Policy Paper 56

Competitive and Comparative Advantage of Major Temperate Fruit Crops of India

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Preface

Temperate horticulture occupies a central place in India's agricultural landscape, particularly across the Himalayan and high-altitude regions where crops such as apple, almond, walnut, and saffron underpin rural economies, cultural heritage, and the livelihoods of millions. These crops not only shape the socio-economic fabric of a region but also contribute substantially to India's agri-export potential and global market footprint. Yet, the sector today stands at a critical juncture. Intensifying import competition, domestic market inefficiencies, climate-induced variability, and shifts in global trade regimes pose mounting challenges to the long-term profitability and resilience of temperate fruit growers. In such a dynamic environment, a rigorous understanding of the comparative and competitive strengths of India's major temperate crops becomes essential for crafting informed, forward-looking policies.

This policy paper presents a comprehensive and analytically robust assessment of the economic viability, competitiveness, and policy-induced distortions shaping temperate horticulture in India. With a particular focus on Jammu & Kashmir, India's leading producer of apples, almonds, walnuts, and saffron, the study applies the Policy Analysis Matrix (PAM) framework to evaluate private and social profitability and the impact of government interventions. The insights generated here offer valuable guidance for strengthening market efficiency, enhancing global competitiveness, and ensuring that farmers in the temperate regions are better equipped to leverage emerging opportunities in a liberalized trade environment. This policy paper will contribute meaningfully to evidence-based decision-making and serve as a useful resource for policymakers, researchers, and all stakeholders committed to advancing India's temperate horticulture and improving the livelihoods of farming communities across the Himalayan region.

Pratap Singh Birthal
Director, ICAR NIAP

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(Authors)

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Executive Summary

The agroclimatic conditions of the hill state of Jammu and Kashmir have traditionally supported the cultivation of several high-value fruits, including apples, walnuts, almonds, and saffron. These crops are a significant source of income and employment for the local population, including farmers, traders, commission agents, and processors. However, the horticultural sector currently faces several challenges such as declining crop yields due to pest infestations, climate change, aging orchards, and outdated farming practices.

Furthermore, the domestic market for horticultural crops is considerably inefficient in terms of insufficient storage facilities, inadequate transportation infrastructure, and limited access to market information. These challenges contribute to post-harvest losses and reduce profitability for farmers. Additionally, rapidly evolving domestic and international markets introduce further uncertainty regarding crop prices and farm profitability. To address these issues, it is essential to analyze the competitiveness of horticultural crops and assess the impact of existing policies. Such an assessment will provide policymakers and stakeholders with valuable insights into developing targeted interventions and strategies to fully exploit the potential of the horticulture sector.

This study employs a policy analysis matrix (PAM) framework to assess the competitive and comparative advantages of traditional apples, high-density apples, almonds, walnuts, and saffron. The principal findings of this study are as follows:

The horticultural sector has undergone a significant transformation: The area under apple cultivation surged from 60.28 thousand hectares in 1980 to 171.2 thousand hectares in 2022–23, with production more than tripling to 1898.6 thousand tons. However, the yield improvements were modest. Similarly, walnut production has experienced a significant increase in both area and production, with a 17-fold increase in production and yield reaching 3.3 tons per hectare. In contrast, almond production declined sharply from 16.32 thousand hectares to 5.47 thousand hectares. Saffron, another traditional crop, has experienced a 65 percent reduction in area between 1996- 97 and 2021–22.

India's exports of high-value horticultural products have declined, while imports have surged: Over the years, India has seen a decrease in the exports of apples, walnuts, almonds, and saffron, while their imports have risen significantly. In 2023, apple imports surpassed 0.5 million tons, fueled by increased demand. India has become a net importer of walnut due to reduced productivity. Although there has been a slight increase in almond exports, imports still dominate. However, saffron trade remains limited.

High-density apple plantations (HDP) have greater competitive advantage and generates higher income for farmers**:** High density apple plantation has exceptional competitive and comparative advantages, as evidenced by the remarkably low private cost ratio (PCR) of 0.17 and domestic resource cost ratio (DRCR) of 0.16. These figures indicate that HDP is highly efficient at utilizing domestic resources and generating value. The income of Rs. 42,87,482 per hectare underscores its financial attractiveness for farmers despite the increased private costs. This high profitability is largely attributed to the policy support measures that benefit farmers. However, a closer examination of social (economic) profits reveals a different perspective. The lower social profit of Rs. 33,38,614 per hectare, coupled with marginally reduced social costs, suggests that HDP may not be as economically efficient as it is from a private standpoint. This discrepancy between private and social profitability highlights the impact of policy intervention.

Traditional apple plantations have a strong comparative advantage and generate significantly higher economic (social) benefits: Traditional apple plantations have a remarkable comparative advantage with a PCR of 0.26. Moreover, a DRCR of 0.12 reveals that traditional apple plantations use domestic resources highly efficiently, generating significant earnings for each unit of domestic resources employed. This economic efficiency translates to substantial potential benefits. The disparity between economic profits (Rs. 18,64,333/ha) and private profits (Rs. 10,19,866/ha) highlights significant untapped economic potential. However, policy inefficiencies or market distortions prevent farmers from capturing the full economic value of their production.

Almond is moderately competitive but offers significant social benefits: Almond production demonstrates a moderate level of competitiveness with a PCR of 0.63 and DRCR of 0.35, which suggest that while almond growers face relatively high private costs, the crop maintains a significant comparative advantage in the market. The financial analysis reveals that almond growers can expect a private profit of Rs. 2,69,750 per hectare, despite facing substantial private costs of Rs. 5,01,140. This indicates that despite the high investment, almond production remains profitable for farmers. Interestingly, when evaluated from an economic perspective that considers social costs and benefits, the profit margin increases significantly to Rs. 5,52,788 per hectare. This substantial difference between private and economic profit suggests that market distortions and policy interventions affect the almond industry.

Walnut is fairly competitive but shows a moderately comparative advantage: Walnut production presents a complex economic picture, combining strong private profitability with moderate overall economic efficiency. The low PCR of 0.25 indicates that walnut farming is highly profitable for farmers. However, a DCRC of 0.70 suggests that from an economic perspective, walnut cultivation is less efficient. The economic benefit of Rs. 60,305 per hectare further underscores this point, indicating that social returns from walnut farming are relatively modest. This discrepancy between private profitability and social efficiency highlights the need for policymakers to carefully consider the allocation of resources and support for walnut production, balancing the interests of farmers with broader economic goals and resource optimization strategies.

Saffron has the lowest competitive and comparative advantage: Saffron cultivation, although financially viable for growers, demonstrates a less favorable broader social impact, as indicated by a high PCR of 0.67 and a DRCR of 0.82. These ratios suggest that saffron cultivation requires substantial private investments and domestic resources relative to the value it generates. This moderate competitiveness and lower efficiency imply that farmers must allocate significant inputs, including labor, land, and capital, to produce saffron, while the returns on these investments remain comparatively limited.

To enhance comparative and competitive advantages, the following interventions are necessary.

Promote fruit-specific clusters and regional branding: Policy should prioritize the development of fruit-specific clusters to enhance regional comparative advantages by establishing a robust framework for input services, nurseries, extension, and logistics within these clusters. By focusing on geographic indication (GI) tagging and region-specific branding strategies, we can significantly increase marketability and unlock the substantial export potential.

Invest in cold chain and post-harvest infrastructure: One of the primary challenges to the competitiveness of temperate fruits is the insufficient cold chain infrastructure and limited processing capacities. Public investment is needed in developing cold chains, including pre-cooling units, mobile cold storage, controlled atmosphere (CA) storage, and refrigerated transport. First-mile infrastructure, such as solar-powered micro-cold storage facilities in orchards and village-level packhouses equipped with grading and waxing lines, should be expanded through public-private partnerships. Community-level fruit processing units offer growers an opportunity to meet the increasing demand for juices, dried fruits, jams, and preserves.

Strengthening farmer collectives: Smallholder farmers often face challenges related to marketing and bargaining power. Farmer collectives, such as Farmer Producer Organizations (FPOs) and cooperatives, have the potential to effectively address these challenges. It is recommended that these collectives be integrated into value chains through strategic partnerships with organized retailers, exporters, and digital marketing platforms. Specialized programs should be developed to provide support for brand development, direct marketing, and export facilitation, including the establishment of on-site aggregation and packaging units.

Accelerate R&D in high-density plantation systems: Temperate fruits currently fall short of the global productivity standards. To address this issue, it is imperative to establish a research and development consortium that focuses on the development and dissemination of climate-resilient, high-yielding, export-quality varieties across major crops. Concurrently, it is essential to scale High-Density Plantation models supported by nurseries, orchard rejuvenation initiatives, and precision horticulture technologies.

Reforming input ecosystems and crop insurance: Ensuring access to high-quality planting materials remains a significant challenge. Therefore, it is essential to ensure certification of private nurseries to improve the availability of genetically pure planting materials. Furthermore, given the vulnerability of fruit crops to frost, hail storms, and unpredictable precipitation, development of parametric insurance products is recommended.

Enhance skills through HRD interventions and extension innovations: To foster a vibrant and market-responsive horticulture industry, it is essential to evolve crop-specific business models by imparting training to growers in orchard management, quality control, post-harvest handling, grading standards, and packaging techniques to ensure that they meet market requirements and maintain freshness during transportation.

Scaling up quality certification and good agricultural practice (GAP) adoption: To ensure that India's temperate fruit crops meet global market standards and achieve premium pricing, it is imperative to institutionalize quality certification frameworks and enhance the adoption of good agricultural practices. Presently, many small and marginal fruit growers lack the awareness, capacity, and institutional support necessary to comply with certification norms, such as India GAP, Global GAP, Organic Certification, or GI registration. This deficiency results in missed opportunities in both the domestic and export markets.

Establishing real-time market intelligence: To move beyond domestic consumption to enhance exports and reduce imports, the government must develop a comprehensive market intelligence system to generate real-time data on domestic and international price trends, demand and supply situations, and quality standards in the global market.

1 Introduction

Trade in agricultural products and food commodities significantly influences the structure, efficiency, and sustainability of agro-food systems. It facilitates the exchange of goods, technologies, and knowledge across borders, enabling countries to specialize in production based on their comparative advantages, which can lead to increased productivity, improved resource allocation, and enhanced food security. Furthermore, trade opens new markets. However, the impact of trade on the agri-food system is complex. Although it can drive innovation and economic growth, it may also expose local producers to increased competition and price volatility. Horticulture is an important component of India's agricultural economy, contributing over one-fifth to the total value of agricultural output. However, exports of horticultural products remain low, accounting for only 1.2% of global exports (TPCI, 2021). Balancing the benefits of trade with the need to protect local food systems and to ensure equitable outcomes for all stakeholders remains a key challenge.

Horticulture is labor-intensive and yields substantially higher returns per unit of land than other crops (Joshi et al., 2004; Birthal et al., 2007). The production of horticultural goods is predominantly undertaken by smallholders, offering considerable potential to mitigate income disparities and alleviate poverty (Birthal et al., 2015). Moreover, by engaging in value-added activities, such as processing, packaging, and marketing, farmers and rural communities can access additional income streams beyond primary production. This vertical coordination not only enhances the economic value of horticultural produce but also promotes the development of ancillary industries in rural areas.

Driven by increasing per capita income and growing urbanization, food consumption patterns in India have been rapidly evolving in favor of high-value nutrient-rich food commodities, including horticultural products. Over the past four decades, the share of fruits and vegetables in food expenditure has nearly doubled from 10 percent in 1983 to 20 percent in 2022-23 (Birthal et al., 2025). Should the underlying factors of these changes persist, the demand for horticultural products is projected to rise to 598 million tons by 2047, from 307 million tons in 2019-20 (GoI, 2024a). While India imports only a small amount of fruits and vegetables, failing to match domestic supply with demand could result in greater dependence on international sources. By 2047, if current trends continue, India is expected to fulfill 2.92 percent of its domestic needs through imports (GoI, 2024a). Additionally, there has been a rapid increase in global demand for horticultural goods.

Horticultural producers encounter both opportunities and challenges in international trade. The increasing demand for fruits and vegetables presents significant opportunities for expansion of the horticulture sector. However, the increase in imports poses a challenge for domestic producers. As international trade barriers diminish and transportation technologies advance, local markets are increasingly inundated with imported products. This influx of foreign goods often results in competitive prices, potentially undermining domestic producers.

This study examines an important question: Can India be competitive in the export of horticultural products? Recent studies suggest that only a limited number of horticultural products, such as fresh onion, cucumber, gherkin, dried vegetables, cashewnut shelled, guava, mango, and tamarind, possess comparative advantages, whereas others, such as tomato, capsicum, pineapple, and orange, exhibit significant comparative disadvantages (Raman et al., 2023; Saxena et al., 2024). However, these studies do not consider the impact of domestic policies, market distortions, and cost structures. This study presents a thorough assessment of the competitiveness of selected horticultural products, with a detailed analysis of private and social profitability to provide insights into the economic viability of these products from individual producers' perspectives and their broader societal impact, as well as the effects of policy interventions in shaping India's competitive advantage.

This study focuses on temperate horticultural crops, including apples, almonds, walnuts, and saffron, which face significant challenges from imports. For instance, the influx of competitively priced apple imports from Iran and the United States disrupted the local market. In 2024, the Government of India reduced import duties on U.S. apples from 70 percent to 50 percent, leading to a surge in imports and further pressure on local producers. Similarly, Indian almond growers face a significant import threat from the U.S. Similarly, competitively priced saffron imports from Iran pose a significant threat to the domestic saffron industry.

India continues to implement protective tariff policies to safeguard domestic producers. Currently, India levies an import duty of 50 percent on apples, 30 percent on walnuts (fresh or dried in shells), 7 percent on almonds (fresh or dried in shells), and 9 percent on shelled almonds imported from the United States. However, recent significant changes in international trade policies, particularly reciprocal tariffs from the U.S., may substantially affect domestic producers. In response to these developments, the competitiveness of these commodities need to be enhanced through productivity improvements, cost reduction, quality improvement; etc.

Specifically, this study addresses the following questions:

- Do temperate horticultural crops have comparative and competitive advantages?
- What are the impacts of policies and divergence on the input, output, and overall dynamics of the input and output?
- What institutional and policy strategies are necessary to turn comparative advantage into competitive advantage?

♦♦♦

2 Progress of Horticulture Sector in India

Over the past two decades, horticulture has experienced significant growth, establishing itself as an important driver of agrarian transformations. The total horticultural production has increased from approximately 170 million tons in 2004–05 to 355 million tons in 2023–24. Horticultural crops occupy only 22 percent of the total cropped area, and contributes one-third of the total gross value added (GVA) from the agricultural sector (GoI, 2023 and 2024b).

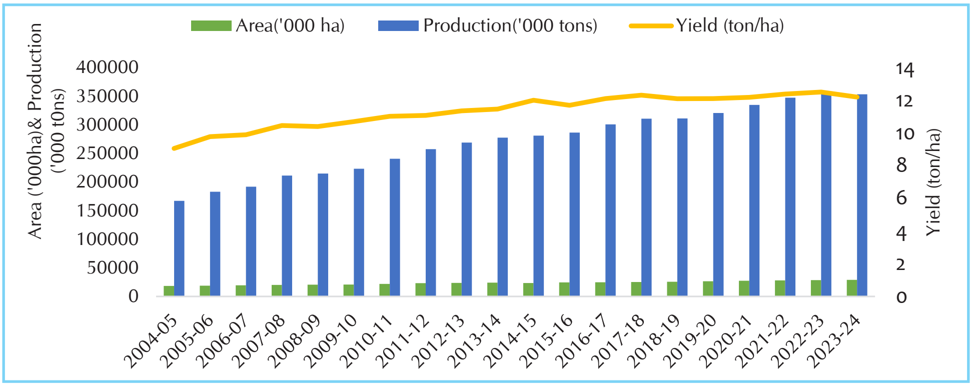
Jammu and Kashmir (J& K) is known for the cultivation of temperate fruit crops, including apples, almonds, walnuts, and saffron. Horticulture plays a vital role in J&K's economy, accounting for 7% of the total GVA and supporting the livelihoods of approximately 3.5 million people. The state's contribution to national production is particularly noteworthy, 70-95% of the country's total output for these specific crops.

2.1 Trends in area, production, and yield: India

Over the past two decades, the horticultural sector in India has undergone a significant expansion (Figure 1). This growth is evidenced by a substantial increase in the cultivated area, which has expanded from 18,445 thousand hectares in 2004-05 to 28,980 thousand hectares in 2023-24. The expansion in area has directly facilitated a rise in the production of horticultural crops, with output doubling from 166.93 million tons in 2004-05 to 353.19 million tons in 2023-24.

Fruits and vegetables constitute approximately 90 percent of total horticultural crop production (GoI, 2023). Vegetable production has increased significantly from 93,205 thousand tons in 2003-04 to 212,908 thousand tons in 2022-23 (Table 1). Similarly, fruit production has increased from 45,766 thousand tons to 108,342 thousand tons. Fruits account for approximately 25 percent of the total horticultural area and contribute to 31 percent of total production. India ranks as the second-largest producer of fruits and vegetables globally, and is the leading producer of mango, banana, guava, papaya, sapota, pomegranate, lime, and gooseberry.

Figure 1. Area, production, and yield of horticulture over the last two decades



Source: GoI (2024b).

Table 1. Area, production, and yield of fruits and vegetables in India

Year	Fruits			Vegetables		
	Area ('000 ha)	Production ('000 tons)	Yield (ton/ha)	Area ('000 ha)	Production ('000 tons)	Yield (ton/ha)
2003-04	4781	45766	9.57	6309	93205	14.77
2004-05	5155	50988	9.89	6744	101286	15.02
2005-06	5454	55505	10.18	7213	111434	15.45
2006-07	5686	59713	10.5	7581	115030	15.17
2007-08	5989	65764	10.98	7848	128486	16.37
2008-09	6237	68639	11.01	7981	129114	16.18
2009-10	6471	71709	11.08	7985	133779	16.75
2010-11	6383	74878	11.73	8495	146595	17.26
2011-12	6705	76424	11.4	8989	156325	17.39
2012-13	6982	81285	11.64	9205	162187	17.62
2013-14	7216	88977	12.33	9396	162897	17.34
2014-15	6110	86602	14.17	9542	169478	17.76
2015-16	6301	90183	14.31	10106	169064	16.73
2016-17	6373	92918	14.58	10238	178172	17.4
2017-18	6510	96447	14.82	10061	184041	18.29
2018-19	6597	97967	14.85	10073	183170	18.18
2019-20	6774	102080	15.07	10310	188284	18.26
2020-21	6930	102481	14.79	10859	200445	18.46
2021-22	7064	107507	15.22	11374	209143	18.39
2022-23	7009	108342	15.46	11358	212908	18.75

Source: As for Figure 1.

2.2 Area, production, and yield of temperate crops: Jammu & Kashmir

Apples account for 60 percent of the total horticultural output in J&K. During the past five decades, the area under apples has expanded significantly, from 60.29 thousand hectares in 1980 to 171.2 thousand hectares in 2022-23 (Table 2). Similarly, production increased by more than threefold, from 536.3 thousand tons to 1898.6 thousand tons during the same period. Despite this manifold increase in production, yield improvement has been modest, hovering at around 10.04 tons per hectare.

J&K almonds are known for their superior taste, high oil content, and attractive appearance. However, despite the monopoly in production with 90 percent of India's total production, the area under almonds has steadily declined due to poor crop health and adverse weather conditions, from 16.33 thousand hectares in 1980 to just 5.47 thousand hectares in 2022-23 (Table 2). Traditional almond varieties are seed propagated and have inherently low yields, and the lack of high-density plantation schemes and improved cultivars, coupled with climatic factors such as early blossom vulnerability to late spring frost and erratic snowfall, have resulted in its decline. Competitively priced almond imports from Afghanistan, Iran, and California have further impacted the almond acreage.

Walnut, also referred to as 'Cracked-Nut,' is a significant horticultural crop of J&K, primarily cultivated as an organic product, renowned for its extended shelf life and substantial export demand. Jammu and Kashmir account for over 90 percent of the walnut production in India. The area dedicated to walnut cultivation has steadily expanded from 26.74 thousand hectares in 1980 to 86.9 thousand hectares in 2022 (Table 2). During this period, production has increased seventeen-fold, from 15 thousand tons to 268.3 thousand tons, driven by a notable rise in productivity from 0.56 to 3.09 tons per hectare. Despite requiring relatively minimal crop management, walnut cultivation in India encounters considerable challenges, including high harvesting risks and lower productivity, compared to other countries (Lone et al., 2023; Pandey and Shukla, 2007).

Saffron is a cash crop predominantly cultivated, particularly in Pulwama, Budgam, Srinagar, and Kishtwar. Despite J&K contributing over 95% of the saffron production, the area under cultivation has experienced a substantial decline over the past two decades (Kumar et al., 2022; Tantry et al., 2017). The saffron area decreased from 5.71 thousand hectares in 1996-97 to 2.72 thousand hectares by 2001-02, subsequently recovering to 3.7 thousand hectares in 2008-09, where it has since stabilized. Overall, between 1996-97 and 2021-22, a 65% reduction in the saffron cultivation area was observed (Table 2).

Traditional saffron area viz. The Pampore Plateau is rainfed and recurrent droughts in recent decades have resulted in a substantial decline in its area. This is due to the Saffron Act 2007, enacted by the erstwhile J & K that the area has not further declined after 2008-09 and has remained constant due to a ban on conversion to other uses with its strict enforcement in order to maintain the heritage crop of the region. Furthermore, a wide variation in production and yield was observed due to the lack of good-quality corms, lack of adequate irrigation facilities and technologies, and low profitability (Ganaie and Singh, 2019). To address these challenges, the National Saffron Mission was launched in 2010-11 to improve the infrastructure, provide high-quality planting materials and irrigation facilities, and strengthen market linkages.

Table 2. Area, production, and yield of major temperate crops of Jammu & Kashmir

Crops	Year	Area ('000 ha)	Production ('000 tons)	Yield (ton/ha)
Apple	1980-81	60.29	536.30	8.91
	1985-86	63.80	760.67	11.92
	1990-91	68.72	658.17	9.58
	1995-96	78.01	714.83	9.16
	2000-01	88.15	751.31	8.53
	2005-06	111.88	1151.34	10.3
	2010-11	154.72	1749.23	11.3
	2015-16	163.02	1721.34	10.56
	2020-21	165.09	1719.42	10.42
	2022-23	171.20	1898.59	11.09
Walnut	1980-81	26.74	15.00	0.56
	1985-86	32.85	13.49	0.41
	1990-91	40.92	38.58	1.01
	1995-96	49.46	63.87	1.29
	2000-01	59.90	83.40	1.39
	2005-06	77.22	108.27	1.4
	2010-11	89.79	163.74	1.82
	2015-16	88.96	263.47	2.96
	2020-21	85.33	258.73	3.03
	2022-23	86.90	268.30	3.09
Almond	1980-81	16.33	1.86	0.11
	1985-86	17.40	2.59	0.15

Crops	Year	Area ('000 ha)	Production ('000 tons)	Yield (ton/ha)
	1990-91	19.20	2.21	0.12
	1995-96	19.32	6.57	0.34
	2000-01	18.06	10.90	0.61
	2005-06	15.55	14.33	0.92
	2010-11	17.59	12.51	0.71
	2015-16	7.13	7.06	0.98
	2020-21	5.48	9.93	1.81
	2022-23	5.47	9.75	1.78
Saffron[a]	1996-97	5.71	15.95	2.8
	2000-01	2.83	3.59	1.27
	2005-06	3.01	6.5	2.15
	2010-11	3.72	10.03	2.69
	2015-16	3.72	16.166	4.35
	2020-21	3.72	18.05	4.86
	2021-22	3.72	15.03	4.04

Source: GoJ&K (various years); GoJ&K (2023). [a]Quantity production is in tons and yield is in kg/ha.

2.3 Export performance

The trade dynamics of horticultural crops, particularly apples and walnuts, have undergone significant change over the past two decades. India ranks 32nd in global fresh apple exports, contributing only 0.20 percent to world exports in TE 2024 (ITC, 2025). Apple exports from India initially showed a promising trend, peaking at 47,077 tons in 2010, but subsequently declining to 21,853 tons by 2023 (Table 3). This decline in export quantity is not proportionally reflected in export value, which saw a modest increase from Rs. 41.7 million in 2000 to Rs. 771.7 million in 2023. On the other hand, India is the third-largest importer of apples, accounting for 4.68 per cent of global fresh apple imports (ITC, 2025). Apple imports surged dramatically, both in quantity and value. The import volume increased from 6,586 tons in 2000 to a staggering 500,445 tons in 2023, with a corresponding value increase from Rs. 210.8 million to Rs. 33,067.1 million. This shift suggests a growing domestic appetite for apples, potentially driven by factors such as consumer preferences for imported varieties, competitive pricing, and the need to fill seasonal gaps in local production.

The walnut trade experienced an even more dramatic reversal. In the early 2000s, India held a strong position as a net exporter of walnuts, with exports of 7,742 tons valued at Rs. 1,099.4 million. However, by 2023, walnut exports had plummeted to just 638.1 tons with a value of Rs. 200.2 million (Table 3). India's position in the global walnut export had also declined from 8^{th} to 25^{th}, contributing only 0.12 percent to world exports in TE 2024 (ITC, 2025). Walnut imports, which were virtually non-existent until 2010, rose sharply to 35,108 tons valued at Rs. 8,461.7 million in 2023. At present, India accounts for 3.32 percent of global walnut imports, ranking 9^{th} in the world (ITC, 2025). This transformation from a net exporter to a significant importer of walnuts indicates a substantial shift in domestic production capacity and market demand, or both.

The trade pattern for almonds in India demonstrates a significant imbalance between imports and exports, highlighting the country's heavy reliance on foreign sources to meet domestic demands. Although almond exports have shown some growth over the years, increasing from a mere 20 tons in 2000 to 129.1 tons in 2023. India currently ranks 32^{nd} in global almond exports, with a minor share of 0.04 percent in TE 2024. However, India is the world's largest importer of almonds, accounting for 16.63 percent of global imports in TE 2024 (ITC, 2025). Almond imports have skyrocketed from 28,114 tons in 2000 to an impressive 273,750.9 tons in 2023, representing a nearly tenfold increase. This substantial growth in import volume is mirrored by a corresponding rise in import value from Rs. 3,599.6 million to Rs. 85,298.5 million over the same period (Table 3).

The saffron trade in India presents a different scenario characterized by limited volumes, but notable fluctuations in value. Export quantities have remained consistently low, rarely exceeding 3 kg/year. However, the export value has shown considerable variation, peaking at Rs. 36.8 million in 2010. The import side of the saffron trade has seen a recent and dramatic shift. While imports were negligible until 2015, they rose to 10.45 kg by 2023. Strikingly, the import value experienced a sharp increase to Rs. 1714.9 million in the same year (Table 3). As result, India has now emerged as the world's second-largest saffron importer, accounting for 11.93 percent of global imports in TE 2024 (ITC, 2025).

These trends in both apple and walnut trade highlight the changing landscape of India's horticultural sector, particularly in Jammu & Kashmir, and suggest the need for a closer examination of factors influencing domestic production, quality, and market competitiveness.

Table 3. Export and import trends of apple, walnut, almond, and saffron from India

Crops	Year	Export		Import	
		Quantity (tons)	Value (Rs. million)	Quantity (tons)	Value (Rs. million)
Apple	2000	2847.0	41.7	6586.4	210.8
	2005	30043.9	381.3	32367.8	905.9
	2010	47077.0	597.5	134576.9	6226.7
	2015	20808.1	598.0	208428.2	13968.1
	2020	30680.5	1066.5	272435.3	17770.9
	2023	21852.6	771.7	500445.7	33067.1
Walnut	2000	7742.4	1099.4	571.2	6.3
	2005	5256.5	1144.7	-	-
	2010	5753.7	1661.0	139.6	15.0
	2015	3289.5	1178.9	35021.5	1070.3
	2020	1069.6	297.9	66639.8	6671.7
	2023	638.1	200.2	35108.9	8461.7
Almond	2000	20.0	2.2	28114.4	3599.6
	2005	296.5	14.8	26806.5	7015.9
	2010	125.4	26.9	75211.3	14353.0
	2015	185.9	102.1	102417.5	51347.8
	2020	205.8	98.6	244260.4	68918.0
	2023	129.1	177.6	273750.9	85298.5
Saffron[a]	2005	1.6	6.3	0.1	1.2
	2010	1.2	36.8	0.1	5.1
	2015	0.7	26.8	2.9	23.4
	2020	1.2	21.0	18.0	140.8
	2023	2.5	19.6	10.4	1714.9

Source: GoI (various years); [a]Quantity export and import are in kgs.

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3 Data and Methods

This chapter outlines the research framework, data, and analytical procedures used to assess the competitiveness of temperate horticultural crops. It describes the research framework, discusses the data, study area, and methodological approaches.

3.1 Research framework

In 1776, Adam Smith defined competitiveness in terms of absolute advantage through his "Trade Theory," which measures "welfare" as the accumulation of endowments (Cieslik et al., 2021). According to this theory, welfare can be enhanced through trade between countries that possess an absolute advantage. Subsequently, Ricardo (1987) introduced the "Law of Comparative Advantage," which posits that mutually beneficial trade is feasible even when a country lacks an absolute advantage in producing certain goods, provided that price differentials exist between trading nations. Furthermore, trade between countries has been elucidated by resource differences and economies of scale (Lindert and Kindleberger, 1993).

Competitiveness is defined as the ability of a sector, industry, or firm to compete successfully and achieve sustainable growth in the global market while earning at least the opportunity cost of the resources utilized (Ohlin, 1993). To enhance exports, it is essential to evaluate the competitiveness of a commodity by implementing policies that enhance its competitiveness in the global market. Competitiveness of an industry or product in the international market is assessed based on two critical factors: comparative advantage and competitive advantage (Saptana, 2010). Comparative advantage is considered a natural factor arising from resource abundance, whereas competitive advantage develops through production capacity (Saptana et al., 2023).

The Policy Analysis Matrix (PAM) is a widely used framework for evaluating comparative advantage, competitive advantage, and the influence of government policies on commodity systems. PAM assists in identifying strategies and policies that can be implemented to enhance agricultural production and farmer welfare, while minimizing social costs.

3.2 Study area and data

This study was conducted in Jammu & Kashmir, located in the Northern Himalayan region of India (Figure 2). To achieve the intended objectives, this study relied on both primary and secondary data. Primary data were gathered from selected households and supplemented by focus group discussions (FGDs) with farmer leaders, traders, and administrators. This study collected comprehensive information on acreage, production, price, and the socioeconomic and demographic characteristics of farmers. Additionally, data on the cost of cultivation of inputs such as fertilizers, manure, labor, plant protection chemicals, farm operations, transportation, marketing charges, and miscellaneous overhead were also collected.

A two-stage simple random sampling technique was adopted. At the first stage, districts were selected based on their maximum proportion of area under crop. In the second stage, farmers were selected randomly based on the orchard size and production practices. For traditional apple plantations, 100 farmers were chosen from the districts of Baramulla, Pulwama, Anantnag, and Shopian, which are known for their significant contribution to apple production. On the other hand, high-density apple (HDP) plantation, a relatively recent innovation, data were collected from 100 farmers across all districts of the Kashmir Valley.

For almonds, 100 farmers from the Budgam and Pulwama districts, which are the dominant contributors to almond production, were selected. Similarly, data on walnut plantations were collected from 100 farmers in the Anantnag and Kupwara districts, both of which are critical to walnut production in the Kashmir Valley. Finally, saffron cultivation, which is a niche but highly valuable crop, was investigated by surveying 100 farmers from the Pampore region of Pulwama district.

Secondary data on Cost, Insurance, and Freight (CIF) and Free On Board (FOB) unit values were collected from the International Trade Centre, trade

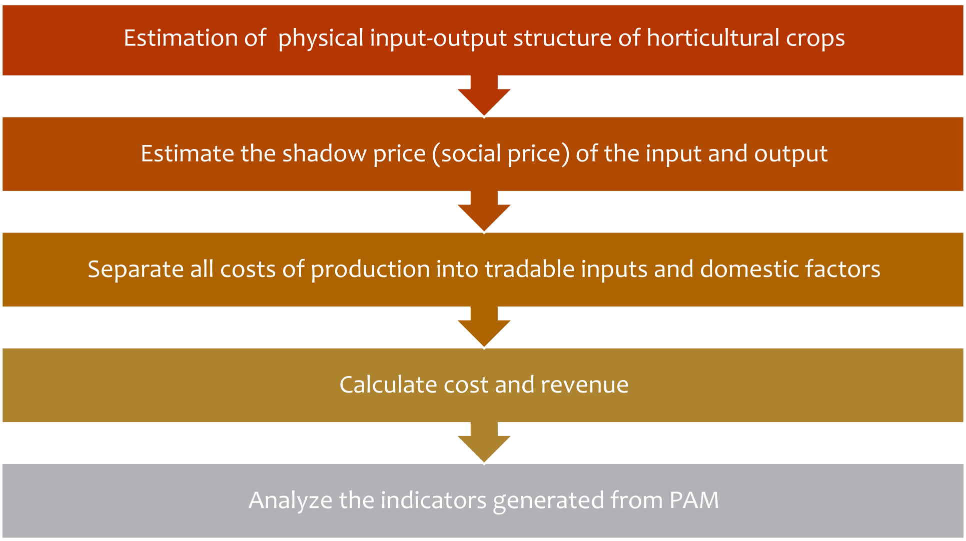
Figure 2. Study area

map, and the Department of Commerce, Ministry of Commerce and Industry, Government of India for the year 2022-23.

3.3 Analytical tools

The policy analysis matrix (PAM) is a powerful tool for evaluating the impact of policy interventions on the profitability and competitiveness of horticultural crops. It provides a comprehensive analysis from both the private (financial) and social (economic) perspectives, making it particularly useful for assessing the economic viability and social welfare implications of policies. The general PAM estimation procedure is illustrated in Figure 3.

Figure 3. PAM estimation procedure



3.3.1 Allocation of tradable inputs and domestic factor components

Within the PAM framework, it is crucial to distinguish production costs between tradable inputs (tradable goods) and domestic factors (non-tradable goods). Tradable inputs encompass costs related to inputs traded on a global scale, whereas domestic factors include the costs of inputs traded within the domestic market. Tradable goods are typically identified based on the following criteria: (i) commodities that are currently exported or imported from global markets, (ii) commodities that can be easily substituted by other imported or exported products, and (iii) commodities that are generally protected by the government through trade policies (Pearson et al., 2005; Chowdhury, 2020; Gittinger, 1986; Saptana et al., 2023).

Total and direct methods are the two techniques utilized for allocating farming costs into tradable input costs and domestic factor components. The total method assumes that each tradable production input cost comprises both domestic and tradable input components. By contrast, the direct approach categorizes the costs of tradable inputs, both imported and domestically generated, as tradable input components. In this study, a direct method was employed to allocate costs to tradable input costs and domestic factor components. The output of fresh produce is entirely tradable, whereas inputs such as planting materials, fertilizers (including Urea, DAP, MOP, NPK, Calcium, and Boron), pesticides, machinery depreciation, packaging materials, and anti-hail nets are also considered fully tradable. Conversely, inputs such as farmyard manure, raffia rope, stakes, labor, building depreciation, and land rent are categorized as entirely domestic factor costs.

The cost components associated with transportation-related operations are determined through consultations with representatives of the business administration. Labor costs in transportation are classified as domestic factors, whereas the equipment rental costs for transportation are considered tradable. Data on post-harvest handling costs were collected through direct discussions with farmers and commodity traders. Material costs are categorized as tradable inputs, whereas labor costs are allocated to domestic factors. Tables 4, 5, 6, 7, and 8 provide detailed information on the allocation of tradable inputs and the domestic factor components.

Table 4. Allocation of tradable inputs and domestic factor components of traditional apple

Particulars	Tradable input (%)	Domestic factor (%)
Fertilizers		
• Urea	100	-
• DAP	100	-
• Potash	100	-
• Boron	100	-
• Calcium	100	-
• Farmyard manure	-	100
Plant protection chemicals		
• Horticultural mineral oil	100	-
• Insecticides/acaricides	100	-
• Fungicide	100	-
• Herbicide	100	-
Labour		
• Pre-harvest	2.7	97.3
• Harvest	76.6	23.4
• Post-harvest	-	100
Packaging material		
• Wooden	-	100

Particulars	Tradable input (%)	Domestic factor (%)
• Cardboard	-	100
Irrigation	-	100
Depreciation on machinery, building and implements	12	88
Land lease	-	100
Other costs	-	100
Capital costs	8.5	91.5

Source: Authors' estimation.

Table 5. Allocation of tradable inputs and domestic factor components of HDP apple

Particulars	Tradable Input (%)	Domestic factor (%)
Fertilizers		
• Urea	100	-
• DAP	100	-
• Potash	100	-
• Boron	100	-
• Calcium	100	-
• Yaramila	-	100
• Other chemicals	100	-
• Vermicompost	-	100
Plant protection chemicals		-
• Horticultural mineral oil	100	-
• Insecticides/acaricides	100	-
• Fungicide	100	-
• Herbicide	100	-
Labour		
• Pre-harvest	19	81
• Harvest	77	23
• Post-harvest	-	100
Packaging material		
• Wooden	-	100
• Cardboard	-	100
Irrigation	-	100
Depreciation on machinery, buildings, and implements	22	78
Land lease	-	100
Other costs	-	100
Capital costs	51.7	48.3

Source: Authors' estimation.

Table 6. Allocation of tradable inputs and domestic factor components of almond

Particulars	Tradable inputs (%)	Domestic factor (%)
Fertilizers		
• Urea	100	-
• DAP	100	-
• MOP	100	-
• Manure	-	100
Pesticide		
• Chloropyriphos	100	-
• Copper oxychloride	100	-
• Mancozeb + Carbendazim	100	-
Labour		
• Pre-harvest	5.7	94.3
• Harvest	-	100
• Post-harvest	-	100
Depreciation of tools	11	89
Land lease	-	100
Other costs	-	100
Capital costs	6.5	93.5

Source: Authors' estimation.

Table 7. Allocation of tradable inputs and domestic factor components of walnut

Particulars	Tradable inputs (%)	Domestic factor (%)
Planting material	-	100
Fertilizers		
• Urea	100	-
• Farmyard manure	-	100
Labour		
• Pre-harvest	-	100
• Harvest	4.5	95.5
• Post-harvest	-	100
Depreciation of tools	-	100
land lease	-	100
Other costs	-	100
Capital costs	9	91

Source: Authors' estimation.

Table 8. Allocation of tradable inputs and domestic factor components of saffron

Particulars	Tradable inputs (%)	Domestic factor (%)
Corms	-	100
Fertilizers		
• Urea	100	-
• DAP	100	-
• Farmyard manure	-	100
Plant protection chemicals		
• Seed treatment (Mancozeb)	100	-
• Rodenticide	100	-
Labour		
• Pre-harvest	15	85
• Harvest	-	100
• Post-harvest	-	100
Irrigation	-	100
Depreciation of tools	11	89
Land lease	-	100
Other costs	-	100
Capital costs	3.1	96.9

Source: Authors' estimation.

3.3.3 Social pricing

Determining private and social prices is essential for evaluating the private and social feasibility of the farming system. Consequently, each input and output of the horticultural crops examined in this study was assigned to both private and social prices. Private prices reflect the actual market prices that producers receive for their outputs, and the prices they pay for production inputs. Taxes, subsidies, and market imperfections affect these prices. Conversely, social prices represent ideal prices that would exist under conditions of perfect market competition or full employment equilibrium (Saptana et al., 2021; Chowdhury, 2020). These prices show the true economic value of goods and services to the society. Social costs represent the opportunity cost to the economy of using resources (land, labor, capital, and inputs) in production systems, reflecting their true scarcity value. In contrast, social benefit represents the value of the output (e.g., crop yield and livestock product) valued at its social price, which reflects the true value of the output.

However, in practice, achieving fully competitive market conditions is challenging because of the market distortions. Therefore, social prices are calculated by eliminating distortions caused by government policies such as subsidies, import tariffs, and value-added taxes. In this study, free-on-board (FOB) prices are utilized for net exports, while cost, insurance, and freight (CIF) prices are applied for net imports. The prices are adjusted for farm gate level by eliminating/adding the domestic market transaction costs, port charges and market margins. For domestic factors, opportunity cost or the average price in the region is used. Tables 9, 10, 11, and 12 list the social prices used in this study.

Table 9. Input and output shadow price of traditional and HDP apple

Particulars	Social price
Planting Material	• Traditional apple: Average price of apple plant in the study area (Rs. 300/plant) • High-density plantation: c.i.f. price in 2022, (Rs. 346.80/plant)
Urea	f.o.b. price (Rs. 40.83/kg)
DAP	c.i.f. price (Rs. 55.44/kg)
Potash	c.i.f. price in 2022 (Rs. 48.17/kg)
Boron	c.i.f. price in 2022 (Rs. 262.5/kg)
Calcium	c.i.f. price in 2022 (Rs. 114.78/kg)
Yaramila	Average of actual price of yaramila in the study area (Rs. 65.625/kg) (for high-density plantation)
Horticultural mineral oil (HMO)	Average of actual HMO price in the study area (Rs. 175/kg)
Farmyard manure	Average of actual price FYM in the study area (Rs. 15/kg)
Dimethoate	c.i.f. price in 2022 (Rs. 538.98/kg)
Chlorpyrifos	f.o.b. price in 2022 (Rs. 991.60/kg)
Fenazaquin	Average of the actual price of Fenazaquin in the study area (Rs. 3412.5/kg)
Mancozeb	f.o.b. price (Rs. 401.70/kg)
Dodine	f.o.b. price in 2022 (Rs. 401.70/kg)
Difenaconazole	c.i.f. price in 2022, (Rs. 667.99/kg)
Zineb	f.o.b. price in 2022 (Rs. 356.82/kg)
Zineb and hexaconazole	f.o.b. price in 2022 (Rs. 787.50/kg)
Xemium and difenaconazole	f.o.b. price in 2022 (Rs. 4375/kg)
Trifloxystrobin and tebuconazole	f.o.b. price in 2022 (Rs. 5337.5/kg)
Flutriafol and pyraclostrobin	f.o.b. price in 2022 (Rs. 7700/kg)
Ziram	f.o.b. price in 2022 (Rs. 401.65/kg)
Pendimethalin	f.o.b. price in 2022 (Rs. 1033.50/kg)
Unskilled labor	(Rs. 311/man-day)
Semi-skilled labor	(Rs. 400/man-day)
Skilled labor	(Rs. 483/man-day)
Land rent	Based on Government-fixed land rent (Rs. 25,000/ha)
Apple output	c.i.f. price in 2022 (Rs. 62.41/kg)

Source: Authors' estimation.

Table 10. Input and output shadow price of almond

Particulars	Social price
Planting Material	Average price of almond plant in the study area (Rs. 250/plant)
Urea	f.o.b. price (Rs. 40.83/kg)
DAP	c.i.f. price in 2022 (Rs. 55.44/kg)
Potash	c.i.f. price in 2022 (Rs. 48.17/kg)
Chlorpyriphos	f.o.b. price in 2022 (Rs. 991.60/kg)
Copper oxychloride	f.o.b. price in 2022 (Rs. 451.29/kg)
Mancozeb and carbendazim	Average of the actual price of mancozeb and carbendazim in the study area (Rs. 599.375/kg)
Farmyard manure	Average of the actual price of FYM in the study area (Rs. 15/kg)
Unskilled labor	Based on Government-fixed wage rates for 2022 in the study area (Rs. 311/man-day)
Semi-skilled labor	(Rs. 400/man-day)
Skilled labor	Based on Government-fixed wage rates for 2022 in the study area (Rs. 483/man-day)
Land rent	Based on Government-fixed land rent (Rs. 25,000/ha)
Almond output (in shell)	c.i.f. price in 2022 (Rs. 680/kg)
Almond output (shelled)	c.i.f. price in 2022 (Rs. 713.42/kg)

Source: Authors' estimation.

Table 11. Input and output shadow price of walnut

Particulars	Social price
Planting Material	Average of actual price of walnut plants in the study area (Rs. 500/plant)
Urea	f.o.b. price in 2022 (Rs. 40.83/kg)
Farmyard manure	Average of actual FYM price in the study area (Rs. 15/kg)
Unskilled labor	Based on Government-fixed wage rates for 2022 in the study area (Rs. 311/man-day)
Semi-skilled labor	Based on Government-fixed wage rates for 2022 in the study area (Rs. 400/man-day)
Skilled labor	Based on Government-fixed wage rates for 2022 in the study area (Rs. 483/man-day)
Land rent	Based on Government-fixed land rent (Rs. 25,000/ha)
Walnut output (in shell)	c.i.f. price in 2022 (Rs. 125/kg)
Walnut output (shelled)	c.i.f. price in 2022 (Rs. 265/kg)

Source: Authors' estimation.

Table 12. Input and output shadow price of saffron

Particulars	Social price
Planting material	Average price of corms in the study area (Rs. 400/kg)
Urea	f.o.b. price in 2022 (Rs. 40.83/kg)
DAP	c.i.f. price in 2022 (Rs. 55.44/kg)
Farmyard manure	Average of actual price of FYM in the study area (Rs. 15/kg)
Mancozeb	f.o.b. price in 2022 (Rs. 401.7/kg)
Zinc phosphate	f.o.b. price in 2022 (Rs. 1033.5/kg)
Unskilled labor	Based on Government-fixed wage rates for 2022 in the study area (Rs. 311/man-day)
Semi-skilled labor	Based on Government-fixed wage rates for 2022 in the study area (Rs. 400/man-day)
Skilled labor	Based on Government-fixed wage rates for 2022 in the study area (Rs. 483/man-day)
Land rent	Based on Government-fixed land rent (Rs. 25,000/ha)
Saffron Output	
• Stigma	c.i.f. price in 2022 (Rs. 1,20,000/kg)
• Stamens	c.i.f. price in 2022 (Rs. 1130.29/kg)
• Petals	Average of actual saffron petal price in the study area (Rs. 450/kg)
• Daughter corms	Average of actual saffron daughter corm price in the study area (Rs. 300/kg)

Source: Authors' estimation.

3.3.4 Computation of policy analysis matrix (PAM)

The PAM matrix is developed by utilizing the farm-level input-output structure, cost of cultivation, and both private and social revenues. Through these estimations, the benefits at both private and social levels were determined. The results of the PAM analysis provide insights into profitability at both private and social levels, as well as comparative and competitive advantages, and the impact of government policies on inputs, outputs, and combined factors. The general framework of the PAM is presented in Table 13.

Table 13. PAM framework

Variables	Revenue (Rs./ha)	Cost (Rs./ha)		Profit (Rs./ha)
		Tradable input (Rs./ha)	Domestic Factor (Rs./ha)	
Private cost	A	B	C	D
Social cost	E	F	G	H
Policy and divergence impacts	I	J	K	L

Source: Saptana et al., 2023.

Where, I = A–E; J = B–F; K = C–G; L = D–H

The following key indicators were estimated using the PAM framework.

- Private profitability (PP): D = A – (B + C)
- Social profitability (SP): H = E – (F + G)
- Private cost ratio: PCR = C/(A–B)
- Domestic resource cost ratio: DRCR = G / (E–F)
- Output transfer: OT = A–E
- Nominal protection coefficient on tradable output: NPCO = A/E
- Transfer input: IT = B–F
- Nominal protection coefficient on tradable input: NPCI = B / F
- Transfer factor: FT = C–G
- Effective protection coefficient: EPC = (A–B) / (E–F)
- Net transfer: NT = D–H
- Profitability coefficient: PC = D / H
- Subsidy ratio to producer: SRP = L/E

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4 Competitive and Comparative Advantages

4.1 Private and social costs and profitability

Competitiveness is assessed from two perspectives: financial or private, which indicates a competitive advantage, and social or economic, which denotes a comparative advantage. Private costs and profits are determined by the expenses incurred by farmers for inputs and revenue generated from the sale of their produce, whereas social costs and profits reflect the optimal scenario under perfect market conditions.

Table 14 lists the PAM results. The findings from the cost and financial (private) price analyses indicate that traditional apple plantations are profitable for both farmers (private profit) and the economy as a whole (social or economic profit). Notably, social profits significantly exceed private profits. Specifically, the economic profits for traditional apple cultivation are estimated at Rs. 18,64,333 per hectare, while the financial profits are estimated at Rs. 10,19,866 per hectare. This suggests that traditional apple cultivation possesses a strong comparative advantage and that market imperfections or policy constraints limit producers' private gains relative to their true economic returns.

High-density apple plantation results in higher profits for farmers, amounting to Rs. 42,87,482 per hectare, despite an increase in private costs. This increase in private costs is primarily due to the need for a greater number of plants per hectare and additional establishment expenses such as trellises, wires, and drip irrigation systems. However, the economic profit of high-density planting was lower at Rs. 33,38,614 per hectare, with slightly reduced social costs. The significant negative divergence effects suggest that private profit may be partially influenced by subsidies, market prices, or policy distortions, although crops continue to exhibit a strong comparative advantage.

Although almond plantations yield moderate financial returns, they exhibit a more favorable position from a social cost-benefit perspective. The financial profit was Rs. 2,69,750 per hectare, with private costs amounting to Rs. 5,01,140 per hectare. However, when evaluated economically, the profit increased to Rs. 5,52,788 per hectare. This improvement is attributed to higher gross economic revenue and reduced social costs. This discrepancy indicates that almond cultivation possesses greater economic value than the market prices suggest, highlighting a significant comparative advantage.

Conversely, while the financial analysis indicates that walnut cultivation is profitable, it significantly underperforms in social terms. Although financial profit is substantial at Rs. 5,72,462 per hectare, attributed to low private costs, economic profit declines sharply to Rs. 60,305 per hectare due to higher social costs and considerably lower economic revenue. This substantial disparity suggests that private profitability may be artificially inflated, potentially because of favorable market prices or policy support, indicating that walnut cultivation has a low comparative advantage.

Saffron cultivation demonstrates moderate profitability from both financial and economic perspectives, with a significant reduction in returns when assessed from a social perspective. The financial profit was Rs. 1,41,786 per hectare, with private costs amounting to Rs. 3,12,245 per hectare, primarily due to domestic factor utilization. Economically, saffron yields a lower profit of Rs. 53,408 per hectare, with a slightly reduced social cost of Rs. 2,91,451 per hectare. This indicates that saffron possesses a limited comparative advantage, and its economic efficiency is hindered by high input costs and potential overvaluation in private markets.

Overall, the PAM framework reveals that at financial prices, high-density apples generate the highest private profit, followed by traditional apple, walnut, almond, and saffron farming. The key consideration for farmers is profitability at financial (private) prices, which directly influences their production decisions. However, from a broader social perspective, both traditional and high-density apple orchards, along with almond cultivation, contributed the highest net social benefits. In contrast, the economic activities associated with walnut and saffron cultivation reduce social benefits. Therefore, high-density and traditional apples demonstrate a clear comparative advantage over almond, walnut, and saffron farming.

Surprisingly, despite the higher establishment costs associated with high-density apple plantations, no other crop proves to be competitive in terms of economic and financial returns. This advantage is primarily attributed to a shorter gestation period coupled with higher productivity, nearly three times that of traditional orchards, and the availability of premium varieties offsets the initial establishment costs. Although the average cost of production in traditional apple orchards is approximately Rs. 10 per kilogram, it is approximately Rs. 3 per kilogram in high-density orchards. Furthermore, varieties viz., the Gala series, grown under a high-density system, reach markets earlier and fetch attractive prices, typically ranging from Rs. 80 to 120 per kilogram in local markets. Moreover, poor technological interventions in almond and walnut crops have reduced their profitability for farmers. High imports have exacerbated this issue.

Table 14. Results of PAM analysis of selected horticultural crops in Jammu & Kashmir, 2022-23

Variables	Gross revenue (Rs/ha)	Cost (Rs/ha)		Profit (Rs/ha)
		Tradable input	Domestic factor	
Traditional apple				
Financial price	15,06,012	1,31,248	3,54,897	10,19,866
Economic price	22,92,444	1,67,018	2,61,092	18,64,333
Divergence effect	-7,86,432	-35,770	93,805	-8,44,467
HDP apple				
Financial price	56,30,240	4,63,407	8,79,349	42,87,482
Economic Price	43,92,291	4,02,381	6,51,294	33,38,614
Divergence effect	12,37,949	61,026	2,28,055	9,48,868
Almond				
Financial price	7,70,891	46,214	4,54,926	2,69,750
Economic price	9,31,467	82,514	2,96,165	5,52,788
Divergence effect	-1,60,576	-36,300	1,58,761	-2,83,038
Walnut				
Financial price	7,66,735	4,140	1,90,133	5,72,462
Economic price	2,12,101	13,202	1,38,594	60,305
Divergence effect	5,54,634	-9,062	51,539	5,12,157
Saffron				
Financial price	4,54,030	23,001	2,89,244	1,41,786
Economic price	3,44,859	41,142	2,50,309	53,408
Divergence effect	1,09,171	-18,141	38,934	88,378

Source: Authors' estimation.

4.2 Competitive and comparative advantages

To assess competitiveness, a direct comparison of private and social profits alone is not sufficient, as variations in input use and output pricing may significantly influence profits. To address this limitation, the private cost ratio (PCR) and domestic resource cost ratio (DRCR) are important indicators used in PAM to assess financial competitiveness and economic efficiency. The PCR is the ratio of domestic factor costs to value added at private (market) prices, shows how much the system can pay for domestic factors (including a normal return to capital) and still remain competitive, that is, break even after earning normal profits. A PCR coefficient of less than one indicates that a crop is financially viable for farmers under current market conditions. The DRCR, on the other hand, compares domestic factor costs to value-added at social (economic) prices; a value less than one implies that the crop uses domestic resources efficiently and has a comparative advantage.

Table 15 presents the PCR and DRCR coefficients. The results show the competitive advantage of crops. High-density apples had the lowest PCR (0.17) and DRCR (0.16), indicating that producing one unit of value added at private and social prices requires 0.17 and 0.16 units of domestic resources, respectively. This shows that high-density apple plantation is both financially competitive and economically efficient. Traditional apples also perform well, with a PCR of 0.26 and a very low DRCR of 0.12, reflecting a strong comparative advantage and efficient use of domestic resources. However, almonds show moderate performance, with a PCR of 0.63 and a DRCR of 0.35, suggesting that while financial costs are relatively high, the crop still holds a strong comparative advantage.

In contrast, walnut and saffron show concerning trends. Although walnut has a low PCR (0.25), its high DRCR (0.70) implies that it is financially viable but not socially efficient, possibly due to overvaluation in the market or inefficient resource use. Saffron, with the highest PCR (0.67) and DRCR (0.82), appears to be moderately competitive and less efficient, requires substantial private and domestic resources to generate relatively limited returns.

Table 15. Private cost ratio and domestic resource cost ratio coefficient for selected horticultural crops of Jammu & Kashmir, 2022-23

Crops	Private cost ratio (PCR)	Domestic resource cost ratio (DRCR)
Traditional apple	0.26	0.12
High-density apple	0.17	0.16
Almond	0.63	0.35
Walnut	0.25	0.70
Saffron	0.67	0.82

Source: Author's estimation.

5 Impact of Divergence and Government Policies

Government policies influence the performance of horticultural production. These policies encompass a diverse array of measures, including trade-related policies, such as export and import tariffs, financial incentives, such as subsidies, and taxation mechanisms, such as goods and services taxes (GST). Furthermore, supportive policies related to infrastructure development, including irrigation systems, roads, and post-harvest facilities, as well as marketing initiatives can substantially influence agricultural productivity.

PAM is a comprehensive framework for assessing the impact of these policies. This analysis provides two measures, absolute and relative. Absolute measures encompass output transfer (OT), which evaluates the discrepancy between market and social prices for outputs; input transfer (IT), which investigates the divergence between market and social prices for tradable inputs; factor transfer (FT), which focuses on the difference between private and social costs of domestic factors; and net transfer (NT), which represents the overall impact of policy interventions. Relative measures provide a more nuanced perspective, with indicators such as the nominal protection coefficient on output (NPCO) and input (NPCI) assessing the extent of protection or taxation on outputs and inputs, respectively. The effective protection coefficient (EPC) offers insights into the combined effects of input and output policies, whereas the profitability coefficient (PC) and subsidy ratio to producer (SRP) provide valuable information on the overall policy impact on farm profitability and the implicit level of policy support.

5.1 Impact of Government policies on output

The impact of government policies on traditional and high-density apples, almonds, walnuts, and saffron farming systems can be further analyzed through the lens of output transfer (OT) and the nominal protection coefficient for output (NPCO). These indicators provide valuable insights into the economic landscape faced by farmers and the effectiveness of policy intervention. A positive OT signifies that farmers benefit from policy support and receive higher prices for their produce than they would in a perfectly competitive market. This can incentivize increased production and investment in these farming systems. Conversely, a negative OT indicates that producers are disadvantaged, potentially owing to factors such as market distortions, inadequate infrastructure, or unfavorable trade policies, which may discourage production or lead to reduced profitability.

NPCO, as a ratio of private-to-social output prices, offers a more nuanced perspective on the degree of protection or taxation experienced by farmers. An NPCO exceeding one suggests that farmers receive a price premium due to government interventions, effectively subsidizing their production. This can lead to increased output and potentially improve livelihoods for farmers. However, this may also result in market inefficiencies and reduced competitiveness in international markets. On the other hand, an NPCO below one indicates that farmers face implicit taxation, receiving lower prices than they would in an undistorted market. This scenario can lead to reduced production incentives, potentially affecting food security and rural economic development. By examining these indicators across different farming systems, policymakers can gain a comprehensive understanding of the effects of their interventions and make informed decisions to optimize agricultural productivity and farmer welfare.

The findings of output transfer (OT) and nominal protection coefficient on output (NPCO) for traditional apples, high-density apples, almonds, walnuts, and saffron farming are presented in Table 16. The results show that the output transfer values are negative for traditional apples and almonds but positive for high-density apples, walnuts, and saffron. The nominal protection coefficient on output was less than one for traditional apple and almond, whereas as greater than one for high-density apples, walnuts, and saffron.

Traditional apple and almond production faces significant challenges, with negative output transfers of Rs. 7,86,432 per hectare and Rs. 1,60,577 per hectare. This huge loss suggests that market prices or production inefficiencies severely affect the economic viability of these crops. Similarly, the NPCO value of 0.66 and 0.83 further indicates insufficient market protection, meaning that producers receive prices below international parity, which reduces their competitiveness. These crops are negatively affected by these policies. For example, the Government of India reduced import duties on apples from the U.S. from 70 percent to 50 percent, leading to a surge in imports, as imported varieties are often sold at lower prices, making it challenging for local growers to compete. Consequently, farmers receive less than the true economic value of their produce. In addition, traditional varieties have size variations, high susceptibility to diseases, and low productivity due to poor scientific interventions.

In contrast, high-density apple production demonstrates significant profitability, yielding a positive output transfer of Rs. 12,37,949 per hectare. This outcome underscores the advantages gained from adopting improved practices, such as increased yields and improved resource management. An NPCO of 1.28 indicates that high-density apple production benefits from market protection.

Walnuts demonstrate significant profitability, with an output transfer of Rs. 5,54,634 per hectare. This profitability can be attributed to low input costs, access to high-value markets, and high demand. The NPCO of 3.61 is notably high, suggesting substantial market protection or premium pricing for walnuts, thereby enhancing their competitiveness in both the domestic and international markets. Similarly, saffron cultivation exhibits a positive output transfer of Rs. 1,09,171 per hectare. However, its profitability is moderate compared with high-density apples and walnuts. Saffron benefits from its niche market and high value status. An NPCO of 1.32 indicates adequate market protection, ensuring favorable pricing relative to international prices.

Table 16. Transfer output value and nominal protection coefficient values for selected horticultural crops of Jammu & Kashmir, 2022-23

Crops	Output transfer (OT) (Rs./ha)	Nominal protection coefficient on output (NPCO)
Traditional apple	-7,86,432	0.66
High-density apple	12,37,949	1.28
Almond	-1,60,577	0.83
Walnut	5,54,634	3.61
Saffron	1,09,171	1.32

Source: Authors' estimation.

5.2 Impact of Government policies on input

The impact of governmental policies on the input sector was examined through the PAM utilization of three indicators: (i) input transfer (IT), (ii) nominal protection coefficient on input (NPCI), and (iii) factor transfer (FT). Input transfer quantifies the discrepancy between total tradable input costs assessed at private prices (financial) and those assessed at economic prices (social). The nominal protection coefficient on input (NPCI) serves as an indicator of input transfer, calculated as the ratio of tradable input costs based on private prices to those based on social prices. This ratio indicates whether producers incur costs above or below the economic value of their inputs as a result of policy interventions. An NPCI value exceeding one implies implicit taxation on inputs, whereas a value below one signifies subsidies. Factor transfer denotes the divergence between the private and social costs of non-tradable domestic factors.

Table 17 presents the IT, NPCI, and FT. values for selected four crops. Traditional apples and almonds exhibited negative IT values of Rs. -35,770 and Rs. -36,300 per hectare, respectively, with NPCI values of 0.79 and

0.56. This indicates that producers benefit from subsidies for tradable inputs. Conversely, high-density apple plantations, walnuts, and saffron demonstrate positive IT values of Rs. 61,026, Rs. 9,062, and Rs. 18,141 per hectare, respectively. The highest NPCI value (1.15) was observed in high-density apple plantations, followed by the traditional apples, saffron and walnut plantations. Consequently, producers encounter higher market-based input costs, potentially due to the limited subsidy coverage of various components and more expensive inputs.

Furthermore, the factor transfer has positive values for all crops, suggesting that market distortions affect domestic resource costs. High-density apples had the highest FT value of Rs. 2,28,055 per hectare, followed by almonds at Rs. 1,58,761 per hectare, and traditional apples at Rs. 93,805 per hectare. Conversely, saffron exhibited the lowest FT value (38,935 per hectare). A positive FT value signifies that farmers incur higher domestic factor prices than market prices. A significant factor contributing to this could be higher wages, as labor wages substantially exceed the government-fixed rate, thereby imposing additional financial burdens on producers and diminishing the overall efficiency of domestic resource utilization.

Table 17. Value of input transfer, nominal protection coefficient on input, and factor transfer for selected horticultural crops of Jammu & Kashmir, 2022-23

Crops	Input transfer (IT) (Rs./ha)	Nominal protection coefficient on input (NPCI)	Factor transfer (FT) (Rs./ha)
Traditional apple	-35,770	0.79	93,805
High-density apple	61,026	1.15	2,28,055
Almond	-36,300	0.56	1,58,761
Walnut	9,062	0.31	51,539
Saffron	18,141	0.56	38,935

Source: Authors' estimation.

5.3 Impact of Government policies on input-output

The PAM framework facilitates concurrent evaluation of the effects of government policy on both the input and output sectors. These effects are represented by the net transfer (NT), effective protection coefficient (EPC), profitability coefficient (PC), and subsidy ratio to producer (SRP). The net transfer (NT) quantifies the disparity between private and social profits. A negative NT value suggests that farmers receive substantially lower returns because of policy distortions. An EPC value of less than one indicates negative protection (or implicit taxation), whereas values exceeding one denote positive protection. The profitability coefficient compares private to social profits, where values below one indicate a reduction in financial returns due to policies, while values above one imply policy-induced profitability. The subsidy ratio to producer expresses the net policy transfer as a proportion of gross revenue, indicating whether producers are net beneficiaries or bear the cost of policy interventions.

The comprehensive effects of the government policy on both the input and output sectors of horticultural crops are presented in Table 18. In the context of traditional apple and almond cultivation, the findings reveal that these crops are adversely affected by current policy frameworks. Specifically, traditional apple cultivation exhibits a significant negative net transfer (NT) of Rs.8,44,467 per hectare, a protection coefficient (PC) of 0.55, and an effective protection coefficient (EPC) of 0.65. These metrics indicate that farmers earn considerably less under the prevailing market and policy conditions than they would in an undistorted market and that the system is characterized by negative protection. Despite the presence of subsidies and support mechanisms, the overall policy environment remains unfavorable for traditional apple growers because of elevated production costs, inadequate price support, and limited market access. A critical challenge for traditional apple producers is insufficient protection against imports, which has led to the availability of cpmpetitively priced apple imports, thereby exerting competitive pressure on local produce and resulting in diminished profits for domestic farmers.

Almond production encounters similar challenges, as evidenced by a negative NT of Rs. 2,83,038 per hectare, a PCR of 0.49, and an EPC of 0.85. These metrics indicate that almond farmers generally face disincentives because their profits are lower than those achievable under optimal market conditions. The negative SRP value of –0.30 further corroborates that producers are effectively subjected to taxation. Despite the Government of India's introduction of various schemes and initiatives aimed at revitalizing the almond industry in Jammu & Kashmir such as medium and high-density almond plantations, the establishment of almond-exclusive nurseries, the enhancement of irrigation infrastructure, and a comprehensive agricultural development plan—the practical implementation and adoption of these measures have been suboptimal. These initiatives have only reached a limited number of farmers, resulting in a decline in the cultivation of this economically significant crop.

Conversely, high-density apples, walnuts, and saffron benefit from policy support and market conditions. High-density apples demonstrated a positive NT of Rs. 9,48,868 per hectare, a PC of 1.28, and an EPC of 1.29, indicating that policy measures enhance both profitability and protection. An SRP of 0.22 further indicates that farmers receive subsidies, reducing their cost burden and enhancing profitability. These findings collectively highlight that high-density apple cultivation in Jammu and Kashmir is competitive and economically advantageous, supported by efficient resource use, favorable pricing, and supportive government interventions, despite the higher input costs due to market distortions and policies.

Walnut stands out with an exceptionally high EPC of 3.83 and PC of 9.49, suggesting a highly favorable policy environment that significantly increases its profitability. Despite these favorable findings, the walnut industry faces significant challenges. These include inadequate infrastructure such as logistics, mechanical harvesting, poor post-harvesting infrastructure, power supply, packing facilities, and marketing support. Although walnuts require minimal inputs, the large canopy and size of trees pose challenges in cultivation. Additionally, traditional harvesting practices, which involve climbing trees, present safety risks owing to tree size and slippery bark.

Similarly, saffron, known for its high economic value, also receives strong policy support, with an NT of Rs. 88,378 per hectare, PC of 2.65, and EPC of 1.42. These crops also report positive SRP values, meaning that they receive net subsidies or indirect policy support. Despite these positive outcomes, saffron cultivation in Jammu and Kashmir faces several challenges. Market fluctuations, climate change, and infrastructural limitations adversely affect saffron production. In addition, traditional farming methods, inadequate irrigation practices, pest and disease infestations, labor-intensive processes, and competition from adulterated products are major constraints in saffron cultivation.

Table 18. Net transfer, profitability coefficient, effective protection coefficient, and subsidy ratio to producer values for selected horticultural crops in Jammu & Kashmir, 2022-23

Crops	Effective protection coefficient (EPC)	Net transfer (NT) (Rs./ha)	Profitability coefficient (PC)	Subsidy ratio to producer (SRP)
Traditional apple	0.65	-8,44,467	0.55	0.37
High-density apple	1.29	9,48,868	1.28	0.22
Almond	0.85	-2,83,038	0.49	- 0.30
Walnut	3.83	5,12,156	9.49	2.41
Saffron	1.42	8,83,78	2.65	0.26

Source: Authors' estimation.

6

Conclusions

This study assesses the competitive and comparative advantages of major temperate fruit crops in Jammu and Kashmir, India, using the policy analysis matrix (PAM) framework. The horticultural sector in Jammu and Kashmir has undergone significant transformation, with substantial increases in the area and production of apples and walnuts. However, almond and saffron cultivation has declined. India's exports of these crops have decreased, whereas imports have surged.

PAM analysis provides valuable insights into the economic competitiveness and comparative advantages of various crops in the region. High-density apple plantations have emerged as clear frontrunners, offering farmers the most substantial competitive edge and income potential. This suggests that investing in modern intensive apple cultivation techniques can yield significant economic returns for agricultural stakeholders. Traditional apple plantations, although not as competitive as their high-density counterparts, still demonstrate a robust comparative advantage and generate considerable economic benefits, indicating their continued relevance in the agricultural landscape.

This analysis also sheds light on the performance of other crops. Almonds, while moderately competitive from an economic standpoint, offer notable social benefits that potentially contribute to community well-being and rural development. Walnuts display fair competitiveness but only a moderate comparative advantage, suggesting that it may be a viable option for diversification but perhaps not as lucrative as apples. Despite its reputation as a high-value crop, saffron ranks lowest in both competitive and comparative advantages among the studied crops. This unexpected finding underscores the importance of comprehensive economic analyses in agricultural decision making, as traditional assumptions about crop value may not always align with economic realities in specific contexts.

A multifaceted approach is recommended to enhance the comparative and competitive advantages of these crops. This includes the promotion of cluster-based fruit-specific agro-zones and regional branding, which can help to create distinct identities for different fruit-growing regions and potentially increase their market value. Investing in cold chain and post-harvest infrastructure is crucial for reducing losses and maintaining fruit quality from farms to markets. Strengthening farmer collectives can improve small-scale farmers' bargaining power and access to resources. Accelerating research and development in high-density plantation systems can lead to increased productivity and efficient land use.

Additionally, reforming the input ecosystem and crop insurance can provide farmers with better access to quality inputs and financial protection against crop failure. Enhancing skills through human resource development interventions and extension innovations can improve farming practices and disseminate knowledge. Scaling up quality certifications and adopting good agricultural practices can ensure higher standards and potentially access premium markets. Finally, establishing real-time market intelligence systems can help farmers and other stakeholders make informed decisions based on current market trends and demands.

Limitations of the study

Policy analysis matrix (PAM) is a widely used framework for evaluating comparative and competitive advantage and the influence of government policies on commodity systems. However, PAM is a static model that cannot capture the potential changes in prices and productivity. Therefore, the findings of this study are subject to changes in the market conditions. Further, PAM provides useful indicators of policy support or disadvantage, they do not reveal which specific policies are responsible for the observed outcomes. Furthermore, variations in farm-level practices, technology adoption, and market access conditions may also influence competitiveness, but these factors fall beyond the scope of the present framework.

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Appendix

Table A1. Private and social cost of cultivation, 2023-24 (Rs./ha)

Particulars	Financial cost	Economic cost	Difference	Percent Change
Traditional apple	4,86,145	4,28,110	58,035	11.93
High-density apple	13,42,756	10,53,675	2,89,081	21.53
Almond	5,01,140	3,78,679	1,22,461	24.44
Walnut	1,94,273	1,51,796	42,477	21.86
Saffron	3,12,245	2,91,451	20,794	6.66

Table A2. Contribution of tradable and domestic inputs among the private and social costs of cultivation of selected crops, 2023-24(%)

Crops	Financial cost		Economic cost	
	Tradable Input cost	Domestic factor cost	Tradable Input cost	Domestic factor cost
Traditional apple	27.00	73.00	40.45	59.55
High-density apple	34.51	65.49	38.19	61.81
Almond	9.22	90.78	21.79	78.21
Walnut	2.13	97.87	8.70	91.30
Saffron	7.37	92.63	13.71	86.29

Table A3. Private and social gross returns, 2023-24 (Rs./ha)

Particulars	Financial returns	Economic returns	Difference	Percent change
Traditional apple	15,06,012	22,92,444	-7,86,432	-52.22
High-density apple	56,30,240	43,92,290	12,37,950	21.99
Almond	7,70,891	19,51,990	-11,81,099	-153.21
Walnut	7,66,735	2,12,101	5,54,634	72.34
Saffron	4,54,031	3,44,859	1,09,172	24.05

Table A4. Private and social profits, 2023-24 (Rs./ha)

Particulars	Financial profit	Economic profit	Difference	Percent change
Traditional apple	10,19,866	18,64,333	-844467	-82.80
High-density apple	42,87,482	33,38,614	9,48,868	22.13
Almond	2,69,750	5,52788	-2,83,038	-104.9
Walnut	5,72,462	60,305	5,12,157	89.5
Saffron	1,41,786	53,408	88,378	62.3

Table A5. Shadow prices of inputs and outputs of traditional apple cultivation in J&K (Rs./ha)

Particulars	Financial cost		Economic cost	
	Tradable input cost	Domestic factor cost	Tradable input cost	Domestic factor cost
Fertilizer & vermicompost				
a. Urea	4,344	-	29,557	-
b. DAP	12,048	-	27,831	-
c. Potash	13,086	-	35,022	-
d. Boron	1,170	-	1,023	-
e. Calcium	840	-	241	-
f. Manure	-	15,405	-	-
Plant Protection Chemicals				15,405
a. Horticultural mineral oil	14,000	-	12,250	-
b. Insecticides/Acaricides				
i)Dimethoate	2,805	-	1,778	-
ii) Chlorpyriphos	4,290	-	3,272	-
iii) Fenazaquin	4,290	-	3,753	-
c. Fungicide				
i) Mancozeb	1,868	-	2,942	-
ii) Dodine	3,608	-	706	-
iii) Difenaconazole	2,516	-	587	-
iv) Zineb	3,296	-	2,614	-
v) Zineb + Hexaconazole	2,970	-	2,598	-
vi) Xemium + Difenaconazole	5,500	-	4,812	-
vii) Trifloxystrobin + Tubeconazole	6,710	-	5,871	-
viii) Floxapyroxad + Pyraclostrobin	5,808	-	5,082	-
ix) Ziram	2,090	-	2,209	-
d. Herbicide	2,000	-	2,066	-
Labour				
Pre Harvest	2,467	8,8912	1,397	-
Harvest & transport	28,099	8,584	16,999	5,034
Post-harvest	-	31,752	-	5,193
Packaging Material				
a. Wooden	-	46,080	-	46,080
b. Cardboard	-	66,570	-	66,570
Irrigation	-	215	-	215
Depreciation on machinery, building and implements	5,225	38,323	3,658	26,826
Land Lease	-	25,000	-	25,000
Other Costs	-	10,214	-	10,214
Capital costs	2,214	23,841	741	10,214
Total	1,31,248	3,54,897	1,67,018	2,45,853
Gross returns	15,06,012		22,92,444	

Table A6. Shadow prices of inputs and outputs of high-density apple cultivation in Jammu & Kashmir

Particulars	Financial cost		Economic cost	
	Tradable input cost (Rs./ha)	Domestic factor cost (Rs./ha)	Tradable input cost (Rs./ha)	Domestic factor cost (Rs./ha)
Fertilizer & vermicompost				
a. Urea	5,904	-	40,171	-
b. DAP	14,064	-	32,488	-
c. Potash	19,224	-	51,449	-
d. Boron	750	-	656	-
e. Calcium	720	-	206	-
f. yaramila	-	27,450	-	24,018
g. other chemicals	13,000	-	14,765	-
h. vermicompost	-	54,000	-	47,250
Plant Protection Chemicals				
a. Horticultural mineral oil	8,000	-	7,000	-
b. Insecticides/Acaricides				
i)Dimethoate (L)	3,825	-	2,425	-
ii) Chlorpyriphos (L)	5,850	-	4,461	-
iii) Fenazaquin (L)	5,850	-	5,118	-
c. Fungicide				
i) Mancozeb (kg)	255	-	401	-
ii) Dodine (kg)	4,920	-	963	-
iii) Difenaconazole (L)	3,432	-	801	-
iv) Zineb (kg)	450	-	356	-
v) Zineb + Hexaconazole (kg)	4,050	-	3,543	-
vi) Xemium + Difenaconazole (L)	7,500	-	6,562	-
vii) Trifloxystrobin + Tubeconazole (kg)	9,150	-	8,006	-
viii) Floxapyroxad + Pyraclostrobin (kg)	7,920	-	6,930	-
ix) Ziram (kg)	2,850	-	3,012	-
d. Herbicide (L)	10,000	-	10,334	-
Labour				
Pre Harvest	38,556	16,4373	19,045	81,192
Harvest & transport	38,881	11,614	34,470	10,296
Post-harvest	-	33,048	-	15,861
Packaging material				

Particulars	Financial cost		Economic cost	
	Tradable input cost (Rs./ha)	Domestic factor cost (Rs./ha)	Tradable input cost (Rs./ha)	Domestic factor cost (Rs./ha)
a. Wooden	-	41,580	-	41,580
b. Cardboard	-	1,79,200	-	1,79,200
Irrigation	-	6,000	-	6,000
Depreciation on machinery, building and implements	21,973	77,904	15,128	53,635
Land lease	-	25,000	-	25,000
other costs	-	38,437	-	38,437
Capital costs	23,6281	2,20,742	1,34,080	1,28,822
Total	4,63,407	8,79,349	4,02,381	6,51,294
Gross returns	56,30,240		43,92,290	

Table A7. Shadow prices of inputs and outputs of almond cultivation in Jammu & Kashmir

Particulars	Financial cost		Economic cost	
	Tradable inputs (Rs./ha)	Domestic factor (Rs./ha)	Tradable inputs (Rs./ha)	Domestic factor (Rs./ha)
Fertilizers				
a. Urea	3,096	-	21,068	-
b. DAP	6,264	-	14,469	-
c. MOP	10,386	-	27,794	-
d. Manure	-	14,820	-	14,820
Pesticide				
a. Chloropyriphos	848	-	1,983	-
b. Copper oxychloride	12,030	-	6,769	-
c. Mancozeb+Carbendazim	8,220	-	7,192	-
Pre-harvest	2,810	46,497	1,499	24,804
a. Human labour				
b. Machine labour				
Harvest	-	80,800	-	48,783
a. Human labour				
b. Machine labour				
Post-harvest	-	2,45,050	-	1,50,800
a. Human labour				
b. Machine labour				
Depreciation of tools	950	9,615	712	7,207
Land lease	-	25,000	-	25,000
Other costs	-	10,000	-	10,000
Capital costs	1,608	23,143	1,025	14,750
Total	46,214	4,54,926	82,514	2,96,164
Gross Returns	7,70,891		19,51,990	
Almond in shell	6,85,575		18,65,038	
Almond shelled	85,316		86,951	

Table A8. Shadow prices of inputs and outputs of Walnut production in J&K

Particulars	Financial Cost		Economic Cost	
	Tradable inputs (Rs./ha)	Domestic factor (Rs./ha)	Tradable inputs (Rs./ ha)	Domestic factor (Rs./ ha)
Fertilizers				
a. Urea	1,680	-	11,432	-
b. Manure	-	3,750	-	3,750
Pre-harvest	-	3,600	-	1,872
a. Human labour				
b. Machine labour				
Harvest and transportation	1,035	22,105	1,460	31,195
a. Human labour				
b. Machine labour				
Post-harvest	-	1,07,520	-	59,904
a. Human labour				
b. Machine labour				
Depreciation of tools	-	3,745	-	3,745
Land lease	-	25,000	-	25,000
Other costs	-	10,000	-	10,000
Capital costs	1,425	14,413	309	3,128
Total	4,140	1,90,133	13,202	1,38,594
Total returns	7,66,735		2,12,101	
Walnut in shell	6,97,815		1,93,838	
Walnut shelled	68,920		18,264	

Table A9. Shadow prices of inputs and outputs of Saffron production in J&K

Particulars	Financial Cost		Economic Cost	
	Tradable inputs (Rs./ ha)	Domestic factor (Rs./ha)	Tradable inputs (Rs./ ha)	Domestic factor (Rs./ ha)
Fertilizers				
a.Urea	1,920	-	13,065	-
b.DAP	6,240	-	14,414	-
c.Manure	-	15,000	-	15,000
d.Seed treatment (Mancozeb)	1,600	-	2,008	-
e.Rodenticide	105	-	516	-
Labour				
Pre-harvest	7,650	43,350	7,650	43,350
a. Human labour				
b. Machine labour				
Harvest	-	24,000	-	24,000
a. Human labour				
b. Machine labour				
Post-harvest	-	12,000	-	12,000
a. Human labour				
b. Machine labour				
Depreciation of tools	474	480	-	-
land lease	-	25,000	-	25,000
Other costs	-	10,000	-	10,000
Capital costs	5,011	1,55,091	4,364	1,35,077
Total cost	23,001	2,89,243	42,019	2,64,427
Total returns	4,54,031		3,44,859	
a. Stigma	2,74,000		1,64,400	
b. Stamens	340		768	
c. Petals	8,262		8262	
d. Daughter corms	1,71,429		1,71,429	

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