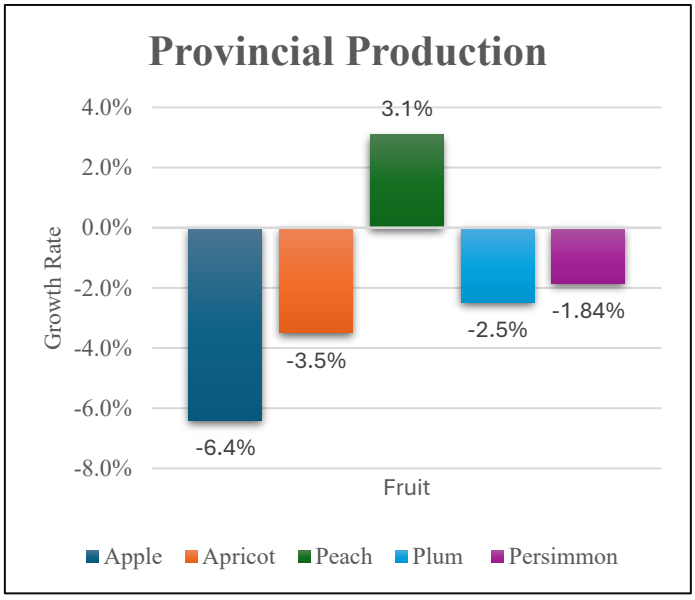


Figure 4. 7 Provincial Production Trends

The above figures represent the trend analysis of the growth rate of area under cultivation and Production of different fruits at the divisional (Malakand Division) and provincial (Khyber Pakhtunkhwa, KPK) levels between 2004 and 2023. The Divisional data was provided by the Provincial Crop Reporting Service of KPK, and the Provincial data was taken from AMIS agriculture statistics, which gives beneficial information about the comparative growth performance of Apple, Apricot, Peach, Plum, and Persimmon crops in the region. This discussion can be crucial in explaining the trends in agriculture and coming up with fruitful policies concerning long-term sustainability in the fruit production industry.

4.2.2.1 Divisional vs. Provincial Area Growth Trends

The comparative Compound Growth Rate (CGR) analysis of cultivated area in Malakand Division and Khyber Pakhtunkhwa Province reveals regional variations driven by localized agro-economic realities. In Malakand, apple cultivation recorded a sharper decline (-7.21%) compared to the provincial level (-4.1%), indicating local issues such as declining profitability, pest pressures, or changing farmer priorities (Rohlupuii, 2024; Khan & Han, 2017). Similarly, apricot farming decreased by -5.33% in Malakand versus a negligible provincial decline of -0.3%, highlighting potential environmental constraints, water availability issues, and preference shifts at the local level (Mehdi et al., 2017).

Conversely, peach cultivation showed healthier growth in Malakand (+5.31%) compared to the province overall (+4.2%), underlining Malakand's emerging significance as a key peach-producing region. Plum cultivation also registered modest positive growth (+0.66%) despite a provincial decline of -1.6%, suggesting successful local investment and land suitability. Persimmon cultivation remained stagnant, with minimal growth at 0.24% in Malakand and 0.1% provincially, reflecting both crop-specific limitations and market-access constraints.

The CGR comparison underscores the need for region-specific policy interventions: for instance, strategies to stabilize declining apple and apricot cultivation in Malakand, and support measures for the expansion of high-growth fruits like peaches and plums. These results align with the broader literature on regional horticultural development in Pakistan, emphasizing the importance of crop diversification, climate-resilient varieties, and infrastructural investment to optimize productivity and value chain performance (Rana et al., 2021; Shahwani et al., 2024).

4.2.2.2. Divisional vs. Provincial Production Growth Trends

The comparison of fruit production growth between Malakand Division and Khyber Pakhtunkhwa Province indicates significant regional variations, reflecting both opportunities and constraints. Apple production in Malakand declined sharply by -11.33%, exceeding the provincial decline of -6.4%, suggesting local factors such as climate stress, pest incidence, and declining yields (Rohlupuii, 2024; Khan & Han, 2017). Apricot production also decreased more in Malakand (-

7.28%) than provincially (-3.5%), highlighting limited adoption of modern practices and restricted access to improved inputs (Mehdi et al., 2017). In contrast, peach production in Malakand grew at +3.74%, slightly above the provincial growth of +3.1%, reflecting favorable agro-climatic conditions and rising market demand. Plum production was relatively stable (-1.95% in Malakand vs. -2.5% provincially), showing resilience, while persimmon remained stagnant at -1.85% locally and -1.84% provincially, indicating limited innovation or market-driven incentives (Rana et al., 2021; Shahwani et al., 2024).

These patterns emphasize the need for targeted policy interventions: declining crops like apples and apricots require investment in disease-resistant varieties, improved orchard management, and cold storage infrastructure, while high-growth fruits such as peaches benefit from enhanced marketing, export promotion, and value addition initiatives. The findings are consistent with previous studies highlighting the importance of localized strategies, infrastructure development, and value chain strengthening to enhance the competitiveness of horticultural production in Pakistan (Aurangzaib et al., 2024; Badar et al., 2021).

Conclusion

Growth patterns at district and provincial levels indicate some very critical divergences in production dynamics in the fruit setting of Malakand Division, both on agroecological grounds and on market grounds, which support each other and concurrently criticize the current literature on mountain horticultural systems. The continuing fall in the production of apples (-7.21% of the contracting area; -11.33% of the decrease in yields) also indicates a reduction in the viability of crops, which experts explain by the lack of winter freezing to the correct number of hours below 7 o C (<800 hours to enable the normal fruit set) (Agriculture Extension Department KP, 2023), and the unavailability of late-flowering varieties that adapted to spring frosts (Horticulture Research Institute, 2022). This is contrary to the national growth in apple production in Pakistan (+3.1% / year; PBS, 2023) and matches worldwide temperate fruit contraction in low-chill countries (Luedeling et al., 2021), as well as empirical results reported by Wardhan et al. (2022) on the Indian Himalayan states, where the increase in microclimatic suitability is already shifting to stone fruits. On the contrary, peach plantations have been growing in areas at a high pace (+5.31%; +3.74% increase in production), owing to climatic conditions fit (1,200-1,500 chilling

hours), a set of 12+ commercial varieties with staggering fruiting seasons (June-September), and the subsequent profit margin holds the benefit of 28-35% advantage of apples (CRS KP, 2023). At the level of the districts, extreme differences appear: the outstanding results of Shangla about the peach and persimmon (9.1 percent and 10.1 percent area growth, respectively) confirm the claims of Kaplinsky (2000) in terms of geographic niche specialization, whereas the complete failure of apple production in Buner (-27.4 in percentage terms) speaks to the literature on the falls of mono-cropping systems (UNDP, 2021). The decomposition analysis qualifies this trend, revealing that the area-dependent growth of peach (132.2 percent contribution) reveals vulnerability to extensification, which has been criticized by the World Bank (2023) as unsustainable. Comparatively, the yield-led growth of apple (62.2%) indicates the presence of intensification issues, even though Malakand holds 59.5% of the provincial share of fruit.

At the provincial level, the leading growth of Malakand in peaches (5.31%) supports the competitive advantage element explained by the Rohlupuii (2024), and the below-average production of apples (-11.33 percent vs. KP) reflects on institutional failures in technology transfer (KP Agriculture Department, 2022). Combined with the above results, these findings require spatially differentiated policies to achieve the following: (1) maximize success issues such as the high-density orchards in Shangla provided through PHDP-funded nurseries, (2) check apple declines through chilling-hour mapping and low-chill varieties (e.g., Anna), and (3) focus on climate-smart intensification more than on land acquisition, which is fitted with the sustainable frameworks provided by Rockström et al. (2017) and aims at solving the 38% yield gap in both crops (World Bank, 2023).

4.2.3 Decomposition Effect Analysis

4.2.3.1 Decomposition Effect Analysis: District-Wise Overview of Fruits in Malakand Division

Table 4. 1 District-Wise Decomposition Analysis of Fruits of Malakand KPK

Fruits	Effect	Buner	Bajaur	Chitral	Dir Lower	Dir Upper	Malakand	Swat	Shangla
Apple	Area	322.40	78.19	8.81	100.87	96.59	81.48	53.02	162.72
	Yield	-362.57	25.66	115.07	-1.75	96.59	24.78	50.95	-64.99
	Interaction	140.16	-3.85	-23.88	0.88	-8.75	-6.26	-3.98	2.28
Apricot	Area	-1479.16	-85.51	50.60	95.63	14.91	-71.85	37.19	30.41
	Yield	20.46	179.70	55.51	6.38	63.66	169.10	64.85	71.55
	Interaction	1558.70	5.81	-6.11	-2.01	21.43	2.75	-2.04	-1.96

Peach	Area	99.86	-123.54	1956.39	85.15	106.89	98.05	151.89	133.16
	Yield	0.13	225.09	-1674.45	14.06	-15.59	1.95	-82.04	-25.94
	Interaction	0.01	-1.55	-181.94	0.79	8.70	0.00	30.15	-7.21
Plum	Area	70.88	145.11		85.53	107.85	47.10	-49.14	116.32
	Yield	32.97	-38.18		15.06	-6.47	54.61	153.09	-18.77
	Interaction	-3.85	-6.92		-0.59	-1.38	-1.71	-3.95	2.46
Persimmon	Area	105.92	154.57	0.00	80.34	106.81	148.29	9.33	156.66
	Yield	3.96	-48.15	100.00	3.87	-5.86	-48.03	110.54	-46.96
	Interaction	-9.89	-6.42	0.00	15.79	-0.95	-0.26	-19.87	-9.70

This decomposition effect analysis assesses the production driversArea Effect, Yield Effect, and Interaction Effectfor five key fruits (apple, apricot, peach, plum, and persimmon) across the districts of Malakand Division. The analysis is based on district-wise production and area data spanning 2004–2023, obtained from the Crop Reporting Service of Khyber Pakhtunkhwa (KPK). Negative values represent declines or adverse impacts, while zero values indicate stagnation or lack of production. The insights highlight the dominant factors influencing production changes and provide a foundation for policy recommendations.

Apple

1. **Buner**

Apple production in Buner is primarily driven by area expansion (+322.40), reflecting efforts to expand the cultivated land. However, this is heavily offset by a sharp decline in yield (-362.57), due to issues such as declining soil fertility, pest attacks, or lack of technical support. The interaction effect (+140.16) shows some positive contribution from the combined effect of area and yield, but it is insufficient to counter the negative yield trend. Addressing yield-related challenges through better orchard management and input provision is crucial.

2. **Bajaur**

In Bajaur, apple production benefits from modest area expansion (+78.19) and improved yield (+25.66), together with driving growth. However, a minor negative interaction effect (-3.85) suggests inefficiencies in aligning area expansion with yield improvements. While the overall outlook is positive, enhancing orchard management practices and addressing interaction inefficiencies could further boost production.

3. **Chitral**

Apple production in Chitral is yield-driven (+115.07), reflecting significant improvements in orchard productivity, due to favorable climatic conditions or better farming practices. However, limited area expansion (+8.81) restricts further production gains, and the negative interaction effect (-23.88) highlights inefficiencies in utilizing expanded cultivation. Policies should focus on optimizing area utilization and addressing interaction challenges to sustain growth.

4. **Lower Dir**

Apple production in Lower Dir is primarily driven by area expansion (+100.87), but the slight decline in yield (-1.75) poses a challenge to sustainable growth. The minimal positive interaction effect (+0.88) adds marginally to production. Efforts to enhance yield through better pest control, irrigation, and modern techniques are essential to maximize the benefits of expanded cultivation.

5. **Upper Dir**

Upper Dir shows balanced growth in apple production, with significant contributions from both area expansion (+96.59) and yield improvement (+96.59). However, the negative interaction effect (-8.75) indicates inefficiencies in aligning area and yield improvements. Policymakers should focus on optimizing orchard practices to reduce inefficiencies and capitalize on the district's balanced growth potential.

6. **Malakand**

In Malakand, apple production is driven by both area expansion (+81.48) and yield improvement (+24.78). However, the negative interaction effect (-6.26) slightly undermines the overall growth. Addressing interaction inefficiencies and improving farming practices, such as providing technical support and better inputs, could further enhance production.

7. **Swat**

Apple production in Swat is equally driven by area expansion (+53.02) and yield improvement (+50.95), indicating a balanced growth pattern. The negative interaction effect (-3.98) shows minor inefficiencies that can be addressed through better resource utilization. Strengthening orchard management and addressing post-harvest challenges could improve the district’s productivity further.

8. **Shangla**

Shangla’s apple production is heavily reliant on area expansion (+162.72), making it the primary driver of growth. However, a sharp decline in yield (-64.99) raises concerns about sustainability, due to poor soil conditions, pests, or climatic challenges. The positive interaction effect (+2.28)

adds minimal support. Focusing on yield enhancement through better farming techniques and input provision is crucial for long-term growth in Shangla.

Apricot:

1. **Buner**

Apricot production in Buner is negatively driven by a significant decline in area (-1479.16), indicating a steep reduction in the land under cultivation. However, this is partially offset by yield improvement (+20.46) and a positive interaction effect (+1558.70), suggesting that the limited remaining area has become more productive. This highlights the need for policies to stabilize and recover cultivation areas while maintaining improved yields.

2. **Bajaur**

In Bajaur, apricot production is primarily driven by yield improvement (+179.70), with moderate area decline (-85.51) and a slight positive interaction effect (+5.81). This indicates that productivity gains are compensating for reduced cultivated land. Strategies should focus on sustaining yield improvements while encouraging area expansion to maintain long-term production levels.

3. **Chitral**

Apricot production in Chitral is driven by yield improvements (+55.51), while area expansion (+50.60) contributes positively but modestly. However, the negative interaction effect (-6.11) indicates some inefficiencies in aligning area and yield growth. Optimizing orchard management and aligning expansion strategies with yield potential can enhance productivity further.

4. **Lower Dir**

In Lower Dir, production is positively influenced by area expansion (+95.63) and a small yield improvement (+6.38). However, a negative interaction effect (-2.01) highlights inefficiencies in integrating the two factors. Policies should focus on improving yield alongside expanded cultivation to achieve balanced growth.

5. **Upper Dir**

In Upper Dir, apricot production benefits from yield improvement (+63.66), with modest area expansion (+14.91). The positive interaction effect (+21.43) further supports growth. This

balanced pattern indicates opportunities to strengthen both areas and yield contributions through targeted interventions, such as providing inputs and technical support.

6. **Malakand**

Malakand's apricot production is driven by yield improvements (+169.10), compensating for a substantial decline in area (-71.85). A slight positive interaction effect (+2.75) also contributes to production. Efforts should focus on addressing area decline by incentivizing farmers to continue cultivating apricots while maintaining yield growth through modern techniques.

7. **Swat**

In Swat, apricot production is heavily yield-driven (+64.85), with a modest positive contribution from area expansion (+37.19). However, a slight negative interaction effect (-2.04) suggests some inefficiencies in combining these two factors. Optimizing land utilization and strengthening yield growth strategies are essential for long-term production sustainability.

8. **Shangla**

Apricot production in Shangla is primarily yield-driven (+71.55), with moderate area expansion (+30.41). A minor negative interaction effect (-1.96) indicates slight inefficiencies. Increasing the area under cultivation while improving orchard practices can help sustain growth in this district.

Peach

1. Buner

Peach production in Buner is driven by area expansion (+99.86), with minimal contributions from yield (+0.13) and interaction effect (+0.01). This suggests that the increase in cultivated areas is the primary growth factor. Policy interventions should focus on improving yields to complement the area expansion for sustained production growth.

2. Bajaur

Bajaur shows a significant increase in yield (+225.09) as the main driver of peach production. However, the sharp decline in area (-123.54) limits overall growth, and a negative interaction effect (-1.55) reflects inefficiencies in combining area and yield. Policies should aim to stabilize and expand peach cultivation areas while maintaining yield gains.

3. Chitral

Peach production in Chitral is severely negatively affected by yield decline (-1674.45) and negative interaction effects (-181.94), despite a substantial area expansion (+1956.39). The mismatch between area and yield highlights inefficiencies. Efforts should focus on addressing factors causing yield reduction, such as environmental challenges or poor orchard management.

4. Lower Dir

In Lower Dir, production is driven by area expansion (+85.15), while yield contributes marginally (+14.06). A positive interaction effect (+0.79) supports growth, indicating balanced development between area and yield. Strengthening yield through improved agricultural practices and input availability can enhance production further.

5. Upper Dir

Upper Dir's peach production is driven by area expansion (+106.89) with a positive interaction effect (+8.70). However, a slight yield decline (-15.59) offsets the growth. This indicates a need to focus on yield improvement by introducing high-quality varieties and better cultivation techniques.

6. Malakand

Malakand sees growth primarily from area expansion (+98.05), with a marginal positive yield contribution (+1.95). A slight negative interaction effect (-0.0027) suggests inefficiencies in aligning the two factors. Policymakers should focus on maximizing yield improvements to complement the increasing cultivation area.

7. SWAT

In Swat, production is driven by area expansion (+151.89) but hindered by yield decline (-82.04). A positive interaction effect (+30.15) mitigates some of the negative impacts of yield loss. Addressing yield challenges by providing technical support and disease-resistant varieties can significantly boost production.

8. Shangla

Shangla's peach production is primarily driven by area expansion (+133.16). However, the yield decline (-25.94) and negative interaction effect (-7.21) limit overall growth. Efforts should focus on reversing the yield decline through better orchard management and input availability.

Plum

There is no production of plums reported in Chitral; hence, no analysis has been conducted for this district.

1. **Buner**

Area expansion (+70.88) is the primary driver of plum production in Buner, supported by positive yield contribution (+32.97). However, a slightly negative interaction effect (-3.85) indicates inefficiencies in combining area and yield factors. Enhancing orchard management practices can optimize overall production efficiency.

2. **Bajaur**

Plum production in Bajaur is driven by area expansion (+145.11), while yield decline (-38.18) and negative interaction effect (-6.92) offset some growth. Targeted efforts to address yield decline, such as introducing disease-resistant varieties and providing better irrigation facilities, can further boost production.

3. **Lower Dir**

Lower Dir's production is driven by area expansion (+85.53) and supported by yield growth (+15.06). However, the slight negative interaction effect (-0.59) suggests room for improving the integration of area and yield factors. Strengthening technical support for farmers can optimize production efficiency.

4. **Upper Dir**

In Upper Dir, area expansion (+107.85) is the key driver of growth, but yield decline (-6.47) and negative interaction effect (-1.38) hinder further progress. Efforts should focus on reversing the yield decline through better fertilization practices and orchard management.

5. **Malakand**

Malakand's production growth is driven by yield improvement (+54.61), complemented by area expansion (+47.10). However, a negative interaction effect (-1.71) reflects inefficiencies in aligning these factors. Improving post-harvest handling and training for farmers can sustain this positive trend.

6. **Swat**

Swat exhibits strong production growth driven by yield improvement (+153.09), despite a negative area effect (-49.14) and negative interaction effect (-3.95). This indicates a focus on maximizing existing yields rather than expanding cultivation area. Expanding plum-growing areas while maintaining high yield levels can enhance production further.

7. **Shangla**

Plum production in Shangla is driven by area expansion (+116.32) but hindered by yield decline (-18.77). A positive interaction effect (+2.46) indicates some alignment between area and yield factors. Introducing high-quality inputs and better water management can help stabilize and improve yields.

Persimmon

1. **Buner**

Area expansion (+105.92) is the primary driver of persimmon production growth in Buner. A positive yield effect (+3.96) also contributes, but the negative interaction effect (-9.89) highlights inefficiencies in combining these factors. To maximize production, efforts should focus on better integrating areas and yield growth, such as by providing technical assistance to farmers.

2. **Bajaur**

Production in Bajaur is driven by area expansion (+154.57). However, this growth is offset by a significant negative yield effect (-48.15) and negative interaction effect (-6.42). Policies should focus on addressing yield issues through the introduction of improved persimmon varieties and enhanced orchard management practices.

3. **Chitral**

In Chitral, persimmon production shows a 100% yield effect, as there has been no area expansion (area effect: 0). This indicates a strong reliance on existing cultivation practices. To enhance production, efforts should focus on expanding cultivation areas while maintaining high yields.

4. **Lower Dir**

Persimmon production in Lower Dir is primarily driven by area expansion (+80.34). A positive interaction effect (+15.79) also contributes, although the yield effect (+3.87) is small. Supporting farmers with inputs to enhance yield can help further improve overall production.

5. **Upper Dir**

In Upper Dir, area expansion (+106.81) is the key driver of production growth, but the negative yield effect (-5.86) and minor negative interaction effect (-0.95) limit potential gains. Addressing yield decline through better pest management and training programs for farmers could stabilize production.

6. **Malakand**

Persimmon production in Malakand is strongly driven by area expansion (+148.29). However, significant negative yield (-48.03) and slightly negative interaction effects (-0.26) suggest inefficiencies. Policymakers should focus on improving yields through better orchard management and investment in post-harvest technologies.

7. **Swat**

In Swat, yield improvement (+110.54) is the primary driver of production, with a small contribution from area expansion (+9.33). However, a substantial negative interaction effect (-19.87) indicates inefficiencies in combining these factors. To optimize production, expanding cultivation areas while maintaining high yields should be prioritized.

8. **Shangla**

Persimmon production in Shangla is driven by area expansion (+156.66). However, negative yield (-46.96) and negative interaction effects (-9.70) significantly hinder potential gains. Introducing

modern farming techniques and addressing soil quality issues could enhance both yield and production efficiency.

4.2.3.2 Decomposition Effect Analysis: Divisional vs Provincial Overview of Fruits

This analysis evaluates the decomposition effects, Area, Yield, and Interaction of fruit production at the divisional (Malakand Division) and provincial (Khyber Pakhtunkhwa) levels. The comparison highlights the driving forces behind production changes in apple, apricot, peach, plum, and persimmon, revealing regional disparities and opportunities for targeted policy interventions.

Table 4. 2: Decomposition Analysis by Division and Province

	Effect	Apple	Apricot	Peach	Plum	Persimmon
Divisional	**Area**	67.10	55.15	132.18	-100.21	-63.05
	Yield	62.24	47.87	-49.51	205.63	191.13
	Interaction	-29.34	-3.02	17.33	-5.41	-28.09
Provisional	**Area**	142.16	30.80	80.34	58.12	-22.68
	Yield	99.25	34.38	3.87	45.72	136.44
	Interaction	-141.41	34.81	15.79	-3.83	-13.76

Apple

In Malakand Division, the area effect (+67.10) and yield effect (+62.24) both contribute significantly to apple production, with the yield slightly less prominent. However, the negative interaction effect (-29.34) indicates inefficiencies in combining area and yield improvements. At the provincial level, the area effect (+142.16) is higher, demonstrating significant area expansion across Khyber Pakhtunkhwa. Yield improvements (+99.25) also contribute positively, but a substantial negative interaction effect (-141.41) suggests systemic inefficiencies at this level. While both levels show positive contributions from area and yield, the provincial level's greater reliance on area expansion contrasts with the division's balanced contributions.

Apricot

In Malakand Division, area expansion (+55.15) and yield improvements (+47.87) are both significant drivers of apricot production, with minimal negative interaction (-3.02) reflecting marginal inefficiencies. Provincially, area expansion (+30.80) and yield improvements (+34.38) also drive growth, though less prominently than in the division. Notably, the provincial level benefits from a positive interaction effect (+34.81), indicating better alignment between area and yield. This suggests that while the division relies more on area expansion, the province achieves a better balance across all factors.

Peach

Peach production in Malakand Division is driven by area expansion (+132.18), with a negative yield effect (-49.51) reflecting declining productivity. However, a positive interaction effect (+17.33) indicates some efficiency in combining growth factors. At the provincial level, area expansion (+80.34) remains significant, though less pronounced, while yield improvements (+3.87) contribute positively, contrasting the division's decline. A positive interaction effect (+15.79) at the provincial level mirrors the division’s trend but with a smaller magnitude. These results highlight the division's over-reliance on area expansion compared to the province's more balanced growth.

Plum

In Malakand Division, plum production is driven entirely by yield improvements (+205.63), with a negative area effect (-100.21) reflecting reduced cultivation. A minor negative interaction effect (-5.41) suggests slight inefficiencies. Provincially, both area expansion (+58.12) and yield improvements (+45.72) contribute positively, with a small negative interaction effect (-3.83). The stark contrast indicates that while the division relies solely on yield, the province benefits from balanced contributions of area and yield. This underscores the need for divisional policies to stabilize or expand plum cultivation areas.

Persimmon

Persimmon production in Malakand Division is heavily dependent on yield improvements (+191.13), as the area effect is notably negative (-63.05). The significant negative interaction effect (-28.09) highlights inefficiencies in combining area and yield factors. At the provincial level, yield

improvements (+136.44) remain a key driver, though area expansion (-22.68) also shows a decline. A moderately negative interaction effect (-13.76) reflects some inefficiencies but is less severe than in the division. These findings emphasize the need for interventions to address declining cultivation areas, particularly in the Malakand Division.

Conclusion

The decomposition analysis presents a detailed understanding of the production dynamics of the key fruits in the Malakand Division, as it becomes apparent that the nature of the dynamics significantly varies at a district level, as well as at a division level. The findings imply: there are considerable differences between area growth, yield gains, and their interrelationship in their contribution to production trends, and the following significant implications concerning agricultural policy and practice. Within the division, peaches exhibit area growth (the contribution of area growth is 132.2 percent), and persimmons have yield growth (the contribution of yield growth is 79 percent). This observation agrees with other studies of Ali et al. (2014) and Majumdar & Basu (2006), who also reported comparable trends in horticultural production. Nonetheless, the adverse yield production in peaches (-49.51%) leads to issues of sustainability, as cited in the World Bank (2023) publication on extensification. Production of apples is the opposite of what has been observed because the contribution to the yield is very high (62.2%), but has not helped the yield as a whole (-11.33%), as is seen in the Wardhan et al. (2022) study on the yield gap in climate in temperate fruits.

There are especially dramatic differences in the district's level of analysis. Complete cessation of apple culture is demonstrated by Buner because much yield (-362.57%) decreased, yet there is a lot of peach growth (1333% increase in areas). Dir Lower displays a dramatic shift in crop constituents whereby the share of apple declines violently (-23.9%) and that of peach rises extremely fast (23.1%). Shangla district is a fit in the list of high performers with uniform growth and expansion in various fruits, especially the persimmons (10.1% area growth) and peaches (9.1%). The detail that apple cultivation vanished in Malakand district (-27.4% over nine years) and was replaced with peaches (9.8% growth) is indicative of the riskiness of the monocropping system (UNDP, 2021).

The three significant trends revealed by the analysis are as follows: (1) unsustainable area growth of peaches that lack corrective infrastructure, (2) positive yield-based trends in persimmons where infrastructure is built, and (3) systemic lapses in apple production because of adverse interaction effects (-29.34% divisionally). The results given in line with the KP Agriculture Department (2022) evidence contribute further to the necessity of a specific intervention. The success of persimmons in Shangla provides scalable models on how yields can be improved, and the increased apple failures in both Buner and Malakand need prioritized interventions in the form of climate-resilient varieties. The findings confirm the framework developed by Kaplinsky & Morris (2000), showing how decomposition analysis may help discover the existence of less obvious constraints in agricultural value chains and steer policy responses to those locales.

4.3 Primary Data Analysis

This study is based on primary data collected through 50 semi-structured interviews with stakeholders involved in the fruit value chain of Malakand Division. The scope of the research was limited to two major fruits of the region, such as peach and persimmon, as their share of overall production is high in provincial fruit production, and also focused on a better analysis of their production, distribution, and marketing systems. The peach and persimmon crops were chosen as the center of the value chain analysis because of secondary data analysis on Khyber Pakhtunkhwa and Malakand Division fruit production. The figures showed that these two fruits had the biggest share of the total production of Malakand in terms of province, with the peach being the maximum producer in the province, with about 81 percent, and persimmons contributing about 73 percent of the total provincial output. The many dominant shares indicate the comparative advantage of the region in the crops; therefore, this makes the crops a strategic domestic market and even as export products. Narrowing down on the fruits enables the study to understand the value chain dynamics in which Malakand can record maximum production power, and in which it has maximum potential to get economic profits on the basis of intervention undertakings.

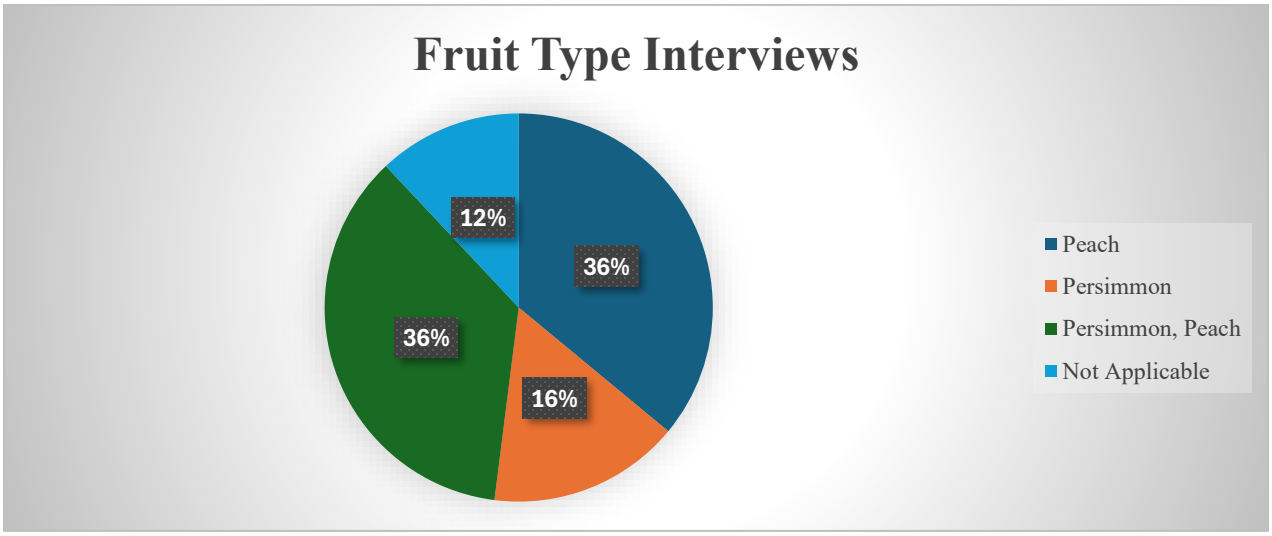


Figure 4. 8: Interviews by Fruit Type

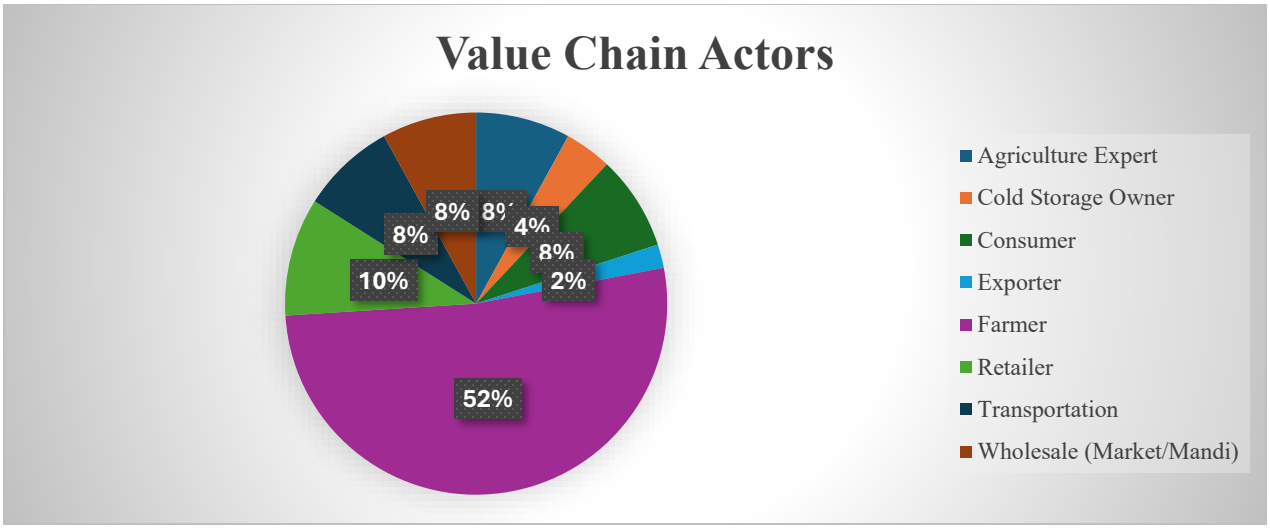


Figure 4. 9: Interviews from the value chain Actors

The interviews were conducted with a wide range of value chain actors, including farmers (52%), retailers (10%), agriculture experts (8%), consumers (8%), transportation agents (8%), wholesale market (mandi) stakeholders (8%), cold storage owners (4%), and exporters (2%). While demographic information such as age, education, experience, and marital status was gathered from all respondents, farm-level data, such as farm area, plant density, and farm age, was collected exclusively from farmers to better understand the production realities on the ground.

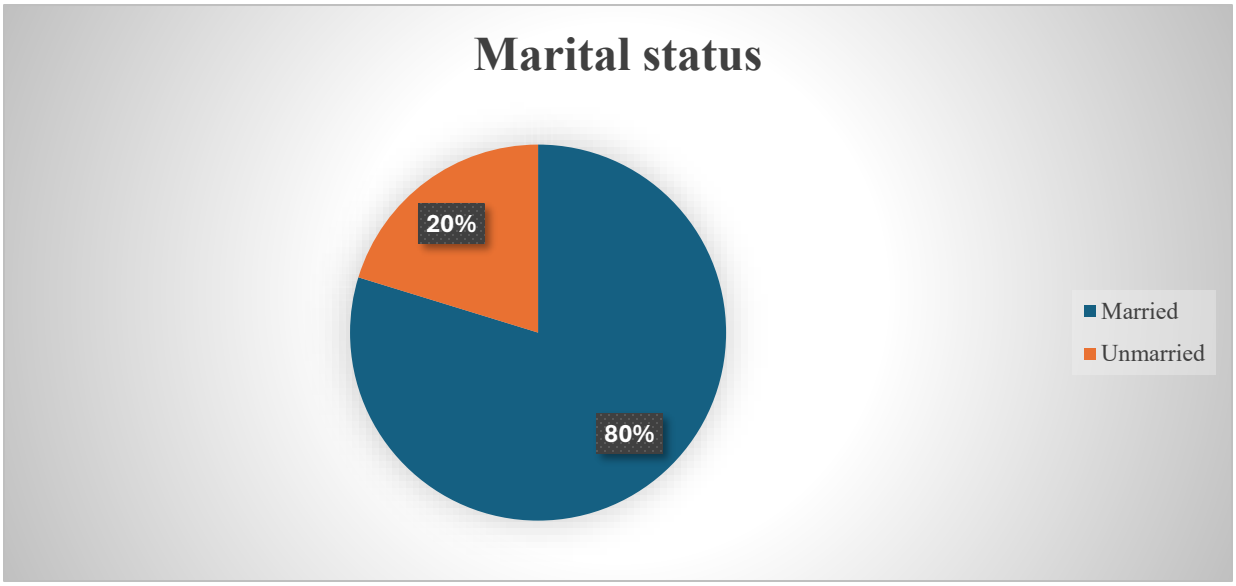


Figure 4. 10: Marital Status of Interview

Table 4. 3: Descriptive Statistics of the Data

Descriptive Statistics		**Peach**	**Persimmon**
Average age	39.12		
Ave Education Level (In Years)	12		
Average Experience (in years)	15		
Ave Farm Area (Acre)	9.32	14.2775	1.394
Ave Farm Age (years)-Plantation	12.92	10.125	17.4
Ave Farm Age (years)- Fruiting	8.46	5.9375	12.5
Ave Plants per acre (Nos.)	1852.85	2832.5	285.4
Ave Distance of Farm from Home (KM)	7.59	10.1875	3.43

The average age of participants was 39.12 years, with an average education level of 12 years and work experience spanning 15 years. The majority (79.75%) of the respondents were married. Among the farmers, the average landholding was 9.32 acres, with farms being 12.92 years old (since plantation) and fruiting for the past 8.46 years. On average, farms had 1,852 plants per acre and were located 7.59 km from the farmer's home. In terms of irrigation, most farmers (69.23%) relied on tube wells, while the remaining 30.77% used canal water. Regarding livelihood, just over half (51.85%) of the farmers reported agriculture as their main source of income, while others were engaged in government or private jobs (29.63%), business, or retired.

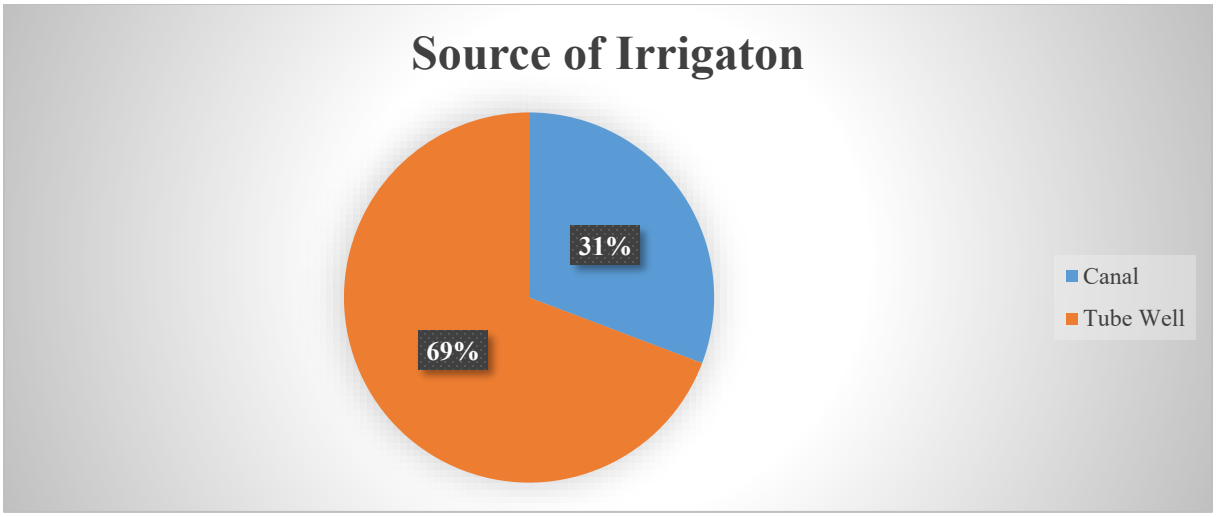


Figure 4. 11: Sources of Irrigation of Lands

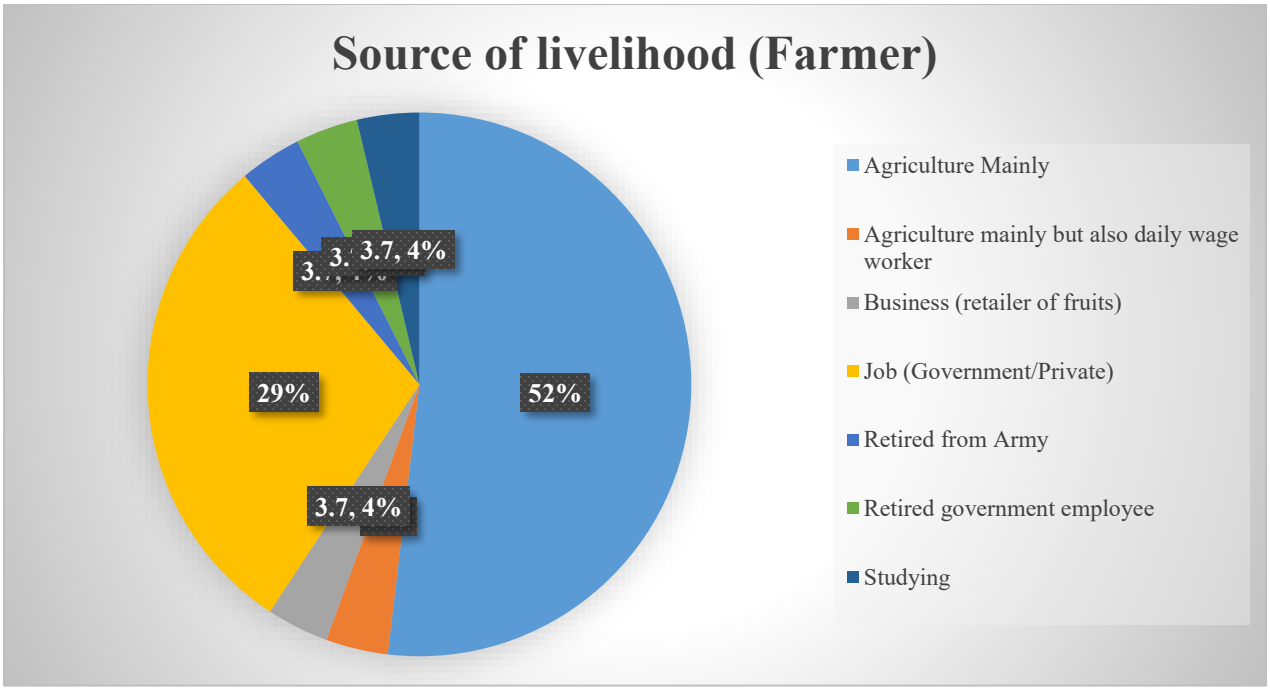


Figure 4. 12: Source of Livelihood of Farmers

A fruit-wise breakdown showed that peach farms were typically larger (14.28 acres), denser (2,832 plants per acre), and farther from home (10.19 km), whereas persimmon farms were smaller (1.39 acres), less densely planted (285 plants per acre), but older in terms of plantation age (17.4 years) and fruiting stage (12.5 years), and located closer to home (3.43 km).

The analysis of this data proceeds through three methods:

- Waste Analysis, where the extent of fruit loss is calculated and key causes of wastage are identified across various stages of the value chain.
- Thematic Analysis, which is divided into two segmentsstakeholder-based themes and agricultural expert-based themesto capture both practical experiences and technical insights.
- SWOT Analysis, which synthesizes the strengths, weaknesses, opportunities, and threats faced by the fruit value chain in the study area.

Together, these analyses aim to provide a comprehensive understanding of the operational bottlenecks and potential interventions needed to improve the fruit value chain for peach and persimmon in Malakand Division.

4.3.1 Waste Analysis

One of the most acute but frequently neglected problems in the horticultural industry in Pakistan is fruit wastage, especially in high-yielding areas, including the Malakand Division. Since fruits are very perishable crops, even slight inefficiency in the harvest, handling, storage, and transport can result in serious physical and financial losses. In this study, an attempt has been made not only to measure the quantity of waste material but also to put an economic price at various points of the fruit value chain. This will help underscore the extent or degree of value being wasted with each node in the chain, thus offering more precise policy suggestions and intervention.

The information was gathered by surveying various participants in the process of production and marketing of two most significant fruits of the area, one is the peach and the other is the persimmon. An estimation of the waste in relation to the production volume, per unit prices, total revenue, revenue lost, and the %age of revenue lost has been calibrated in the table below under six major categories of stakeholders, namely, farmers, wholesalers, transporters, cold storage owners, retailers, and exporters

***Table 4. 4*: Waste Analysis**

Stakeholder	Production (000)	Price/kg	Total Revenue (000)	Revenue Lost	% Revenue Lost
Farmer	96	108	10382	403285.3846	4
Wholesaler	1600	143	228000	4544625	2
Transporter	113	154	17362	23968.8	0.1
Cold Storage	225	178	39937.5	4512.5	0.011
Retailer	10	450	877	18210	2.1
Exporter	3.5	248	4500	112500	2.5
Total/Average	341.3	213.3	50176	851183.6	10.6

According to the table, the total amount of revenue that has been lost due to the waste of fruits in the considered value chain is estimated to constitute around PKR 851,183, which is a huge economic blow when it comes to discussing the overall economy of the Malakand Division. The overall figure for the %age of revenue lost along the value chain comes to 10.6, which is due to the serious economic implications of the wastage of fruit in the region.

Farmers

The largest %age loss of revenues of 4.0 % (PKR 403,285) was among the farmers. Modernity factors like poor harvesting practices, non-availability of grading/sorting machines, as well as poor on-farm stores, are among the reasons for this huge loss.

Wholesalers

The highest level of absolute loss was incurred by the wholesalers with a loss of PKR 4.5 million; however, the %age ratio of revenue lost stood marginally lower at 2.0%. The causes of these extrusions are primarily poor handling in bulk aggregations, long-term exposure to ambient temperatures, or waiting points when loading or unloading.

Transporters

The segment of the transporters has few revenue losses (just 0.1 %), which amounts to approximately PKR 23,969. This figure does not seem to be too high, but it can be an underestimation of the unavoidable losses that are incurred through road conditions, overloading, not using insulated cars, and mechanical breakdowns in the process of transportation.

Cold Storage

The cold storage facility experienced the least %age of loss (0.011 %) or a value of about PKR 4,512. This little loss shows the advantage of using cold storage, which decreases perishability. Nevertheless, the role of access to such facilities is narrow, and it is rather expensive, particularly among small-scale producers.

Retailers

Retailers who are the last in line before consumers make their purchase reported a loss of 2.1 % in revenue. The retail losses are typically brought about by the inventory that is not sold, adulteration of quality, and the absence of display units fitted with the refrigerator.

Exporters

The exporters lost a sum of PKR 112,500 or 2.5% of their revenue. Such a loss can be blamed on strict export regulations, refusal of low-quality consignment, and port congestion. The result of the rejection of export terminals is that, besides the direct loss, there would be a demerit in the international markets.

The waste assessment demonstrates the view that fruit chain losses after harvest are not only a logistical problem, but also a severe economic problem, which relates to all levels of stakeholders. This illuminates the necessity of immediate improvements on all levels of the value chain, as the loss of over PKR 850,000 and 10.6 % of the possible income is critical. It also points out the necessity of a vital investment in harvesting technology as well as cold storage, transportation infrastructure, and more effective regulation in the local markets.

The paper will be a significant source of empirical knowledge to policymakers, donors, and the private sector players interested in promoting the efficiency and profitability of fruit farming in Khyber Pakhtunkhwa (more specifically, the Malakand division) as it identifies the areas and the methods of fruit losses with a view to minimizing such losses.

4.3.1.1 Causes of Wastage of Fruit throughout the Value Chain

The problem of fruit waste is of great concern to the horticultural industry, with considerable losses taking place at all levels of the value chain, including production on the farm as well as post-harvest management. This study was designed not only to evaluate the quantity and the economic level of the lost fruit but also to identify certain causes of these losses. Such causal factors are crucial in coming up with viable interventions, which can curb the inefficiencies and overall improve the state of the value chain.

Farmer:

Farm Maintenance (Production-Level) Losses.

However, most of the fruit loss at the production stage was due to pest attacks (47.62%), resulting in significant losses in both quantity and quality before harvesting. This highlights the importance of improved pest management practices and the availability of integrated pest control for smallholder farmers. Natural calamities (38.1%), such as sudden rains, hailstorms, and droughts that can devastate an orchard, were the second major factors.

Other production-related issues include plant diseases (11.9%), primarily due to inadequate interventions or disease surveillance, and theft (2.38%), although the latter was not significant. Collectively, these problems stem from environmental and systemic issues faced at the farm level, including poor extension services, climate resilience efforts, and farm-level security.

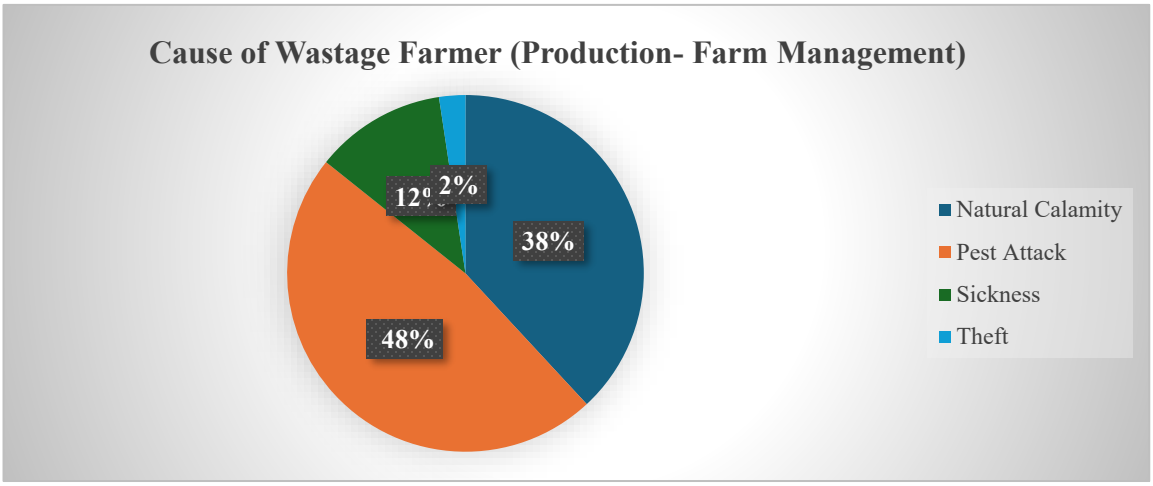


Figure 4. 13: Cause of Wastage Farmer (Production- Farm Management)

Harvesting-Stage Losses:

In harvesting, mechanical damage (40.98 %) and over-ripeness (40.98 %) were found to be the two major waste factors of fruit. Mechanical damages are mostly caused by careless plucking, inappropriate tools used, or rough treatment, which is most of the time associated with the absence of technical skills among the workers. Over-ripeness, on the other hand, indicates failure to harvest the fruits on time as a result of labor shortage or the harvesting schedules, and therefore fruits become prone to wastage. In addition, these would be compounded by poor labor skills (11.48%) and inadequate harvesting methods (6.56%). These observations show that there is a major loophole in the labor training and harvesting activities, and thus specific training initiatives, proper tools of harvesting, and improved protocols on harvesting time are necessary.

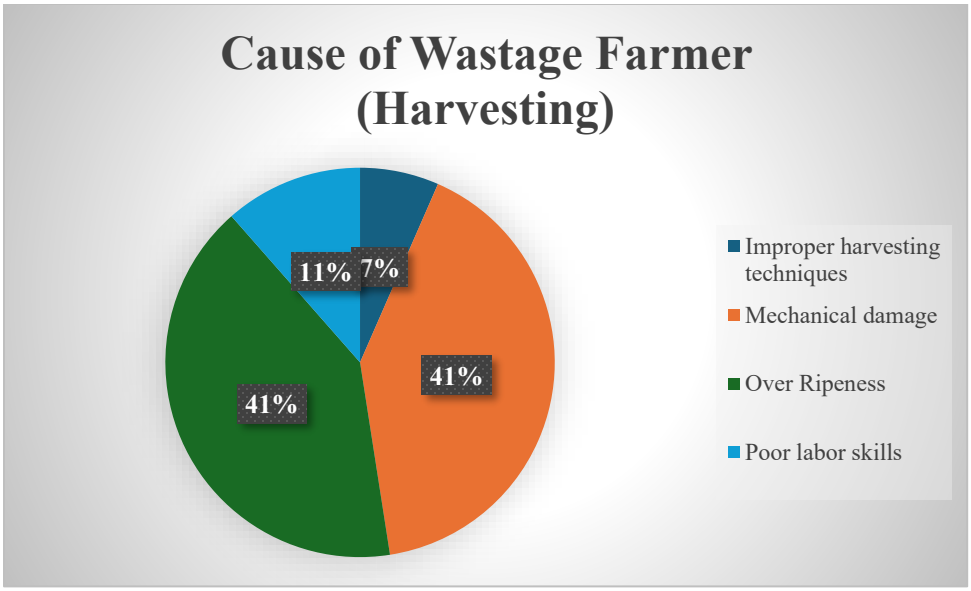


Figure 4. 14: Cause of Wastage from Farmer (Harvesting)

Post-Harvest Losses:

During the post-harvest handling process, the greatest contributor to wastage was that of fruit bruising (41.51%), which is caused by rough handling during transport, loading or unloading. This makes fruits unsustainable, particularly to the fresh market segment. Poor collection and grading (35.85%) also add a lot to post-harvest losses. This is due to a lack of uniformity resulting in spoilage during storage and rejection in the market. Other factors that enhance perishability include delays during processing (20.75%), whether the movement to cold storage or market is slow. The assessment of the lack of proper handling equipment (1.89%) is of a minor nature, but it too indicates the shortcomings in infrastructure, particularly for the small traders and middlemen who maintain manual practices.

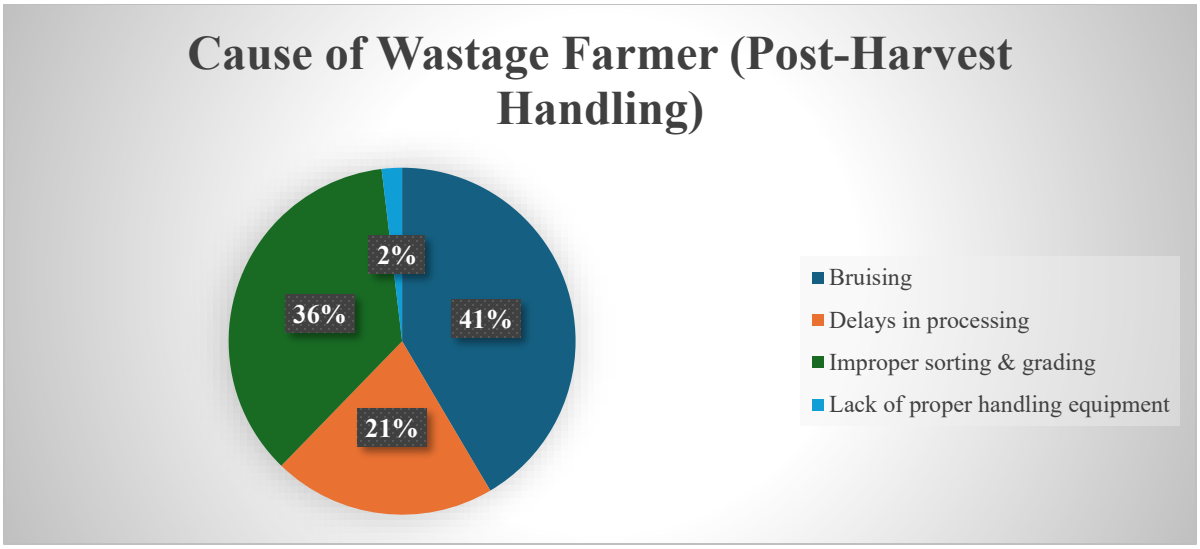


Figure 4. 15: Cause of wastages from Farmer (post-harvesting)

Wholesale

On the wholesale side, overstocking fruits (44.44%) is the main cause of loss of fruits, since there is inaccurate demand planning and bulk buying due to high seasons of the year. It results in losses due to spoilage since fruits are perishable. The situation is worsened by low demand prices (33.33%), which would make wholesalers wait to sell products, hoping that the market will normalize and hence, the quality deteriorates. Furthermore, inferior storage facilities in mandi (11.11%) and exposure to weathering (11.11%) add to the wastage, especially at places where the infrastructure does not have adequate ventilation and sufficient cover from environmental factors. Such revelations note that better inventory planning and storage facilities, in addition to market information systems, are necessary to minimize the wastage of products at this vital point of the value chain.

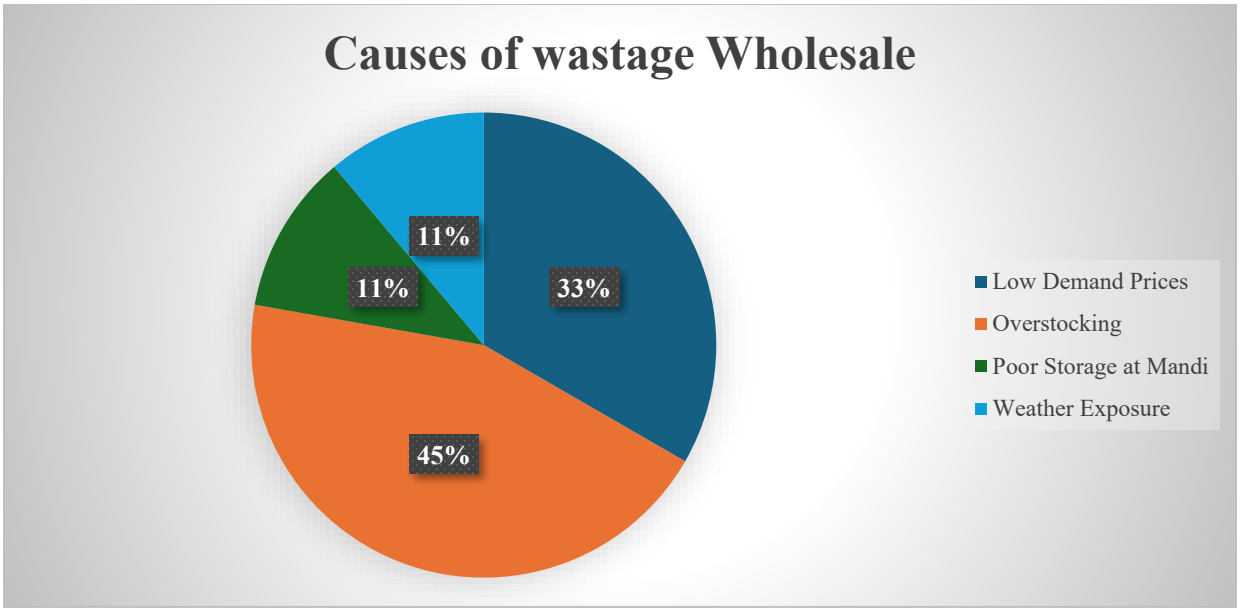


Figure 4. 16: Causes of wastages of Wholesalers

Cold-Storage Facilities:

Electricity shortage (66.67%) is the most cited cause of wastage at the cold storage stage, which affects the temperature maintenance in a huge way, impairing the shelf life of stored fruits. Recurrent electricity shortage or a proper backup supply leads to wastage, especially when demand is high and cooling of products is a must due to high temperatures. The other reason also shows that there was an incidence of already damaged fruit (33.33%), and this fruit cannot be stored even in ideal circumstances. This indicates problems in the previous steps of the value chain- especially bad harvesting or handling, or transportation techniques. The results signify the necessity of having credible energy pipelines and controls on quality until the time of storage in order to reduce the wastage caused to the economy.

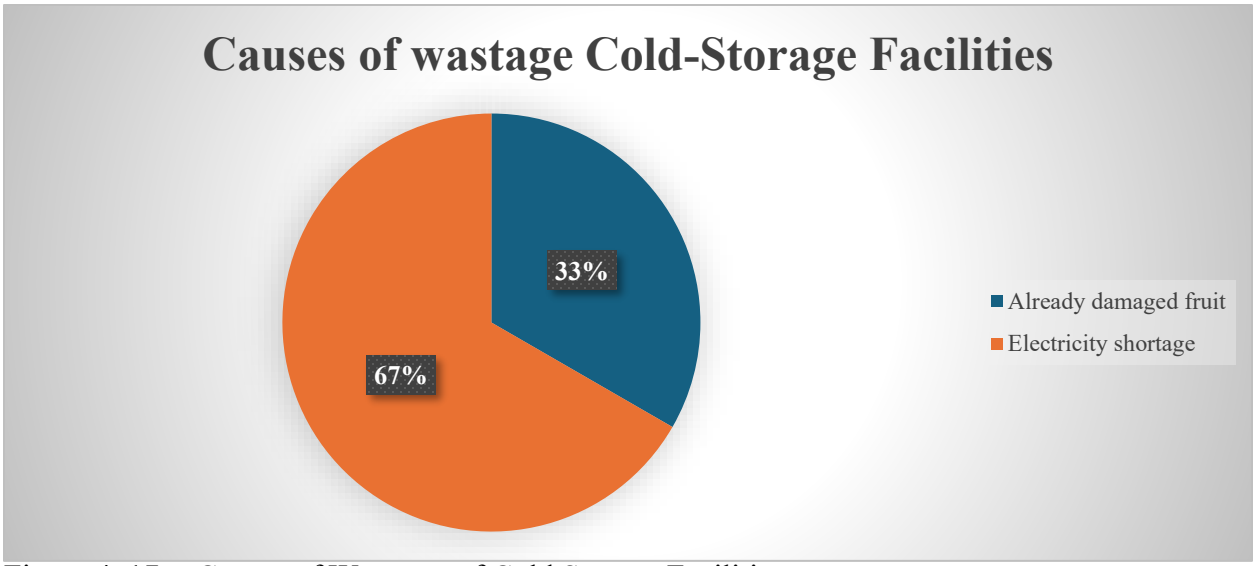


Figure 4. 17: Causes of Wastages of Cold Storage Facilities

Transportation:

Transportation-related fruit wastage is caused by a mix of logistical and handling issues. The leading cause is the transport of already damaged fruit (37.5%), which indicates that losses are often carried forward from earlier value chain stages, such as harvesting and post-harvest handling. Accidents and emergency delays (25%) and heavy traffic congestion (25%) further contribute to deterioration, particularly for highly perishable fruits like peaches and persimmons. Extended transit times under unsuitable conditions accelerate spoilage. Additionally, poor packing and improper loading practices (12.5%) damage fruits through physical impact or compression, reducing both market value and edibility. These findings highlight the importance of improved pre-transport quality checks, investment in better packing materials, and streamlined logistics to reduce transit-related losses in the fruit value chain.

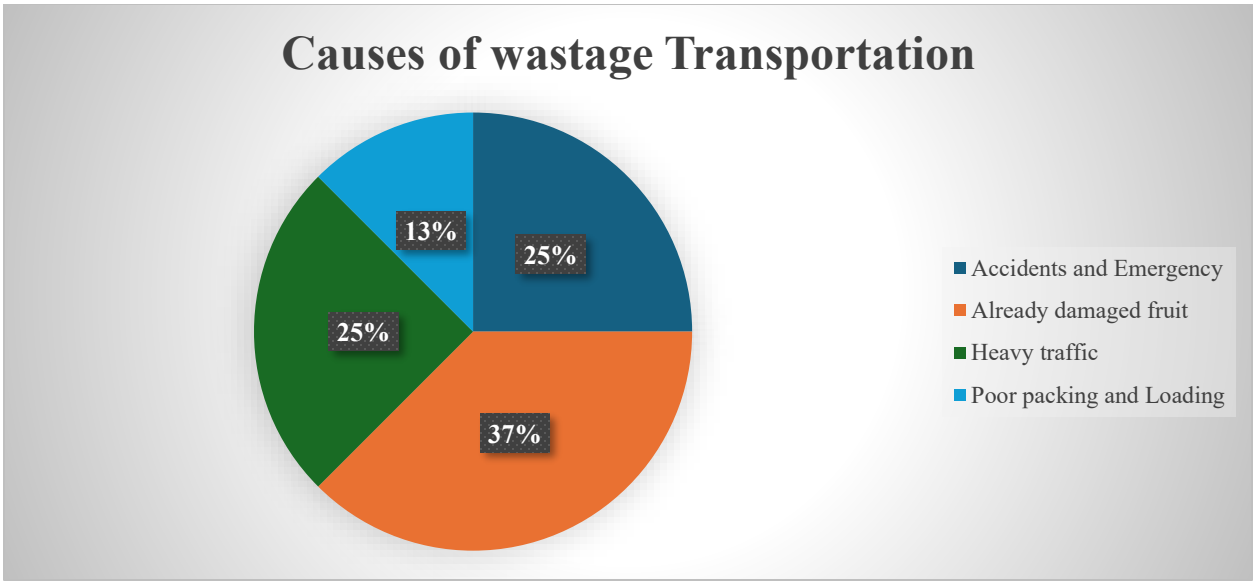


Figure 4. 18: Cause of Wastages from Transportation

Export:

At the export stage, fruit wastage is primarily attributed to two equally significant factors. Delays in transportation (50%) hinder the timely movement of fruit to international markets, especially critical for perishable varieties such as peaches and persimmons. Prolonged transit can lead to spoilage before reaching the destination, particularly when cold chain systems are weak or disrupted. The short shelf life of fruits (50%) further compounds the issue, as exporters often face constraints in preserving fruit quality over long distances. This challenge is intensified in the absence of adequate pre-cooling, refrigeration, or preservation technologies. Together, these factors underline the need for efficient logistics management and advanced post-harvest technologies to extend fruit freshness and reduce losses during export operations.

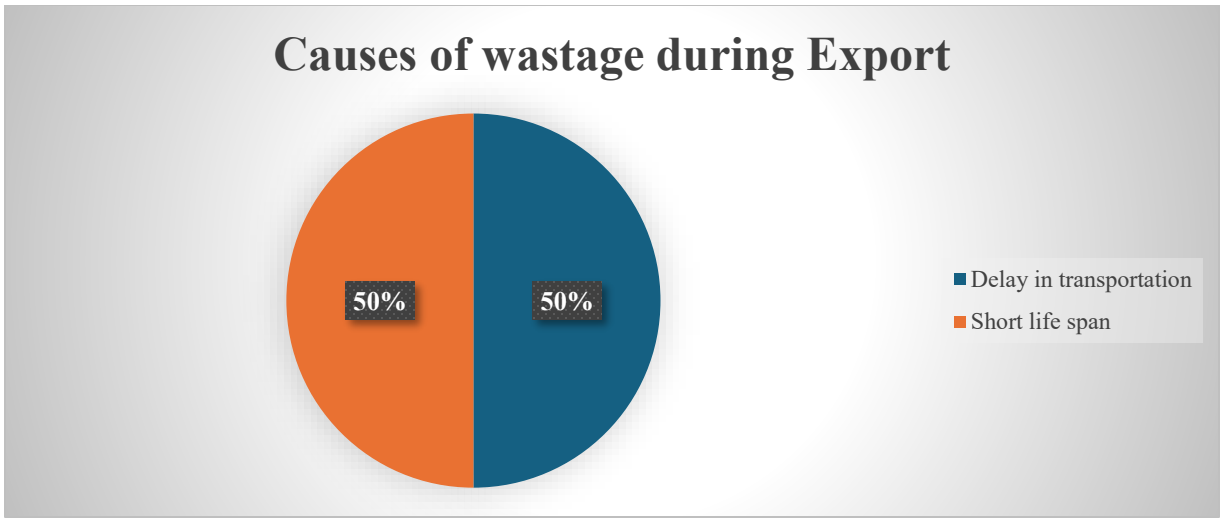


Figure 4. 19: Causes of Wastages from Exports

Retail:

In the retailing level, the wastage of fruit is mostly attributed to the brief life of fruits (71.43%), which implies the short period frame that fruits have to be sold prior to their decay. Many retailers do not have cold storage or preservation systems, such that they rely extremely on quick turnover rates. There are delays in sales, particularly in the off-peak demand periods, which cause great spoilage. Also, exposure to weather (28.57) includes constructions of weather, i.e., exposure to direct sunlight, heat, or humidity that further hastens the deterioration process when fruits are kept under exposure in open settings that lack shading and regulation of the climate. These results indicate the necessity of better retail facilities, including shaded booths and availability of cooling facilities, to reduce losses and preserve fruits to their consumers.

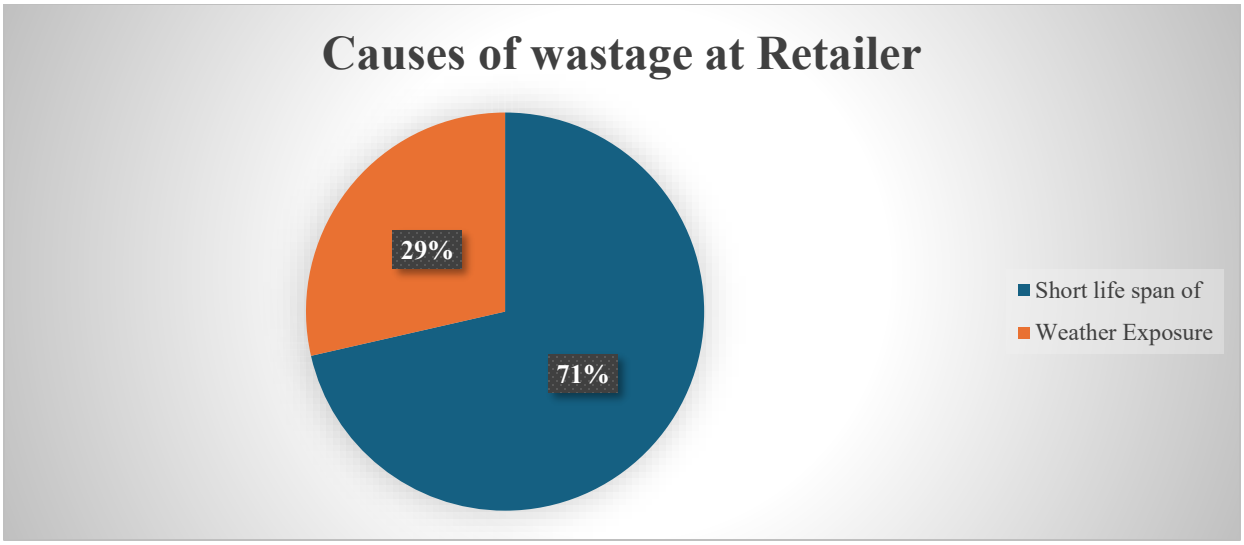


Figure 4. 20: Causes of Wastages from Retailer

Consumer

Fruit wastage at the consumer level is also associated with three major causes: buying already damaged fruit (33.33%), poor storage at home (33.33%), and exposure to the weather (33.33%). Consumers often accidentally purchase bruised or past fruit because of bad sorting or care during the chain. Unless one is aware or checks carefully, such fruit goes bad soon after getting home. Also, the use of proper storage, no freezing or dry and shaded storage, extends the usability of the fruit further. Degradation of quality by environmental exposure (e.g., heat or humidity in non-air-conditioned homes) is a major factor, too. The findings highlight why there is a need to enhance consumer awareness as well as upstream handling to curb wastages on the final stage of consumption.

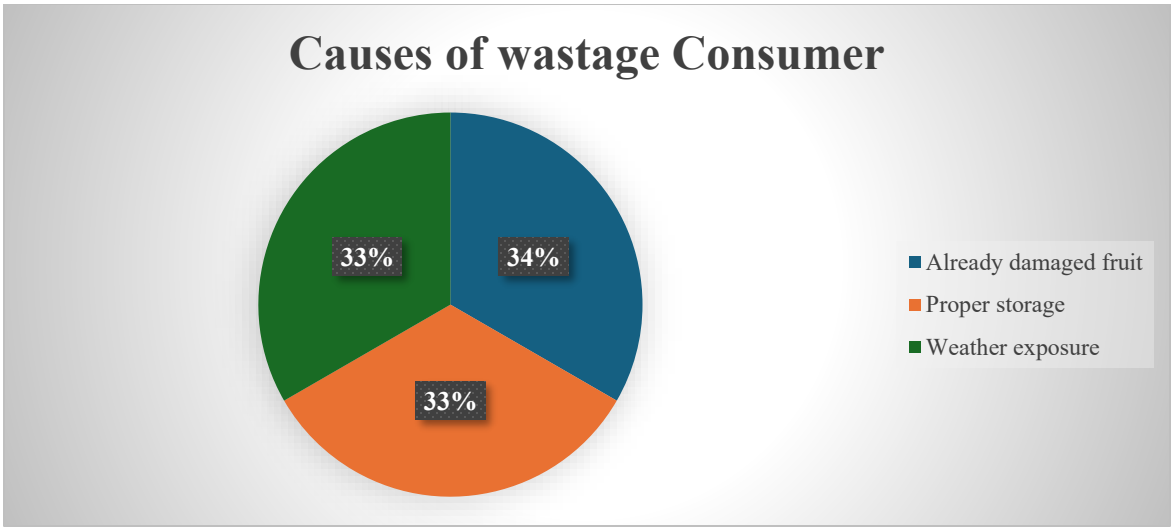


Figure 4. 21: Causes from wastages by consumers

4.3.1.2 Post-Waste Handling Practices

When fruits are treated as waste throughout the value chain, the stakeholders implement diverse disposal and recovery practices. This part of the critique attempts to determine the process of managing this form of waste, and this is of great relevance to environmental sustainability, economic efficiency, and food security of the populations served by the waste.

Farmer:

The answers to the questions about how the farmers cope with fruit after it has become waste indicate various coping methods. A huge %age (37.08) indicated giving up the inedible fruits to other people who can still use them as edible. This is socially positive behavior and an approach to reducing total loss. Nonetheless, it is worth noting that 29.21 % of farmers get rid of the waste in ordinary garbage, which means that there are no organized or environmentally friendly ways of waste management. Approximately 21.35 % of the people prefer to eat waste themselves, which is basically fruits that are damaged yet still edible. A very minute ratio claimed to do something better with waste- use it as a fertilizer or even as a compost- 7.87 is the ratio, and even smaller,

3.37% were able to reply that they sell waste as a by-product. An even lesser proportion (1.12%) said that they sell the rubbish to low bidders at low prices.

These figures indicate the fact that, although some farmers prefer to reduce losses by reusing or redistribution, most of them are not able to access the appropriate infrastructure to recover their values. It is obvious that at the farmer level, waste management can be enhanced by training as well as the provision of infrastructure, especially in composting and processing by-products.

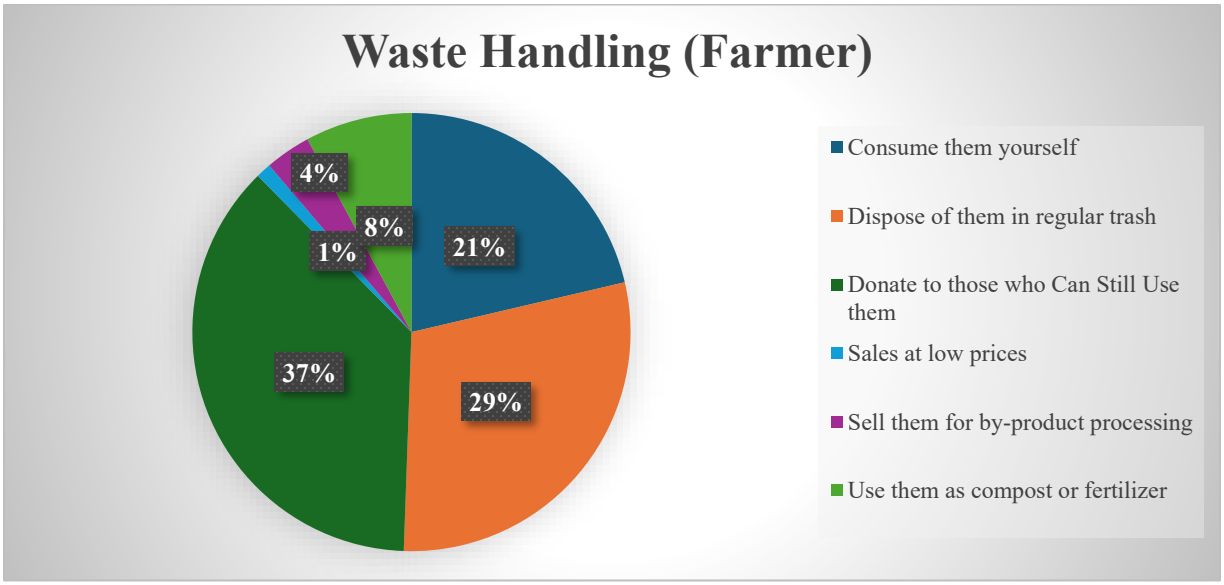


Figure 4. 22: Post Waste Handling by Farmers

Wholesale:

The strategies used by wholesalers in addressing fruit waste are relatively diverse, but most of the strategies are informal. A good %age (33.33) of them said they hand over the waste fruit to the people who can still make use of it, and this is a sign that they will be socially responsible and end up reducing the wastage of the fruit altogether. Still, another 22.22 % forces decayed fruits into ordinary garbage since they did not have a highly organized waste recovery system. The rest of the responses are balanced as each gives 11.11 per cent of the respondents who indicated that they

themselves consume the waste, sell it cheaply, use it as compost or fertilizer, or sell it to be processed into by-products.

Such findings imply that even though the most prevalent method is donation, the general practice is disconnected and deprived of size or even integration with a larger waste management system. It can be considered to organize by-products markets and composting projects to minimize waste-related losses on a wholesale level.

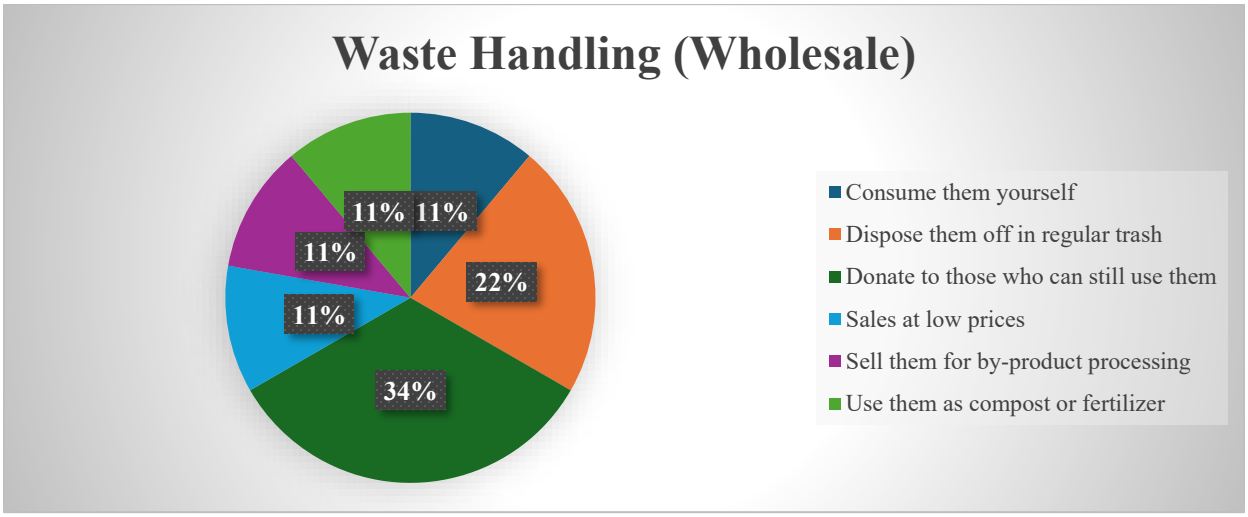


Figure 4. 23 Post Waste Handling by Wholesale

Cold-Storage Facilities:

The cold storage operators exhibit fairly realistic and socially accountable practices dealing with fruit waste. Most (60%) of the respondents indicated that they ate spoiled or unsaleable fruits; perhaps in a bid to minimize individual waste and avoid wastage. In the meantime, 40 % of respondents noted that they give waste fruits to the people who can still use the goods, which is a community-based strategy.

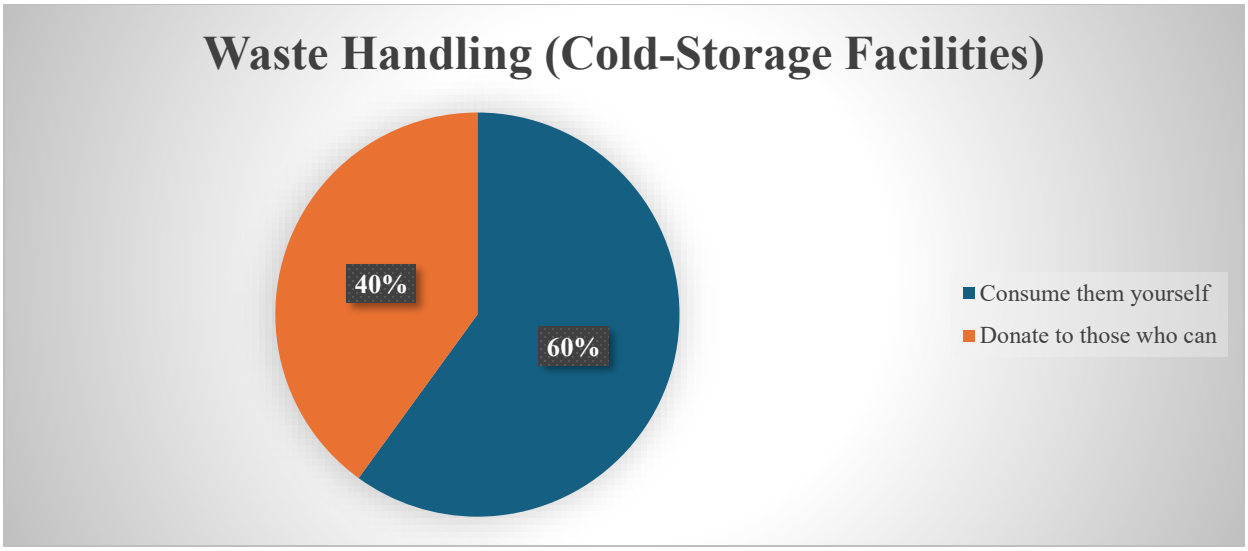


Figure 4. 24 Post Waste Handling in Cold Storage Facilities

Transport:

In the type of post-waste management, donation has emerged to be the most common method among the transporters, and 60 % of the respondents said that the damaged or even unusable fruits are donated to other people who can still use them. This is a socially conscious effort in controlling wastage and benefiting the community members, specifically those who are in the rural or underprivileged sectors. Nonetheless, 40 % of transporters still make use of the fruits in normal waste bins, an indication that no system of organization or environmentally friendly means of disposal are found at the transport part of the product chain value. This habit not only causes waste to the environment but also causes a waste of economic loss that can otherwise be prevented. These findings imply that there should be better rules and sensitization in an attempt to facilitate better environmental protection in terms of transporting waste.

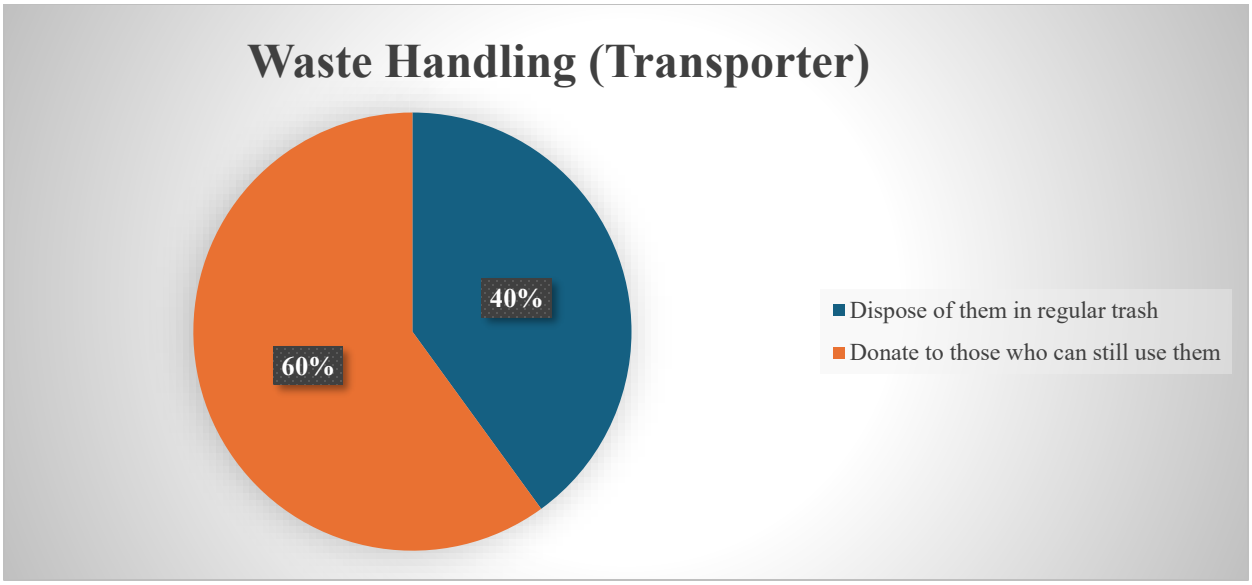


Figure 4. 25 Post Waste Handling in Transportation

Exporter:

The exporters in the fruit value chain exhibit 100 % dependency on the donation process of fruit waste. All the respondents mentioned that some of the damaged or unsaleable fruits are donated to those people or organizations that can still use them. This indicates a great desire to act in a socially responsible way at the export level, which is probably affected by the quality control regulations that do not allow shipping even relatively damaged fruit to the foreign market.

Retailer:

Retailers discard most of the fruits when they are already wasted. Approximately 71 % of them claimed that they end up throwing the fruit in the garbage, and that only 28 % of the total people donate the remaining fruits to those who can still use them. What it implies is that, at the retail level, a lot of fruits that could still be used as food are being thrown away. This is because the customers demand fresh-looking fruits, including anything that is slightly damaged, thus ends up in the garbage bin.

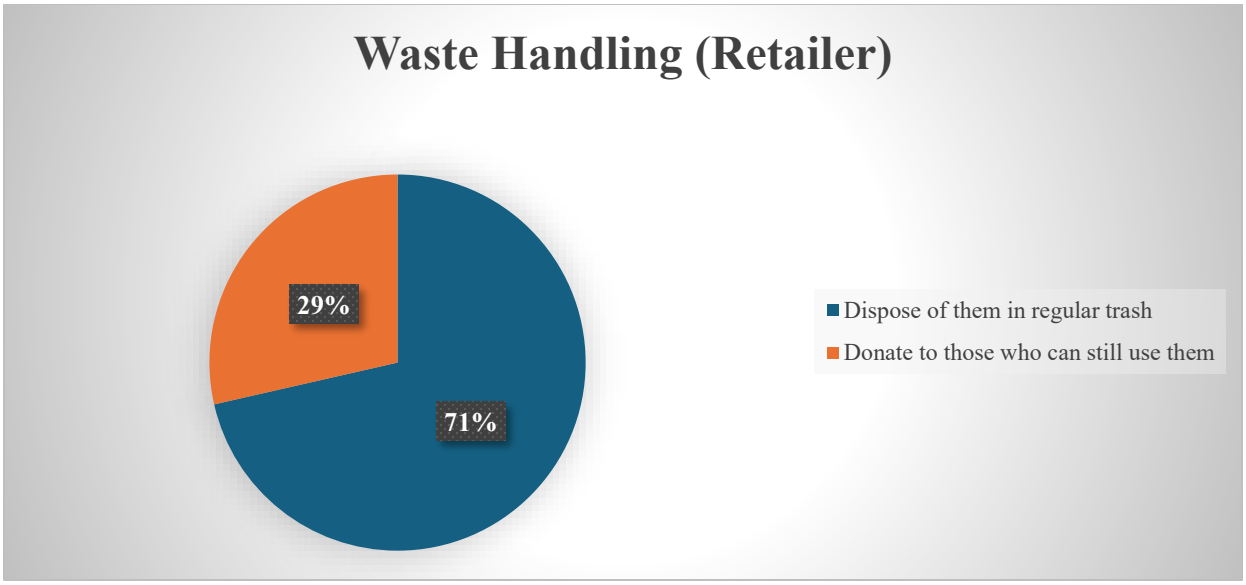


Figure 4. 26 Post Waste Handling by Retailers

Consumer:

The results at this stage of the value chain highlight a major gap in awareness and waste management options for consumers, as100 % of the consumers at this level interviewed said they discard fruits when they believe that they are waste. This would imply that alternative usage, such as composting, donations, and repurposing, is not implemented at this point.

4.3.1.3 Conclusion

The wastage analysis of the fruit value chain in Malakand Division reveals extensive inefficiencies and high economic losses in the fruit value chain, mainly in the farm and wholesale/regional levels. The total monetary loss due to waste was estimated to be PKR 851,183, and the farmers were estimated to lose an absolute (compared to their shareable revenue) of 4 per cent, and the wholesalers together would lose PKR 4.5 million. Such losses are particularly important given that most of the producers are on subsistence or smallholder levels. Among the main causes of fruit wastage noted are fruit fly infestation identified by 47.6 percent of the respondent farmers,

mechanical damage during harvesting (40.98 percent), and premature ripening due to late picking, and cold storage breakdown, since 66.7% of the existing cold storage facilities are either non-functional or have been relocated. Additional conditions of poor road infrastructure, high costs of transport, and time delay in the market further worsen the spoilage, especially in crop peak gathering periods. These findings are consistent with the literature. To provide an example, poor pest control, insufficient modern storage, and low investment in a cold chain are cited by Waqar et al. (2018) among the major factors resulting in post-harvest losses in the fruit production sector of Pakistan. In the same context, Khan and Han (2017) stress that such geographically mountainous locations as Chitral, which is analogous to Malakand's position, are experiencing cumulative losses on the basis of terrain-based logistics issues and poor infrastructure. There is also the question of post-waste handling practices that the analysis sheds light on. The majority of the farmers interviewed said they abandoned spoiled produce in open fields or fed it to animals, but a limited number reused partially spoiled fruit in their households. Composting, secondary processing, and recycling are not organized, which means it is not only economically inefficient but environmentally as well. Such informal methods represent the lack of more institutional support or awareness of waste use as a whole, which is also evident in Siddique and Garnevska (2018), where they present similar tendencies in the case of a citrus value chain in Pakistan. The other important aspect is that there is no reward or responsibility on the part of the traders and transporters to cause minimal harm. Use of outdated materials (e.g., gunny bags, wooden crates with no cushioning in the crates) is normally used in the process of packaging, and this compounds the mechanical damage during transportation. Ineffective cold storage, which is usually affected by the common failure of power and other alternate sources of energy like solar power, implies that fruits are preserved under ordinary temperatures, which hasten their deterioration.

In sum, the result of the waste analysis is evidence of a system-wide inefficiency marked by bad harvesting practices, fundamental shortage of infrastructure, and ineffective governance, all of which militate against the realization of horticultural potential that is otherwise high in the nation. These results support the argument of the necessity to implement special measures: funding solar-powered cold heart, educating farmers to understand that it is necessary to extrude the goods, not scuttle them and motivating better packaging with the higher quality on the one hand, and on the other one helping to promote circular waste usage (e.g., creating markets to sell pulp, composting,

making animal feed). Feeding into more general research (e.g., Rehman et al., 2011; Ahmad, 2018), it is revealed by the study that there is still technological and institutional neglect in Pakistan on its supply chain of fruits. The issue of post-harvest waste is more than a solution to economic losses since it is a crucial step to sustainability, food security, and boosting income in rural areas.

4.3.2 Thematic Analysis

Thematic analysis was conducted to uncover the underlying issues, perspectives, and suggestions shared by key actors involved in the fruit value chain of Malakand Division. This analysis is divided into two segments: the first captures the voices of stakeholders, such as farmers, retailers, transporters, and exporters, who shared their on-ground experiences and challenges; the second reflects insights from agricultural experts, offering a more technical and policy-oriented viewpoint. Collectively, these themes provide a balanced and practical insight into how the peach and the persimmon value chains work, where they encounter challenges, and what could be done to make them more efficient and sustainable.

4.3.2.1 Stakeholder-wise Thematic Analysis

Through in-depth interviews with the key actors in the fruit value chain, such as farmers, transporters, wholesalers, retailers, cold storage owners, as well as exporters and consumers, it was identified that six broader themes highlighted the complex and intertwined problems facing the sector in Malakand Division. Each theme contains particular issues that are brought up by the stakeholders, based on what they experience in their lives, which point to what specific areas need to be addressed so that the fruit value chain can operate in a more efficient as well as sustainable manner.

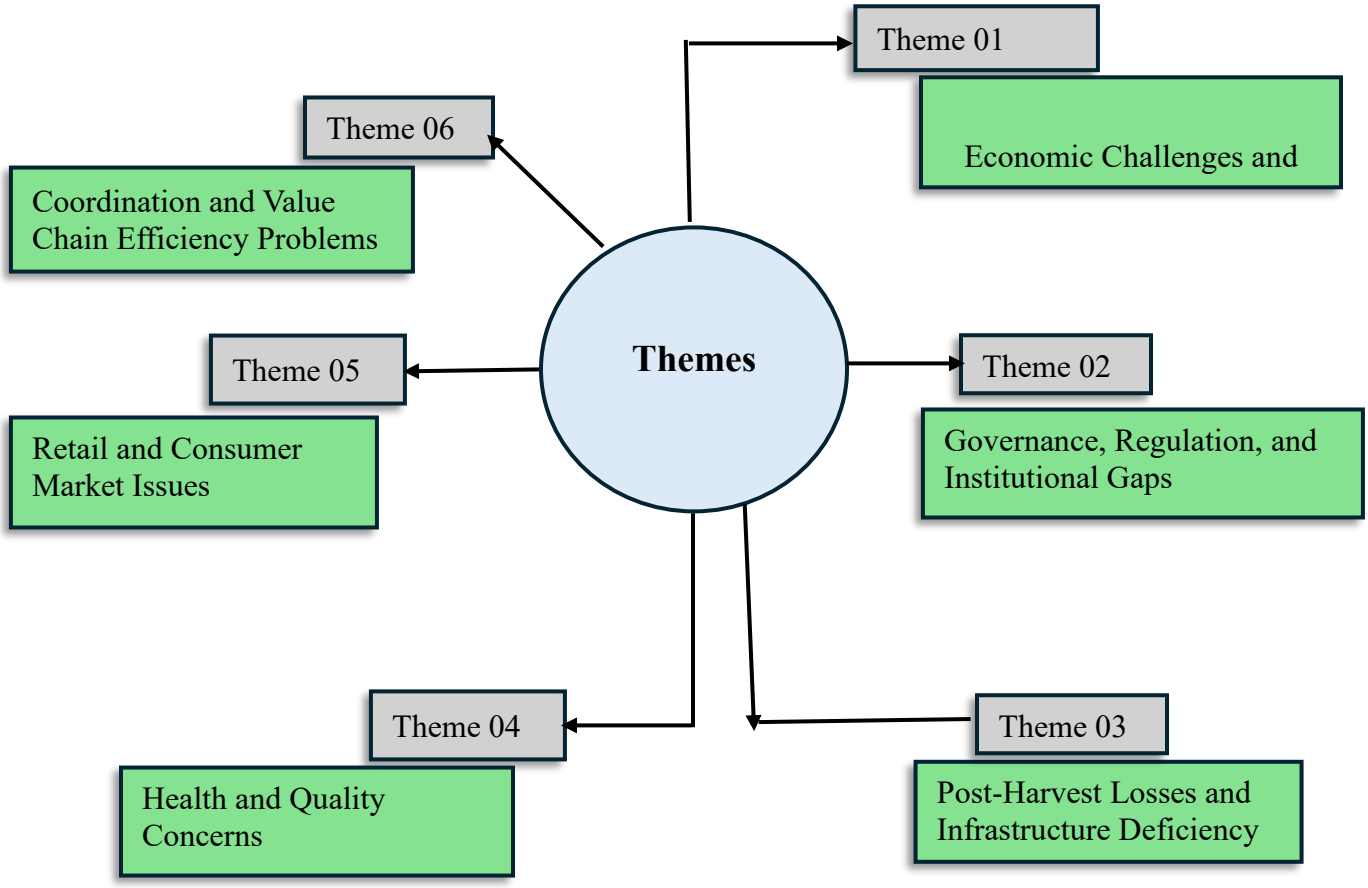


Figure 4.31 Stakeholder-wise Thematic Analysis

1. Economic Constraints and Market Volatility

The responses generated one of the most notable themes, which was the economic pressure experienced throughout the fruit value chain. Producers (farmers) to retailers were constantly complaining about increasing expenses, volatile pricing models, and narrowing profit margins. This is not only an issue of operation but also a problem that threatens the long-term survival and development of the sector.

a. Rising Input Costs

To most farmers, the increase in the cost of input is an increasingly big impediment to fruit production. They have highlighted how the rising cost of fertilizers, pesticides, and diesel is gobbling up much of their earnings, leaving little to profit. Such costs of input, especially in the case of small-time farmers, are the difference between breakeven and loss.

Transporters also raised similar concerns, pointing out how the excessive cost of diesel makes logistics more expensive. Since fruit transportation is time-sensitive and requires proper handling, any attempt to cut costs can lead to further losses through spoilage or damage.

Distributors added that their operational expenses have increased significantly due to higher fuel prices and labor charges, yet they are unable to pass on these costs down the chain due to competition and low market prices. Cold storage facility owners shared that electricity costs, exacerbated by load shedding, are a heavy financial burden. Maintaining the correct temperatures and conditions for fruit preservation has become extremely costly, reducing the affordability and accessibility of cold storage for many farmers.

Exporters, too, are reflected in the economic strain they face. According to them, air freight charges have skyrocketed, and this, combined with the extra costs demanded by local authorities (such as informal payments and red tape), makes it difficult to compete in international markets.

b. Unstable Pricing Mechanism

The other significant concern that both the farmers and retailers raised was a gap between auction rates in the mandi (wholesale market) and the government-regulated prices. The farmers cited that the recommended prices are always published, but the real prices they get at auction are always

lower, and they are therefore left with no choice but to sell their produce below the price. The retailers, however, argued that they have to frequently operate between a situation where they are forced to buy at the high auction price and then forced to sell at the government list price or the retail price.

This difference in prices has caused confusion and disappointment in the chain of supply. It leads to a lack of transparency and distrust amongst stakeholders, where many believe that the system is not fair to them. Consumers are also affected directly since the prices they often pay are not equal to the rates charged by the government, in most cases in informal markets where little control is exercised over the charging and displaying of prices.

c. Market Saturation and Excess Supply

Some of the respondents, especially the farmers and distributors, noticed that at the peak season, when the fruit is ripe, there will be an abundance of fruit in the market. This over-supply reduces prices by huge margins, and where there is limited space to store or export. The farmers reported that during this situation, the tendency is that the produce will not be sold out, leading to wastage and additional financial loss.

Retailers also addressed the issue of a crowded market concerning their earnings. Many varieties of similar fruit will have flooded the market, particularly by local farmers, and this brings competition, and prices decline. Many retailers explained that the presence of informal vendors of low-grade fruit with lower prices leads to the loss of customers in the formal shops. This undermines their business and continues an era of poor returns.

From the consumer's perspective, while an oversupply might seem like a benefit, it often leads to inconsistent quality and confusion over pricing, especially when lower prices do not always mean better value.

Low Profit Margins Across the Chain

Across all levels of the value chain, stakeholders expressed concern about how slim their profit margins have become. Farmers lamented that after deducting all production and transportation expenses, there is hardly any money left for reinvestment or savings. In many cases, they are simply working to stay afloat.

Transporters and distributors shared similar struggles. Rising costs, post-harvest losses, and limited control over selling prices mean their businesses are under constant pressure. Cold storage operators said that despite charging service fees, they often struggle to cover their operational costs due to irregular demand and the financial limitations of smallholder farmers.

Exporters also explained that due to the risks involved and limited government facilitation, most local dealers avoid exporting altogether, further shrinking income opportunities for the entire value chain. Even retailers, who have some pricing power, reported that their profits are undermined by spoilage, inconsistent customer turnout, and price competition from informal sellers.

d. Price Manipulation and Weak Enforcement

Price manipulation emerged as a major grievance, especially among consumers and retailers. Consumers complained that many retailers charge well above the official prices, especially in local bazaars and street stalls where there is no oversight. They also shared concerns that quality is not consistent with the unaffordable prices charged.

Retailers, while acknowledging this perception, argued that they are forced into such practices due to high purchase prices and limited flexibility in pricing. Many blamed the lack of effective enforcement, claiming that market inspectors either turn a blind eye or apply regulations inconsistently.

Farmers also suffer indirectly from this manipulation. Since they have little control over final market prices and because intermediaries often dictate rates in mandis, farmers are left with limited bargaining power and reduced income. These inefficiencies are supported by the lack of transparency and mechanisms of price regulation that impede trust in the whole chain.

2. Governance, Regulation, and Institutional Gaps

Inefficiencies in governance and regulatory controls became an issue of serious concern to the smooth operation of the fruit value chain. The general view that came out on different categories of concerned stakeholders is that the market is not effective or fair due to poor institutional support, heavy regulation that is overreaching, and unstable, amongst other related issues of corruption at different levels. Frustration, mistrust, and increasing feelings of abandonment among those involved in the value chain have been caused by these systemic problems.

a. Corruption and Bribery in Licensing and Transport Regulation

Transporters in particular complained about the difficulties we faced with the checking of the roadsides, traffic restrictions, and the collection of fines. Most of them expressed that, besides the official punishments, there is a likelihood of being asked to pay bribes to cross the checkpoints when carrying heavy loads. These unofficial payments constitute a major cost in addition to the running of the operations and may slow down the delivery of fruits, hence ending up rotting due to spoilage.

The exporters also complained about bureaucracy, illegal fees, and delays in obtaining permits or flying into airports with fruits. The uncertainty of such processes deters them from expanding export activities. Even farmers reportedly complain about the problem of orientation with the local government regarding transportation and licensing, in particular when transporting the product to the city.

This generalized sense of corruption and unequal application is an indicator of more basic institutional failings. Many rules are considered as rent-seeking opportunities instead of serving to promote the healthy movement of goods, hence undermining the trust of stakeholders in official processes.

b. Excessive and Inconsistent Regulatory Policies

Several stakeholders, such as transporters, retailers, and exporters, showed worry over a perplexing and continuously overemphasized regulatory environment that prevailed fruit trade. Transporters reported a checkerboard of traffic regulations and transport authorizations that differ according to region and hence, cannot efficiently operate. Retailers observed that formal price lists are usually implemented more arbitrarily, with certain vendors punished and others not.

Distributors claimed that they are not allowed to operate licenses which are not necessary and inspections that interfere with their business activities. Exporters pointed out that although the fruit sector has the potential to export, it does not have an encompassing structure to facilitate international standards compliance or facilitate the bureaucratic process.

Such inconsistencies present unfavorable conditions that encourage most actors to conduct business informally, further deteriorating regulatory compliance and institutional accountability.

c. Poor Implementation of Government Price Controls

One common topic encountered by consumers and retailers was the ineffective introduction of government-regulated fruit price lists. Consumers had complained that the retailers sell products at much higher prices as compared to the official prices, particularly in the informal markets and on the stalls along the roads. The retailers, on the other hand, stated that the prices fixed by the government would not match the actual cost of procurement, where the prices obtained during the auction at the mandi are exaggerated.

Such a difference in prices also hurts farmers. When the farm produce is supposed to be sold off to the highest bidder, depending on the market requirement, the farmers during the mandi auction are usually underpaid, and then the same fruit is resold to the consumers at a higher price. This ineffective enforcement and lack of price enforcement both undermine the trust and build resentment throughout the chain.

Without open and binding price mechanisms, the stakeholders end up engaging in informal bargaining and pricing through their self-interest, which increases inequality and inefficiency.

d. Lack of Policy Support and Institutional Coordination

Lastly, a lack of long-term policy support and interdepartmental coordination was cited as a huge frustration by various stakeholders. Farmers and cold storage owners complained about subsidies, technical education, and investment in infrastructure. Distributors and transporters noted the inability of the government to create an improvement in logistics and access in the market.

Exporters claimed to have no strategic aim or institutional support to facilitate fruit exports, and the retailers stated that there is no authoritative body that could check on the level of quality and hygiene in the domestic markets.

Such a gap in policy helps to create a lack of cohesion in the chain of value. The fruit industry is still marred by inefficiency and lost opportunities in the absence of a coordinated strategy in the sectors of agriculture, trade, transportation, and health. A strong feeling of being left to their own devices came out as many stakeholders stated that they were being left alone to traverse complex systems with little or no support and protection.

3. Post-Harvest Losses and Infrastructure Deficiency

Post-harvest losses and infrastructural shortcomings emerged as one of the most pressing concerns across the fruit value chain. Stakeholders consistently pointed to gaps in storage, transportation, and handling systems that not only reduce profitability but also threaten the overall sustainability of fruit production and distribution. These losses are particularly damaging in a perishable commodity like fruit, where timing, care, and efficiency are crucial.

a. Wastage Due to Delays, Improper Transportation, and Storage

The farmers and transporters had a commonality in the aspect of pointing to the fact that a substantial percentage of fruit is wasted because of the delays in getting to the market, especially during the peak seasons of harvest. Most perishable produce is transported in poor conditions, with hours and even days under the sun without temperature and humidity controls. This leads to spoilage, bruised, and over-ripening effects, thus making the fruit lose its market value greatly.

Transporters cited the reason why delays are likely enhanced by a bad road network, jams on the road, and delayed regulatory inspections that take time. The farmers pointed out that at the time the farmer gets his or her fruit to the mandi, a significant percentage is already in the process of going bad, and this translates poorly in the sale at the auction, where prices are low and rejection is high.

Retailers also echoed that by the time fruit reaches their shops, it is often already in a deteriorated condition, forcing them to either discard part of the stock or sell it at heavily discounted prices. This directly contributes to both food waste and income loss across the chain.

b. Inadequate Cold Storage and Packaging Facilities

Cold storage owners pointed out that energy shortages and high electricity costs restrict the capacity and quality of cold chain infrastructure. Load shedding and irregular power supply compromise the cooling process, which is vital for extending the shelf life of fruits such as peaches. Some cold storage facilities are outdated and lack proper insulation or backup power, making them unreliable.

Farmers and distributors expressed a strong need for accessible and affordable cold storage solutions, especially near production hubs. Many small-scale farmers do not have the means to rent cold storage units and thus are forced to sell immediately at whatever price is available, often incurring losses.

Retailers also commented on the poor packaging standards at both the farm and distribution levels. Improper or loose packaging leads to fruit damage during loading and unloading, further reducing quality and consumer appeal.

c. Poor Road and Energy Infrastructure

Transporters and distributors frequently raised concerns about the condition of rural and inter-city roads. Broken, narrow, or unpaved roads not only delay delivery but also physically damage the fruit due to excessive shaking and impact during travel.

Cold storage owners emphasized that without a reliable energy grid, they cannot maintain consistent temperature levels, particularly during hot months. Electricity fluctuations not only affect cooling systems but can also lead to gas leaks or even safety hazards, especially in aluminum-based storage units.

Farmers also mentioned how diesel-powered tubewells are becoming increasingly costly to operate, due to fuel price hikes. This has a cascading effect higher costs at the farm level are passed down the chain, but without any improvement in infrastructure that could reduce inefficiencies.

d. Shortage of Skilled Labor for Handling, Packing, and Storage

Several stakeholders cited the lack of trained workers as a key factor contributing to post-harvest losses. Cold storage owners noted that careless handling of refrigeration equipment and gases by unskilled labor has led to leakages and accidents.

Distributors and farmers stated that fruit during harvesting, sorting, and packing experiences improper handling, which causes mechanical damage and lessens shelf life. Most of the laborers are seasonal or unskilled, without knowing anything about hygiene or the handling of fruits.

Retailers criticized bruised or chemically ripened fruit, a relatively common outcome of irresponsible post-harvest handling, as being hard to sell and causing customer dissatisfaction. This

level of inefficiency is human-level and is based on a lack of training and institutional support, which is compromising quality along the chain.

4. Health, Safety, and Environmental Concerns

Health and safety considerations have become one of the issues in the fruit value chain, particularly those offered by consumers and retailers. The reasons behind these concerns are the prevalence of using harmful chemicals, poor hygienic handling, and harmful packaging procedures to the environment. These problems not only impact on the well-being of the consumers but also facilitate the loss of confidence in the fruit market, leading to a drop in demand and profitability in the chain.

a. Excessive Chemical Sprays and Health Risks to Consumers

The farmers confessed that the overuse of pesticides and fertilizers has become the order of the day without proper guidance and technical education. Most of them depend on the advice of pesticide dealers, whose main concern is selling more than the safety of the people. Consequently, fruits are sprayed even during the harvest season, leaving chemical residues on the produce, which ultimately find their way into the market.

Consumers raised very concerning matters regarding the health implications of consuming excess sprayed fruits. Several respondents described that they or their family members had suffered some health problems, which were thought to be caused by chemical contamination. The distributors and retailers were also not ignorant of the fact that fruit that has been over-sprayed is not only less appealing in terms of its freshness, but it also decays quickly to further losses and customer dissatisfaction.

b. Use of Artificial Ripening Agents Like Carbide

Another alarming issue that both consumers and retailers were pointing out was the presence of artificial fruit ripening chemical agents, like calcium carbide. Because farmers are under pressure to get the fruits into the market as soon as possible, they usually harvest fruits that are not even ripe, and through chemicals, they artificially accelerate the ripening process.

The retailers highlighted that chemically ripened fruit may bear an unnatural taste and look, and be deprived of the nutritional value of naturally ripened fruit. Consumers also said the same thing, that these fruits are not only tasteless and utterly uninteresting, but they are also potentially unhealthy. They also condemned the failure by authorities to ensure checks in the use of prohibited or unsafe substances in fruit ripening.

c. Poor Hygiene at the Retail Level

Both the retailers and consumers realized the hygienically poor conditions under which fruits are being sold and especially in the local markets. The fruits are usually kept in open supply areas that have exposure to dust, flies, and pollution. Moreover, most retailers do not apply good cleanliness standards when packing the product or handling the same.

The consumers reported that in the majority of instances, they are not permitted to inspect and touch the fruit prior to their purchase. Instead, retailers will present only the best quality fruit on the front and pack up poor quality fruit that is damaged or bruised, which causes consumer distrust and accusations of fraud. Such a practice only impacts negatively on health outcomes, as well as reducing repeat purchases in the entire value chain.

d. Use of Non-Biodegradable Plastic in Packaging

There were environmental concerns, especially on the part of the consumers, who criticized the overuse of low-grade plastic bags and packaging materials. These bad practices not only threaten to jeopardize human health, particularly through the storage of fruits in plastic containers under the sun but also act as contribute to environmental degradation.

Retailers have confessed that they depend on plastics because of convenience and cheapness. Sellers and buyers are, however, becoming increasingly conscious that an alternative is required, which is biodegradable.

Nevertheless, no institutional pressure or policies have shown much-directed influence to move towards the eco-friendly packaging methods. Farmers and distributors on the other side revealed that fruits are usually squeezed in regular baskets or bags that are not durable or hygienic, and this also acts as a contributing factor to such damages and contamination during transportation.

5. Retail and Consumer Market Issues

The problems at the retail level and the issues on the consumer side are of great importance to the dynamics of the value chain of fruit. This theme brings attention to issues on pricing policies, transparency, quality guarantee, and access. Being the last point of the chain, the retail segment passes along inefficiencies from the more upstream actors, and the consumer is the ultimate decision-maker of the system's functionality.

a. Retailers Overprice Fruits and Violate Government Rates

The discrepancy between the prices charged at the retail level, which included both the prices officially set by the government and the selling price charged at the retail level, was one of the most frequently mentioned problems cited by both consumers and wholesalers. Many retailers neglect the actual price list and offer much higher rates, in particular, in cities where law enforcement is poor.

This discrepancy was severely criticized by the consumers who mentioned that, in spite of having the government price lists publicly provided, it is rarely adhered to. The retailers justify such practice by indicating its high cost of procurement in both monetary terms, transport, and competition in the market. But, due to this diversity, there exists confusion and distrust mostly on the part of lower- and middle-income buyers.

Wholesalers added that this price distortion discourages transparency throughout the chain, making it difficult to maintain standardized pricing from mandi to market. The disconnect between government policy and market reality results in losses for some and unjustified profits for others.

b. Selling Low-Quality, Bruised, or Under-Ripe Fruit

Retailers often engage in misleading practices such as displaying high-quality fruit to attract buyers but packing bruised, under-ripe, or overripe fruit at the point of sale. All consumer respondents raised this issue; many of whom complained of being deceived or denied the right to inspect the produce before purchase.

The ability of farmers and distributors to evolve and meet the consumer demand was reflected as well through frustrations with delays during transportation or poor packaging of the goods up the

chain, leading to bruised or spoiled fruit making it to the market. Retailers will sell this damaged fruit to unsuspecting buyers to cut their losses. This kind of practice not only dissatisfies the consumer, but it also hurts the overall image of the entire fruit industry.

c. Poor Transparency in Fruit Quality and Packaging

Consumers pointed to the lack of transparency with regard to fruit quality at the retail level with a high degree of emphasis. Many expressed frustrations over not being allowed to touch, inspect, or even see the packed fruit before completing the purchase. This practice undermines consumer rights and results in distrust between buyers and sellers.

Retailers argue that customer handling can damage the fruit and result in wastage. However, this often becomes an excuse to sell poor-quality produce. The absence of standardized grading, labeling, or certification of quality leaves consumers at the mercy of the seller's claims, further exacerbating the problem.

Some respondents suggested that retailers should be required to clearly label the fruit's grade, variety, origin, and ripening method, along with offering transparent packing practices.

d. Fruits Unaffordable for Middle- and Lower-Income Consumers

Rising fruit prices have made it increasingly difficult for low- and middle-income households to access quality fruit regularly. Consumers who shared those fruits, once considered a household staple, are now viewed as luxury items. This affordability gap is especially troubling in a country like Pakistan, where nutritional deficiencies are prevalent.

Farmers and retailers acknowledged this issue but attributed it to high production and transportation costs. However, due to limited purchasing power, massive quantities of fruit remain unsold or are wasted, especially high-quality or premium varieties that fewer people can afford.

Some wholesalers observed that this affordability gap limits market expansion and results in high dependence on informal vendors, who offer lower prices but often sell lower quality or unsafe produce.

6. Coordination and Value Chain Efficiency Problems

The coordination between all the stakeholders in the fruit value chain, including the farmers, transporters, wholesalers, cold storage owners, retailers, and exporters, etc. must be efficient in reducing losses, ensuring quality, and maximizing profits. Nevertheless, the results of stakeholder surveys reveal the broad aspects of the distribution of fragmentation, mistrust, and inefficiencies in operations along the chain. The theme will address the issues related to coordination and their impact on the fruit sector.

a. Mistrust and Weak Coordination among Value Chain Actors

There was a persistent message among farmers, distributors, and retailers regarding a hurdle between low trust and cooperation within the value chain. According to the farmers, the price is controlled by middlemen and mandi dealers who deduct their clandestine charges as they feel exploited. Likewise, distributors complained that they have to deal with farmers using improper harvest packages or delaying harvesting, which affects fruit quality. Retailers also complained of non-uniform supply and fluctuating prices from wholesalers. Instead of serving as a cooperative network, the fruit value chain in most instances is a chain of uncoordinated and self-protecting deals. This mistrust minimizes the exchange of information, investment in enhancement, and the vulnerability of small stakeholders in their bargaining power.

b. Lack of Support for Export-Oriented Practices

The exporters complained about the narrow portfolio of international trade, especially in high-value fruits such as peaches. A particular exporter was observed to have said that air transport exposes it to more markets abroad, but at a higher price. Moreover, bureaucratic challenges like permits, additional charges, and bribery discourage several prospective exporters.

This was also echoed by the farmers and the distributors, who were able to explain that they were unable to produce fruit that would be exported because of limited training and certification, and the fact that they do not have an infrastructure in order to be able to implement the cold chain. Pakistan does not have good connections with the markets to which it exports its fruits, and competitive institutionalized models that support global standards, which is the reason its fruit industry is not fully exploited and is still local.

c. Dominance of Informal Actors and Street Vendors

Retailers and consumers have noted an increase in the power of informal street vendors who peddle fruits at a low price and may neglect quality, safety, and hygiene. These sellers are affordable, but uncontrolled entry in the market destabilizes the pricing discipline, negatively impacts the business of formal retailers, and consumers lack confidence in the market. Street vendors were observed to be breaking into the formal system of mandi by the distributors, which not only causes the price undercutting but also avoids taxes and regulations. This is a trend that compromises formal value chain agents who incur the expense of compliance, storage, transportation, and quality assurance. Moreover, the rise of informal actors perpetuates inefficiencies, as these vendors often operate without proper packaging, hygiene practices, or traceability, posing risks to consumer health and market standards.

Conclusion

Thematic analysis of the fruit value chain in Malakand Division by stakeholders shows structural, logistical, and institutional problems that are deeply ingrained in the value chain at every level that requires a fundamental overhaul to optimize the value of production of the fruit by goalless producers to reform the role of exporters. Post-harvest losses through poor handling, non-existence of proper cold storage, volatility of the market, high transport cost, and poor coordination amongst the players are the most common. The farmers, being the core element of the chain, have to suffer the consequences of both a lack of knowledge of post-harvest technologies and access to markets. This falls in line with results by Rehman et al. (2011), who stressed the fact that it is area expansion as opposed to productivity levels that has been the primary growth driver to a large extent due to inefficient access to inputs and diffusion of technology. On the same note, Waqar et al. (2018) also point out the digital divide and low ICT adoption by the smallholders as an important impediment that is also additionally echoed in Malakand, where the majority of farmers are unconnected with any digital marketing systems and use the traditional ones instead. The traders and wholesalers raised concerns about the volatility of pricing, the absence of market control, and manipulation by the middlemen. These issues conform to B. Ahmad (2018), where the citrus exporter in Sargodha was limited by price manipulation and price non-transparency, which had an overall impact on both the producer and the intermediary. It is found that in the province of Malakand, the same

problems were raised due to unregulated fruit mandis, where prices are changed now and then with no regulations. Cold storage owners complained about constant power cuts and no maintenance support by the government, a factor that left most of the plants dysfunctional. This can be found in your waste analysis, where 66.7 percent of cold storage facilities were reported as being dysfunctional or closed. The results validate the findings by Khan and Han (2017), who wrote about the scarcity of infrastructure as one of the most crucial challenges of establishing effective supply chains in Chitral, a different fruit-growing district of KPK. Although exporters were fewer in number, their main reasons included the rigidity of sanitary and phytosanitary (SPS) requirements, high costs of logistic services, and delays in certification processes. These considerations are aligned with the findings of B. Ahmad et al. (2021) based on the research contingencies, stating that, although fruit export performance in Pakistan is promising, its competitiveness is hampered by ineffective branding, lack of quality, and licensing obstacles. Newly added studies reinforce these observations: Aurangzaib et al. (2024) and Shahwani et al. (2024) reported similar gaps in apple value chains in Balochistan, including underutilized grading, cold storage, and packaging, as well as weak institutional support and market access, which limit profitability. Mehdi et al. (2017) found that mango value chains in Pakistan suffer from similar systemic vulnerabilities in handling, storage, and market connectivity. Mazhar et al. (2022) emphasized that farmers' participation in modern supply chains depend heavily on knowledge, extension services, and integration with market networks, which mirrors the challenges faced by Malakand growers. Traders and wholesalers in the division raised concerns about price volatility, market manipulation, and middlemen dominance, consistent with B. Ahmad (2018) for citrus markets in Sargodha. On the whole, the issue of the lack of vertical integration and coordination became one of the systemic themes. The new stakeholders operate independently, and there is a lack of a precise feedback process among the production, processing, and market players. This fragmentation is also observed by Siddique and Garnevska (2018), who identified that in the citrus chain,

the growers, contractors, and exporters work in silos, undermining the chain-level governance.

Overall, the stakeholder-wise thematic analysis shows that the Malakand Division has a high agro-ecological potential, production capacity, but the value chain of fruit in the region is affected by

the typical constraints of developing countries, poor infrastructure, a problem of information asymmetry, and institutional disinterest. Nonetheless, the best practices related to the identified solutions could serve as entry points where the findings can be met with improvement, both in the form of post-harvest training, investments in cold chain, and integration with the digital market proposed in both domestic and comparative literature.

4.3.2.2 Agriculture Experts Interviews Thematic Analysis

Based on interviews conducted with agricultural experts, five broad themes emerged that collectively highlight the multifaceted challenges affecting the fruit value chain in Malakand Division. These include policy and governance gaps, regulatory constraints, production inefficiencies, technological limitations, and pest-related crop losses. Each theme encompasses specific sub-themes, discussed below.

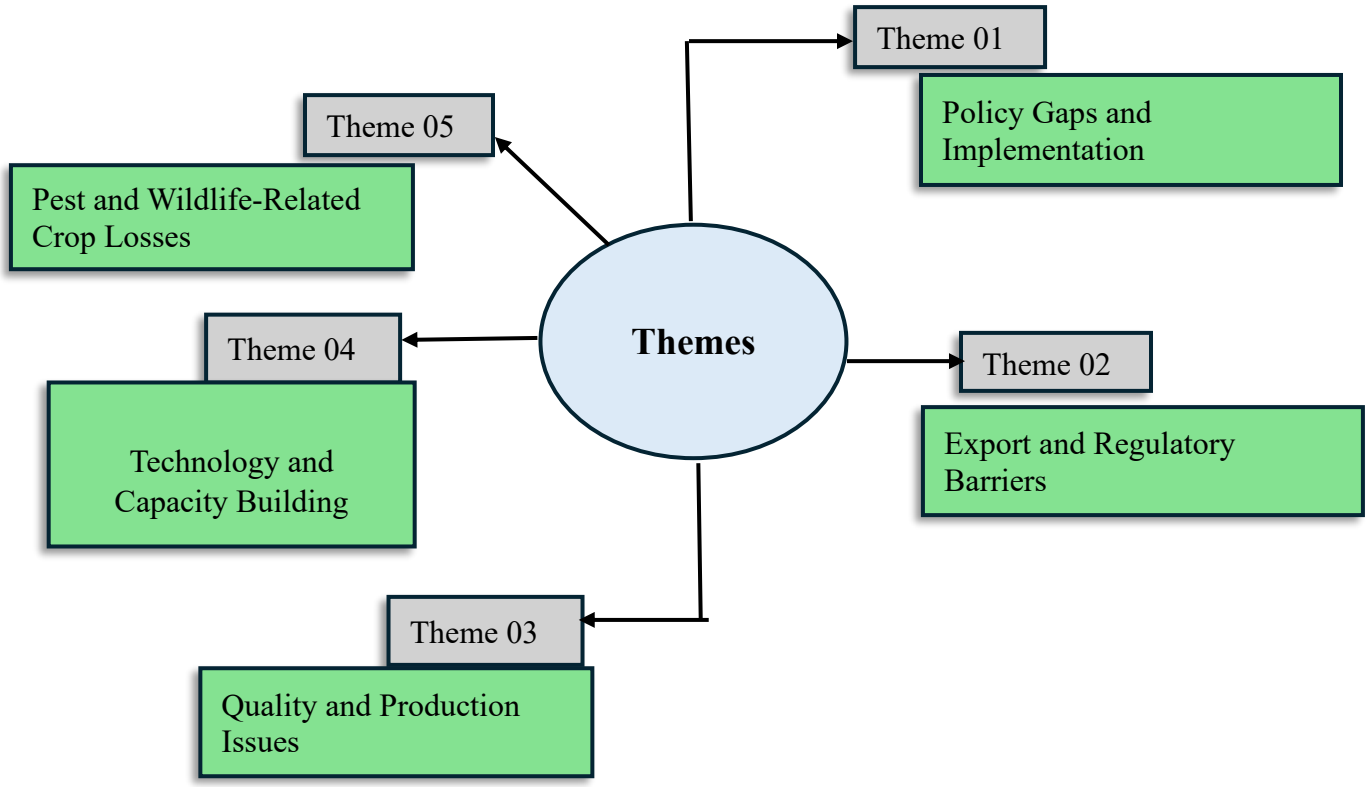


Figure 4.31 Stakeholder-wise Thematic Analysis

1. Policy Gaps and Implementation

This theme highlights that policy frameworks exist but are poorly implemented due to low awareness among farmers and exporters and weak enforcement at the grassroots level. As a result, stakeholders do not benefit from government schemes or adopt required standards, creating gaps between policy design and actual practice across the value chain.

a. Low Awareness Among Farmers/Exporters

Experts emphasized that a major barrier to effective policy implementation is the lack of awareness among key stakeholders, particularly farmers and exporters. Many are not adequately informed about government schemes, subsidies, or protocols essential for enhancing fruit quality and market access. This disparity restricts the adoption of the best practices and integration into the domestic and global markets.

b. Weak Enforcement at the Grassroots Level

Although there are policy frameworks to enhance agricultural productivity and to control supply chains, the respondents observed that there is poor implementation at the grassroots level. Institutions fail to enforce rules either because they do not have the people to do the work or because they do not have the will. Such misalignments in the policy and practice result in broken compliance and inefficiencies through the value chain.

2. Export and Regulatory Barriers

Experts emphasized that complicated regulations, poor compliance with SOPs, and credibility issues among exporters restrict Malakand's fruit export potential. Frequent consignment rejections due to pesticide residues, hygiene issues, and improper packaging damage the region's reputation and limit access to international markets.

a. Complex Regulations

Agricultural professionals insisted that the export framework is complicated by unnecessary regulations of many government bodies, often redundant to one another. These administrative obstacles impede small and medium-sized export of their products in the world, thereby limiting the international exposure of locally produced fruits.

b. Non-Compliance with SOPs

Hygiene plans (SOPs), residue limits, and package SOPs are common areas that are ignored by farmers and distributors. Analysts have identified that this non-compliance not only renders the quality of exports unacceptable to customers overseas but also exposes the export potential to direct rejection by overseas buyers, which thus creates a bottleneck in the expansion of export potential.

c. Exporter Credibility Issues

The next concern was the lack of credibility in local exporters, particularly when exporters do not match the quality or safety standards observed in overseas markets. The number of rejected consignments based on pesticide residues or bad packaging harms the image of regional products, so that honest exporters find it difficult to win orders from overseas buyers.

3. Quality and Production Issues

Substandard fruit quality, unstable production, and climate-related risks emerged as core problems affecting both domestic sales and export readiness. Traditional farming practices, irregular yields, and weather extremes reduce consistency, while diseases driven by moisture and temperature fluctuations further undermine fruit viability.

a. Substandard Fruit Quality

All experts agreed that the poor quality of fruits is a recurrent problem in the Malakand Division. This has been mostly blamed on poor pre-harvest and harvest practices and lack of quality input, and on how to grade, pull, and handle fruits. These aspects lower the levels of domestic consumer confidence and export competitiveness.

b. Unstable Production

The area also has problems with irregularities in levels of production because of traditional farming techniques, inconsistent weather, and division of property. The experts noted that such volatility impairs planning and influences the market pricing system so that farmers and suppliers cannot afford to stabilize their revenues.

c. Climate-Related Crop Viability Problems

Climatic factors like increased rainfall, hailstorms, and temperature fluctuations were some of the main issues respondents most frequently identified as significant threats to fruit viability. These natural disasters not only impacted crops but also led to fungal and bacterial diseases, such as brown rot, which further decreased both yield and quality.

4. Technology and Capacity Building

This theme reflects the limited adoption of modern technologies such as drones, digital tools, and improved post-harvest methods. Farmers lack technical knowledge and have minimal access to effective training programs, resulting in weak pest control, inefficient input use, and poor post-harvest handling.

a. Limited Use of Drones and Digital Tools

Respondents also said that in Pakistan, there is access to more innovative agriculture technologies, such as drones to monitor crops or digital resources to access the market, yet in Malakand, the use thereof is very low. The reason behind this lag in technology use is twofold: not only is the technology device unknown, but most smallholder farmers cannot afford it.

b. Lack of Technical Training

Experts highlighted the fact that capacity-building programs are required urgently. Many farmers lack basic training in pest control, fertilizer use, and post-harvest handling. Training programs that do exist often fail to reach the grassroots level or lack follow-up, thereby reducing their long-term impact. Technical literacy remains a major constraint to value chain improvement.

5. Pest and Wildlife-Related Crop Losses

Experts identified severe fruit fly infestations, bat attacks, and poor pest management practices as major causes of yield losses. Heavy dependence on chemical sprays increases residue levels and affects export acceptance, while biological control methods remain underutilized due to low farmer awareness and limited government support.

a. Fruit Fly Attacks Reduce Marketable Yield and Export Potential

One of the most pressing concerns expressed by all experts was the epidemic-level fruit fly infestation in peach orchards. These pests significantly reduce the marketable yield by causing internal damage to the fruit. In the context of exports, fruit flies are a red flag for international buyers, leading to rejections or strict phytosanitary inspections.

b. Bat Attacks Cause Direct Fruit Damage, especially at the Ripening Stage

Bats were identified as a unique and difficult challenge, particularly for persimmons. Experts explained that bats feed on ripe fruits at night, causing extensive damage just before harvest. Since there is no sustainable or humane control strategy in place, this issue continues to cause significant yield losses.

c. Lack of Effective Pest Management Practices

Most farmers lack access to integrated pest management (IPM) tools and continue to rely heavily on chemical sprays. This not only contributes to environmental and health concerns but also leads to increased Minimum Residue Levels (MRLs), making the fruit unfit for export. Experts highlighted the need for coordinated pest control interventions supported by scientific research.

d. Inadequate Farmer Awareness and Government Response to Biological Control Methods

Although biological control, like using pheromone traps or natural predators, is practical and environmentally friendly, there has been little implementation of this in Malakand. Experts assigned this to the absence of sensitization of people and the scarce country situation in the government to focus on sustainable pest management measures. They demanded the enforcement and enhancement of extension services and an enhancement of demonstration projects that would foster adoption.

The expert remarks demonstrate an intricate web of interdependent issues that vary in magnitude, such as policy failures, pest attacks, and others, which all contribute to the ineffectiveness of the fruit value chain in Malakand Division. While some efforts have been made in training and introducing improved varieties, these interventions are often fragmented and poorly implemented. A coordinated, multi-stakeholder approach that combines policy reform, technological adoption, training, and effective pest control is crucial for unlocking the full potential of this sector.

Conclusion

Thematic analysis of interviews with experts provides significant knowledge about the systemic and policy-level constraints of the fruit value chain in the Malakand Division. Scholars kept pointing to four general areas of institutional fragmentation, poor infrastructure, low farmer capacity, and stretched regulation. The themes not only represent reality at the ground verified via stakeholder interviews but are also consistent with the general national issues previously defined in the literature. Among the most outstanding issues addressed by specialists, there is the absence of united institutional support. They highlighted the disintegrated functions of agricultural, marketing, and trade bodies with less communication and having no common goals. This statement relates to many findings of Siddique and Garnevska (2018), who have also reported comparable institutional silos in the Pakistan citrus value chain in which producers, contractors, and exporters act independently with no harmonious governance. Shortage of functional cold storage and transport infrastructure, particularly in high-yield districts such as Swat and Lower Dir, was indicated as a major concern by experts as well. This aligns with the findings reflected in your waste analysis that governs the use of cold storage contributed to considerable losses, and further references obtained by Khan and Han (2017) indicate that inadequate road accessibility and the lack of preservation plants are major issues that greatly complicate fruit supply chains in the mountains of KPK. In terms of farmer capacity, the commensurate observed by experts was that the majority of the farmers are not trained in post-harvest handling or in market-oriented production skills. They suggested routine extension activities, demonstration plots, and integrated pest management schemes. Such recommendations are consistent with the conclusions by Mossie et al. (2020), who showed that education and access to extension services trigger massive participation of farmers in value chains, and Rehman et al. (2011) highlighted that area-based

growth prevails in Pakistan because yield-improving interventions are unlikely. The other theme is the complexity of regulation in exports, such as the time-consuming certification process and disparity in the application of sanitary and phytosanitary (SPS) standards. Such bureaucratic challenges are also related to the issue brought up by B. Ahmad et al. (2021), according to which the fruit exporters in Pakistan manage to struggle with the lack of quality standard enforcement, as well as the lack of structured branding and traceability systems, the latter once again reducing their competitiveness on the international market. Finally, researchers promoted the use of digital market platforms, the public-private partnership, and the regional value chain approach that could support the efficient pricing discovery, enhanced coordination, and limited dependence on informal middlemen. All these recommendations are aligned with the ICT-based solutions proposed by Waqar et al. (2018), who emphasized the possibilities of transformative access to information in the fruit markets.

In conclusion, expert thematic analysis is complemented by stakeholder analysis as it offers a macro-level insight into structural bottlenecks in the value chain of fruits in Malakand. The expert opinions not only support the grassroots concerns raised by farmers, traders, and exporters but also offer a policy framework that complements the available empirical evidence. The coordination of governance and investment into infrastructural capacity building is the only method to unlock the potential of the horticultural region.

4.3.3 SWOT Analysis

A SWOT analysis was conducted to obtain a strategic understanding of the fruit value chain in Malakand Division. This framework helps to identify the external opportunities and threats in the industry as well as the internal strengths and weaknesses. The analysis, which is based on primary and secondary data, provides an in-depth understanding of the current situation by emphasizing essential elements that affect the region's peach and persimmon production, processing, and marketing. The SWOT (Strengths, Weaknesses, Opportunities, Threats) method was applied to explore the factors inside and outside the fruit sector that contribute to its success and future. The analysis concentrates on peaches and persimmons, since these crops are important in the region, using data from local experts and stakeholders.

Table 4. 5 Results of SWOT Analysis

Strengths	**Weaknesses**
Agroclimatic suitability in Malakand for high-quality peach and persimmon production, confirmed by farmers and experts.	• Only two operational cold storages in the division, forcing reliance on quick sales and leading to high post-harvest losses.
• Established farmer knowledge of traditional cultivation techniques complemented by partial adoption of pruning, spacing, and pest management learned from Farmer Field Schools.	• No formal grading, waxing, or export-standard packaging in local markets, reducing competitiveness.

• High seasonal demand from Swat, Peshawar, and Punjab markets during peak harvest.	• Limited access to certified high-yield and disease-resistant peach and persimmon varieties.
• Presence of the Agriculture Department's research wing for variety trials and extension support.	• Price instability due to dependence on middlemen and weak farmer bargaining power.
Opportunities	**Threats**
• Potential for value addition through small-scale processing (drying, pulping, jams) as identified by women processors and local entrepreneurs.	• Climate variability (late frosts, hailstorms) damages blossom and reduces yields, especially in persimmon.
• Scope for export to the Middle East and Central Asia if proper handling, grading, and phytosanitary compliance is ensured.	• Persistent pest pressure (fruit fly, powdery mildew) without adequate integrated pest management.
• Government-backed mechanization schemes and training programs have already been introduced in select districts.	• Rising cost of farm inputs and labor is reducing net returns.

• Growing domestic demand for clean, traceable fruits among urban consumers.	• Rapid conversion of orchard land to non-agricultural uses in peri-urban areas of Swat and Buner.

Strengths

The Malakand Division also has a comparative advantage in the production of peaches and persimmons due to favorable climatic conditions, good soils, and appropriate altitudes as validated severally in KIIs with Swat, Shangla, and Buner farmers. The conditions constantly achieve high-quality fruits in terms of taste, texture, and shelf life--a factor that meets the objective of the study, which is to determine the competitiveness of major fruits. Besides, the management of the orchard landing inherited by farmers and now complemented by specific training of the Agriculture Department provides a rather low threshold of quality and stability in yield. The high domestic demand in major domestic markets like Punjab and Karachi also boosts the commercial feasibility of these crops.

Weaknesses

Though these have been the benefits, there have been systemic weaknesses limiting the efficiency of the value chain. The complete lack of modern cold storage, with only a couple of units running within the whole division, leads farmers to engage in distressed sales, resulting in 2030% of losses during peak harvest weeks. No grading, waxing, or export type of packaging indicated the inability to access higher-value markets was observed with KIIs respondents with traders. Low rates of spreading high-yield and pest-resistant varieties keep productivity below potential, and price volatility due to the control by middlemen destroys farmer margins. These least competencies have a direct correlation to the thesis value chain analysis aim, which indicates that post-harvest and marketing are the key points of loss.

Opportunities

The result of KIIs is an indication of uncovered potential that can be taken advantage of to increase the level of income as well as competitiveness. There was a willingness on the part of women to be involved in home-based processing (drying, pulping, and jams) that would provide value addition and market expansion. Exporters have agreed that there is a market in the Middle East and Central Asia, depending on how they meet phytosanitary and quality requirements, which shows a gap in demand that can be filled through training and certification. The policy environment is enabled by continuing governmental programs of subsidized tools, mechanization, and the use of solar drying in Swat and Dir Lower. Urban market needs hygiene, and branded fruits give an opportunity to premium charging and branding of Malakand products.

Threats

The industry has serious threats, which may affect its sustainability. Climatic jolts such as late frosts, hailstorms, and sporadic rainfall destroy blossoms and decrease yields of fruit, and in particular, persimmon is also vulnerable. There was also poor integrated pest management by farmers and extension workers, where pests like fruit flies and powdery mildew kept attacking crops. Increasing costs of inputs (fertilizers, pesticides, and labor) pose a threat to profitability, and conversion of land along already established housing and commercial development in the peri-urban regions limits the area of orchards. Red tape during exports also slows down market penetration as far as competitiveness is concerned. These threats are related to the purpose of the study, which is to find out systemic risks in the value chain.

This SWOT, particular to the fieldwork, specifies that Malakand possesses peach and persimmon chains with good natural and market strength, which are compromised by structural inefficiencies within the storage, quality compliance, and varietal adoption chains. The opportunities are also actionable and largely correlate with policy interventions, especially those opportunities involving value addition, women's involvement, and the tapping of the export markets. Nonetheless, these strengths and opportunities may be lost without specific interventions to safeguard against climatic, pest, and cost pressures of a potential competitive horticulture center.

Conclusion

The SWOT analysis shows a fair picture of internal strengths, internal weaknesses, external opportunities, and external threats that define the fruit value chain in the Malakand Division. The review shows that the region has very important comparative advantages, which include, among others, agro-ecological diversity, seasons, and high consumption volumes. Despite this, the region has systemic vulnerabilities and new threats that continue to resurface and hinder its potential. Another strength noted is the suitable climate and soil aspect of the region to grow a variety of fruits, and this discussion is also in line with the argument of Waqar et al. (2018), who also attributed the relationship between ecological endowment and regional competitiveness of horticulture production. The value of this is that the variety in the seasons allows staggered harvesting such that, at some times of the year, producers get a competitive advantage in the market, especially during off-season harvesting of peaches, apples, and persimmons. Nevertheless, the key weaknesses are still there, such as insufficient cold storage, obsolete post-harvest operations, weak farmer expertise, and inadequate access to markets. These results are corroborated by Rehman et al. (2011), who observed that area-based growth is what defines the fruit industry in Pakistan because of the lack of technological production of technology. On the same note, Khan and Han (2017) noted that infrastructure shortages in Chitral share the same problems discussed in Malakand due to a lack of road networks and effective handling practices. Considering the opportunities, the analysis presents that there is potential for value addition, particularly in fruit processing and exports. Possibilities of Solar-powered cold storage, online marketing platforms, and access to quality standards and certification were highlighted. These opportunities concur with the proposed policy directions that Siddique and Garnevska (2018) proposed to address the Pakistani citrus chain by promoting organized intervention in the form of cooperative models, market intelligence, and investment in the infrastructure. On the other hand, the three threats indicated, comprising climatic changes, transformation of land use, and exploitation of the sector by middlemen men are severe to the sustainability of the sector. Both the experts and the stakeholders had to worry about the uncertainty in the weather patterns, the increase in input prices, and the non-regulation of local mandis. Such threats confirm the evidence of B. Ahmad et al. (2021), who also documented the equality in the export and market-related risks of the citrus industry in Sargodha, which was presented by informal market structures and policy inertia.

In general, the SWOT analysis incorporates important structural and environmental influences in the fruit value chain. It highlights the demand for policy congruence, infrastructural aid, and institutional transformation in a bid to exploit strengths and opportunities as well as forestall the threats posed in the long term. This combined perspective helps prove the argument of the study as a whole: the Malakand region has the potential to unlock its horticultural potential only with carefully chosen and evidence-based interventions that rely on the local reality and trends found in literature at the national level.

CHAPTER 5

CONCLUSION, AND RECOMMENDATION

5.1 Conclusion

The primary objective of this study was to analyze the challenges faced by each stakeholder (Farmer, Wholesaler, Transporter, Cold storage owner, exporter, retailer, and Consumer) involved in the value chain of major fruits of Malakand Division, KPK, and the amount of fruit wasted and the causes of wastage at each stage of VC. The study also analyzed the overall growth trends of the major fruits, and decomposition analysis was also done to identify the contributing factors that enhance the production of these fruits. The study also carried SWOT analysis and identified the strengths, weaknesses, opportunities, and threats of fruit production and its value chain.

To explore the total share of major fruits (Apple, Apricot, Peach, Plum and Persimmon) of Malakand Division to total production and area of Khyber Pakhtunkhwa Province (KPK), we carried out trend analysis and the results shows that Peach and Persimmon have the highest share to KPK's total production as 79% of the provincial area and 80% of production for peaches, and 81% of the area and 73% of production for persimmons. The trend analysis was also done for the above-mentioned fruits district-wise, and a comparison was also drawn between Malakand Division and KPK. The results reveal that over the past 19 years, fruit farming patterns in Malakand Division have changed noticeably. In many districts, especially Buner and Malakand, apple farming has dropped sharply or stopped altogether. This decline points to serious issues like changing weather, diseases, or poor returns from the market. Other areas, such as Dir Lower and Dir Upper, have also seen steady decreases in both the land used and the amount produced for traditional fruits like apples, apricots, and persimmons, highlighting the need for immediate government support. On the other hand, peaches are gaining ground. Their farming and production have grown steadily in several districts, including Dir Lower, Buner, Dir Upper, and Shangla. This shows that farmers are moving toward fruits that grow better in the current conditions and bring in more income. Among all, Shangla has shown strong progress across most fruit types, making it a promising area for expanding fruit farming.

This study provided a comprehensive value chain analysis of major fruits, particularly peaches and persimmons the Malakand Division of Khyber Pakhtunkhwa (KPK), Pakistan. Utilizing both secondary data (2004–2023) and extensive primary data collected through stakeholder interviews, the research explored trends in fruit cultivation and production, post-harvest dynamics, market structures, institutional challenges, and the economic and environmental context shaping the fruit sector.

The analysis of trend growth indicated a sharp contrast at the district level. In terms of peaches and persimmons, there have been positive improvements in area and even production, especially in regions such as Shangla, Upper Dir, and Swat; however, in apples and apricots, both area under cultivation and yield have declined significantly, especially in Malakand and Lower Dir. This finding highlights the fact that a change to more resistant and commercially viable crops, in this case, peaches, has made its way into new climatic conditions and commercial pressures.

Decomposition further broke up the sources of output growth, and it was observed that growth in cultivated area was the most dominant source in most districts. Nevertheless, such area-based expansion is inefficient and ultimately unsustainable, particularly in the case of peaches, because there were found to be negative yield implications were found even though it was expanding. In comparison, persimmons in such districts as Shangla showed an encouraging trend of yield-driven development, and thus, with sufficient infrastructural and agronomic backing, production can be enhanced more sustainably. The decomposition results also indicate untapped potential in both technological adoption and yield-enhancing practices, and extreme interaction effects in certain (e.g., negative interaction effects of apples in Buner and Malakand), which indicate system-wide failures of coordination in input utilization and farm practices.

The primary data analysis revealed systemic inefficiencies across the value chain. From farmers to exporters, actors face major constraints, including post-harvest losses, poor cold storage facilities, price volatility, regulatory inefficiencies, excessive pesticide use, and weak market linkages. Stakeholders consistently expressed frustration over governance issues, institutional neglect, inadequate infrastructure, and limited access to export markets.

The analysis of the waste identified substantial losses in almost all stages of the fruit's value chain, including before harvest, after harvest, processing, and retailing. The biggest losses were registered

at the farm and wholesale level, with some major factors being the fruit fly infestation (47.6 percent), physical damage during harvesting (40.98%), and a common power shortage that hit 66.7% cold stores lastly. Another loss was caused by inefficient post-harvest handling, poor sorting and grading, and ineffective transport conditions. It is estimated that the overall cost of fruit waste was over PKR 851,000, which demonstrates that the solar-powered cold storage requires investment, harvesting practices should be improved, and the regulatory control must be enhanced to minimize the economic consequences and to increase the efficiency of the value chain.

Thematic analysis identified six interconnected limitations that hurt the fruit value chain in the Malakand Division. First, economic problems like volatility and the cost of input reduce the profitability of farmers and make them more susceptible to market shocks. Second, post-harvest infrastructure is in a very poor state, and poor cold storage, poor packaging, and the absence of transport infrastructure also result in high losses. Third, regulatory and institutional constraints, such as delays in the certification of exports and weak governance structures, hinder the efficiency of value chains. Fourth, environmental issues include pest attacks and fruit fly infestation in particular, and fluctuation in temperature further promotes yield instabilities. Fifth, access to market information, as well as weak outreach digitally, does not keep the farmers and the traders well informed, and they are unable to make good decisions. And finally, there is poor coordination of the different actors in the value chain, namely farmers, transporters, wholesalers, and exporters; this causes waste and duplication, and they do not trust one another. Cumulatively, such themes indicate why integrated policy responses that deal beyond technical inefficiencies are needed, including institutional, infrastructural, and market system weaknesses.

The expert interviews also provided additional understanding of the systemic barriers that were present in the fruit value chain. Experts and advisors in farm production and export production noted the absence of technical skills in farmers, especially in terms of integrated pest management, new pruning technologies, and post-harvest care. Lack of strong connections between research institutions and producers is also identified by experts as a reason for poor adoption of improved cultivars and practices. Lack of smooth and efficient quality certification and traceability systems was noted by export stakeholders as one of the biggest problems preventing access to high-value international markets. Also, they observed that the absence of branding and cold chain logistics

investment has continued to expose the fruit industry in Malakand to trades with low margins, restricted to the local industry. These professional insights supplement the farmers' stories by providing a more institutional observer ship that highlights the necessity of the alignment of capacity building, export promotion, and application of researched knowledge in the value chain.

To strategically assess the region's potential and challenges, a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis was conducted. Among the key **strengths** identified are the favorable agro-climatic conditions in Malakand Division, which are particularly suitable for the cultivation of peaches and persimmons. The region also benefits from strong local knowledge and traditional expertise in horticulture, complemented by the presence of institutional support mechanisms such as Farmer Field Schools and agricultural extension services. However, the region faces several **weaknesses**, including inadequate post-harvest infrastructures such as cold storage and transport facilities, limited adoption of high-yield and disease-resistant fruit varieties, weak enforcement of quality and market regulations, and restricted access to essential inputs, credit, and mechanization for smallholder farmers. On the **opportunity** side, Malakand holds significant promise due to rising domestic demand for fruits and strong export potential, particularly if value-added practices like fruit drying and pulping are promoted. There is also increasing farmer awareness of modern production methods and growing support through government-led climate resilience and rural development initiatives. Nonetheless, the region is exposed to several **threats**, including climate variability and extreme weather events, pest-related damage (notably from fruit flies and bats), ongoing price instability in unregulated markets, and rising input and energy costs that undermine the viability of cold chains and other critical infrastructure. In conclusion, while Malakand Division possesses substantial natural and human capital to become a competitive fruit-producing region, systemic challenges continue to hinder its growth. Addressing weaknesses and threats through targeted investment, institutional reform, improved coordination, and market facilitation can help unlock the region's potential and foster an inclusive, sustainable fruit value chain. The next section outlines specific recommendations to guide this transition.

5.2 Recommendations

1. Policy Recommendations Based on CGR and Decomposition Analysis

- Since the decomposition results show that production growth in the region is mainly driven by expansion in cultivated area rather than improvements in yield, policy should shift towards enhancing productivity by improving orchard management and promoting high-yielding, climate-resilient varieties instead of relying further on area expansion.
- Prioritize productivity enhancement rather than land expansion by improving access to better seedling nurseries, quality inputs, and improved orchard establishment practices.
- Encourage greater cultivation of persimmon and peach, as CGR findings show these fruits maintain consistently high growth rates and offer strong potential for both domestic and export markets.
- Strengthen seasonal advisory systems to help farmers manage climate-related risks that heavily influence yields, including guidance on irrigation, disease control, and orchard timing.
- Support structured orchard rehabilitation programs in low-growth districts, focusing on replacing old or degraded orchards with improved, climate-resilient varieties.

2. Policy Recommendations Based on Thematic Analysis

- Enhance the presence of extension services by increasing on-farm visits and focusing training on input use, pest control, orchard management, and compliance with market standards.
- Develop targeted awareness campaigns and farmer field schools to educate farmers, traders, and exporters about SOPs, hygiene practices, grading, packing, and residue management.
- Simplify regulatory procedures and ensure exporters are informed about updated requirements for residue limits, documentation, and packaging.
- Promote coordinated pest management through synchronized spray schedules, orchard sanitation, and collective action against major pests such as fruit flies.

- Address wildlife-related crop losses, particularly bat attacks on persimmon, through community-based protective practices and proper orchard management.
- Improve institutional coordination among agriculture departments, marketing committees, and regulatory bodies to reduce implementation gaps highlighted during interviews.
- Strengthen value addition practices, as findings indicate very limited value addition in the region; promote training and small-scale facilities for fruit pulping, drying, grading, packing, and basic processing to increase product value and reduce post-harvest losses.
- Raise awareness among farmers and traders on the economic importance of value addition and encourage participation in basic processing and packaging activities.
- The results of the study indicate that several cold storage units in Malakand Division are either non-functional or operating below capacity, which is mainly because of high electricity prices, frequent power outages, and failure to maintain them. To overcome these limitations, cold storage facilities powered by solar energy are to be introduced, especially in Lower Dir, Malakand, and Upper Dir, where apple and peach production is strong and storage facilities are very limited.

3. Policy Recommendations Based on Waste Analysis

- Improve post-harvest handling by promoting careful picking, sorting, and grading practices to reduce mechanical injury and bruising at the farm and market levels.
- Replace low-quality or damaging packaging with more standardized and durable alternatives to reduce compression and deformation losses during transport.
- Reduce transport-related losses by promoting refrigerated transport options and encouraging the timely movement of produce from farm to market.
- Establish clear operational standards for cold storage facilities, ensuring routine inspection, maintenance, cleanliness, and proper temperature management.
- Provide wholesalers and retailers with practical training on fruit display, stacking, and stock rotation to limit spoilage in markets.

- Improve coordination among farmers, traders, and wholesalers to avoid excessive delays, overhandling, and unnecessary storage cycles that contribute to wastage.

4. Policy Recommendations Based on SWOT Analysis

- Establish a district-level coordination platform to improve communication among farmers, extension agents, marketing officials, traders, and exporters for seasonal planning and resource alignment.
- Strengthen market linkages through transparent pricing systems, reliable market information, and improved producer–buyer communication.
- Encourage medium- to long-term supply relationships that improve price stability and reduce uncertainties arising from production fluctuations.
- Improve quality assurance systems through routine monitoring of pesticide use, hygiene practices, grading standards, and packaging quality.
- Promote community-level campaigns for orchard sanitation, pest monitoring, and seasonal disease management to address major threats identified in the SWOT analysis.
- Leverage Malakand's strong agro-climatic potential by supporting diversified fruit cultivation, while also encouraging farmers to adopt varieties suited to local conditions and market demand.

5.3 Limitations and Contributions of the Study

5.3.1 Contribution of the Study

The study has a number of key contributions to the existing body of literature and knowledge on agricultural value chains, specifically the production of fruits in Pakistan. To start with, it employs quantitative methods like Compound Growth Rate (CGR) and Decomposition Analysis to evaluate the production dynamics of five major fruits, which are peach, persimmon, apple, apricot, and plum, over 19 years. Compared with the previous studies, which only address a specific crop or a specific district, this research takes a wider perspective since it covers more than one fruit and multiple levels of administrative impacts, including the grassroots (district) level and the provincial

level. Such an overall framework allows a better understanding of regional currents and factors of production. Second, the research fills the knowledge gap between the stakeholders, especially farmers and policymakers, by producing empirical evidence on which of the fruits have a comparative advantage and require a policy. This is a huge contribution because past research activities have not focused much on this disconnect, leading to disjointed or mismatched interventions. Third, another unique aspect of this study is the fact that it incorporates an analysis of value chain and provides policy recommendations. Although extensive research on value chains is evident, what has not been developed clearly is a direct relationship between the empirical results and policy measures to be employed as a measure of enhancing efficiency of the market, waste minimization and feasible applications of exports. Lastly, the paper gives way to new methodological contribution by determining the monetary value of the post-harvest losses at every level of the value chain of fruits involved. It will measure the volume of waste together with the monetary cost of wastage in the Pakistani Rupees (PKR), giving tangible figures on the economic impact on the various participants, especially the farmers and the wholesalers. Such detail is quite scarce in the available literature and can be viewed as a secure base for organizing specific interventions aimed at reducing losses and increasing the overall performance of the value chain.

5.3.2 Limitations of the Study

Although this study was comprehensive, it had several limitations as follows:

Narrow Secondary Data Accessibility

The secondary data that was to be used in trend and decomposition analysis was not accessible in any online source. It was acquired manually in the form of official visits to the Directorate of Crop Reporting Services, Khyber Pakhtunkhwa. Moreover, the dataset that can be considered is limited to 2004-2023. Years before 2004 did not have any official documentation, and thus, it limits the carrying out of a longer-term historical analysis.

Cold Storage Information Limitations

During the field research, it was learned that of the total number of cold storages that used to operate in the area in the past, only two were operating at the current time. The others were either closed or moved without due permission. Such a dearth of verifiable information restricted the

capacity to determine the total capacity, distribution, and effects of cold storage infrastructure on the fruit value chain.

Geographic and Commodity Scope of Primary Data

Primary data (Key Informant Interview (KII)) was done based on limited time and lack of sufficient financial and logistic means to cover a larger area, and thus it was limited to the collection of data on two fruits and three districts in the Malakand Division. Although these were chosen concerning production share, relevance, it remains that the results cannot be comprehensive to capture the trend of the other fruits or districts in the division.

Although these limitations do not invalidate the performance of the study, they can provide pointers to future research and more thorough future evaluations of the fruit value chain in Khyber Pakhtunkhwa and elsewhere.

5.3.2 Way Forward

Further study of the fruit value chain in Khyber Pakhtunkhwa ought to be conducted in regard to increasing the time frame, geographical location, and crop range of the study to develop a more holistic concept. There should be an attempt to develop longer-term historical datasets through enhanced cooperation with government agencies and the optimization of archival records through computerization. The capacity and status of cold storage infrastructure should be better evaluated by conducting systematic mapping and verifying the accurate status of various cold storage infrastructures that can inform specific investments in the infrastructure. An increase in the number of covered fruits, districts, and stakeholders in the collection of primary data with sufficient financial and logistical support would allow us to better assess the dynamics along the value chain. These broader, better-resourced studies will be stronger on evidence of policy interventions to be taken to improve efficiency, post-harvest losses, and competitiveness in the market.

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Appendix

Interview Guide: Fruit Value Chain in Malakand Division (Peach & Persimmon Focus)

Fruit Value Chain Stakeholder Questionnaire

Basic Profile Table

Field	**Response**
Value Chain Actor Type *(Select one)*	☐ Farmer ☐ Distributor ☐ Retailer ☐ Cold Storage Owner ☐ Financial Institution ☐ Agriculture Expert ☐ Transporter ☐ Exporter ☐ Consumer ☐ Other (Specify): _____
Respondent Name	_____
Age (in years)	_____
Gender	
Marital Status	

City/Village	_____
Education Level *(year)*	
Experience (Years)	
Source of Livelihood	
Total Farm Area (Acre)	
Farm Age (years)-Plantation	
Farm Age (years)- Fruiting	
Plants per acre (Nos.)	
Distance of Farm from Home (KM)	
Tenancy Status	
Fruit Type *(Select all that apply)*	☐ Persimmon ☐ Peach ☐ Other (Specify): _____

Qualitative:

What are the three main challenges you face in your role within the fruit value chain?

What are the three possible solutions or interventions that could help overcome these challenges?

Value Addition:

Value Chain Actor	**Value Addition** **Yes =1** **No= 0**	**Type of Value Addition** 1, Processing into Juice/Nectar 2, Processing into Jam/Jelly 3, Processing into Dried form 4, Canning (preserved in syrup) 5, Pulp Extraction for Further Processing 6 None	**Total Production/ Quantity handled**	**Price/kg**	**Profit Margin** **Rs.**
Farmers					

Transportation					
Wholesale (Market/Mandi **Distributor)**					
Storage **Cold Store**					
Exporters					
Retailers					
Consumer					

Waste Calculation:

Value Chain Actor	**Stage of Wastage**	**Cause of Wastage**	**Total Production/**	**Quantity Lost (kg)**	**Price/kg**	**What do you usually do with fruits once**

			Quantity handled			**they are considered waste?** **Options:** Dispose of them in regular trash Use them as compost or fertilizer Feed them to animals/livestock Sell them for by-product processing (e.g., jams, juices, etc.) Donate to those who can still use them Consume them yourself (e.g., in smoothies, jams, etc.) Other (Please specify)

Farmers	**Production-Farm Management**	Natural Calamity Pest Attack Theft Sickness	N/A			
	Harvesting	Improper harvesting techniques, Over ripeness, Mechanical damage, Poor labor skills, Lack of harvesting tools				
	Post-Harvest Handling	Bruising, Improper sorting & grading, Delays in processing, Poor hygiene, Lack of proper handling equipment				
Transportation						

Wholesale (Market/Mandi Distributor)		Overstocking, Low demand, Price fluctuations, Poor storage at mandi, Poor hygiene, Weather exposure				
Storage Cold Store						
Exporters						
Retailers						
Consumer						

Policymakers and Agricultural Experts

1. What are the main challenges affecting the peach and persimmon value chain in Malakand Division?

2. What opportunities exist to strengthen the fruit value chain in the region?

3. How can fruit wastage be reduced across the value chain, and what steps has the government taken to address this issue?

4. What strategies or technologies can improve fruit production, processing, and distribution?

5. What initiatives have been introduced to enhance fruit productivity, support farm mechanization, and provide training to farmers?

6. What efforts have been made to introduce and promote improved fruit varieties, and how aware are farmers of them?

7. Have the introduced varieties improved yield, quality, or disease resistance, and what policies support their adoption?

8. What key challenges hinder value addition in the fruit sector, and what steps and training programs exist to address them?

9. What policies can enhance value addition and processing in the fruit sector?

10. What are the major barriers to exporting fruits (e.g., regulatory constraints, certification, costs), and what initiatives exist to overcome them?

11. How effective are existing policies in improving fruit production, marketing, and international competitiveness?

12. What future policy directions should be prioritized to strengthen the fruit value chain?

13. Are digital tools like drones and mobile apps used for crop monitoring? How efficient are they, and what challenges limit their adoption?

14. What policies can promote wider adoption of digital tools in agriculture?

15. Do you have any recommendations or feedback for improving the fruit value chain?