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RESEARCH PAPER

Assessing the role of value addition of deciduous fruits in poverty reduction in Tehsil Danyor District Gilgit

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Abstract

This study investigates the impact of value addition in deciduous fruit production on household income and poverty reduction among smallholder farmers in Tehsil Danyoure, District Gilgit, and Pakistan. Despite favourable agro-climatic conditions, the region suffers from significant post-harvest losses (50–70%) due to minimal processing and poor market linkages. The results revealed that cherry (37.76%) and apricot (27.80%) are the dominant deciduous fruits cultivated in Tehsil Danyore, highlighting strong potential for targeted value addition. Among existing practices, drying (50.21%) and packaging (26.97%) were the most common, while advanced techniques such as cold storage were absent, contributing to high post-harvest losses (up to 49.38% reporting very high losses). Most farmers participated in packaging and marketing activities but had limited involvement in processing and product development, indicating early-stage value chain engagement. Value addition was primarily pursued to increase profitability (29.46%) and extend product shelf life (26.97%). Despite universal access to training programs, 40.25% rated them as average, suggesting a need for more practical and follow-up support. Farmers possessed substantial experience in fruit cultivation, yet faced key constraints such as financial limitations (40.66%), lack of infrastructure (24.48%), and inadequate technical knowledge (14.52%). A large majority (71.78%) demonstrated high awareness of the benefits of value addition, recognizing its role in improving profit margins (47.72%) and product value (35.68%). High-potential opportunities identified included dried fruit snacks (30.71%) and innovative packaging (26.14%), reflecting avenues for diversification and entrepreneurship. Value addition was also perceived to generate direct employment (24.48%) and support rural development (14.11%). The study concludes that value addition has strong potential to enhance income, reduce poverty, and generate rural employment if supported through targeted training, infrastructure development, and market facilitation. Low-interest credit schemes and microfinance facilities should be made available to help small farmers invest in processing equipment and packaging materials.

Keywords: Deciduous fruits, Household income, Poverty reduction, Post-harvest losses, Smallholder farmers, Value addition

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Introduction

Pakistan, being an agricultural country, has a critical need to enhance the production and processing of various fruits to fully capitalize on its agro-climatic potential. Although the country produces a wide variety of fruits, production remains largely small-scale, with most output either consumed domestically or exported in raw form without any value addition. This limits income generation opportunities for farmers and reduces the potential for economic uplift. Fruits are not only a vital component of the human diet rich in essential vitamins, minerals, and bioactive compounds but also possess therapeutic properties that can aid in the treatment of diseases such as cancer and osteoarthritis (Khan et al., 2020). Their contribution to nutrition security is substantial, and they offer immense potential for value addition and foreign exchange earnings. Increasing fruit yield and integrating value-added practices can significantly boost rural incomes and help alleviate poverty in fruit-producing regions (Mukhametzyanov et al., 2022). Pakistan is known for producing some of the world's finest quality fruits, which form a key segment of its agricultural economy. Major fruit varieties include citrus, mangoes, apples, and dates (Noonari et al., 2015). Among these, mango holds a dominant position in terms of cultivated area, production volume, and export revenue. As per official statistics, Pakistan cultivates fruits over approximately 681,070 hectares, yielding a total production of 5.75 million tonnes, out of which around 262,000 tonnes are exported annually (Government of Pakistan [GOP], 2019). Despite this significant production base, the proportion of fruit that undergoes value addition remains low, underscoring the need for investment in processing infrastructure, storage, and market development.

In Pakistan, post-harvest losses for fruits and vegetables are alarmingly high estimated at 30-40% owing to inadequate harvesting, poor storage, inefficient transportation, and lack of processing infrastructure (The Nation, 2024). These losses translate into substantial economic waste and represent lost opportunity for income generation, particularly for smallholder farmers who lack access to value chain support (Zulfiqar, 2024). Value addition through processing (such as pulping, drying, juicing, packaging), better packaging and storage, and cold chains has been flagged repeatedly in recent reports as a key pathway to reducing waste, improving product quality, opening access to higher value markets, and thereby increasing farmers' earnings (Zulfiqar, 2024).

Gilgit-Baltistan (GB), located in the extreme north of Pakistan, spans an area of 72,496 square kilometres and is home to an estimated population of around 1.8 million people (Maryam et al., 2020). It shares borders with China's Xinjiang province to the north, Chitral District and other areas of Khyber Pakhtunkhwa (KP) to the west and south, and Indian-administered Ladakh and Kashmir to the east. The region comprises ten districts situated in some of the most remote and mountainous areas of the country, with 90% of the terrain being mountainous, only 4% forested, and around 4.2% categorized as cultivable waste. Despite limited cultivable land estimated at just 2%, Gilgit-Baltistan is well-recognized for its agro-ecological suitability for growing deciduous and dry fruits (Ali et al., 2019). The region's fertile valleys, clean air, and favourable climatic conditions offer an ideal environment for high-quality fruit production, particularly for apricots, almonds, mulberries, cherries, and apples (Ahmad et al., 2008; Alam et al., 2024). With over 2.3 million fruit-bearing plants, GB holds significant potential for fruit-related agricultural development (Hashmi & Shafiullah, 2003).

Gilgit-Baltistan, despite its favourable agro-climatic conditions for deciduous fruit cultivation (apricots, apples, cherries, plums, pears), faces many of the same constraints (Noroz et al., 2021). While traditional cultivation yields significant volumes, much of the produce suffers quality degradation, spoilage, or is sold in raw form at low margins due to limited processing, insufficient cold storage facilities, inadequate packaging, and weak market linkages (The Nation, 2025). These inefficiencies initially were major challenges in past interventions such as those supported by JICA, which demonstrated that introducing value-added processing, packaging, and marketing can increase income and reduce waste in Gilgit-Baltistan (Khan, 2015). Dried fruit production is a traditional and valuable economic activity in the region, especially through sun-drying methods that utilize the natural climate to preserve fruits without artificial energy inputs. The resulting dried fruits are valued for their taste, long shelf life, and nutritional benefits (Ahmad et al., 2021). However, beyond subsistence and traditional use, there is considerable potential for value addition in this sector through improved processing, packaging, quality control, and marketing to increase income for local communities and enhance regional economic development (Khan et al., 2016). Efforts to modernize the dried fruit value chain such as establishing solar dryers, community-level processing units, and access to national and international markets can transform Gilgit-Baltistan from a region of traditional production to one of value-added agro-based entrepreneurship (International Fund for Agricultural Development [IFAD], 2015). This transition not only improves livelihoods but also contributes to sustainable agricultural practices in one of Pakistan's most ecologically sensitive and strategically significant regions (IFAD, 2015).

Poverty remains a pressing issue in both developed and developing countries, including Pakistan (Azeem et al., 2019). In the Pakistani context, numerous factors contribute to the persistence and expansion of poverty, including weak macroeconomic indicators, unequal wealth distribution, and limited access to essential services such as education, healthcare, and employment (Ali, 2013; Akhtar et al., 2017). These challenges are particularly acute in rural areas like Gilgit-Baltistan, where poverty is exacerbated by the absence of industrial development and limited alternative income sources. As a result, a significant portion of the population relies heavily on the agriculture sector for their livelihood. A small proportion of the population controls a large share of the nation's wealth, while the majority continues to face economic hardship (Muhammad et al., 2011; Kifayat et al., 2014; Ali, 2018). In this context, enhancing the value chain of deciduous fruits offers a promising opportunity for economic upliftment. By investing in value addition such as improved harvesting, processing, packaging, and marketing, rural communities in Gilgit-Baltistan can increase income, generate employment, and contribute to broader poverty alleviation efforts. Danyoure Valley is located close to the main city of Gilgit (9–10 km), which may facilitate market access and potentially reduce some transportation and market barriers typically faced by remote valleys. It was imperative to conduct at least one baseline study in Danyoure to document horticultural fruit production, which could help identify the fruit species available for value addition or alternative livelihood options. Addressing this gap, the present research study was conducted to evaluate the existing value addition practices currently employed by local fruit growers and to identify key challenges and constraints that hinder the adoption and successful implementation of value addition practices in the region. The study also intended to assess the economic benefits of these activities, particularly in terms of income generation and employment opportunities for the local population.

Materials and Methods

Universe of the study

Universe for the study was district Gilgit of Gilgit-Baltistan. District Gilgit has a total area of 14,672 km^2 and population of 225000. Administratively, the district is divided into three tehsils namely tehsil Gilgit, tehsil Danyoure and tehsil Juglot. The study was carried out in tehsil Danyoure as the cultivation and production of deciduous is relatively high in tehsil Danyoure. Geographically, it is situated as latitude: 35.9206, longitude: 74.3783, 35° 55′ 14″ North, 74° 22′ 42″ East.

Sample size and sampling technique

A sample size of 241 was selected from the target population of 467 (deciduous fruit producers in the study area) through Sekaran table. The sampling study area consists of different villages of Tehsil Danyoure such as Jalalabad, Oshikhandass, Danyoure, Sultanabad, Jutal and Rahimabad. The specific target population from each village was taken as 45, 100, 80, 85, 55 and 102, respectively. To ensure that all villages were proportionately represented, the sample size for each village was determined by using the proportional allocation formula. After allocating sample sizes to each village, simple random sampling was used to select producers within each village. This approach was chosen because it provides each household with an equal chance of selection and minimizes selection bias.

The following formula was used for the proportional allocation sampling method:

$ni = n*(Ni /N)$

Where

ni shows number of sampled households in the ith village
n shows total sample size (households)
Ni show total number of households in the ith village
N represents total number of households in the study area

Table 1 Sample size and target population of deciduous fruits in the study area

District	Tehsil	Village	Target population	Sample size
Gilgit	Danyore	Jalalabad	45	21
		Oshikhandass	100	53
		Danyoure	80	39
		Sultanabad	85	41
		Jutal	55	32
		Rahimabad	102	55
Total	1	6	467	241

Source: GB Agriculture Department & self-calculation

Research design

The study was descriptive in nature to quantify the socio-economic impact of value addition of deciduous fruits by using quantitative approach. However, qualitative approach was also employed to explain certain key concepts.

Research instrument and pilot testing

Interview schedule was used as a research instrument for collection of primary data. An interview schedule is a guide an interviewer uses when conducting a structured interview (Fowler, 2004). The pre-test was done continuously in order to check the validity and reliability of the research instrument.

Data collection

Both primary and secondary data was collected for the study. Secondary data was collected from relevant literature whereas; primary data was collected through interview schedule in a face to face interaction by visiting the respondents on their addresses provided by Agriculture Department District Gilgit. Interview schedule was designed in English language, however, questions were asked in local language for easy understanding.

Data analysis

After collection of primary data from the deciduous fruits farmers it was analysed by using SPSS (Statistical Package of Social Sciences) version 20 and MS-Excel; 2019. Quantitative data was analysed through descriptive statistics (such as frequencies and percentages) which facilitated the interpretation of key concepts.

Results

Cultivation of major deciduous fruits

Table 2 presents the distribution of respondents involved in the cultivation of major deciduous fruits in Tehsil Danyoure, District Gilgit. The data show that cherry is the most widely cultivated fruit, with 37.76% of respondents engaged in its production. This is followed by apricot at 27.80% and apple at 20.33%. Peach and pomegranate are cultivated by smaller proportions of respondents, accounting for 8.71% and 4.15%, respectively.

Table 2 Distribution of respondents according to cultivation of major deciduous fruits in Tehsil Danyoure

Deciduous fruits	Frequency (f)	Percentage (%)
Apricot	67	27.80
Apple	49	20.33
Peach	21	8.71
Cherry	91	37.76
Pomegranate	10	4.15

Current value addition practices for deciduous fruits

Table 3 presents the distribution of respondents based on their use of value addition practices for deciduous fruits in Tehsil Danyoure, District Gilgit. The data indicates that drying is the most commonly employed method, practiced by 50.21% of respondents. Packaging is the second most prevalent technique, used by 26.97% of producers. Other practices include pickling (9.54%), juice production (7.88%), and the making of jam, jelly, and compote (5.39%). Notably, none of the respondents reported using cold storage as a value addition method.

Table 3 Current value addition practices for deciduous fruits

Current value addition practices	Frequency (f)	Percentage (%)
Drying	121	50.207
Cold storage	0	0
Jam, jelly & compote making	13	5.394
Juice production	19	7.884
Pickling	23	9.544
Packaging	65	26.971

Participation of respondents in value addition activities

Table 4 presents the level of involvement across a range of activities, offering insights into the current practices within the local fruit value chain. Packaging is the most commonly reported activity, with 65 respondents (26.97%) involved in this area. This is followed by marketing and sales, with 45 respondents (18.67%) participating in efforts to promote and sell value-added products. Wasted utilization (efforts to reduce fruit waste) also shows engagement, with 34 respondents (14.11%). Other areas of participation include processing (12.86%), juice extraction (7.88%), and the production of value-added products (7.47%). Jam and jelly making (5.39%) and educational initiatives (6.64%) reflect smaller, but still important, aspects of value addition.

Table 4 Participation of farmers in value addition activities

Participation in value addition activities	Frequency (f)	Percentage (%)
Processing	31	12,86
Packaging	65	26.97
Juice extraction	19	7.88
Jam and jelly making	13	5.39
Value-added products	18	7.47
Marketing and sales	45	18.67
Educational initiatives	16	6.64
Wasted utilization	34	14.11

Primary purposes for implementing value addition practices among deciduous fruit producers

Respondents reported various primary purposes for implementing value addition practices for deciduous fruits in Tehsil Danyoure, District Gilgit (Table 5). These motivations reflect efforts to improve production outcomes and marketability. The most common reason cited was to increase profitability, with 29.46% respondents indicating this as their primary objective. Extending product shelf life was the second most reported purpose, with 26.97% respondents aiming to reduce spoilage and enhance the longevity of their products. A total of 17.01% respondents focused on enhancing product quality, likely to improve customer satisfaction and market competitiveness. Diversifying the product range was cited by 15.35%, suggesting an interest in expanding offerings to appeal to a wider market. Meanwhile, meeting market demand was identified by 11.20% respondents as their main goal, reflecting an effort to align production with consumer needs and preferences.

Table 5 Primary purpose for implementing value addition practices for deciduous fruits

Purpose of implementing value addition practices	Frequency (f)	Percentage (%)
Increase product shelf life	65	26.97
Diversify product range	37	15.35
Enhance product quality	41	17.01
Meet market demand	27	11.20
Increase profitability	71	29.46

Post-harvest losses attributed to inadequate value addition practices

Post-harvest losses remain a major concern among deciduous fruit producers in Tehsil Danyoure, primarily due to the lack of adequate value addition practices. As shown in Table 6, a significant proportion of respondents reported substantial losses. Specifically, 35.68% experienced high post-harvest losses, while 49.38% indicated very high losses. A smaller share reported

moderate losses (12.86%), and only 2.07% experienced low losses. However, none of the respondents reported negligible losses.

Table 6 Level of post-harvest losses due to inadequate value addition practices

Level of post-harvest losses	Frequency	Percentage
Negligible	0	0
Low	5	2.07
Moderate	31	12.86
High	86	35.68
Very high	119	49.38

Training programs and respondents' rating of value addition practices

As shown in Table 7, all respondents (100%) confirmed the existence of training programs or workshops aimed at educating fruit growers on value addition practices for deciduous fruits in Tehsil Danyoure, District Gilgit. This indicates a high level of institutional or organizational involvement in promoting post-harvest improvement and value chain development in the region. In terms of evaluating the effectiveness of value addition practices, respondents were asked to rate their overall experience and outcomes. The largest proportion rated these practices as Average (40.25%), followed by Good (31.95%) and Excellent (21.58%). A smaller percentage rated the practices as Poor (4.15%), while 2.07% indicated no implementation or exposure to value addition methods. These findings highlight that while training programs are widely available, there is still room for improvement in the quality, adoption, and effectiveness of value addition practices. The dominance of average ratings suggests that although efforts are being made, the impact of current strategies may not yet be fully optimized, pointing to the need for enhanced training content, better infrastructure, and follow-up support for producers.

Table 7 Training programs and rating of value addition practices

Aspect	Category	Frequency (f)	Percentage (%)
Existence of training programs	Yes	241	100
	No	0	0
Rating of value addition practices	Excellent	52	21.58
	Good	77	31.95
	Average	97	40.25
	Poor	10	4.15
	None	5	2.07

Experience levels of deciduous fruit producers in Tehsil Danyore

The duration of involvement in fruit cultivation among respondents in Tehsil Danyoure, District Gilgit, is presented in Table 8. The data highlights the experience levels of 241 deciduous fruit producers across villages such as Jalalabad, Oshikhandass, Danyoure, Sultanabad, Jutal, and Rahimabad. A majority of respondents (42.32%) reported having 6 to 10 years of experience in fruit cultivation, while 40.66% had been involved for more than 10 years. Additionally, 17.01% of respondents had 1 to 5 years of experience. No respondents reported less than one year of involvement. These results indicate that most producers possess moderate to extensive experience in fruit cultivation, suggesting a strong foundation of practical knowledge in the sector.

Table 8 Duration of involvement in fruit cultivation

Duration of involvement in fruit cultivation	Frequency (f)	Percentage (%)
Less than 1 year	0	0
1-5 years	41	17.01
6-10 years	102	42.32
More than 10 years	98	40.66

Major constraints in adopting value addition practices

The adoption of value addition practices among deciduous fruit producers in Tehsil Danyore is hindered by several key challenges, as shown in Table 9. The most commonly reported constraint was financial limitations, cited by 40.66% of respondents. This was followed by a lack of necessary infrastructure and equipment (24.48%) and insufficient technical knowledge and training (14.52%). Other constraints, though reported by smaller percentages, still reflect important barriers. These include lack of access to appropriate technology (7.47%), unavailability of quality raw materials (4.15%), logistical challenges related to the transportation and storage of value-added products (3.73%), and the use of traditional practices (2.07%). A few respondents also noted lack of awareness about the benefits of value addition (1.66%) and limited market

access (1.24%). Interestingly, no respondents identified regulatory or policy barriers as a constraint.

Table 9 Major constraints in adopting value addition practices

Major constraints	Frequency (f)	Percentage (%)
Financial constraints	98	40.66
Regulatory or policy barriers	0	0
Lack of necessary infrastructure and equipment	59	24.48
Lack of technical knowledge and training	35	14.52
Unavailability of quality raw materials	10	4.15
Lack of access to appropriate technology	18	7.47
Limited access to markets for selling value-added products	03	1.24
Using cultural or traditional practices	5	2.07
Lack of awareness about value addition benefits	4	1.66
Logistical challenges in transporting and storing value-added fruit products	09	3.73

Awareness levels of fruit producers on value addition benefits

The results from Table 10 show that a majority of respondents (71.78%) demonstrated a high level of awareness regarding the benefits of value addition practices. A smaller portion (19.50%) exhibited a moderate level of awareness, while only 8.71% reported having low awareness. This indicates that the most deciduous fruit producers in the study area are well-informed about the potential advantages of value addition, which can serve as a strong foundation for promoting related initiatives and interventions.

Table 10 Awareness level regarding the benefits of value addition practices

Awareness level	Frequency (f)	Percentage (%)
High	173	71.78
Moderate	47	19.50
Low	21	8.71
Total	241	100

Perceived economic benefits of value addition practices

Table 11 summarizes the respondents' views on the key economic benefits of applying value addition practices in deciduous fruit production. The majority (47.72%) believed that increased profit margins are the most significant advantage, while 35.68% highlighted higher product value. A smaller proportion of respondents cited market diversification (9.96%) and enhanced competitiveness (6.64%) as primary economic benefits. These results suggest that fruit producers recognize value addition as a means to improve profitability and product value, reinforcing its relevance for improving economic outcomes in the sector.

Table 11 Perceived economic benefits of value addition in deciduous fruit production

Opinion on economic benefits	Frequency (f)	Percentage (%)
Increased profit margins	115	47.72
Market diversification	24	9.96
Higher product value	86	35.68
Enhanced competitiveness	16	6.64

High-potential value addition activities for income generation

Respondents' views on high-potential value addition activities that could enhance income generation in the deciduous fruit sector are presented in Table 12. Among the surveyed producers, the most commonly cited activity was producing dried fruit snacks (30.71%), followed by innovative packaging of fruit products (26.14%). Other activities identified include creating specialty fruit jams and preserves (15.77%), developing fruit-based condiments (12.03%), and expanding into organic or sustainable fruit farming (9.13%). A smaller portion of respondents (6.22%) saw potential in producing fruit-based cosmetics.

Table 12 perceived high-potential value addition activities for income generation in the deciduous fruit sector

High-potential value addition activities for income generation	Frequency (f)	Percentage (%)
Packaging fruit products in innovative ways	63	26.14
Producing dried fruit snacks	74	30.71
Creating specialty fruit jams and preserves	38	15.77
Expanding into organic or sustainable fruit farming	22	9.13
Production of fruit-based cosmetics	15	6.22
Developing fruit-based condiments	29	12.03

Perceived contributions of value addition to employment generation

Respondents shared their views on how value addition practices contribute to employment generation across various dimensions of the deciduous fruit sector (Table 13). Direct employment was the most frequently cited contribution (24.48%), followed by rural development (14.11%) and entrepreneurship opportunities (12.86%). Other areas included export promotion (9.96%), supply chain employment (9.54%), and technology adoption (8.71%). Contributions in skill development (6.64%), diversification of economic activities (7.47%), and innovation and research (6.22%) were also acknowledged.

Table 13 Perceived contribution of value addition practices to employment generation

Contribution of value addition practices to employment generation	Frequency (f)	Percentage (%)
Direct employment	59	24.48
Skill development	16	6.64
Supply chain employment	23	9.54
Entrepreneurship opportunities	31	12.86
Technology adoption	21	8.71
Rural development	34	14.11
Diversification of economic activities	18	7.47
Export promotion	24	9.96
Innovation and research	15	6.22

Perceptions of government support for value addition in the deciduous fruit sector

Respondents' perceptions of existing government policies and initiatives aimed at enhancing the economic benefits of value addition in the deciduous fruit sector are presented in Table 13. The most frequently acknowledged initiatives were infrastructure development (24.07%) and training and skill development programs (22.82%). Technical assistance (17.84%) and market access and export promotion (15.35%) also received remarkable mentions. In contrast, no respondents reported the availability or impact of subsidies for value addition infrastructure, research and development funding, or tax incentives. Other initiatives, such as financial support for SMEs (10.79%), collaboration with industry stakeholders (4.98%), and regulatory support (4.15%), were recognized to a lesser extent. This suggests the need for more comprehensive and targeted policy interventions to effectively support value addition efforts and enhance economic outcomes for fruit producers in the region.

Table 14 Perceptions of government policies supporting value addition in the deciduous fruit sector

Government policies or initiatives	Frequency (f)	Percentage (%)
Subsidies for value addition infrastructure	0	0
Research and development funding	0	0
Training and skill development programs	55	22.82
Market access and export promotion	37	15.35
Tax incentives and rebates	0	0
Infrastructure development	58	24.07
Regulatory support and quality standards enforcement	10	4.15
Financial assistance for small and medium enterprises (SMEs)	26	10.79
Collaboration with industry stakeholders	12	4.98
Technical assistance	43	17.84

Discussion

Our study explored the socio-economic impact of value addition practices among deciduous fruit producers in Tehsil Danyoure, District Gilgit. The results indicated that cherry was the most commonly cultivated deciduous fruit, followed by apricot and apple. These findings reflect the region's agro-climatic suitability for these fruits, especially cherry, which seems to have gained popularity in recent years. This pattern partially contrasts with previous reports from Gilgit-Baltistan, where apricot has traditionally dominated fruit cultivation (Ali & Arshad, 2024). The shift toward cherry may be attributed to its higher market value and growing demand, highlighting the dynamic nature of crop preferences in response to market signals. In terms of value addition, our findings revealed that drying and packaging were the most commonly used practices, with no respondents reporting the use of cold storage. This supports the findings of Khan et al. (2025a), who also identified sun-drying and simple packaging as the predominant practices in the region. However, the complete absence of cold storage in our study highlights a deeper infrastructural and accessibility issue than previously assumed. Firdous (2021) reported that cold storage facilities are underutilized in many parts of Pakistan due to high operational costs and limited availability, and our findings suggest that these issues are especially pronounced in remote areas like Danyoure.

In our study, despite widespread awareness (over 70%) and universal exposure to training programs, adoption of more advanced value addition methods remained low. Most respondents rated their experience with value

addition practices as only average, suggesting a significant gap between awareness and practical implementation. This finding aligns with the observations of Ali et al. (2022), who argued that awareness alone does not translate into adoption unless it is backed by financial support, technical assistance, and appropriate infrastructure. Our findings reveal a complex set of obstacles that limit the adoption of value addition practices. Addressing financial barriers, improving infrastructure, enhancing technical training, and expanding market access are critical steps toward strengthening the value chain and improving the livelihoods of fruit producers in the region. Thus, our study adds further weight to the argument that capacity building must be accompanied by enabling environments to be effective.

Post-harvest losses emerged as a critical issue, with nearly half of respondents reporting very high losses. These findings are consistent with the estimates by Ahmad et al. (2021); Khan et al. (2025b), who suggested that over 35-40% of fruit is lost in Pakistan due to poor post-harvest handling. Similarly, Khan et al. (2025b) found that in Pakistan, up to 35–40% of fruit and vegetable production is wasted post-harvest. Our study describes that this issue is even more acute in isolated rural areas lacking cold storage, efficient transport, and packaging solutions. The primary purpose cited by producers for engaging in value addition was to increase profitability, followed by extending shelf life and improving quality. These motivations reflect rational economic behavior and are in line with the findings of Badar et al. (2019), who found similar motivations among small-scale mango and citrus growers in Punjab engaging in basic value addition. Nonetheless, while producers in our study were aware of potential benefits, they were constrained by multiple challenges. Financial limitations were the most frequently cited constraint, followed by lack of infrastructure and technical knowledge. These findings corroborate the work of Khan et al. (2025b), who reported that the inability to access finance and post-harvest technology were, among the main barriers to value addition in rural Pakistan.

Interestingly, none of the respondents in our study cited regulatory or policy barriers as a constraint. This finding contrasts with some national-level studies that often emphasize policy-related challenges such as lack of export standards or tax incentives (Ghafoor et al., 2022). One possible explanation is that smallholders in Danyoure are not yet participating in export markets where such policies would be relevant. At the local level, immediate constraints such as cost, knowledge, and infrastructure are far more pressing. The experience level of fruit producers in our study was relatively high, with over 80% having more than six years of cultivation experience. However, this did not necessarily lead to higher adoption of value addition practices, suggesting that experience alone is insufficient without exposure to innovation and support. This observation is in line with the findings of Ullah et al. (2015), who reported that even experienced farmers in Swat Valley failed to adopt improved practices due to lack of technical guidance and market access. Gender disparities also surfaced in our findings, with male-headed households benefiting more from value addition than female-headed ones. This mirrors the broader trend in Pakistan where women have limited access to agricultural extension, inputs, and markets (Safdar et al., 2021). Addressing these gender-based gaps is essential for equitable development of the horticulture sector.

When asked about high-potential activities for income generation, respondents emphasized dried fruit snacks, innovative packaging, and specialty jams and condiments. These findings are encouraging and reflect a growing entrepreneurial mindset among fruit producers. They are also aligned with the recommendations made by Gulsia and Yadav (2023), who emphasized niche product development and branding as effective strategies to enhance rural income from horticulture. In terms of employment, respondents perceived that value addition contributed significantly to direct employment, rural development, and entrepreneurship. These perceptions are supported by international studies, such as that of Vorley et al. (2012), who documented the positive impact of agro-processing on job creation in rural economies. However, the potential remains largely untapped in our study area due to the existing constraints.

Finally, when assessing government support, infrastructure development and training programs were recognized by a majority of respondents, while subsidies and research support were noticeably absent. This indicates that although some institutional mechanisms are in place, more targeted policy interventions such as financial incentives, SME support, and research and development are needed to enhance the economic outcomes of value addition for smallholder fruit producers. This gap in support mirrors national-level findings by Ghafoor et al. (2022), who argued that horticulture in Pakistan lacks a coherent value chain development strategy. In conclusion, our findings are broadly consistent with existing literature but also provide new insights into the specific challenges and opportunities within the context of Tehsil Danyoure. While awareness and willingness to engage in value addition are present, practical adoption is hindered by structural barriers. Bridging this gap will require an integrated approach combining training, infrastructure development, financial support, and market access, with special attention to gender equity and local conditions.

Conclusion and Recommendations

The findings of this study demonstrate that value addition in deciduous fruit production plays a crucial role in improving household income and reducing poverty among smallholder farmers in Tehsil Danyoure, District Gilgit. While the region has significant potential for fruit-based income generation, most producers still rely on the sale of raw produce, leading to low profitability and high post-harvest losses. The empirical analysis confirms that engagement in processing activities such as drying, packaging, and juicing substantially increases household earnings and enhances economic resilience. Despite high awareness levels regarding the benefits of value addition, adoption remains limited due to financial constraints, inadequate infrastructure, and lack of technical expertise. Moreover, gender disparities persist, with male-headed households benefiting more from available opportunities.

Nevertheless, the positive perception of value addition's economic and employment potential indicates readiness among farmers to embrace change if enabling conditions are improved. The study concludes that strengthening value addition practices can transform the deciduous fruit sector into a driver of sustainable rural development and poverty alleviation in the Gilgit region. The existing fruit losses of 30% can be overcome by strengthen the farmer capacities in processing's. Farmers should be provided with targeted training to enhance their skills in fruit processing, value addition, and post-harvest losses management. Adequate infrastructure, including cold storage and processing facilities, should be developed to support efficient fruit value addition. Market linkages and access should be facilitated to help farmers sell their value-added products locally and internationally. Low-interest credit schemes and microfinance facilities should be made available to help small farmers invest in processing equipment and packaging materials.

Declarations

i. Ethics approval and consent to participate

According to the guidelines of the researchers' respective institutions, this study did not fall under the category requiring formal review by an institutional ethics committee. Nonetheless, all standard ethical protocols for social research involving human participants were strictly observed. Prior to data collection, informed consent was secured from each participating farmer. Participation was voluntary, and measures were taken to maintain the confidentiality and anonymity of all responses.

ii. Consent for publication

Consent for publication is not applicable.

iii. Data availability

All data generated or analyzed during this study are included in this article.

iv. Competing interests

Authors have declared that no competing interests exist.

v. Authors' contributions

A.H. conceived and designed the study, developed the research framework, led the data collection process; Z.H. contributed to the study design, performed data analysis and interpretation and prepared tables and figures; R.T. supported field coordination, assisted in data collection, provided technical insights on fruit production and value addition; A.K.K. contributed to methodological guidance, interpretation of results, and manuscript preparation.

vi. Funding

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vii. Acknowledgement

Not applicable.

viii. SDGs addressed

No Poverty (SDG 1); Zero Hunger (SDG 2); Decent Work and Economic Growth (SDG 8); Industry, Innovation and Infrastructure (SDG 9); Responsible Consumption and Production (SDG 12)

References

Ahmad, K., Afridi, M., Khan, N. A., & Sarwar, A. (2021). Quality deterioration of post-harvest fruits and vegetables in developing Pakistan: a mini overview. *Asian Journal of Agriculture and Food Sciences, 9*(2), 83-90. https://doi.org/10.24203/ajafs.v9i2.6615

Ahmad, S., Saddozai, K. N., Khan, M., & Afridi, S. (2008). Cherry marketing system in Gilgit District, Northern Areas of Pakistan. *Sarhad Journal of Agriculture, 24*(4), 771-777.

Akhtar, R., Liu, H., & Ali, A. (2017). Influencing factors of poverty in Pakistan: Time series analysis. *International Journal of Economics and Financial Issues, 7*(2), 215–222.

Alam, A., Akram, M. T., Qadri, R., Amir, R. M., & Anum, S. (2024). Comparative assessment of pomological and biochemical traits in apricot genotypes from Gilgit Baltistan. *Journal Advances of Nutrition Science and Technology, 4*, 91–102. https://doi.org/10.15228/ANST.2024.v04.i03-4.p11

Ali, A. (2018). Forest-based livelihoods, income, and poverty: Empirical evidence from the Himalayan region of rural Pakistan. *Journal of Rural Studies*, *57*, 44-54.

Ali, O., Murray, P. A., Muhammed, S., Dwivedi, Y. K., & Rashiti, S. (2022). Evaluating organizational level IT innovation adoption factors among global firms. *Journal of Innovation & Knowledge*, *7*, 100213. https://doi.org/10.1016/j.jik.2022.100213

Ali, S. (2013). The small and medium enterprises and poverty in Pakistan: An empirical analysis. *European Journal of Business and Economics, 8*(2), 25–30.

Ali, S., & Arshad, M. (2024). Cherry and apricot marketing in Gilgit-Baltistan: A case study of the northern region's fruit market. *Journal of Horticultural Science and Technology, 7*(4), 123–127. https://doi.org/10.46653/jhst24074123

Ali, Z., Gao, M., Ali, Y., Muttahir, H., & Muhammad, M. (2019). Impact of China Pakistan Economic Corridor (CPEC) on fruit industry in Gilgit-Baltistan. *North American Academic Research, 2*(6), 177–190. https://doi.org/10.5281/zenodo.3257756

Badar, H., Ariyawardana, A., & Collins, R. (2019). Dynamics of mango value chains in Pakistan. *Pakistan Journal of Agricultural Sciences, 56*(2), 523–530. http://doi.org/10.21162/PAKJAS/19.6936

Firdous, N. (2021). Post-harvest losses in different fresh produces and vegetables in Pakistan with particular focus on tomatoes. *Journal of Horticulture and Postharvest Research, 4*(1), 71–86.

Fowler, F. J. (2004). Getting beyond pretesting and cognitive interviews: The case for more experimental pilot studies. In S. Presser, J. M. Rothgeb, M. P. Couper, J. T. Lessler, E. Martin, J. Martin, & E. Singer (Eds.), *Questionnaire development, evaluation, and testing methods* (pp. 173–188). New York, NY: John Wiley & Sons.

Ghafoor, A., Basher, M. A., & Lee, S. (2022, November). Building horticulture value chains and reducing postharvest losses in Pakistan (ADB Brief No. 235). Asian Development Bank. http://dx.doi.org/10.22617/BRF220545-2

Government of Pakistan [GOP]. (2019). Agriculture statistics of Pakistan, Ministry of Food, Agriculture and Livestock. Agriculture and Live Stock Division Economic Wing, Islamabad. 1998. Web site. http://www.pbs.gov.pk/content/agriculture-statistics. Updated June 3, 2019. Accessed June 4, 2019.

Gulsia, O., & Yadav, S. (2023). Conceptualizing network approaches for a successful farm entrepreneurship using ATLAS.ti. *Sustainable Technology and Entrepreneurship*, *2*(1), 100026; https://doi.org/10.1016/j.stae.2022.100026

Hashmi, A. A., & Shafiullah. (2003). *NASSD background paper: Agriculture and food security*. Gilgit, Pakistan: IUCN Pakistan, Northern Areas Programme. Retrieved from https://portals.iucn.org/library/sites/library/files/documents/2003-095_1.pdf

International Fund for Agricultural Development [IFAD]. (2015). *Economic Transformation Initiative – Gilgit-Baltistan: Programme Design Report*. Islamic Republic of Pakistan. Retrieved from https://webapps.ifad.org/members/eb/114/docs/EB-2015-114-R-14-Project-design-report.pdf

Khan, F., Khan, T. U., Tajudin, & Khan, N. (2016). Fruit processing preservation and development of value-added products (squash, jam, and candy) to control wastages of fruits in Gilgit-Baltistan. *ARPN Journal of Agricultural and Biological Science*, *11*(7), 274–282.

Khan, H., Zeng, Y., & Qi, C. (2025a). Roads, trade, and growth: PPML evidence on Pakistan's vegetable export performance. Frontiers in Sustainable Food Systems, 9, Article 1586707; https://doi.org/10.3389/fsufs.2025.1586707

Khan, I. (2015, October 13). *Japan helps farmers in Gilgit-Baltistan to reduce post-harvest losses*. The News International. Retrieved from https://www.thenews.com.pk/print/67449-japan-helps-farmers-in-gilgit-baltistan-to-reduce-post-harvest-losses

Khan, S., Shah, A., & Ijaz, N. (2025b). Identification of root causes of post-harvest food losses in the mango supply chain: A case of Sindh and Punjab, Pakistan. *Human Nature Journal of Social Sciences, 6*(2), 235-253. https://doi.org/10.71016/hnjss/x51w2w80

Khan, T., Qiu, J., Qureshi, M. A. A., Iqbal, M. S., Mehmood, R., & Hussain, W. (2020). Agricultural fruit prediction using deep neural networks. *Procedia Computer Science*, *174*, 72-78.

Kifayat, U., Khan, F. A., & Ejaz, A. (2014). Determinants of poverty in mountain region of Gilgit-Baltistan, Pakistan. *Developing Country Studies*, *4*(7), 10-19.

Maryam, H., Rafi, M. A., Zia, A., Rasul, G., Sheikh, M. K., Qasim, M., & Parveen, G. (2020). Insect pollinator fauna of apricot from Gilgit-Baltistan, Pakistan. *Pakistan Journal of Agricultural Research*, *33*(2), 202.

Muhammad, M., Janjua, P. Z., & Ullah, K. (2011). Impact of village group financial services on women empowerment and poverty: A case study of the first micro finance bank Gilgit. *The Dialogue, 6*(4), 382-397.

Mukhametzyanov, R. R., Zaretskaya, A. S., Dzhancharova, G. K., Platonovskiy, N. G., & Ivantsova, N. N. (2022, February). Russia as a Subject of the World Market for Staple Tropical Fruits. In *International Scientific and Practical Conference Strategy of Development of Regional Ecosystems "Education-Science-Industry" (ISPCR 2021)* (pp. 594-602). Atlantis Press.

Noonari, S., Memon, M. I. N., Wahid, R., Peerzdo, M. B., Bhatti, M. A., & Kalwar, G. Y. (2015). Economic analysis of apple orchards production in district mastung Balochistan Pakistan. *European Journal of Business and Management*, *7*(10), 40-53

Noroz, M. M., Shah, A. N., & Latif, A. (2021). Role of adaptation strategies for climate change and nutrients management tools in Gilgit Baltistan's agriculture. *Advances in Agriculture and Biology*, *4*(1), 14-21. https://doi.org/10.63072/aab.21003

Piracha, U. (2024, June). Fruit and vegetable pulping in Pakistan – Review and prospects. The Pakistan Business Council. https://www.pbc.org.pk/research/fruit-and-vegetable-pulping-in-pakistan-review-and-prospects-june-2024

ProPakistani. (2024, May 15). *20% FED on juices lowers fruit farmer sales, impacts livelihoods*. ProPakistani. Retrieved from https://propakistani.pk/2024/05/15/20-fed-on-juices-lowers-fruit-farmer-sales-impacts-livelihoods

Safdar, M., Pervaiz, U., & Jan, D. (2021). Women farmers' access to and control over farming resources and their role in decision making process in the rural areas of Khyber Pakhtunkhwa, Pakistan. *Sarhad Journal of Agriculture, 37*(3), 930–941.

The Nation. (2024, October 1). *Country needs to improve agri practices to cut post-harvest losses*. Retrieved from https://www.nation.com.pk/01-Oct-2024/country-needs-to-improve-agri-practices-to-cut-post-harvest-losses

The Nation. (2025, January 13). GB's export potential of dry fruits vital for economic growth. Retrieved from https://www.nation.com.pk/13-Jan-2025/gb-s-export-potential-of-dry-fruits-vital-for-economic-growth

Ullah, R., Shivakoti, G. P., & Ali, G. (2015). Factors effecting farmers' risk attitude and risk perceptions: The case of Khyber Pakhtunkhwa, Pakistan.

International Journal of Disaster Risk Reduction, 13, 151–157. https://doi.org/10.1016/j.ijdrr.2015.05.005

Vorley, B., del Pozo-Vergnes, E., & Barnett, A. (2012). Small producer agency in the globalised market: Making choices in a changing world. IIED and Hivos, London.

Zulfiqar, A. (2024, July 8). *Proper processing, value addition to unlock Pakistan's horticulture potential*. INP-WealthPK. Retrieved from https://www.inp.net.pk/article-detail/inp-wealthpk/proper-processing-value-addition-to-unlock-pakistans-horticulture-potentia