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MARKET ASSESSMENT OF AGRI SECTOR

GILGIT BALTISTAN & CHITRAL

Assessment of Strategic Gaps, Market Opportunities, Technology Pathways and Systemic Constraints

Title:
Unlocking Agricultural Potential in Gilgit-Baltistan and Chitral: Assessment of Strategic Gaps, Market Opportunities, Technology Pathways and Systemic Constraints

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Prepared by:
Praxsys Associates Pakistan
[www.praxsysassociates.com] | [info@PraxsysAssociates.org]

Study Team:
Principal Investigator: Noor Alam Khan
Research & Fieldwork: Zulfiqar Ali Ghazi and Hasnain Hyder

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Executive Summary

Gilgit-Baltistan and Chitral (GBC) possess a powerful agro-ecological advantage for high-value horticulture, yet systemic constraints across its agricultural market systems trap farmers in a cycle of subsistence. This report identifies five strategic gaps and proposes targeted investments in "system anchor" ventures to catalyze a transformation towards an inclusive, resilient, and high-value agricultural economy.

Context

Agriculture is the bedrock of the rural economy in Gilgit-Baltistan and Chitral (GBC), with around 90% of households reliant on it for livelihoods. Despite this, the sector operates far below its potential, trapped in a cycle of subsistence and traditional farming and low-value production. GBC possesses a powerful agro-ecological advantage: its high-altitude, temperate climate is ideal for producing premium fruits (cherries, apricots, apples), nuts (walnuts, almonds), and off-season vegetables that are in high demand domestically and internationally. The region's minimal chemical use also provides a strong foundation for an "organic" and "natural" brand identity.

However, systemic failures across the market system prevent farmers and agribusinesses from capitalizing on these advantages. Accelerate Prosperity (AP) is uniquely positioned to catalyze a transformation by investing in startups and Small and Growing Businesses (SGBs) that can address these systemic gaps, driving the region towards a more inclusive, resilient, and high-value agricultural economy.

Study Objectives

The primary objective of this study was to systematically map the agricultural value chains in GBC, assess market demand and potential, diagnose underlying systemic constraints, and pinpoint specific leverage points where targeted investment and technical assistance (TA) from AP could yield the greatest sustainable impact. The findings are intended to inform AP's three core operational areas:

- Venture Investment: Identifying and financing investable enterprises that address system-wide bottlenecks.
- Technical Assistance (TA): Designing programs that build capacity and foster market coordination among actors.
- Ecosystem Facilitation: Engaging with government, financial institutions, and other non-market actors to improve the enabling environment.

Methodology

A mixed-methods scoping approach was employed, combining a literature review, secondary data analysis, and primary fieldwork, including 75 key informant

interviews and surveys across Gilgit, Baltistan, Chitral, and downstream markets. The market systems development framework was used as an analytical framework. This approach moves beyond analyzing individual firms to diagnosing the root causes of market failure (rules, norms, and supporting functions) that affect entire categories of actors.

- Value chain mapping, extensive primary data collection (Key Informant Interviews with farmers, traders, and government officials), and secondary data review.
- S**ystemic Analysis and triangulation:** Data was analyzed to understand functional relationships within the market, identify critical missing functions, and determine where current incentives are skewed against smallholder participation. The data was triangulated using multiple soruces of data.
- **Synthesis:** Findings were validated through regional workshops and synthesized to propose actionable, non-project-based interventions that target the structural causes of poor performance.

The Five Strategic Gaps

Our analysis identifies five interconnected strategic gaps that collectively undermine GBC's agricultural competitiveness:

- **The Productivity Gap:** Yields for major crops are 10-40% below achievable benchmarks due to traditional practices, limited access to quality inputs (seeds, plants), and low adoption of modern technologies.
- **The Post-Harvest Loss (PHL) Gap:** An estimated 25-35% of perishable produce is lost due to poor handling, a lack of cold storage, and inefficient transport, eroding potential farmer income.
- **The Quality and Market Mismatch Gap:** Farmers grow dozens of unimproved local varieties that do not meet the size, uniformity, or shelf-life standards of premium national and export markets. Less than 20% of produce often qualifies as Grade A.
- **The Resource Allocation Gap:** Over 60% of cultivable land is allocated to low-value subsistence cereals (wheat, maize), despite the potential for 6-10x higher income per hectare from high-value horticulture.
- **The Marketing and Value Capture Gaps:** The marketing system is volume-oriented and spot market trader-dominated. Farmers are price-takers, capturing only 20-30% of the final retail value, with minimal value addition, branding, or direct market linkages.

The Opportunity: Demand Driven Transformation

Significant and growing market opportunities exist for GBC's produce across multiple market segments:

- **National Markets:** Urban centers and modern retail in Pakistan show strong demand for quality, safe, and traceable food. GBC's off-season production window allows it to supply fresh potatoes, peas, cherries, and apples when supplies from other regions are low, commanding premium prices.
- **Regional & Tourist Markets:** The booming tourism and local HoReCa (Hotels, Restaurants, Cafés) sector represents a major, under-tapped opportunity. Currently, up to 76% of vegetables and 88% of meat consumed in GB hotels are imported from outside GBC, highlighting a massive leakage and a clear target for import substitution.
- **Export Markets:** Latent potential exists for cherries (to China), dried apricots, walnuts, and medicinal plants. Success requires overcoming challenges in quality, certification, and volume consistency.

Value Chain Prioritization: The study maps value chains based on Growth Potential, Readiness to Scale, and Social Impact. The highest-priority value chains for immediate investment are:

- Accelerate & Leverage (High Potential, High Readiness): Apricots, Cherries, Apples, Walnuts. These chains have established markets, private-sector engagement, and clear potential for rapid scaling and value addition.
- Develop for the Future (High Potential, Low Readiness): Grapes, Peaches, Pomegranates, Vegetable Seeds. These require medium-term investment in input systems, infrastructure, and market linkages to unlock their potential.

The Technology Imperative: Leapfrogging with Ag-Tech

Technology adoption is no longer optional; it is essential to overcome GBC's constraints of land scarcity, labour shortages, and climate volatility. Globally, agri-tech is delivering dramatic gains in productivity, efficiency, and resilience. For GBC, the most relevant and feasible technologies include:

- Climate-Resilient Structures: Passive solar greenhouses and high tunnels to extend growing seasons by 4-5 months and enable off-season production.
- Precision & Digital Tools: IoT sensors for irrigation, AI-based pest diagnostics, and SMS-based frost alerts to optimize resource use and mitigate risks.
- Labor-Saving Mechanization: Small-scale, modular equipment (e.g., battery-powered pruners, micro-tractors) to address the acute labour shortage.
- Post-Harvest Solutions: Solar dehydrators and low-cost cold storage (e.g., CoolBot rooms) to drastically reduce losses and stabilize supply.

The key is to bundle these technologies with financing, training, and market access to ensure adoption and commercial viability.

Market System Dysfunctions: A Deeper Look

The core constraints are rooted in dysfunctional market systems:

- **Input Markets are "Thin and Shallow":** There is a severe shortage of quality input suppliers, especially for improved seeds, fruit plants, and farm machinery. Input dealers act as passive shopkeepers, not service providers, offering generic products with no embedded advisory.
- **Output Markets are a Mixed Basket:**
  - Apricot, Cherry, Apple markets are "Thick but Shallow": While many actors are involved, transactions are low-value and lack quality-based differentiation.
  - Markets for other fruits (pears, grapes) are **"Thin and Shallow"**: They suffer from fragmented production, high transaction costs, and a lack of aggregators, preventing them from connecting to national demand.
- **Supporting Functions are Broken:** Critical services are missing or weak, including:
  - Finance: A near-total absence of agricultural credit for farmers and agri-SMEs.
  - Market Information: Opaque price signals and poor buyer-farmer linkages.
  - Extension & Skills: Outdated public extension and a lack of skilled labor for modern agribusiness.

Strategic Recommendations and Investment Priorities for AP

For AP to achieve a transformative impact, its strategy must move beyond supporting individual firms to actively shaping the market system. Investments should be targeted at "system anchors" ventures that solve multiple constraints and create positive spillovers.

Priority Areas for Investment & Programming:

- **Demand-Aligned Varietal Upgrading:** Support SGBs that introduce and multiply high-yielding, market-preferred varieties of fruits and vegetables through modern nurseries and grafting services.
- **Input Bundling and Rural Distribution:** Invest in ventures that bundle quality seeds, fertilizers, and bio-inputs with embedded advisory and flexible credit, reaching farmers directly.
- Labour-Saving and Post-Harvest Solutions: Finance SGBs offering mechanization-as-a-service and affordable post-harvest technologies (cold storage, solar dryers) to reduce losses and costs.
- **Aggregation Platforms and Buyer Linkages:** Back tech-enabled aggregators, cooperatives, and marketing platforms that can consolidate smallholder produce, ensure quality, and build direct contracts with premium buyers, exporters, and the HoReCa sector.
- **Embedded Finance and Input Credit Models:** Partner with financial institutions to pilot innovative financing models (e.g., input credit, invoice discounting, lease-to-own) tailored to

the needs of farmers and agri-SMEs.

- Youth and Women-Centered Innovation: Actively seek and support youth-led and women-led SGBs in agri-tech, digital marketplaces, and value-added processing, unlocking underutilized talent and perspectives.

Priority Areas for Investment & Programming:

- Track 1: Smart Production & Climate Resilience: Solutions for modern nurseries, protected farming (greenhouses), and land-saving technologies.
- Track 2: Value Addition & Market Access: Ventures focused on branding, premium packaging, organic certification, and digital marketplaces for authentic GBC products.
- Track 3: Tech-Enabled Services for Smallholders: ICT-based advisory platforms and bundled service models that combine information, inputs, and finance.

Conclusion

The potential for a prosperous, high-value agricultural sector in GBC is undeniable. The region's natural advantages and growing market demand create a compelling business case. The primary barrier is not a lack of opportunity, however, a dysfunctional system that inhibits innovation and investment.

AP's unique role is to be a systemic change facilitator. By deploying catalytic capital, targeted technical assistance, and strategic facilitation, AP can unlock this potential. The goal shall be to catalyze a virtuous cycle where investments in pioneering SGBs crowd in other actors, shift market norms, and ultimately create a self-sustaining ecosystem where farmers, entrepreneurs, and the environment all thrive. The time for strategic, system-smart investment in GBC's agricultural future is now.

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List of Abbreviations

AKDN	AKDN Aga Khan Development Network
AKRSP	Aga Khan Rural Support Programme
AP	Accelerate Prosperity
B2B	Business-to-Business
BDS	Business Development Services
CAGR	Compound Annual Growth Rate
CEA	Controlled Environment Agriculture
CPEC	China-Pakistan Economic Corridor
D2C	Direct-to Consumer
DAP	DAP Data Analysis Plan
ETI	Economic Transformation Initiative
F&V	Fruits and Vegetables
GAP	Good Agricultural Practices
GB	Gilgit-Baltistan
GBC	Gilgit-Baltistan and Chitral
GDP	GDP Gross Domestic Product
GSM	Global System for Mobile Communications
HACCP	Hazard Analysis and Critical Control Points
HKH	Hindu Kush Himalaya
HORECA	HORECA Hotel, Restaurant, and Catering
HORECA	Hotels, Restaurants, and Cafés
ICIMOD	International Centre for Integrated Mountain Development
ICT	Information and Communication Technology
IFAD	International Fund for Agricultural Development
ILO	International Labour Organization
IoT	Internet of Things
KIIs	KIIs Key Informant Interviews
KPK	Khyber Pakhtunkhwa
MFI	Microfinance Institution
MSD	Market Systems Development
PATTA	Pakistan Agricultural Technology Transfer Activity
PHL	Post-Harvest Losses
PKR	Pakistani Rupee
ROI	Return on Investment
SGBs	SGBs Small and Growing Businesses
SMEs	Small and Medium sized Enterprise
SPS	Sanitary and Phytosanitary Measures
SWOT	SWOT Strengths, Weaknesses, Opportunities and Threats
TA	Technical Assistance
TAM	TAM Addressable Market
TVET	Technical and Vocational Education and Training
VC	Venture Capital
WUE	Water Use Efficiency
WWF	WWF World Wildlife Fund
ZTBL	Zarai Taraqiati Bank Limited

1. Introduction and Background

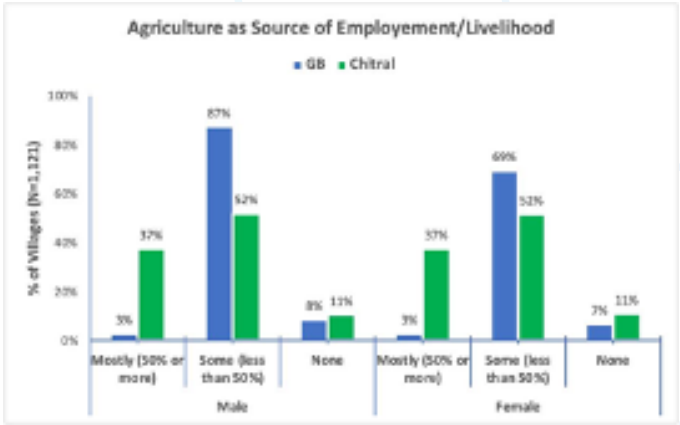
Agriculture is one of the key sources of livelihood for 90% of the population in Gilgit-Baltistan and Chitral, yet its potential remains locked. This report uncovers the gaps, opportunities and systemic failures trapping farmers in subsistence and identifies the strategic investments needed to unlock transformative, high-value growth.

Introduction

Agriculture contributes 24% to Pakistan's GDP and employs 37.4% of the workforce. In Gilgit-Baltistan and Chitral (GBC), around 90% of households rely on agriculture, compared to 51% nationally, underscoring its importance for local livelihoods, food security, and economic growth. While reliance on agriculture for income has declined over time, with non-farm income rising from 43% in 1994 to over 70% (Shahzad et al., 2021), agriculture remains a cornerstone of the regional economy, contributing to food security and on-farm and off-farm employment, and income generation for smallholder farmers and women.

Farming systems in the region are largely traditional, encompassing field crops, horticulture, livestock, dairy, fisheries, and forestry. Farmers have gradually shifted from subsistence to semi-subsistence over the past three decades, with emerging pockets of small-scale commercial production. High-value horticulture has emerged as the most dynamic sub-sector, producing a wide variety of fruits and vegetables for both local and domestic markets. Seasonal and ecological advantages, combined with gradual improvement in road connectivity and targeted agricultural development programs, have contributed to this transition. These changes have reinforced commercialisation trajectory, making agriculture a leading contributor to agricultural output and household income.

Figure 1-1: Agriculture as a Source Livelihood



Despite these positve developments, agriculture sector's development potential remains underutilized. The sector has significant untapped development potential which if unlocked can drive inclusive economic growth and improve food security in the region.

Gaps in critical core market functions such as aggregation, processing and marking and support functions such as finance business development and technical support services have constrained the growth of the sector.

Accelerate Prosperity (AP) is strategically investing in startups and small and growing businesses (SGBs) to unlock growth and foster inclusive economic development in the agriculture sector. To ensure these investments are systemically targeted, AP seeks to identify critical market gaps and constraints that, if addressed, can drive transformative change.

In this context, AP commissioned Praxsys Associates to conduct a market study assessing the growth potential of key cash crops in GBC. The study focuses on focusses on assessing and exploring market opportunities in crop sector, identifying strategic gaps and systemic constraints, identifying opportunities, and outlining recommendations to inform AP's interventions for catalyzing transformative change in agriculture sector.

1.1. Purpose and Objectives of the Study

The purpose of the assessment is to identify growth potential, prospects, strategic gaps, and opportunities in GBC's agricultural sector, as well as barriers and challenges, to inform strategic interventions, sustainable investment, and business opportunities. Specific objectives include;

- Assess the agricultural landscape of GBC and identify cash crops grown in the region to explore their potential for agriculture-driven economic growth.
- Assess and prioritise cash crops based on demand and market potential, investment potential, and potential to create positive social impact.
- Assess the potential and prospects for (smart) farming technologies to address current and future production challenges and unlock growth opportunities.
- Assess systemic constraints and provide strategic recommendations to realise potential, investment, and business opportunities across the agricultural markets to unlock growth.

The findings from this study are intended to inform:

- Donor and government programs in market systems strengthening and innovation support
- Programmatic design for inclusive agri-enterprise development in GBC
- Startup accelerators and BDS providers seeking to engage in agriculture
- Agribusinesses, entrepreneurs and investors that aim to invest in agriculture in GBC

1.2. Methodology

The study employed exploratory mixed-method design. A visual representation of the methodology is visually presented in Figure 1-1.

1.2.1. Analytical Framework

The study adopts a Market Systems lens as diagnostic framework to understand the underlying constraints and opportunities in GBC's agriculture sector. This allows for a holistic analysis of how actors, support functions, and rules interact to shape outcomes for farmers, agri-enterprises, and the broader system. Instead of focusing solely individual market actors, the approach emphasises identifying underlying causes, systemic constraints, and leverage points to unlock scalable, sustainable change.

1.2.2. Data Collection Methods and Tools

A combination of qualitative and quantitative tools was used, including:

a. Desk Review

The literature review combined academic and grey sources, published statistics, and datasets. Searches were conducted in Google Scholar, Scopus, government websites, and NGO repositories, supplemented by direct contact with institutions to obtain additional publications. Production and trade statistics, descriptive reports, and sector analyses were extracted and reviewed. The retrieved data were systematically summarized and mapped, with data gaps clearly identified. A preliminary Data Analysis Plan (DAP) was then developed to determine what additional evidence was needed to meet the study objectives.

b. Primary Data Collection

Based on the preliminary DAP, primary data sources and collection techniques were identified. Methods included surveys of local retail markets and semi-structured interviews with key informants, such as major market actors and stakeholders. This approach allowed

to ensure adequate coverage sub-sectors and geographic area and representation of diverse value chain actors and stakeholders. Table 1-1 summarizes the sampling approach, sample size, sample distribution, and data collection tools used.

1.2.3. Data Analysis and Synthesis

The data was systematically evaluated, integrated, and analyzed using a mixed-methods approach. The process involved cleaning and validating the data, organizing it into analytical templates, and generating evidence-based insights. These insights covered strategic gaps and opportunities, estimated losses and potential gains, market size and consumer preferences, and key trends across critical stages of the value chain.

A diagnostic assessment was also conducted, incorporating market system constraints and causal analysis to identify underlying challenges and structural bottlenecks. Source triangulation was applied throughout the process to enhance the reliability and robustness of the findings.

1.2.4. Ethical Considerations

Ethical considerations were adhered to in accordance with AKDN's safeguarding policies, including obtaining informed verbal consent, ensuring voluntary participation, and implementing measures to maintain privacy, confidentiality, cultural sensitivity, and participant well-being throughout data collection.

1.2.5. Study Limitations

Although the study applies a rigorous methodological approach, it remains subject to several inherent limitations. we note the following limitation to the study.

- First, the findings rely primarily on secondary data and a rapid diagnostic, and therefore do not constitute a full feasibility assessment or investment due diligence.
- Second, the quantitative estimates, such as market size, potential value additions, and loss-reduction projections, are indicative and based largely on secondary sources; they should be validated through future implementation or more detailed analysis.
- Third, the study's coverage is selective and opportunity-driven, meaning that certain relevant areas, actors, or value chains may not have been captured.
- Finally, the analysis is susceptible to perception bias due to its reliance on stakeholder-reported information rather than direct measurement or independent verification.

Figure 1-1: Study Process Diagram

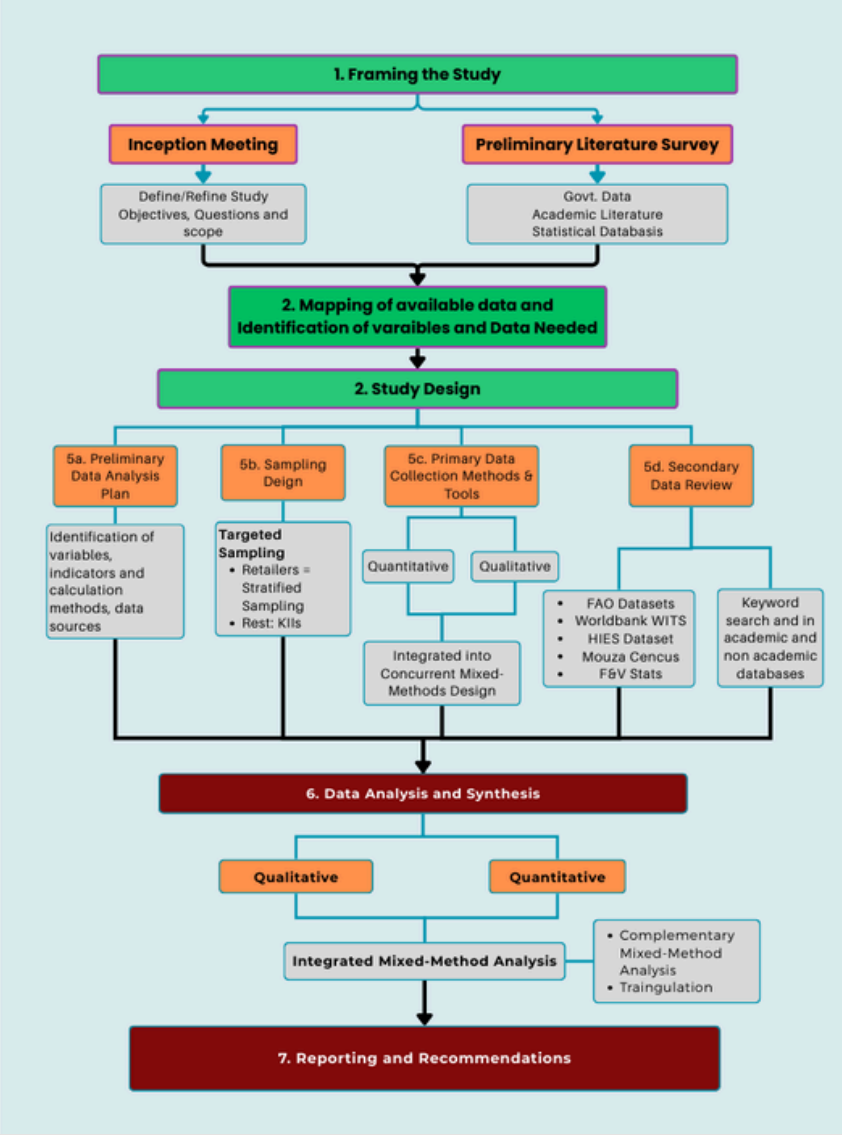


Table 1-1: Distribution of Surveys and Key Informant Interviews

Data Sources	Respondents Category	Method	SS	Distribution of Sample Across Regions*			
				GILGIT	BALTISTAN	CHITRAL	DOWN COUNTRY
Inputs Supply	Inputs stores	KII	3	1	1	1	0
Primary Production	Lead Farmers	KII	5	1	1	3	
	Cooperatives/ Lead Farmers	KII	5	4	1	0	0
Trading	Fresh Produce Market Traders	KII	9	4	1	2	2
	Dry Fuit Traders	KII	5	2	2	1	0
Retail	F&V Retailer	Survey	15	5	5	5	0
	Dry Fruit Retailer	Survey	18	4	5	5	4
	Super Markets	KII	2	0	-	-	2
	Online Retailers	Survey	3	1	-	-	2
Processing	Processors	KII	1	1	0	0	0
Exporting	Exporters	KII	3	1	1	0	1
Policy and Support Services	Agricultural Departments	KII	4	2	1	1	0
	NGOs	KII	2	1	0	1	0
			75	27	18	19	11

*The sample has been divided among three sub-regions, purposively focusing on key producer areas within these regions.

2. Sector Overview & Strategic Challenges

Farmers in GBC face a significant opportunity cost: over 60% of its scarce cultivable land is allocated to low-value subsistence cereals, despite the potential for 3-5x higher income from high-value horticulture crops for which the region has a natural competitive advantage.

Agriculture in GBC is predominantly smallholder-based, with farms averaging 0.5–3 hectares, often fragmented due to mountainous terrain and partible inheritance. Production is mixed and subsistence-oriented: cereals and fodder are grown mainly for household consumption, livestock, while fruits and nuts contribute to both food security and cash income. Livestock remains integral, contributing food, fertilizer, and social capital. Women play a major role in production and post-harvest handling however, they have a limited role in agricultural decision making and lack access to finance and other services.

The farming system is shaped by traditional practices adapted to geography, socio-cultural norms, and historical market isolation. These characteristics exhibit a pattern of risk-aversion, prioritizing resilience over productivity. These patterns of behavior have significant implications for agriculture sector investments and programming.

2.1. Role of Agriculture in the Local Economy

Agriculture remains a foundational sector for rural livelihoods in GBC, contributing significantly to food security, seasonal employment, and household income. While income diversification is growing, particularly through remittances and tourism, agriculture still anchors the rural economy. Most households rely on smallholder plots (average <2 hectares) with a mix of subsistence and market-oriented production. Women play a critical role in crop processing and post-harvest handling.

2.2. Ecological Advantages of the Region

The GBC region is characterized by a mountainous topography ranging from 1,000 to over 7,000 meters above sea level. This altitudinal variation, coupled with glaciation and diverse microclimates, creates unique agro-ecological zones that shape cropping patterns, water availability, and ecosystem dynamics (Khan et al., 2020). The climate spans from mild to cold and from arid to semi-arid, resulting in a mosaic of production systems across valleys.

The region is broadly divided into four vertical agro-climatic zones, each with distinct crop production patterns and systems, as shown in Error! Reference source not found.. Potatoes and peas are produced in summer months in high

altitude single-cropping zones, while wheat and fruits are more common in both single and double-cropping zones.

Table 2-1: Cropping Zones of GBC

Zone	Altitude (m)	Areas in GB Region	Areas in Chitral Region	Dominant Crops
Double Crop Zone	1200–1600	Chilas, Jaglot, Gilgit	Drosh, Ayun, Chitral town, Koh UC, Reshun	Wheat/Barley – Maize/Mung Bean, Vegetables, Clover
Marginal Double Crop Zone-A	1600–2000	Ghanche, Skardu	Booni, Lotkuh, Mastuj, Mulkhow, Torkhow	Wheat, Maize, Barley, Vegetables, Clover, Millet
Marginal Double Crop Zone-B	2000–2400	Karimabad, Yasin, Kharmang, Khaplu	—	Wheat, Millet, Barley, Turnip, Vegetables
Upper Single Crop Zone	2400–3000	Darkut, Phandar, Naltar, Gultari	Lotkuh, Mastuj, Mulkhow, Torkhow	Wheat, Maize, Potato, Barley

GBC's agro-climatic conditions provide a comparative advantage in growing temperate fruit crops not widely cultivated in other parts of Pakistan. The high-altitude terrain, relatively pest-free environment, and diverse microclimates support the production of apples, cherries, apricots, and walnuts with unique flavour profiles.

Seasonal differences also allow GBC to supply early or late-season produce to national markets, potentially commanding price premiums. The region also offers organic potential due to low agrochemical usage, although certification and verification systems are largely absent.

2.3. Key Sub-Sectors and Value Chains

The agriculture sector in GBC spans a range of sub-sectors supported by diverse agro-ecological conditions. The sector consists of several sub-sectors, including crop production, aquaculture (trout), apiculture, and small livestock, which offer niche opportunities and contribute to household income and food security.

While all sub-sectors are significant, crop production forms the backbone of the region's agrarian economy and is the primary focus of this study. The crop sector is highly diverse, encompassing cereals, perennial fruits, vegetables, pulses, and nuts, each playing a distinct role in livelihoods, commercial activity, and food systems. Cereals remain central to household food security; fruits and nuts provide cash income; and vegetables contribute to both household income and food and nutrition security. The scale and distribution of cultivated area and production volumes across these categories are summarized in Table 2-2.

2.3.1. Overview of Crop Sector

a. Cereals

Cereals dominate the crop sector in the region, with wheat, maize, and barley being the principal crops. They are cultivated on approximately 59,000 hectares, producing around 130,000 metric tons annually. Cereals are primarily grown for subsistence consumption, with only a small proportion of total output marketed. For example, only 3% of wheat produced is locally exchanged or marketed, and 40% of maize is marketed locally.

In terms of geographical spread, wheat is the most widely grown crop, cultivated in 94% of villages in Chitral and 90% in Gilgit-Baltistan (GB). Maize follows, with broader cultivation in Chitral (84% of villages) than in Gilgit-Baltistan (56%) which reflects regional preferences for crops (PBS, 2020). Barley in a limited area. It remains an important complementary crop in higher-altitude zones grown mainly as animal fodder.

b. Fruits

Fruits are cultivated on approximately 25,600 hectares, with an annual production of nearly 175,000 metric tons. Historically, fruit production was for subsistence consumption only. Over time, however, fruit production has gradually transitioned to semi-subsistence and commercial production, with surplus produce gaining steady market access.

Among fruit crops, apricots, apples, cherries, grapes,

Table 2-2: GBC Crop Production Summary in Metric Tons[1]

Crops/Commodities	Area (ha)			Production (MT)		
	Chitral	GB	GBC Total	Chitrall	GB	GBC Total
Cereals	17,406	41,637	59,043	35,338	94,962	**130,300**
Wheat	8,350.00	19,110	27,460	16,120	43089	**59,209**
Maize	5,500.00	17,660	23,160	11,880	43403	**55,283**
Rice	1,831.00	20	1,851	4,578	500	**5,078**
Barley	1,725.00	4,262	5,987	2,760	6,819	**9,579**
Buckwheat	-	585	585	-	1,151	**1,151**
Fruits	3,660	21,951	25,611	22,990	151,707	**174,697**
Apricot	1,200.00	12,750	13,950	7,200	89,250	**96,450**
Apples	1,000.00	4,242	5,242	5,000	25,452	**30,452**
Cherries	170	820	990	1,020	6,560	**7,580**
Grapes	400	1,145	1,545	3,200	8,393	**11,593**
Pomegranates	250	707	957	2,100	4,525	**6,625**
Peaches	150	529	679	930	3,259	**4,189**
Pear	190	434	624	1,140	2,604	**3,744**
Mulberries	300	1,324	1,624	2,400	11,664	**14,064**
Nuts	350	2,589	2,939.00	3,150	19,222	**22,372**
Walnut	250	1,429	1,679	2,450	11,861	**14,311**
Almond	100	1,160	1,260	200	2,361	**2,561**
Apricot nuts		-	-	500	5,000	**5,500**
Vegetables	2,410	10,987	13,397	52,504	152,995	**205,499**
Potato	1,441.00	9,116	10,557	43,023	128,073	**171,096**
Tomato	389	760	1,149	3,594	15,960	**19,554**
Onions	370	548	918	4,561	5,381	**9,942**
Peas	206	551	757	1,285	3,437	**4,722**
Cucumber	4	12	16	40	144	**184**
Grand Total	**23,826**	**77,164**	**100,990**	**113,981**	**418,886**	**532,867**

Source: various sources including (Hussain, 2022 #1), AKRSP 2013. Apple Value Chain Study and Action Plan for Gilgit-Baltistan and Chitral. Aga Khan Rural Support Programme., KP Crop Statistics, MOPDSI 2020. Almond Cluster Feasibility and Transformation Study. Planning Comission, Ministry of Planning, Development and Special Initiatives.,

and pomegranates are particularly significant for income generation, as more than half of their total output is marketed. Apricots stand out, with 54,998 tons dried and sold, representing 41% of total production (and up to 60% in GB). Apples follow closely, with 18,258 tons marketed, equivalent to 57% of total output. Other fruits, including grapes (6,353 tons), pomegranates (3,740 tons), and cherries (4,952 tons), also exhibit strong commercial trends, with around 58–59% of their production sold.

According to the Mouza agricultural census 2020, only 40% of villages report fruit production or fruit orchards. Fruit production is concentrated in the double and marginal double cropping zones, where agroclimatic conditions are particularly favorable for apples, apricots, cherries, grapes, and mulberries.

c. Nuts

Nuts are cultivated on approximately 2,900 hectares, producing over 22,000 metric tons annually. This crop category is among the most commercially integrated in GBC, with 86–98% of total production marketed, reflecting its strong market orientation.

Within nuts category, walnuts dominate both in area and volume, accounting for 14,008 tons marketed, representing nearly 98% of total production sold. Apricot

kernels and almonds follow, with 5,044 tons and 2,347 tons marketed, respectively, both maintaining marketing ratios above 85%. Strong marketability, strong domestic and export demand, shelf stability and premium price potential make nuts a strategic commodity group for agribusiness expansion and value chain investment across the region.

d. Vegetables

Vegetable cultivation is widespread across the region, occurring in approximately 67 percent of villages (PBS, 2020). Production, however, is highly skewed towards potatoes, which account for more than 80 percent of total vegetable output. Potatoes and peas are primarily produced for sale, whereas most other vegetables are grown mainly for seasonal household consumption.

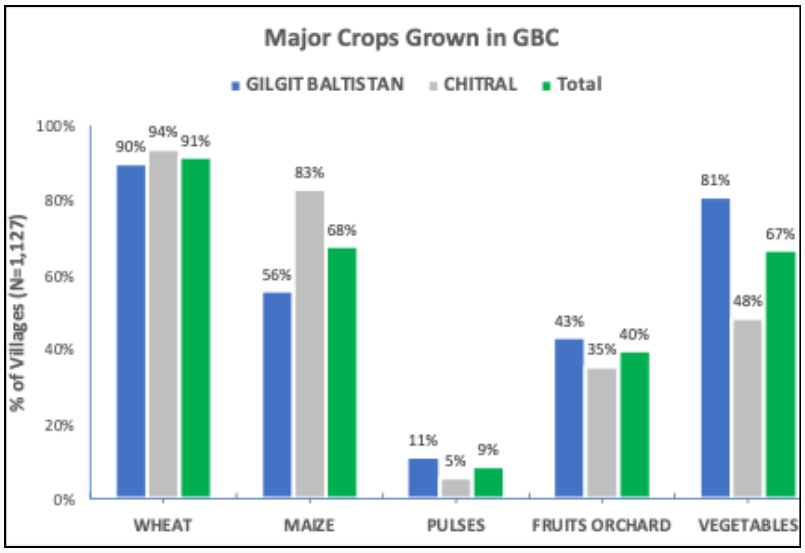
For example, onions are typically cultivated on small plots ranging from 0.5 to 2 kanals (ZTBL, 2023), reflecting their limited scale and subsistence-oriented purpose.

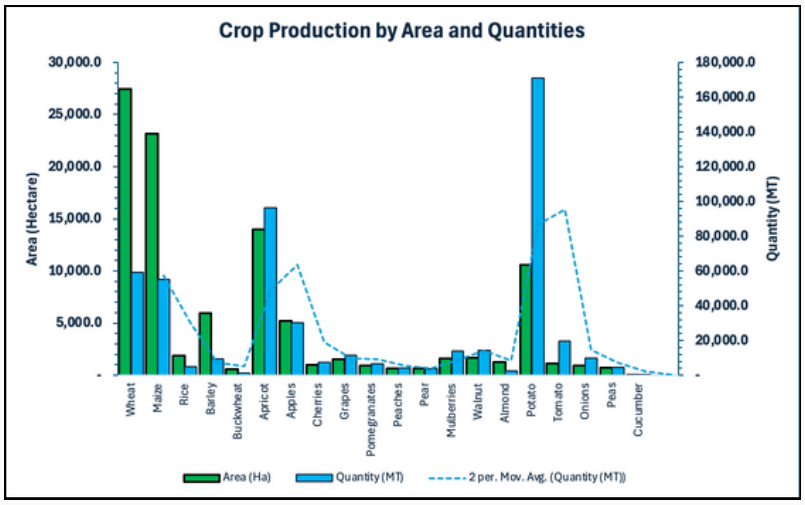
The region produces an estimated 171,000 metric tons of potatoes annually, of which about 89 percent enters the market, predominantly destined for down-country trade. Onions, peas, and tomatoes also exhibit moderate to high commercialization rates (54–84%), though their absolute production volumes remain comparatively small.

An emerging niche is off-season greenhouse cultivation of vegetables, especially near urban centers, supplying both regional towns and down-country markets. For example, greenhouse-grown tomatoes are produced in limited scale targeting local market which can be expanded to national market targeting autumn window, when prices rise due to supply shortages in the country during this window.

Overall, the crop sector in the region is highly diversified, with farmers cultivating a broad mix of cereals, vegetables, fruits, and nuts for both subsistence and commercial purposes. The production pattern indicates that fruits, vegetables, and nuts exhibit higher levels of commercialization compared to cereals, and that production shares of crops types vary significantly within each category. There is also substantial varietal diversity within individual crops, further contributing to the sector's heterogeneous structure.

Given this diversity, crop-sector upgrading should prioritize subsectors that align most closely with market demand, local agro-ecological conditions, and evolving demographic dynamics. Such efforts should aim to foster complementary efficiencies across crops while preserving the ecological and commercial benefits associated with a diversified production system.





2.4. Crop Marketing System

Crop marketing systems across GBC remain largely informal. GBC crops are often destined to three major markets including;

- Domestic markets in down-country urban centers,
- Regional markets within GBC, and
- Export market.

The domestic market absorbs most of the marketed produce while local and export market have a limited share of absorption of GBC's produce.

Market access to the the domestic markets are primary mediated through traditional trading chains dominated by aggregators/trader that have evolved to manage logistical challenges and market risks. Farmers play minimal or no role in activities beyond farm gate. The supply to local market is often directly done by farmers to retailers as the volumes are small and limited buyers and sellers operate.

This system patronize the central role of informal actors and the prevalence of early-season or farm-gate contracts, which ensure off-take. The market system is sligthly different for fresh produce and dry fruits and nuts.

a. Fresh Produce Marketing

As shown in Figure 2-4 (f), most fresh produce is sold at the farm gate or in local markets. Only a few organized groups, mainly in apple and pear value chains, supply directly to down-country wholesale markets. There is a limited market for local produce concentrated in local towns/ cities such as Gilgit, Skardu, and Chitral.

High-volume crops such as potatoes, peas, apples, and cherries are predominantly sold to contractors and brokers at farm gate, who provide advance payments and manage logistics to wholesale markets in Rawalpindi, Lahore, and Gujranwala. Although this arrangement offers farmers immediate cash and reliable off-take, it also reduces their agency, as prices are determined by intermediaries.

b. Dry Fruits and Nuts Marketing

Dry fruits and nuts, including dried apricots, mulberries, walnuts, almonds, and apricot kernels, are mostly processed on farm and sold in raw or semi-processed form to local traders and hawk walnuts, almonds, and apricot kernels, are mostly processed on farm and sold in raw or semi-processed form to local traders and hawk aggregators. About 90% of production is traded at the farm gate, with minimal grading, packaging, or branding. Less than 10% is handled by local formal agribusinesses that reprocess and package for down-country retail or online sales, while exports remain negligible (<1%) due to quality and certification constraints.

A few processors, such as Mountain Fruits (Gilgit), Shazdy Fruits (Skardu), and North Naturals (Chitral), work with smallholders but operate at a limited scale. Cooperative-led village auctions in parts of GB have improved price transparency and farmers' bargaining power. However, their role in collective marketing or marketing on behalf of farmers is limited.

2.5. Trends and Issues

2.5.1. Primary Production Trends

Primary and secondary evidence show a gradual shift away from subsistence cereals toward higher-value horticultural crops. Production of cherries, apples, tomatoes, cucumbers, and peas continues to expand, with cherries increasingly regarded as the premier cash crop.

Despite this momentum, production of grapes, pomegranates, and pears has stagnated, even though Pakistan imports these fruits in large volumes at high prices. The absence of functional inter-reginal value chains for these crops appears to be a major constraint.

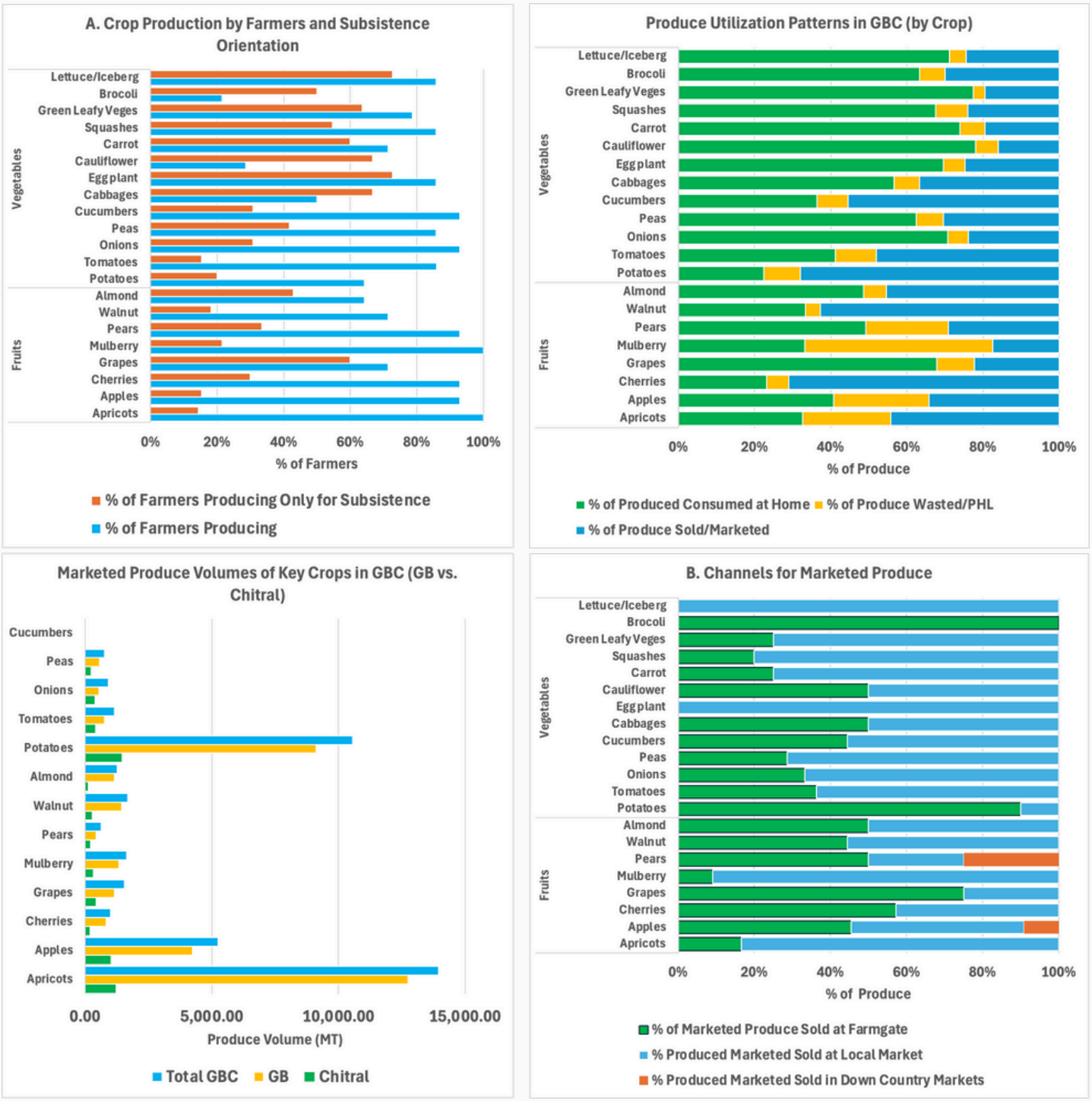
Zone-Specific Production Dynamics

- **Single-cropping zones with good road access:** Potato cultivation has replaced much of the traditional cereal area.
- **Double- and marginal double-cropping zones:** Production of cherries, apples, and almonds has increased noticeably.
- **Double-cropping zones:** Controlled and protected vegetable production is expanding, allowing farmers to extend the marketing season and capture higher prices in late seasons supply.

Regional Differences:

- The shift toward commercial horticulture is more advanced in GB than in Chitral. Higher wheat subsidies and stronger public-sector

Figure 2-2: Crop Production by Volume and Crop Utilization



agricultural support appear to have accelerated the transition in GB.

In Chitral, the most dynamic emerging opportunities include vegetable seed production and cherries. Pea and potato cultivation has become concentrated in select single-cropping valleys. New horticultural crops such as broccoli and french beans are being piloted by development programs targeting off-season demand in urban markets.

Improved rural infrastructure, improved market linkages, and capacity building support by development programs are driving the shift from subsistence cereals to more profitable cash crops.

2.5.2. Agriculture Technology Landscape

Technology adoption in GBC has remained limited, and traditional practices still dominate. Historically, there has been a push for adopting fruit drying techniques and basic technologies to improve the quality of produce and reduce post-harvest losses. Funded programs largely drive the technology adoption efforts. For example, AKRSP and local partners have helped more than 500 farmers build passive solar greenhouses since 2023, extending the vegetable season by 4-5 months and substituting a portion of imported supply in the cold season and improving access in regions where imported supply cannot reach. Similarly, efforts are ongoing to improve localised technologies and methods. Drip and sprinkle irrigation methods are also being sparsely tested; however, their presence is negligible. The use of small hand-held tractors has recently improved, especially in areas where the reach of tractors is limited and bullock raring is declining. Mobile based digital weather and crop advisory services have been tested in the past by mobile network operators.

Cooperatives and village associations are also gaining traction, allowing farmers to aggregate production, access inputs, and negotiate with buyers. The successful marketing of Saspolo apples through collective action provides a model for scaling. Youth led SMEs are increasingly using social media for market information and weather forecasts, suggesting readiness for digital extension.

Entrepreneurs are leveraging social media and digital marketplaces and stores to unlock the Direct-to-Consumer (D2C) potential.

2.5.3. Structural Transformation Trends

GBC is experiencing ongoing structural transformation marked by:

- Outmigration of working-age males to urban areas or abroad, reducing available agricultural labour
- Urbanisation and rising non-farm employment, especially among youth
- Gendered labour shifts, with women increasingly managing farming activities in the absence of men

These trends present both constraints and opportunities. Labour shortages are affecting key pre- and post-harvest activities, while youth disengagement threatens long-term sector renewal. At the same time, they create openings for mechanisation, labour-saving technologies, and youth-led agri-enterprises, provided that systemic barriers to innovations innovation commercialization are addressed.

2.5.4. Widening Labour and Skill Gap

The agriculture sector in GBC is increasingly constrained by demographic shifts and structural transformation. Declining fertility rates have slowed population growth, while rising dependence on non-farm activities has accelerated outmigration. The share of household income derived from non-agricultural sources has risen from approximately 43% in the mid-1990s to over 60–70% in recent years in some areas. While this transition reflects diversification of livelihoods, it also diminishes the pool of available agricultural labour.

The younger generation in particular does not aspire to engage in farming, especially under conditions characterized by traditional, low-productivity practices and limited mechanization.

Consequently, the burden of agricultural work is increasingly borne by an ageing farming population, especially women, who have historically carried a disproportionate share of agricultural labour. This demographic imbalance weakens intergenerational farm succession and undermines the region's potential in labour-intensive horticultural crops.

Despite the centrality of labour-intensive crops (e.g., horticulture) to the region's livelihood and growth strategies, promotion of labour-saving technologies has been limited. Mechanization faces inherent constraints in the mountainous terrain with steep slopes, fragmented landholdings, and the nature of crops, such as fruits. As a result, harvesting operations in crops such as cherries often rely on migrant labour from other regions, typically hired and mobilised by contractors. This labour is frequently unskilled, leading to high levels of post-harvest losses and efficiency losses.

In this context, the adoption of mechanisation and labour-saving technologies is imperative to ensure sustained growth and development of high value horticulture sector in GBC.

2.5.5. Climate Change Pressures

Climate variability and change are the most cited destabilizing factor in GBC agriculture. Farmers and cooperatives describe water insecurity as increasingly acute, caused by erratic glacial melt and periodic flooding that damage irrigation channels. Shortages during sowing seasons (February–April) are particularly critical.
Unpredictable weather events, unseasonal rains, regularly destroy blossoms and reduce fruit set, while floods damage standing crops. One region reported a 100% wheat loss in 2022 due to these events. New pest and disease pressures, including fruit fly, shot hole fungus, and blights, further threaten productivity and crop quality.

While climate change has enabled some opportunities, such as slightly expanded fruit-growing areas, it overwhelmingly presents risks that exacerbate existing vulnerabilities in subsistence systems.

2.5.6. Land Use and Agricultral Extensification

Landholdings in GBC are small and continue to fragment over time, resulting in a production system that is predominantly smallholder-based and spatially dispersed. Land extensification remains highly constrained due to the limited availability of land suitable for cultivation, as well as unresolved land rights issues. Despite these structural limitations, existing land use practices have been inefficient. Although the region has pursued intensification, measured by an increase in the number of cropping cycles per year, the utilisation of available land remains suboptimal, contributing to persistently low productivity per hectare.

Efforts to expand cultivable land have been attempted; however, lifting water to upland areas for agricultural use remains prohibitively costly under current irrigation practices.

Adopting land-saving technologies, prioritising high value crops that generate high returns from small plots, and strengthening land management practices are therefore imperative for sustaining productivity and maximising the value derived from the region's scarce agricultural resources.

2.6. Key Strategic Challenges and Performance Gaps

Evidence suggest that there are five intertwined strategic gaps that undermine GBC's agricultural sector's competitiveness and transformation. These gaps are the symptoms of deeply seated constraints and issues in the agriculture and food systems. Addressing these gaps is essential to enhance the sector's competitiveness in both national and export markets, unlocking additional economic value for the region and increasing farm-level incomes.

2.6.1. Productivity Gaps

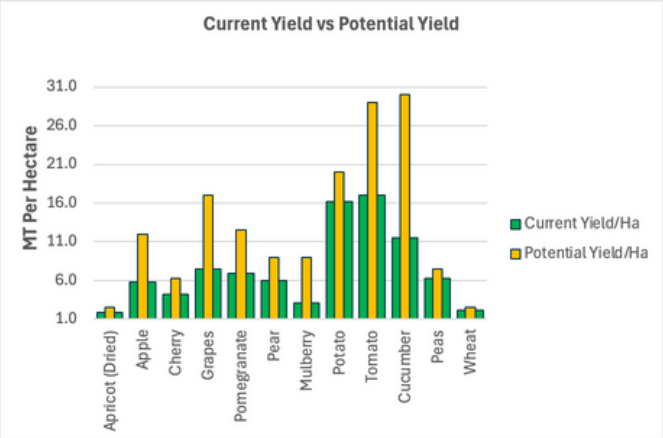
Despite favorable conditions that support a wide range of high-value crops, agricultural productivity in GBC remains well below its potential. On average, yields for major crops are 10–40% lower than achievable benchmarks, reflecting systemic constraints in production systems and resource management.

As shown in Figure 2-2, yield gaps are particularly pronounced in fruit crops, where apples (5.81 vs. 12.0 MT/ha), grapes (7.5 vs. 17.0 MT/ha), and pomegranates (6.92 vs. 12.5 MT/ha) achieve less than two-thirds of their potential. Similar trends are observed in vegetables, with tomatoes (17.02 vs. 29.0 MT/ha) and cucumbers (11.5 vs. 30.0 MT/ha) performing substantially below optimal levels. Even relatively high-performing crops such as potatoes (16.21 vs. 20.0 MT/ha) and walnuts (8.52 vs. 10.0 MT/ha) show measurable productivity gaps.

Several factors contribute to these yield gaps;

- Lack of farmers' awareness and knowledge of improved inputs and modern inputs and their benefits and use
- Traditional, non-commercial farming practices that limit input use and mechanization
- Limited access to improved seeds, plant materials, and cultivars constrains the genetic potential of fruits
- Limited adoption of modern soil, water, and pest management innovations
- Fragmented landholdings that restrict economies of scale and reduce efficiency
- Inefficient use of land for cultivation, such as random plantation and production methods

Figure 2-3: Comparison of current and potential yield



Collectively, these factors result in poor resource-use efficiency, and underutilization of GBC's agroecological potential. Addressing these productivity gaps will require investment in input supply systems, extension services, and technology adoption mechanisms tailored to local conditions.

2.6.2. Post-harvest Losses

Post-harvest losses (PHL) significantly erode potential economic gains from crop production across GBC. As shown in Figure 2-1(e), fruits experience higher losses than vegetables, largely due to their perishability and handling requirements. Overall, the estimated PHL for perishable produce, such as stone fruits and vegetables, ranges between 25% and 35%.

Among fruits, mulberries exhibit the highest losses (55%), followed by apples (30%), apricots (22%), and pears (19%). These high losses are partly linked to larger production volumes, short shelf life, and inadequate storage, transport, and processing infrastructure. In contrast, vegetables such as potatoes (5%), tomatoes (7%), and cucumbers (3%) report comparatively lower losses, reflecting their shorter supply chains and faster market turnover. Cereals, including wheat (2%) and maize (3%), experience minimal losses due to their longer storage stability.

- Key drivers of post-harvest losses include:
- Production of traditional fruit cultivars with limited shelf-life.
- Labour shortages during peak harvest season
- Poor handling and lack of sorting or grading practices
- Limited or underutilized post-harvest infrastructure, such as cold storage, solar dryers, and packing houses
- Long distances to markets without appropriate transport or aggregation systems
- Poor packing and packaging

Addressing these constraints could substantially reduce avoidable losses, improve value retention within the region, and enhance the overall competitiveness of GBC's agricultural sector.

Table 2-3: Post-Harvest Losses of various Crops

Crops	% PHL
Apricot (Dried)	22%
Apple	30%
Cherry	7.1%
Grapes	13.4%
Pomegranate	17.2%
Pear	18.7
Mulberry	55%
Potato	5%
Tomato	7%
Cucumber	3%

2.6.3. Quality Gaps and Market Mismatch

In addition to productivity and post-harvest challenges, the quality and marketability of produce in GBC are often below market standards, resulting in a significant mismatch between production and demand. Most fruits grown in the region, traditional varieties lack the physical characteristics preferred by high-end domestic and export markets.

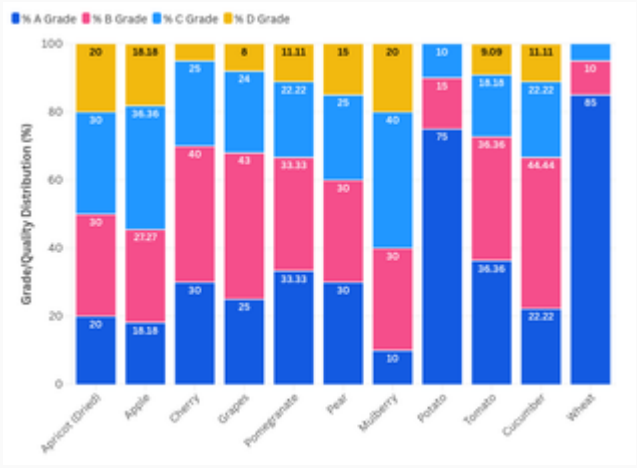
Undesirable varietal diversity and lower standardisation further complicate market alignment. For example, more than 28 cherry varieties are reportedly grown across the region, yet only a small fraction meet export-grade quality standards in terms of size, firmness, and color.

Similarly, over 90 apricot varieties have been identified, but only 9 meet market requirements for taste, color uniformity, and shelf life. The situation is comparable for apples, where many existing cultivars are not commercially viable due to inconsistent size and short storage life. In contrast, vegetables generally meet domestic quality standards more effectively, owing to shorter supply chains and faster market turnover.

Table 2-4 illustrates the current and potential quality ratios for major crops, indicating that less than 20% of current produce qualifies as Grade A, while most fall into lower commercial grades. Quality gaps stem from multiple, interconnected factors:

- Use of traditional cultivars and lack of varietal renewal programs
- Weak soil fertility management and minimal quality assurance during production
- Limited access to certified seeds and improved planting materials
- Low farmer awareness of market standards and grading systems
- Lack of orchard management skills of farmers
- Lack of crop farm management and advisory support services.

Table 2-4: Crop Quality by Grades



2.6.4. Land Resource Use/ Allocation Gap

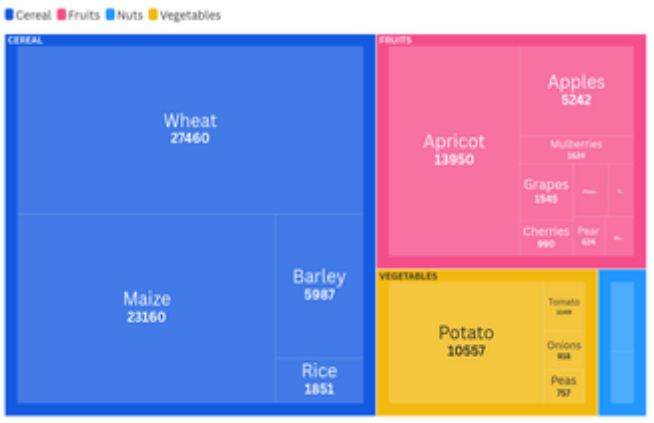
Although GBC possesses favourable agroecological conditions for a wide range of high-value horticultural crops, a substantial proportion of agricultural land, approximately sixty percent, remains allocated to low-value cereal cultivation. This represents a significant opportunity cost, as farmers could realise two to three times higher net returns by shifting from cereals to horticultural crops.

The continued dominance of cereals such as wheat and maize, which are primarily grown for subsistence consumption, limits the potential to diversify into higher-value, market-oriented crops including fruits, nuts, and off-season vegetables. These alternative crops are better suited to local agroecological conditions and offer considerably higher economic returns per hectare. This inefficiency in land allocation is driven by several interrelated factors:

- Risk aversion among households that depend on cereals for food security
- Limited market infrastructure and weak extension services for horticultural production
- Insufficient access to finance and quality inputs required for high-value crops
- Policy and institutional preferences that favour staple food production
- The role of cereals as a fodder source for livestock rearing

Shifting land use from low-value cereals to high-value horticultural crops would enable farmers to substantially improve their economic gains. This transition would requires a strategic reorientation of land-use policies, targeted investments in horticultural value chains, and the promotion of crop diversification programmes that balance household food security needs with opportunities for higher income generation.

Figure 2-4: Land Allocation to various crops in GBC



2.6.5. Marketing Gaps

Beyond productivity, efficiency, and quality gaps, the agricultural marketing system in GBC exhibits significant gaps in market targeting, positioning, and value realization. Agricultural marketing remains volume-oriented rather than value-driven, with limited attention to product differentiation or premium market development. Processing and branding activities remain limited, with few enterprises able to position their products in differentiated or branded market segments.

This lack of strategic market targeting means producers rarely access high-value domestic or export segments, where buyers pay premiums for specific attributes, certification, or traceability. High-potential crops such as cherries, apples, apricots, and walnuts are therefore sold as undifferentiated commodities, capturing only a fraction of their full value. The resulting low-value equilibrium discourages innovation, product development, and market responsiveness.
Given GBC's natural production constraints and geographic limitations, competing on volume and price is not a sustainable long-term strategy.

To overcome these marketing gaps, GBC's agricultural system must transition toward market-led differentiation and value addition. This includes segregating products by quality, developing niche and origin-linked products, building branding capacity, and forging direct linkages with premium buyers. Such a shift would strengthen market feedback loops, reward quality, and foster continuous improvement in production and innovation.

3. Market Demand and Opportunity Analysis

Significant and growing market opportunities exist for GBC's produce, but the region captures only a fraction of this value. From premium national markets to a booming local tourism sector—the demand potential is clear and compelling and require strategic targeting to enhance GBC's market position and value capture.

Assessing market segments is critical to understanding the market potential for crops and related products. This section assesses geographic markets, market trends, and market preferences and dynamics to inform agricultural decision-making, such as the prioritisation of crops and value chains, market-development programming, and the marketing strategies of agribusinesses for current and potential market segments.

3.1. Geographic Market Segments

GBC's agricultural products have access to a range of geographically distinct market segments, each with different demand patterns, entry requirements, and potential value capture. These markets are briefly summarised in Table 3-1 along with challenges.

3.2. Market Size Estimates

3.2.1. Regional Market

The Regional Market includes demand originating within GBC. It is a complex segment, further divided into three key segments, including households, Hotels, Restaurants, and Cafés (HoReCa), and tourists. Local fresh produce retailers (Fruits and Sabzi shops) and dry fruit retailers serve these segments. The fresh produce primarily serves households and HoReCa segments. Each segment is further elaborated below.

a. Households

The household consumer segment consists of two sub-segments including subsistence-oriented rural households and market-dependent urban households. The rural population constitutes approximately 83.5% of GBC's total population, while urban residents account for about 16.5%.

Among rural households, market dependence for horticultural produce is relatively low and seasonal. During the summer, most rural families produce their own vegetables and fruits, relying on home gardens and small orchards. Their purchases from the market are typically limited to non-local or tropical fruits, and other staples, which are not grown locally. In contrast, urban households depend almost entirely on market supply, purchasing both locally produced and (domestically) imported fruits and vegetables and other staples throughout the year.

Local production meets a large share of consumption in

Table 3-1: Market Segments Summary

Segments	Sub-Segments	Location and Access	Target Products
National Market	Urban High-end Population	Islamabad, Lahore, Karachi – growing high-income segments	Cherries, dried apricots, trout, honey
	Urban Mid-range Population:	Rawalpindi, Peshawar, Faisalabad	Potatoes, fresh apples, honey
	Institutional Buyers (HORECA)	Hotels, cafes, restaurants in urban centers	Pear, Nuts, traditional products, Apples, Off-season vegetables such as peas, brocoli, jams, juices, etc.
Local Regional Markets	Households	Skardu, Hunza, Gilgit, Chitral (peak season)	Fresh produce, honey, vegetable baskets
	Tourists	Towns and cities within the region includign Gilgit City, Chitral, Hunza, Skardu Bazar	Dry Fuits, Nuts, Traditional Products, Sovenier Packs
	Institutional Buyers (HORECA)	Hotels, cafes, restaurants in tourism zones & urban centers	Trout, stone fruits, vegetables
Export Market	Institutional buyers	Europe, US, Japan, China and Middle East	Dried apricots, Dried Cherries, herbs,

Note: Market segment potential depends not just on demand but on GBC's ability to reliably and profitably supply those segments.

summer, whereas in winter, dependence on domestic imports from November to May.

Total annual household demand for cereal, fruits, vegetables and nuts is estimated at PKR 26.27 billion, with PKR 20.65 billion (83%) spent in rural areas and PKR 4.23 billion (17%) in urban centers. Roughly half of this expenditure is allocated to horticultural products, including fruits, vegetables, dry fruits and nuts. The combined market demand for local fruits and vegetables from both rural and urban households is estimated at PKR 12.515 billion. Within this category, vegetables dominate, representing about 93% of horticultural market demand.

b. Tourist Market

Tourism generates significant seasonal demand for horticultural commodities and products in GBC. Based on 2024 tourist inflow estimates, tourists spend an estimated PKR 6.92 billion on local food consumption (about 11% of total spending) and PKR 3.42 billion takeaway dry fruits and local products (about 6.6%).

The share of local horticultural products in the tourist segment is significant. During the summer harvest season (Jun-Sep), a high percentage of fresh fruits (e.g., cherries, apricots, apples) and dry fruits purchased by tourists are sourced locally. However, a large share of the food consumed within restaurants (part of the PKR 6.92 billion) is sourced from outside GBC, as detailed in the HoReCa section below.

Local horticultural products primarily target the tourist segment through dry fruit and nut outlets, where visitors purchase souvenirs such as dried fruits, nuts, and fresh seasonal produce. While tourist preference is strongly in favour of local products, the peak tourist period overlaps with the processing cycle of the new harvest, leaving limited carry-over stocks. This seasonal mismatch creates a supply gap that is filled by imports from other regions, resulting in a lost market share for local producers. Figure 3-1 presents the volumetric demand and market value of the tourist segment, where nuts and dry fruits remain top-selling categories.

The key characteristics of the regional retail market are summarized in the Table 3-6 below.

Table 3-6: Regional Market Characteristics

Aspect	Local Buyers	Tourist Buyers
Primary Demand	Low-price staples	High-quality, organic, specialty items
Key Products	Non-local fruits, all vegetables.	Kilawo, pine nuts, dried apricots, gift packs bundles
Packaging	Basic, practical	Premium, small gift-size
Price Sensitivity	Very high	Low
Seasonality	Nov–Feb	May–Sept

Table 3-2: Household Market Demand and Market for Fruits, Vegetables, and Nuts[1]

Crops/Commodities	Market Demand Voluem (MT) Total Qty Consumed/Capita - Non-purchased consumption/Capita) x Population			Market Size (PKR in Million) (Total Annual Purchased Consumption x Average Retail Price)/1000000		
	Chitral	GB	GBC Total	Chitral	GB	GBC Total
Cereals	**30,166**	**143,075**	**173,241**	**3,923**	**9,832**	**13,755**
Wheat	24,013	119,515	143,527	2,881.50	5,975.74	8,857.24
Maize	1,737	6,651	8,388	114.65	465.56	580.21
Rice	4,077	15,609	19,686	896.93	3,199.86	4,096.80
Barley	313	1,200	1,513	29.77	119.96	149.73
Buckwheat	26	101	127	-	70.57	70.57
Fresh Fruits	**1,332**	**5,099**	**6,431**	**363**	**1,098**	**1,461**
Apricot	113	432	545	0.11	41.03	41.14
Apples	716	2,742	3,458	208.89	466.15	675.04
Cherries	148	566	713	45.79	216.32	262.11
Grapes	186	713	899	59.9	189.11	249
Pomegranates	38	146	184	13.06	50.62	63.68
Peaches	67	257	324	16.03	49.61	65.64
Pear	64	244	308	19.14	85.47	104.61
Dry Fruit and Nuts	**140**	**535**	**674**	**196**	**902**	**1,098**
Dried Apricot	54	206	259	108	381.95	489.96
Dried Apples	9	33	41	16.92	257.07	273.99
Dried Cherries	10	37	47	13.75	41.13	54.88
Dried Persimmon	19	72	91	6.89	24.54	31.44
Mulberries	15	58	73	7.99	35.34	43.33
Walnut	16	62	78	9.78	47.99	57.76
Almond	8	31	39	20.95	67.87	88.81
Apricot nuts	10	37	47	11.55	46.27	57.82
Vegetables	**16,762**	**64,174**	**80,936**	**2,017**	**7,938**	**9,955**
Potato	4,439	16,994	21,432	474.38	1,742.71	2,217.09
Tomato	2,899	11,099	13,998	398.6	1,522.73	1,921.33
Onions	3,443	13,180	16,623	367.92	1,702.97	2,070.89
Peas	498	1,906	2,403	112.31	426.88	539.19
Cucumber	4	15	18	0.43	1.63	2.06
Green Leafy Vegetables	1,654	6,334	7,989	90.21	345.36	435.57
Bitter Gourd, Lady finger	1,597	6,115	7,712	314.78	1,205.15	1,519.92
Cabbacge, Cauliflower	1,104	4,226	5,330	121.54	465.33	586.87
			Total	**6,499**	**19,770**	**26,269**

c. Hospitality (HoReCa) Sector

The hotels, restaurants, cafés (HoReCa) segment in GBC, encompassing other food service outlets, has grown rapidly alongside tourism and urbanization. This segment is a critical intermediary between producers and end-consumers (tourists and locals), as it purchases agricultural products for food preparation.

The HoReCa sector has grown rapidly, with hotels in GB increasing from 819 in 2021 to 1,026 in 2022 (+25%). The HoReCa sector is characterized by high service quality expectations and consistency. Hotels and restaurants require steady supplies of fresh ingredients (fruits, vegetables, meat, dairy) to serve their guests, especially during the summer tourist rush. This sector exhibits the most significant gap between local demand and local supply, sourcing the majority of its requirements from outside GBC.

A recent survey of hotel supply sources in GB revealed that a large share of food items are procured from outside the region. For instance, about 76% of vegetables and 88% of meat used by GB hotels are

1. Author's estimates based on HIES Dataset and GB Agri-statistics

Figure 3-1:Local Household Demand and Market Size by Product Categories

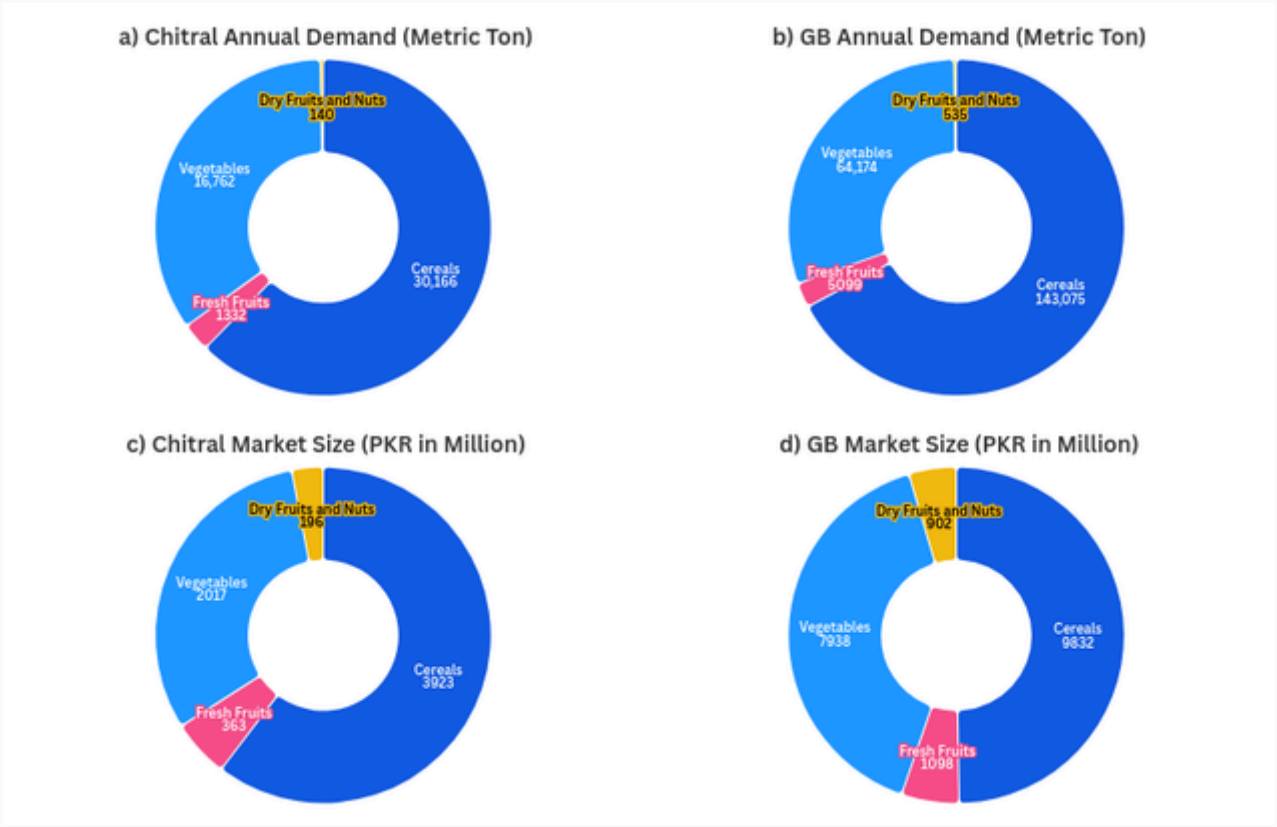
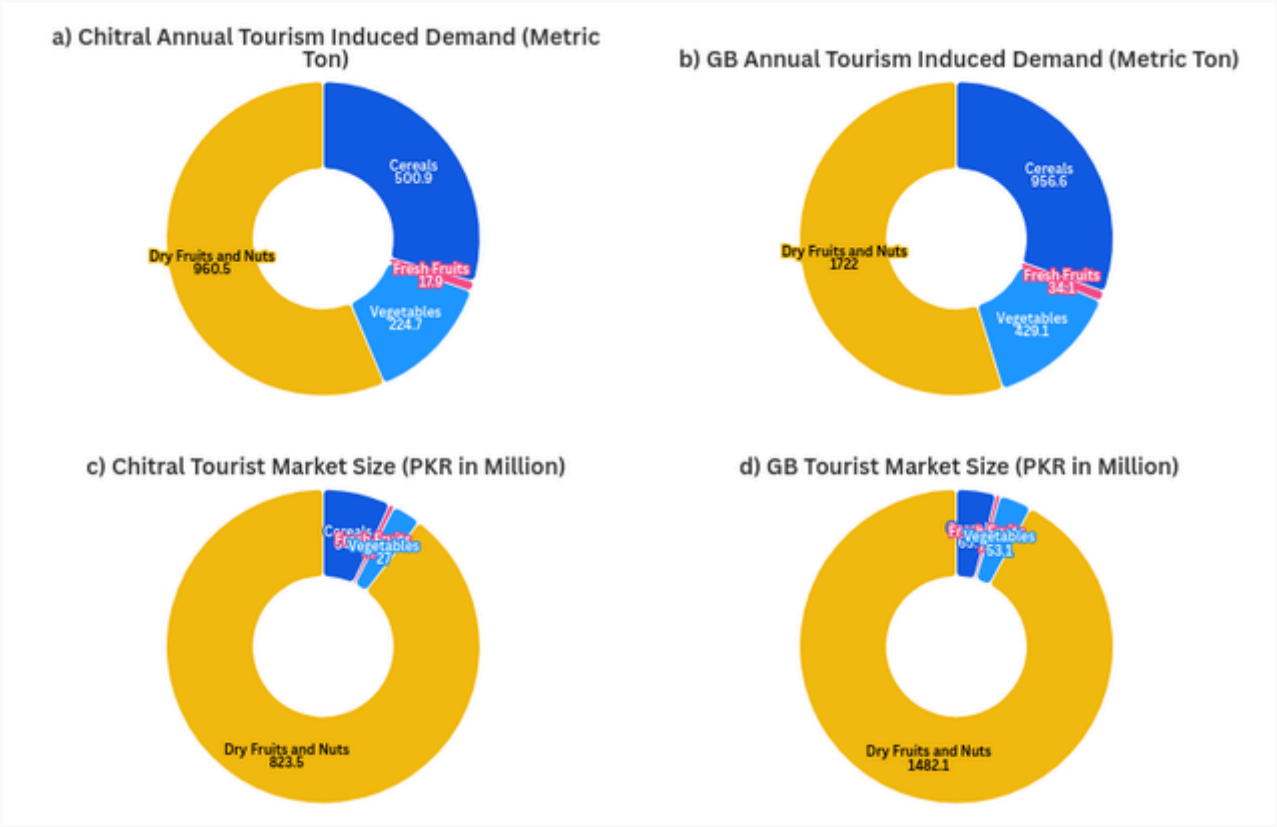


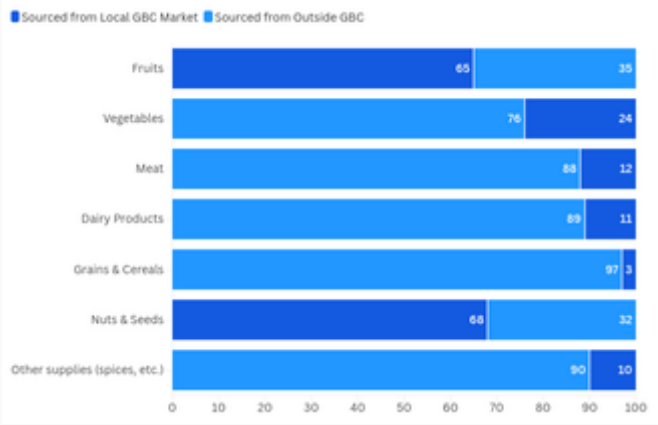
Figure 3-2:Tourism Induced Demand and Market Size by Product Categories



sourced from markets in down-country Pakistan as shown in Table 3-3 (Karim, 2024 #3). This represents a significant import leakage and a major missed opportunity for local producers.

From a strategic perspective, the HoReCa segment is a high-value market that demands reliability. They require consistent supply through out all seasons, food safety, and often specific quality standards (uniform size produce, graded and cleaned produce, etc.).

Figure 3-3: HoReCa Sector Food Sourcing in GB (% Share)



Source: Hotel Eye database, GB Tourist Police (GBTD, 2023) (Karim, 2024 #3)

3.2.2. National Market

The National Market (down-country Pakistan) is the primary outlet for GBC's bulk cash crops. According to the market intelligence report, the combined market size for fruits and vegetables in Pakistan was estimated at $9.08 billion in 2024 and is projected to grow to $9.80 billion by 2025, with a compound annual growth rate (CAGR) of 7.3% expected to reach $13.93 billion by 2030.[3] Among the most consumed commodities are fruits such as citrus, mangoes, bananas, guava, apples, and melons. In the vegetable category, potatoes lead, while onions and tomatoes rank as the top condiments.

The demand for tomatoes and onions is particularly high due to their income elasticity, which indicates increased consumption with increased income (Mari and Lohano, 2007). Urbanization and current low per capita vegetable and fruit consumption also indicate growth potential in the national market.

Table 3-4 provides statistics of fruits, vegetable and condiment production, import and export and apparent (purchased) consumption and Figure 3-2 provides a comparison of the trends.

The market can be broadly segmented into household and HoReCa based on their demand characteristics.

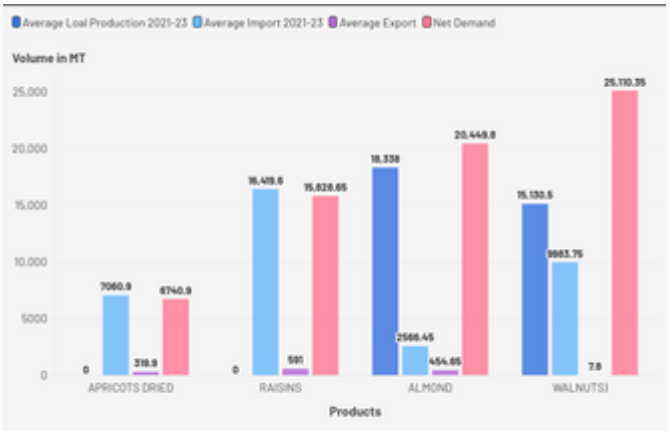
The HH segment is mainly served by specialised fresh produce retail shops that source their supplies from wholesale markets. Supermarket chains also stock fresh produce to offer a one-stop shopping experience to consumers.

The HoReCa segment includes establishment of all sizes from small to medium and large hotels and restaurants and their chains. The medium to large entities purchase their supplies through contractors who ensure a quality supply throughout the year. Their purchase of an individual or seasonal supplier is rare.

GBC's produce reaches retailers and food services through trading channels, specifically traditional spot/wholesale fruit and vegetable markets. GBC's position is that of a seasonal supplier, providing off-season produce such as potatoes, peas, cherries, and apples during the summer months when domestic production and fresh produce supply from downcountry producers is limited. While frozen peas and store potatoes are available in urban markets, consumers prefer fresh produce, resulting in sustained demand for fresh potatoes and peas from the GBC and other regions that produce during the same window. Consumers in Punjab particularly prefer fresh red-skinned potatoes produced in the highlands of GBC compared to the cold store potatoes.

GBC's production volume is small, yet it can command higher prices in the national market. The trade pattern suggests that Pakistan is already importing cash crops that GBC farmers produce or can produce, indicating a confirmed demand for GBC's products and produce. Scaling up production in GBC can substitute for costly imports if farmers are able to produce competitively.

Figure 3-4: Dry Fruit Production, Import and Export



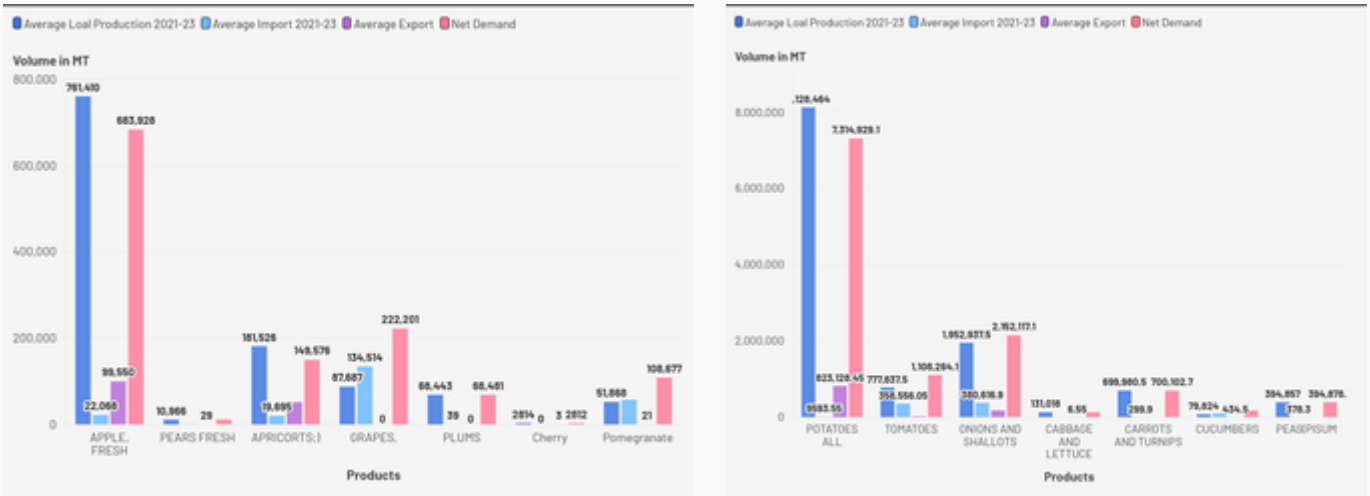
[1] Mordorintelligence Report 2024: https://www.mordorintelligence.com/industry-reports/pakistan-fruits-and-vegetables-market

Table 3-4: Local Production, Import, Export & Consumption of Fruits & Veg in Pakistan*

Crops/Commodities	Local Production		Import		Export		Apparant Consumption (Excluding Trade with GB)	
	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22
Fresh Fruits	**1,195,889**	**1,133,536**	**205,285**	**261,395**	**148,035**	**154,428**	**1,253,139**	**1,240,503**
APPLE, FRESH	790,533	732,287	31,833	12,302	127,761	71,338	694,605	673,251
PEARS FRESH	10,283	11,649	7	382	-	29	10,290	12,003
APRICORTS	204,029	159,022	24,292	15,098	20,250	83,039	208,071	91,081
GRAPES,	67,831	107,542	115,755	153,274	-	-	183,586	260,816
PLUMS	76,605	60,280	30	47	-	-	76,635	60,327
Cherry	2,875	2,753	-	-	4	1	2,871	2,752
Pomegranate	43,733	60,003	33,368	80,291	20	21	77,081	140,273
Dry Fruits	**33,132**	**33,805**	**33,546**	**38,536**	**1,103**	**1,648**	**65,576**	**70,693**
APRICOTS DRIED	-	-	9,803	4,319	392	248	9,411	4,071
CHERRIES, DRIED	-	-	-	-	6	5	-6	-5
APPLES DRIED	-	-	-	21	1	-	-1	21
RAISINS	-	-	13,844	18,995	334	848	13,511	18,147
ALMOND	18,106	18,570	2,651	2,482	370	539	20,387	20,513
WALNUTS)	15,026	15,235	7,247	12,720	-	8	22,273	27,947
Vegetables	**12,305,801**	**12,024,036**	**1,014,454**	**688,506**	**1,147,754**	**919,153**	**12,172,501**	**11,793,389**
POTATOES ALL	8,319,767	7,937,161	12,107	7,080	1,070,289	575,968	7,261,586	7,368,272
TOMATOES	762,737	792,938	282,529	434,583	51,352	4,907	993,914	1,222,614
ONIONS AND SHALLOTS	1,843,539	2,062,336	625,059	136,175	24,715	338,160	2,443,883	1,860,351
CABBAGE AND LETTUCE	144,807	117,229	1,853	1,783	12	1	146,648	119,011
CARROTS AND TURNIPS	720,854	679,107	403	197	322	33	720,934	679,271
CUCUMBERS	112,231	47,417	91,852	108,583	435	-	203,648	156,000
PEAS	401,866	387,848	652	105	631	83	401,887	387,870
Grand Total	**13,534,822**	**13,191,377**	**1,253,285**	**988,437**	**1,296,892**	**1,075,229**	**13,491,215**	**13,104,585**

*Data Source: Fruits, Vegetables, and Condiments Statistics of Pakistan 2023

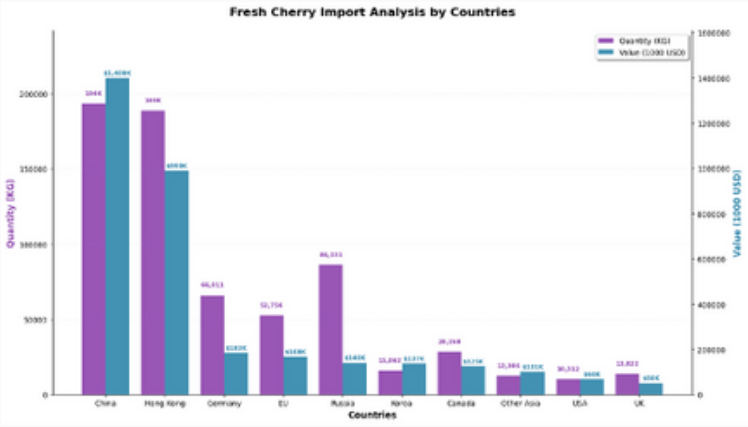
Figure 3-5: Production, Import, Export, and Local Consumption of F&V, in Pakistan



3.2.3. Export Market

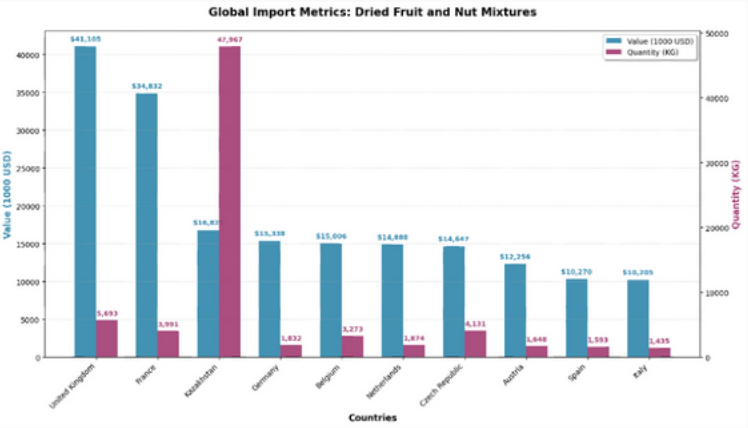
The export market for fruits, vegetables, and nuts is enormous. World vegetable imports totaled 880.82 billion in 2022, while fruit imports reached 505.97787 billion in 2023. China is the leading importer of fruits, with imports of fruits valued $ 131,028,000, accounting for 26% of the world's fruit imports. China is followed by the United States (US), which accounts for 6% of the world's fruit imports. China and Hong Kong are the leading importers of Cherries in terms of both value and volume.

Figure 3-6: Cherry Imports by Countries



Dry Fruits and Nuts: The global import market for mixed dry fruits and nuts stood at USD 316 million with a total of 96019.5 metric tons in 2023. The major importers of mixtures of dried fruit and nuts, nes are the United Kingdom ($41.1M, 5,692.7 MT), France ($34.832.4M, 3,991MT), Kazakhstan ($16.82M, 47,967.2MT), Germany ($15.338M, 1,832.3 Kg), Belgium ($15.006M, 3,273MT Kg).

Figure 3-7: Global Import of Dry Fruit Mixtures



The export market often pays a premium price for some fruits and vegetables; however, it comes with trade barriers. Inhibit exports. Typical barriers include Sanitary and Phytosanitary Measures (SPS), import duties, and certification requirements imposed by importing countries. SPS measures create barriers for exporters from traditional and SME-driven sectors that cannot fulfil the SPS requirements and other standards of importing countries due to a lack of capacity and access to services.

The share of GBC producers in the export market is almost nonexistent, with less than 1% of GBC production entering global value chains. However, there is traction for niche, high-value products. A few enterprises from GBC already export dry fruits and nuts to the Japanese and United Kingdom markets, setting good examples for other entrepreneurs. There has been some effort to export cherries to China; however, success has remained limited with volume and quality on supply side.

The main products with existing or potential export potential and traction are:

- Fresh cherries (to China and the Middle East)
- Sun dried apricots
- Apricot Oil/Kernels
- Processed Almonds and Walnuts
- Honey and herbal products and their ingredients

With strategic investment in primary production, product development, marketing and branding, GBC's position in the export market can be strengthened, and its current market share can increase manifold.

3.2.4. Demand Characteristics Across Segments

- Local market of for fresh produce in GBC is small and seasonal and cater a small amount of supply. The local market shows stronger potential for tourist products and takeaways.
- The traditional spot market chains have no clear preferences for quality and all produce gets sold albeit at a lower price. Traditional markets are less demanding but offer limited price premiums and low incentives for investment in quality.
- Premium national buyers require graded, safe, and visually appealing produce that make buyer attractive. They are willing to pay premiums but expect post-harvest handling, grading, and reliable supply.
- Export buyers prioritise varietal integrity, uniformity, and have product specification. Apart from quality they need third party assurance such as traceability, transparency, testing, food safety certifications and compliance audit, etc.

3.2.5. Price Transmission

- Price differentials between bulk and premium markets can be as high as 2–3x.
- Farmers often receive only 20–30% of the final retail price in national/export chains in the traditional trade chains.
- Price transmission is higher in more formal local agribusinesses to than traditional informal chains.

Aligning with the requirements of higher-value market segments is critical. Without this, GBC producers remain trapped in low-margin channels. Strengthening backward and forward linkages, including varietal upgrading, post-harvest handling, and high-end buyer engagement, is essential to reposition GBC agriculture for value-driven growth.

3.3. Market Trends

3.3.1. Regional Market Trends

The regional retailers serve local consumers and tourists. The market is undergoing a consumer-driven transformation, shaped by tourism, health consciousness, and digital connectivity. Demand is shifting from subsistence and bulk trading to quality, diversity, and convenience. Key trends include:

- **Rising Demand for Vegetables:** Consumption of diverse vegetables such as cabbage, okra, and bell pepper has increased sharply, driven by higher incomes, evolving diets, and health awareness. Perceived functional vegetables such as bitter gourd, turmeric, and ginger are sought for their medicinal properties.
- **Growth in Dry Fruits & Nuts:** Demand for traditional and value-added dry fruits (e.g., pitted cherries, dried persimmons) is growing steadily, offering opportunities for small-scale processing and branding.
- **Tourism-Driven Premium Demand:** Expanding tourism fuels demand for regional specialties, herbal teas, honey, and nuts, creating premium channels and opportunities for agri-tourism and local product branding.
- **Retail Transformation:** A surge of small mobile vendors and hawkers in bazaars and peri-urban areas has improved access and affordability, stimulating year-round consumption.
- **Digital Market Entry:** Local enterprises increasingly sell via online platforms (e.g., Daraz, Facebook), though weak logistics, inconsistent quality, and packaging issues limit expansion.

Local retailers provide clear insights and suggestions for producers:

- Prioritize short-cycle, high-return vegetables, which can deliver profits within 3–4 months.
- Expand production of high-demand fruits: cherries, apples, pears (Shoghori), pomegranates (Kandhari), peaches, and grapes.
- Focus on vegetables: tomatoes, potatoes, onions, peas, cucumbers, cabbage, cauliflower, and bell peppers.
- Adopt hybrid and preferred market varieties, such as Red Delicious apples, to improve yields and marketability.

Retailers remain optimistic about growth driven by tourism, infrastructure improvements, and online sales. However, supply-side fragility undermines this growth. In summer, local supply exceeds demand, while in winter, road blocks and poor storage lead to shortages and price volatility. Strengthening cold storage, transport, and resilient supply systems remains critical.

Box 3-1: Key Opportunities

- Climate-resilient storage and logistics to mitigate seasonal shocks
- Product innovation/diversification, improve branding and packaging to premiumise the local products for tourist markets
- Scaling of less-perishable, niche items (dried fruits, teas, ready-to-use ingredients) targeting tourists and digital consumers
- Target seasonal supply gaps in vegetables during fall and winter through protected agriculture (Greenhouses).
- Investment in temperature-controlled storage
- Convert seasonal gluts of fruits (apricots, cherries, apples) into stable, value-added products (dried fruit, jams, pulps) that can be sold year-round to tourist markets as local products at reasonable price.

3.3.2. National Market Trends

Pakistan's agri-food market is undergoing a rapid transformation driven by urbanization, rising incomes, digital commerce, and a growing preference for healthy and convenient foods. While demand is expanding and diversifying, structural supply-chain inefficiencies continue to constrain performance. There are three key demand shifts happening.

- **Fresh Produce Upgrade:** Urban consumers increasingly favor functional, low-glycemic, and nutrient-dense foods, leafy greens, cruciferous vegetables, berries, and other "superfoods."

- Demand for off-season, sorted and cleaned, pre-cut, and packaged produce is growing, filled partly through imports and controlled-environment agriculture.
- Modern Retail & E-Grocery: The expansion of supermarkets and e-grocery platforms has accelerated the shift toward hygiene, branding, standardization, and home delivery. These channels increasingly require traceability, consistent grading, and reliable supply partnerships.
- Premiumization of Dry Fruits: Dry fruits and nuts remain culturally central but are now marketed as premium, gift-ready wellness snacks. Import inflation has renewed interest in high-quality local alternatives such as walnuts, almonds, and apricots.

National Demand Patterns & Consumer Preferences

- **Year-Round Staples:** Potatoes, onions, tomatoes, bananas, and apples remain the dominant high-volume items across all retail formats and all seasons.
- Growing Appetite for Novelty & Health: Consumers are more willing to try new varieties and exotic products such as fresh turmeric, living herbs, pomelo, asparagus, and blueberries.
    - Traceability is gaining traction, exemplified by the success of Metro's traceable kinnow program.
    - Convenience formats, such as pre-cut vegetables, salad mixes, and branded packs, are expanding rapidly.
    - Organic Demand: Interest in organic produce is increasing, but remains niche due to high prices, limited certified supply, and verification constraints.

- Seasonal Spikes: Demand and prices surge during Ramadan and other festive periods, shaping retailers' procurement and stocking strategies. In summer, demand persists but supply shrinks for fresh vegetables, leading to high prices. This creates a seasonal opportunity for high-altitude growers such as GB, as higher prices can cover the increased costs of transportation and aggregation in the fragmented production in the hilly areas.

3.3.3. Export Market Trends

Global trade in fruits and vegetables has quadrupled over the past two decades. World imports increased from about $56 billion in 2001 to $213 billion in 2020 (GoP, 2023). This makes horticulture one of the largest and fastest-growing agricultural trade categories (over 20% of world agri-food exports) (UNCTA, 2012).

High-income countries are the primary buyers of horticultural products. The EU alone accounts for ~41% of global imports and the US 15% (GoP, 2023). In total, OECD developed economies take about 68% of world fruit and vegetable imports, reflecting strong year-round consumer demand for diverse produce. Developed markets also tend to require strict quality and safety standards, influencing global supply chains.

Developing countries are rapidly rising as consumers of horticulture. Driven by urbanization and higher incomes, Asia's import demand has surged. China has become the 3rd largest fruit importer (imports up from $3.7 billion in 2010 to $14 billion in 2020), now taking 9% of world imports. Likewise, ASEAN countries' imports more than doubled in the past decade.

Within horticulture, fruit trade is growing faster than vegetable trade. From 2016–2020, global fruit import demand grew at ~4.5% annually, whereas vegetables grew ~1.6%. Consumers worldwide are eating more fruits for health and variety. Bananas remain the single most traded fruit (about $14.5 billion import value in 2020, ~10% of fruit trade), but many other fruits (over 50 categories) each exceed $1 billion in trade, including high-value tropical fruits and berries. On the vegetable side, the top traded item is tomatoes (13% of global veg imports),though much of Pakistan's tomato output, for example, is consumed domestically.

Global supply chains have evolved to offer fruits and vegetables year-round by sourcing from opposite seasons. Off-season and tropical suppliers in the Southern Hemisphere and developing countries fill gaps in Northern markets. For instance, Chile's summer exports of cherries flood Asian markets in winter.

Chile now provides over 50% of the world's cherry exports (DP World, 2025), largely to meet China's huge winter demand (cherries formed 23% of China's fruit import value in 2024/25) (Zang, 2025). Similarly, apples and pears from growers in Europe, North America, and China are complemented by counter-seasonal supplies from New Zealand, South Africa, and South America. Dry fruits and nuts (e.g. almonds, cashews, dates) are less seasonal but see demand spikes around cultural festivals – for example, global date shipments peak ahead of Ramadan each year to supply Muslim markets.

Pakistan is a major global producer of fruits and vegetables but exports only about 3% of its output, with horticulture exports worth just $679 million in 2020, around 0.33% of the world total, revealing large untapped potential. A handful of products dominate exports: citrus, mangoes, dates, onions, and potatoes make up over 80% of earnings, though Pakistan exports far less than it produces, especially for mangoes. Most exports go to regional markets such as GCC countries, Afghanistan, Russia, Malaysia, and Sri Lanka, while access to high-income Western markets remains limited due to strict standards and weak cold-chain logistics.

Recent years have seen strong growth, particularly a surge in vegetable exports in FY2024 driven by onions and potatoes, and a rebound in mango and citrus shipments, yet earnings remain volatile due to weather, quality issues, and seasonal factors.

The trade in dried fruits and nuts is less tied to season, given these products' long shelf-life, but it is influenced by harvest cycles and festive demand. Major nut exporters include both developed and developing nations, e.g. the United States (California) dominates almond exports, Vietnam and India process and export cashew kernels, Turkey and Iran lead in pistachios, while Central Asia and the Middle East supply dried apricots, figs, and raisins. Global demand for healthy snacks has steadily increased, boosting this segment.

Pakistan produces significant quantities of dates, apricots, almonds and walnuts, but exports only a small portion after domestic needs. Overall, Pakistan's share in the global nut/dried fruit market remains modest. There is a a potential to expand by improving processing of apricots and other stone fruits from GBC.

3.4. Key Opportunities Challenges

MARKETS	OPPORTUNITIES	CHALLENGES
Local Market	• Rising local vegetable consumption; controlled-environment production can substitute winter imports. • • Tourism boom creates demand from hotels, cafés, direct farm sales, and agro-tourism/farm stays. • • Potential for tourist-oriented product development (packaged, bundled, ready-to-carry).	• Small market size with seasonal demand peaks (mainly winter). • High upfront cost for controlled-environment production and lack of financing. • Weak local transport & fragmented retail buying—smallholders struggle with daily deliveries. • No local storage; high loss risk during weather/road disruptions. • Lack of packaging services locally.
National Market	• Strong national consumer perception healthy northern people associating it with pure, natural, and organic food. • Branding potential for traceable "GBC-origin" products (e.g., Hunza Apricots, GB Cherries). • Growing demand for health-conscious, convenience-oriented products (ready-to-eat, pre-cut). • E-commerce and digital marketplaces expanding access. • Retailer demand exists for reliable quality and consistent supply. • Untapped processed product demand (filleted trout, dried fruit snacks, fruit bars with better packaging and branding). • Summer window for exotic fruits/herbs (asparagus, blueberries, etc.). • Farmers increasingly organized; NGOs reducing supply chain transaction and capacity-building costs.	• Most producers sell opportunistically, not building long-term business relationships. • Dependence on low-value traditional bulk trade channels. • Limited intermediaries to link GBC suppliers to major national buyers. • Weak collective marketing and inadequate capacity of farmer groups/enterprises to access premium markets or premiumize local products.
Export Market	• Duty-free access to China under existing trade agreements. • Natural/organic positioning fits global premium demand for unsulfured, low-input, dried and semi-processed fruits. • Strong provenance branding potential ("Himalayan", "Hunza", "GBC-origin"). • Proven viability: cherry exports to China (~3,000 tons in 2024). • Expanding opportunities in Middle East & Central Asia.	• Weak cold chain and low processing capacity. • Inconsistent quality and low production volumes. • Lack of required certifications (phytosanitary, GLOBALG.A.P., organic). • Pakistan's export ecosystem is geared toward large-scale crops, not GBC's niche temperate crops—existing traders don't serve GBC well. • Local exporters have limited capability to meet export market requirements.

4. Mapping of Value Chains

Crops and value chains vary in their development potential, market prospects, and agro-ecological fit. A multi-criteria analysis shows a clear divide: a few high-potential value chains, apricot, cherry, and apple, are ready for acceleration, while others need foundational work to take off. The mapping guides value chain prioritizations, potential approaches and strategies for value chain development.

Prioritising value chains with the greatest potential and development impact, and that are relatively more feasible to demonstrate impact, is essential to inform interventions and investments. This section presents a structured mapping of key value chains, using a multi-criteria evaluation methodology that integrates market, economic, operational, and developmental dimensions. The resulting matrix supports a tailored prioritization approach, ensuring that interventions and investment in agricultural value chains promote inclusive, market-driven, and climate-resilient agricultural growth.

4.1. Mapping Method

To identify the most promising value chains for targeted investment and programmatic support, a multi-criteria evaluation approach was adopted. The process include the following steps:

- **Mapping Criteria Construct Development:** Aligning with Accelerate Prosperity's approach and established value chain prioritisation frameworks, three main criteria constructs were selected including 1) Grow and Development Potential, 2) Readiness and Feasibility to Scale and Potential Contribution to Social, economic development and environment sustainability.
- **Sub-criteria and Indicators Development:** For each construct, further sub- criteria were developed and weight were assigned to each sub-criteria. To measure each sub-criteria, specific indicators were defined and scoring mechanism from 1-100 was defined. The list of criteria, indicators and their definition are available at Annex xx.
- **Model Development:** An excel based tools was developed for analysis based on this framework.
- **Scoring and plotting:** A scoring for each value chain agains all indicators which provided weighted score for against each criteria construct. The data was then plotted in a scatter chart to generate results again three criteria placing the value chain based on the score in quadrant chart. Figure 4-1 summarises the results of the the analysis where the value chains are plotted in a 2x2 matrix showing the positions of the value chains agains the defined criteria construct. The X-axis represents Readiness and Feasibility for Scaling while Y-axis represents Growth and Development Potential. The bubble size corresponds to the

Social and Environmental Impact score.

4.2. Mapping Results

The scoring results were then plotted into a 2x2 matrix to present a 3-dimensional mapping of the value chains against the three main criteria. The results are presented visually in Figure 4-1 below.

The matrix suggests that most of the crops cluster around medium growth potential and readiness and the fruits and vegetable value chains have greater potential to socio-economic development and environmental sustainability. the matrix also groups value chains across these dimensions yields four groups, each with distinct strategic implications for programme design, private-sector engagement, and producer decision-making. These groups are discussed further for their strategic implications for programming and investments and followed by strategic recommendation.

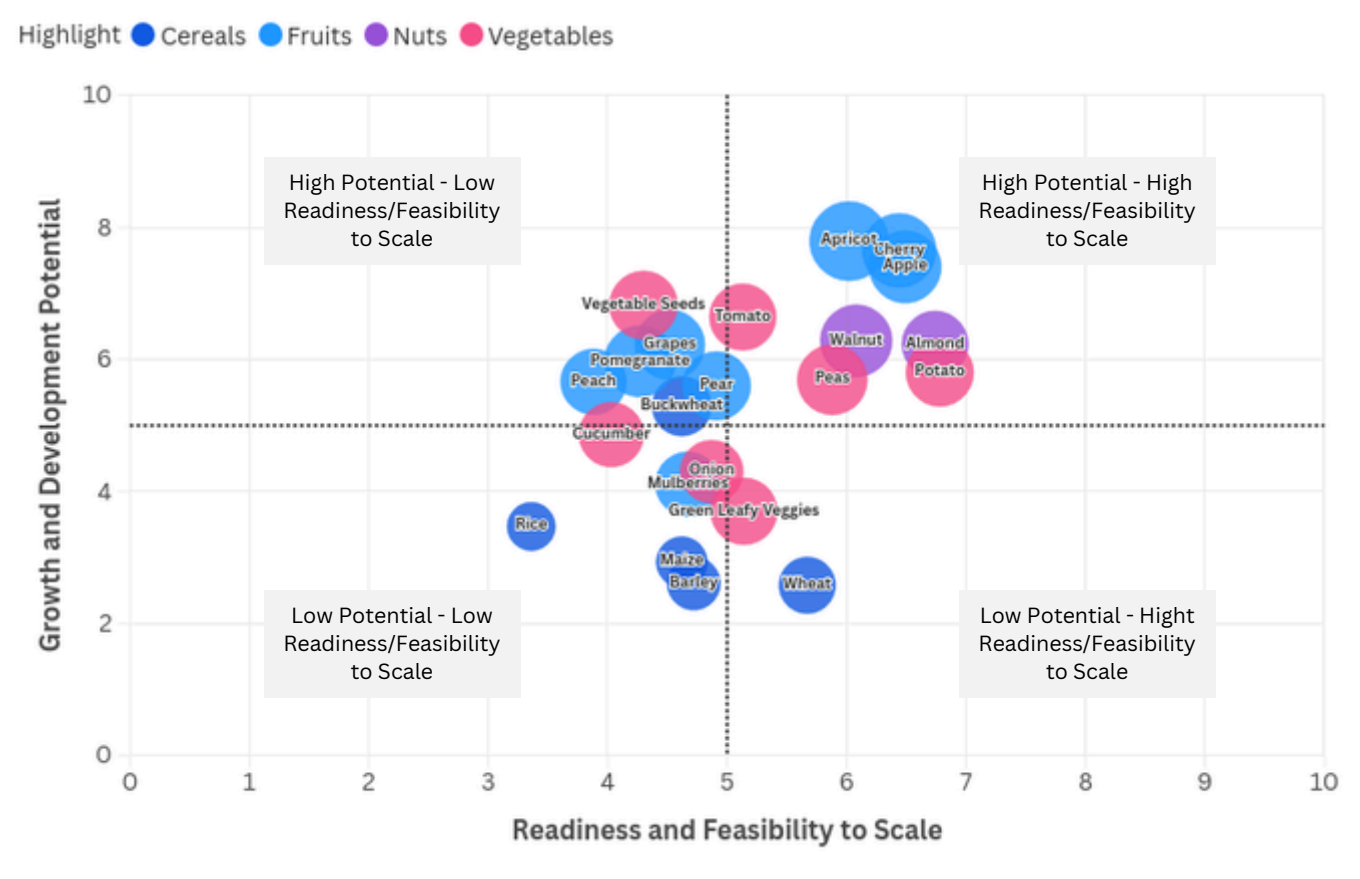
4.2.1. High Potential – High Readiness ("Growth Drivers")

These value chains combine stronger market demand, established production systems, and favorable enabling conditions compared to peers.

Apricots, cherries, and apples, potato, pea, almond and walnut fall in this category. Among these apricot, cherry and apples show the highest potential for growth and investment compared to other the peer in the category, underpinned by their current scale of production, demand, and production growth.

These value chains are functional with presence of private actors, and there is a potential for upgrading these value chains to maximize gains through branding, premiumization, processing and business model innovations and introduction of new land-saving and resource saving methods and technologies.

Figure 4-1: Value Chain Mapping Matrix



These value chains are favorable and feasible for private-sector investments, both on the input and output sides, and in financing advanced production systems and technologies. Investments in these chains can yield short- to medium-term impact, particularly through improved aggregation, processing, or branding.

4.2.2. High Potential – Low Readiness (“Future Bets”)

The top-left quadrant includes value chains with significant development potential but that currently face systemic constraints limiting their scalability. These value chains include grapes, pear, pomegranate, and to some extent tomatoes. Similarly, buck wheat and vegetable seed production (in Chitral) fall in this category. Compared to others in this category, buckwheat has a lesser impact potential considering its low potential contribution to income growth compared to others.

Although there is a demand in the national market for the crops and align well with the production window of GBC, however, there are no or limited businesses or intermediaries to engage farmers and provide them market access. Thus these value chain either remain niche or under developed.

Most of the current production is either consumed locally or sparingly access down country markets by a limited specialised market actors. One of the reason for limited market access for such crops include production of traditional varieties that are difficult to transport due to perishability and high PHL.

These value chain require high investments and medium to long time to develop and recover costs. Targeted investments are required to shift the production from traditional to market oriented production which require a a combination of value chain development, production clusters develop-men and market access approach. The focus shall be to enter use local market and existing national spot market trading chains as a stepping stone towards high and premium markets. Investments in farmers capacity building to make them ready for commercial production.

Engagement of traders, buyers and private sector will be critical. Such as strengthening input supply systems, enhancing extension services, improving producer organisations, and addressing infrastructure gaps are also critical. These value chains can be moved to the top right quadrant with these interventions.

For complex value chains such as vegetable seeds, partnership with more formal private sector with strong capabilities and established chains would be required. Long term investments in such enter-prises or co-investments through grant models can enable such seed companies or seed producers to reduce their cost of suppliers development.

4.2.3. Low Potential – High Readiness (“The Sustainers”)

Value chains in the bottom-right quadrant are relatively easy to scale or already well-established however, they have limited market potential. These chains, such as onion, green leafy vegetables, and mulberrie. By growing these crops farmers are facing a significant opportunity cost.

These crops shall be carefully maintained as secondary crop rather than main crops to support food security and sustenance. This means and incrementally improved through efficiency gains, reduced losses, and better agronomic practices, but without major new investment. Resource allocation and policy support to such crops shall be reduced and farmers shall be support to allocate resources to either current growth leader or future bets category to minimize opportunity cost.

4.2.4. Low Potential – Low Readiness (“The Stragglers”)

Value chains in the bottom-left quadrant demonstrate limited commercial promise and low feasibility for scale. These chains (rice, barley, wheat, and maize), should receive minimal investment except for subsistence or social protection purposes, with periodic monitoring to identify any emerging opportunities. Rice, barely, and maize, show the lowest potential, while cucumber exhibits the highest potential within in this category, and rice exhibits the lowest.

These value chain shall be de-prioritised in policy and support and resources shall be focus on shifting farmers to top right and top left sectors.

It is important to note that that these categories are not rigid. Depending on local context, value chains may move from one quadrant to another, especially since many fall near the midpoint of market potential and readiness. For example, cucumber value chain sits on

the boundary between low and high potential, and in some sub-regions can be upgraded to a high-potential chain due to strong local and domestic market demand.

4.3. Strategic Interventions and Investments

Table 4-2 presents some potential interventions and investments in each of the four categories of value chains.

Figure 4-1: List of Potential Interventions and Investments

Quadrant	Proposed Approach and Strategy	Strategic Interventions & Investment Priorities
Growth Drivers - high-readiness, high-potential value chains	Promote and scale these value chains by leveraging existing private-sector actors and startups. Focus on upgrading production, improving quality regimes, and driving product, process, and business-model innovation to unlock premium market opportunities.	• Scale out production by supporting existing and new farmers to expand and adopt modern practices (e.g., formal orchards, high-density planting, vertical vine production). • Develop alternative supply chains and explore export pathways to capture higher-value markets. • Invest in product development, diversification, and improved packaging. • Enhance quality standards to access premium domestic and export market segments. • Strengthen branding and marketing to position the region competitively. • Promote technology adoption to improve productivity and reduce post-harvest losses. • Invest in local processing and trading enterprises to move toward higher-value activities (grading, drying, extraction, cold storage). • Provide technical support to SMEs and startups to scale innovation, paired with patient capital to strengthen their market position. • Advocate for enabling policies and improved support services such food safety and quality services, certification services, etc.
Future Bets - Low Feasibility and Readiness but High Potential	Build foundational production capacity and strengthen input and output market functions. Use a value-chain development and inclusiveness approach to gradually move these sectors toward the Growth Drivers category.	• Invest in capability-building across production, input delivery, and marketing functions. • Strengthen input supply systems (nurseries, seed systems, technologies, tools, advisory services). • Develop targeted production clusters to concentrate services, aggregation, and attract off-takers. • Enhance producer skills through technical training and exposure to innovation. • Address infrastructure gaps (cold chain, storage, transport) that limit scale. • Promote collective marketing and producer organisations to improve early market access.
The sustainers - Low Potential and High Feasibility and readiness	Maintain essential production while improving efficiency and reducing costs. Redirect major resources toward higher-potential value chains while ensuring local food-system stability.	• Focus on cost reduction through efficient input use and mechanisation. • Support modest productivity improvements to maintain stability and local food security. • Avoid large-scale investments; prioritise low-cost efficiency gains. • Limit expansion and maintain production primarily as a food-security buffer.
The Stragglers - Low potential and readiness or feasibility to scale	De-prioritise these value chains and gradually shift public and private resources toward higher-return opportunities.	• Gradually phase out or reduce support to these value chains. • Redirect investment toward higher-potential sectors. • Provide minimal support only where subsistence or vulnerability concerns justify it. • Monitor periodically for shifts in market dynamics, but avoid major structural investments.

5. Prospects for Technology Adoption

Adoption of modern technologies is no longer a choice, it is imperative to overcome land scarcity, labor shortages, and climate volatility and effective decision making. Leapfrogging with feasible agri-tech is the key to bridging the region's strategic performance gaps.

Climatic changes, land fragmentation, labour shortages, stagnant yields, migration driven by structural transformation, and limited market access, combined with the rapid evolution of modern agricultural tools, make technology adoption in GBC more relevant than ever. Integrating advanced technologies into farming systems can directly address many of these gaps and challenges, helping farmers improve productivity, resilience, and market competitiveness.

5.1. Global & Regional Ag-Tech Trends

Agriculture is undergoing rapid technological transformation driven by climate pressures, land constraints, labour shortages, and market demands for higher quality and transparency. The global agritech sector continues to expand, despite fluctuations in venture funding, signalling sustained confidence in tools that lift productivity, reduce costs, and support climate resilience. This period has seen surging investment, the introduction of new digital tools on farms, and growing evidence of productivity gains and resource savings.

Global venture funding in agritech (agricultural technology) soared to a record $51 billion in 2021. Although it lowered to $29.6 billion in 2022 amid broader VC downturns (AgFunder, 2023 #23), it remains dramatically higher (approximately 2.5 times) than five years prior. The global smart agriculture market is projected at $15.9 billion in 2025, with forecasts of reaching $43.3 billion by 2034 (11.8% CAGR) as Internet of Things (IoT), Artificial Intelligence (AI), and robotics continue driving farm productivity short, digital and data-driven farming solutions are becoming central to meeting rising food demand, climate challenges, and labor shortages in agriculture (GlobenewWire, 2025). Five major technology trends now shape global and regional agricultural systems, many of which hold direct relevance for GBC.

- **Precision & Data-Driven Farming (AI, IoT, Drones, Remote Sensing):** Global agriculture is moving toward data-based decision-making, combining IoT sensors, AI analytics, drones, and satellite imagery. These technologies help farmers optimise water, nutrients, and labour, reducing waste while improving yields. Precision irrigation and disease forecasting alone can lift yields by 10–15% and cut water use by ~30%.

- **Resource-saving, climate-resilient systems and technologies:** Land-saving and season-saving technologies are converging into a single global trend: maximising production within limited land and short seasons. This includes:
  - Low-cost tunnels, solar greenhouses, and passive heating structures (season extension)
  - High-density orchards and intercropping (land optimisation)
  - Hydroponics and CEA for high-value vegetables (land & climate risk reduction)
  - These systems allow year-round or early/late production and deliver higher-value crops even in marginal conditions.
- **Labour, Time & Cost-Saving Mechanisation (Small-Scale & Modular Equipment):** A global shift is underway from heavy machinery to small, modular, portable mechanisation, especially for smallholders:
  - Mini tillers, micro-harvesters, battery-operated sprayers
  - Attachments/modular tools for seeding, weeding, spraying, mulching
  - Mechanisation-as-a-service (custom hiring centres)
  - Lightweight, women-friendly, low-horsepower tools
  - Solar-powered mechanisation units

These improve timeliness, reduce drudgery, and fit well with fragmented fields.

- **Sustainable & Bio-Based Solutions (Bio-inputs, Regenerative Tools, Solar Technologies):** Sustainability-focused technologies are becoming mainstream because they reduce environmental harm and input dependency:
  - Bio-solutions: Global agriculture is pivoting toward bio-based fertilisers, bio-pesticides, microbial inoculants, compost accelerators, and biological soil enhancers. They:
    - Reduce synthetic input use
    - Improve soil health and water retention
    - Increase resilience to pests
    - Lower production costs in the long run

Bio-input markets are expanding rapidly due to climate commitments, consumer demand for safe food, and improved performance of modern bio-products.

  - Climate-smart sustainable technologies
    - Solar-powered irrigation pumps
    - Drip and micro-irrigation
    - Precision nutrient delivery
    - Regenerative agriculture supported by digital tools
    - Blue/green credit markets for climate-smart farming

Table 5-1: Global Examples of Tech-Driven Agriculture

Trend	Cases and Examples
AI-driven precision	• Deere's "See & Spray Ultimate" retrofit kits and CNH-Raven autonomous tractors now in > 42 countries; AI crop-stress maps cover > 140 M ha (Balyan et al., 2024).
Robotics & automation	• Orchard-picking arms, swarm seeders, UAV sprayer fleets grow at 18 % CAGR; Western markets face 25-40 % farm-labour gaps (ILO, 2023).
Transparent data chains	• Mango QR codes in Peru & rice in Thailand use blockchain; market forecast ≈ USD 9-10 bn by 2034 (Tang, 2025).
Regenerative/ climate-smart ag	• 52 countries list CSA in NDCs; voluntary carbon prices rebound to USD 12-15 t-CO_2e.
Controlled environment farming	• LED-stacked farms in the Gulf & Singapore cut water > 95 %; desert greenhouse mega projects under China's BRI. • Controlled-environment agriculture (CEA) attracts 7 % of agrifood VC; vertical farms achieve 300-- 400 t ha¹ lettuce with 95 % less water (Wamiq, 2023).

5.2. Emerging Market Trends

Table 5-2: Trends and Examples in Emerging Economies

Trends	Cases and Examples
Mobile-first advisory & fintech	India's e-Sahib and Kenya's Twiga Fresh serve ≥ 6 M growers; bundled weather, soil, BNPL inputs (GSMA, 2024).
Low-cost IoT & analytics	GSM soil probes (< USD 40) in Vietnam cut diesel irrigation 35 % (Rajak et al., 2023).
Community mechanisation hubs	Shared harvesters lift maize net returns 15-20 % in Nigeria (Castelein et al., 2022).
Index-based climate insurance	Satellite NDVI triggers payouts in Zambia; premiums 30 % below traditional cover (Lieder & Schröter-Schlaack, 2021).

5.3. Tech Trends Mountain Regions

Table 5-3: HKH & Other Mountainous Regions Trends

Mountain trend	Pilot & scale metric	Relevance to GBC
Passive-solar & tunnel greenhouses	> 12 000 structures across Uttarakhand, Nepal & Bhutan; vegetables year-round (ICIMOD, 2023).	Confirms GBC tunnel roll-out potential.
Digital climate-hazard services	SERVIR-HKH early-warning + crop advisories reach 150 k farmers (World Bank, 2024).	Integrates with GLOF alert needs.
Drone logistics corridors	Skye Air trials move 20 kg apple boxes 12 km in 6 min, cutting mule costs 35 % (Skye Air PR, 2024).	Model for Hunza & Chitral harvest peaks.
High-value niche diversification	Quinoa, buckwheat biscuits, medicinal herbs scaled via ICIMOD Innovation Fund.	Aligns with GBC buckwheat & sea-buckthorn niches.

5.4. Pakistan Ag-Tech Landscape

Pakistan's ag-tech adoption is still low, estimated at <10% of India's level; however, the ecosystem is expanding rapidly under climate pressure and rising market demand. Three technology domains now dominate national uptake: climate-smart irrigation (≈32%), agri-finance and insurance solutions (≈25%), and greenhouse/protected cultivation technologies (≈14%). These trends closely align with GBC's needs, as water scarcity, short growing seasons, and market access challenges shape production decisions.

Startup clusters in Karachi, Lahore, and Islamabad are accelerating innovation in input marketplaces, precision hardware, drones, and greenhouse automation. Over 54% of ag-tech VC deals since 2022 have gone to these segments, signalling investor confidence in scalable, smallholder-focused models.

Policy developments are also improving the enabling environment. The National Food Security Policy (Draft 2024) proposes a digital innovation sandbox for piloting drones, IoT systems, and advanced inputs, while the government has introduced zero duties on sensor imports and lower tariffs on irrigation equipment and greenhouse components.

These national trends lower technology costs and expand supplier networks, making drip irrigation, solar pumps, protected cultivation, digital advisory tools, and modular mechanisation increasingly feasible for farmers and agripreneurs in GBC.

5.5.Regional Drivers of Technology Adoption

Rural labour availability in South Asia is declining by ~1 %annually (ILO, 2023). Aging rural populations and youth out-migration create acute labour gaps.

Table 5-3: HKH & Other Mountainous Regions Trends

Indicator (2024)	Global	South-Asia	Mountain areas (HKH)
Rural labour force change (2010-24)	-0.9 % yr^{-1} (ILO 2023)	-0.6 % yr^{-1}	-1.4 % yr^{-1}
New farm robots sold	180 k units	28 k	nascent
Avg. mechanisation level (hp ha^{-1})	2.6	1.4	0.6

Drivers include rising rural wages (+32 % in India in 2015,-23), COVID-19 mobility shocks, and social aspiration shifts. Technologies filling the gap range from two-wheel micro-tractors and walk-behind harvesters (Naylor 1992) to vision-guided fruit-picking arms (Sharma & Shivandu 2024) and swarm drones (Jin & Han 2024). In Pakistan's uplands, youth outmigration deepens seasonal labour gaps, pushing demand for battery pruning shears, micro-tractors, UAV sprayers, and co-op machinery pools (Naylor, 1992; Sharma & Shivandu, 2024). Service-provider models, Farmicon's drone spraying, or Kyrgyz "greenhouse SMEs" financed via KyrSEFF, show capital-light pathways for smallholders.

Table 5-4: Tech Startups from Pakistan and HKH Region

#	Enterprise / Location	Tech & Business Model	Supply-Chain Node	Verified Outcomes	Source
1	**GeoKrishi — Nepal**	Freemium advisory (Android + cloud) blending satellite NDVI, hyper-local weather & produce auctions; earns from input ads and micropayments.	On-farm decision support	50 000 farmers onboard; 12-15 % gross-margin lift (USAID, 2023).	GeoKrishi 2023
2	**Hydroponics Nepal — KTM & Pokhara**	Turn-key passive-solar hydro/fog-ponic kits (1–300 m²) sold with annual maintenance contracts.	Protected production	6 579 t veg; 3.7 M L water saved; ROI < 3 yr.	Hydroponics Nepal 2024
3	**Farmicon Drone Services —, India**	Pay-per-acre UAV spraying & mapping; IIT-Roorkee hardware.	Crop protection	−65 % labour, −50 % pesticide across 1 200 ha.	Farmicon 2024
4	**Skye Air Logistics — Himachal, IN**	Cargo drones (20 kg) haul apples from orchards to roads; per-kg-km tariff.	First-mile logistics	Bruise loss −35 %, haul cost −30 %.	Skye Air PR 2024
5	**Tazah — Pakistan**	B2B F&V e-commerce; IoT-tracked cold boxes, predictive demand.	Aggregation & last-mile	Serves 7 000 retailers; shrink < 8 % vs 15 % baseline.	P@SHA 2024
6	**Farmdar — Pakistan**	AI satellite analytics for exporters & insurers; subscription per acre.	Remote-sensing QA	60 000 ha scanned; > 90 % stress-detection accuracy.	Farmdar 2025
7	**Altyn-Jer Greenhouse Farm,**	EBRD credit line finances biomass-boiler greenhouses; repayments from winter crops.	Controlled production	25 000 m² built; 1 000 t CO_2e saved yr^{-1}.	EBRD 2023
8	**IWS Smart Farm — Bishkek**	10 ha automated hydroponic park under MIGA guarantee; sells to Gulf.	Large-scale CEA	40 kg m^{-2} cucumbers; 200 local jobs; 90 % WUE.	World Bank 2024
9	**AeroRoots (Nepal)**	Aeroponic vertical farm systems (soil-free rooftop farming)	Aeroponic farming	Uses ~1% of the water of field farming and no pesticides	
10	**E-Satya / AgriClear (Nepal)**	AgriClear" logs food provenance via QR-coded blockchain helping farmers sell organic/quality crops at better prices. Promotes transparency in rural supply chains	Blockchain-based produce traceability platform		UNCDF

5.5.1 Case Studies

Box 5-1: Greenhouse SME Success - Altyn-Jer Greenhouse Farm

Greenhouse producers in Kyrgyzstan face a persistent market challenge: short growing seasons and high winter heating costs restrict off-season vegetable supply, forcing supermarkets to rely heavily on imports. Local SMEs struggle to compete because traditional plastic tunnels lose heat quickly, leading to low winter yields, inconsistent quality, and higher production costs. This creates a consistent market gap; urban buyers want local, fresh vegetables year-round, but domestic producers cannot supply them profitably.

Altyn-Jer Greenhouse Farm, a family-run SME, addressed this gap through KyrSEFF's blended finance. With a USD 48,000 loan and a 10–15% EU incentive, the farm upgraded to insulated polycarbonate greenhouses, solar-assisted heating, a biomass boiler, automated climate control, and drip fertigation. These upgrades transformed the business from a low-productivity operation into a reliable off-season supplier. Market Problem Solved: The SME filled a critical market gap by providing consistent, locally produced winter vegetables, reducing dependence on imports, and meeting supermarket quality and supply standards.

The key benefits of the investment include:

- Energy-efficient technologies lowered heating costs by 45%.
- Season extension enabled nearly two additional months of high-price production.
- Quality consistency met formal retail requirements.
- KyrSEFF technical support reduced investment risk.
- Blended finance made modernisation affordable.

This combination allowed the enterprise to become a competitive, high-margin supplier in a previously import-dominated market.

Box 5-2: IWS Smart Farm – Transforming High-Tech Greenhouse Production in Bishkek

Vegetable supply in Kyrgyzstan has long faced a structural challenge: short growing seasons, harsh winters, and outdated greenhouse systems limit domestic production, especially during high-demand winter months. As a result, supermarkets and food processors rely heavily on imported tomatoes, cucumbers, peppers, and leafy greens. Local producers have been unable to compete on quality, consistency, or volume, leaving an unmet demand for reliable, year-round, locally grown produce.

IWS Smart Farm, a high-tech greenhouse enterprise located near Bishkek, set out to close this gap through a fully automated, hydroponic smart-farming system. Backed by a MIGA (World Bank Group) investment guarantee, the company developed a 10-hectare hydroponic greenhouse complex equipped with climate-control automation, LED lighting, precision fertigation, and advanced nutrient-film technology. These systems allow continuous production regardless of external weather conditions while dramatically reducing water and fertilizer use. **Market Problem Solved:**
IWS Smart Farm provides consistent, high-quality vegetables year-round, enabling supermarkets and wholesalers to replace imported produce with domestic supply. The operation stabilizes prices, improves food security, and meets growing consumer demand for fresh, safe, and traceable produce.
Success Factors

- Advanced controlled-environment technology enabling year-round production.
- Hydroponic efficiency, reducing water use and improving yields.
- ·Strategic location near Bishkek with strong retail demand.
- International investment guarantee, reducing financing risk.
- Skilled technical management, ensuring reliability and quality.

IWS Smart Farm has responded to market opportunities by adopting more efficient technology, becoming one of Kyrgyzstan's leading models of commercially viable, climate-resilient agriculture.

5.6. Current Technology Landscape of GBC

Although still dominated by hand tools, GBC farmers have begun to pilot a spectrum of "Agriculture 4.0" solutions:

- Passive solar and high-tunnel greenhouses: AKRSP and local partners have helped more than 500 farmers build passive solar greenhouses since 2023, extending the vegetable season by 4-5 months and stabilising winter diets.
- Climate-smart agronomy research – Karakoram International University (KIU) is running joint studies with AKRSP on climate-smart practices and policy gaps for high-altitude farming.
- Technology-transfer networks – USAID's Pakistan Agricultural Technology Transfer Activity (PATTA, 2017-21) showcased drip kits, solar pumps and small-scale fruit graders now available through regional ag-input dealers.
- Farmer-led innovation – Case studies from Diamer and Ghizer valleys describe growers installing DIY IoT temperature loggers and solar-powered fans inside greenhouses to avoid frost damage.

These early successes indicate both receptivity to new tools and a need for systematic scaling mechanisms.

Table 5-5: Typology of Applicable Ag-Technologies

Technology domain	Regional use-case & rationale
Digital & Data-driven (IoT sensors, AI analytics, blockchain)	Glacier-fed canal flows vary daily; low-cost flow meters linked to GSM modules can automate water turns and record volumes for community water-user associations. Smartphone image-based disease diagnostics, similar to AgroPath's 99 % accuracy model (Ahmed et al., 2022), can help dispersed orchardists.
Water & Irrigation	Solar-pump drip kits, canal-flow flap-gates, automated micro-sprinklers. 30-40 % water savings critical in uplands where water lifting is costly and difficult.
Precision agriculture & remote sensing	Consumer-grade drones can create high-resolution orthomosaics of terraced orchards to map crown density and locate hail damage; variable-rate foliar feeding on steep slopes reduces input waste.
Resource-efficient systems (hydroponics, aquaponics)	Passive-solar tunnels, high-tunnel berries, hydro-/fog-ponics, aeroponics seed-tubers Solar-heated hydroponic "rain-shelters" are being trialled in Hunza for lettuce and herbs destined for tourism outlets, using one-fifth the water of open-field beds.
Biotechnology (gene editing, bio-fertility)	Local researchers have begun screening wild Prunus genotypes for cold-tolerance alleles that could be edited via CRISPR to shorten chilling requirements—critical as winters warm yet spring frosts persist.
Renewable-energy packages	PV-powered drip units (0.5–1 kW) now cost under PKR 200 000 and can lift meltwater to bench terraces 30-50 m above channels, expanding cultivable area without diesel.
Labour-saving mechanisation	Lightweight battery pruners, two-wheel micro-tractors, and mobile threshers address out-migration of youth and the scarcity of hired labour during peak periods (Naylor, 1992; Castelein et al., 2022).

5.6.1. Relevance of Technology Trends for GBC

GBC possesses many of the enabling conditions for agricultural technology adoption, growing market demand, rising labour scarcity, strong community organisation, and increasing exposure to modern practices through NGO and government programmes. However, adoption remains uneven due to structural, financial, and institutional bottlenecks. Global and regional trends show that technologies delivering productivity gains, cost savings, climate resilience, and quality improvements are highly relevant in a resource-constrained mountain ecosystem such as GBC.

The benefits of these technologies are visible and measurable across comparable regions:

- **Yield & Quality Gains:** Passive-solar greenhouses can produce 5.2 kg/m² winter tomato yields, compared to near-zero in open fields, while sensor-guided fertigation reduces urea use by 30%.
- **Income Stability & Market Access:** Blockchain-enabled traceability has enabled dried apricot exporters to certify origin and secure premiums. Digital auction tools help farmers time harvests for better prices.
- **Resource Conservation:** Drip irrigation reduces water abstraction by 25–40%, a critical advantage for glacier-fed valleys. Solar tunnels could avert ~1,700 t CO_2e/year in diesel savings.
- **Climate Resilience:** Weather stations and SMS-based frost alerts give orchardists a 3-hour lead to protect buds, reducing early-season losses.
- **Gender Inclusion:** Greenhouse management and digital tools can be operated near homesteads, enabling greater participation of women in seedling production, dehydration, and value addition.

A theoretical five-year investment packag, for example, 4,000 solar/passive greenhouses, 8,000 ha of drip-fertigation, and 250 community weather stations—could generate:

- PKR 10–12 billion in additional gross farm value through off-season vegetables and premium fruit grades (15% yield lift, 20% price premium).
- 6,000+ local service jobs in fabrication, sensor maintenance, advisory, and greenhouse installation.
- Significant environmental gains: 30 million m³ water savings and 20,000t CO_2e avoided, aligning with national climate commitments.

5.6.2. Analysis of Tech Adoption Factors

A mix of structural and behavioural factors shapes technology adoption in GBC:

- Risk & Uncertainty: High climatic variability (frosts, glacial melt, pest outbreaks) increases farmers' perceived risk. Weak market linkages further discourage investment in unfamiliar technologies.
- Farm Size & Fragmentation: Most farms are <1 ha, making high fixed-cost technologies less viable. Scalable, modular, and low-cost innovati-ons (mini-tunnels, drip kits, solar dryers) show better uptake.
- Labour Availability: Youth migration reduces labour availability, but family and women's labour remain central. Labour-saving tools are highly relevant; however, adoption is slow due to capital barriers.
- Human Capital: Limited technical training and weak extension constrain adoption. Knowledge spreads mainly through NGOs, peer learning, and project demonstrations.
- Credit & Capital Constraints: Collateral shortages, low bank penetration, and reliance on informal credit severely limit investment in irrigation, storage, and greenhouse technologies.
- Complementary Inputs & Services: Poor access to certified seed, fertilisers, irrigation services, and cold storage limits the benefits of technology. Technologies fail when introduced without supporting value chain infrastructure.

5.6.3.Tech adoption barriers

While adoption is increasing in pockets with NGO support, structural obstacles persist. Addressing these requires simultaneous improvements in technology access, supporting markets, and the enabling environment.

Table 5-6: Implementation Bottlenecks

Barrier	Manifestation in GBC	Practical Response Options
High capital cost	PKR 150–600k needed for tunnels, drip, solar pumps	Blended microcredit, output-based grants, carbon-financed incentives
Connectivity gaps	Poor 3G/4G in remote valleys limits IoT and advisory apps	Limited response option and focus shall be on valley and areas with good connectivity.
Technical capacity	Few local vendors for sensors, drone services, calibration	TVET upgrades, university partnerships, "village tech champion" network
Regulatory clarity	No clear rules for bio-tech trials or drone use	Integrate innovation sandbox in GB Agriculture & Food Security Bill
Land fragmentation	0.3 ha orchards make mechanisation unviable	Cooperatives or cluster-based service providers to pool demand

5.6.3. Priorities for Tech Adoption in GBC

To convert macro trends into localized results, GBC must focus on applied solutions that combine modern tools with on-the-ground realities. Technologies should be bundled with training, input access, and market linkages.

Table 5-7: Technology Taxonomy & Suitability Matrix: Comprehensive Tech Taxonomy for GBC

Technology type	Potential use	Potential Benefits
Digital & IoT	GSM/LoRa soil-moisture probes, AWS + SMS frost alerts, AI pest-diagnosis apps	Low-bandwidth tools fit valley connectivity; decision support for scattered orchards
Water & Irrigation	Solar-pump drip kits, canal-flow flap-gates, automated micro-sprinklers	30-40 % water savings critical under glacier regime shifts
Protected & Resource-Efficient Cultivation	Passive-solar tunnels, high-tunnel berries, hydro-/fog-ponics, aeroponics seed-tubers	Extend season; diversify into high-value micro-greens & seed potatoes
Soil Health & Crop Breeding	CRISPR cold-tolerant Prunus, bio-fertility (arbuscular mycorrhiza), nano-fertilisers, composting & biochar	Boost productivity while maintaining soil organic matter on shallow terraces
Mechanisation & Labour-Saving	Two-wheel micro-tractors, battery pruning shears, mini-threshers, agro-robots, exoskeletons	Compensate for labour scarcity and reduce drudgery for women
Post-Harvest & Cold-Chain	CoolBot rooms, cargo drones, solar dehydrators, seed-drying beads, ionising-radiation treatment	Slash losses, capture premium markets
Renewable Energy & Carbon Tech	PV pumps, biomass-heated greenhouses, bio-digesters, silicate soil amendments	Lower emissions, tap carbon finance
Finance & Organisational Models	Digital micro-loans, index crop insurance, service-provider co-ops	De-risk and democratise access to high-capex tech

The above list showcases start-ups, SMEs, and cooperative models that have integrated technology along the fruit and vegetable (F&V) value chain in the HKH, Pakistan, and comparable mountainous economies.

GBC's unique agroecology aligns with global and regional ag-tech trends. A practical roadmap for adoption should combine modular, low-capital technologies with service models and targeted financing. Early pilots and anchor enterprises can de-risk adoption and create proof points for scale. By bundling tools with training, inputs, and market access, and addressing capital and capacity barriers, GBC can become a replicable model of high-altitude agricultural innovation.

Table 5-8: Technology Promotion Actions Summary

Technology Area	Recommended Technologies	Implementation Priorities for GBC
Climate-smart structures	Passive solar tunnels, high tunnels, polyhouses, fogponics, hydroponics, aeroponic seed tuber production	Community-based fabrication and installation; train local builders; promote off-season vegetables, berries, microgreens, and seed potato niches
Water-use efficiency	Solar-pump drip kits, automated fertigation, micro-sprinklers, GSM/LoRa moisture probes, canal flow gates	Focus more for water scare regions and train famrers on use and deployment.
Smart agriculture (Digital & IoT)	AWS weather stations, SMS frost alerts, AI pest diagnostic apps, soil moisture sensors, LoRaWAN IoT pilots	Deploy low-bandwidth tools suitable for valleys; build digital literacy through NGOs/TVET; integrate orchard decision-support tools
Mechanisation & labour-saving	Two-wheel micro-tractors, battery pruning shears, mini-threshers, compact sprayers, modular robotic tools, women-friendly tools	Establish village-level hiring/service centres; prioritise women/youth operators; reduce drudgery and labour bottlenecks
Soil health & bio-inputs	Mycorrhiza and biofertility products, nano-fertilisers, compost and biochar systems, CRISPR-ready cold-tolerant seedlings	Link to regenerative agriculture pilots; certify suppliers; promote soil organic matter restoration on shallow terraces
Post-harvest systems	CoolBot cold rooms, solar dehydrators, seed-drying beads, drones for peak-season transport/logistics, improved packaging units, ionising radiation for quarantine compliance	Anchor with producer groups; target cherries/apricots; deploy drones in hard-to-reach valleys; reduce losses and access premium markets

6. Market Systems Analysis

The core constraints facing GBC's farmers are rooted in dysfunctional market systems: input markets are "thin and shallow," offering generic products with no advisory, while output markets are often "thick-or thin-shallow" trading high volumes at low value with minimal quality differentiation.

As described in the previous section, despite strong market potential for horticultural crops, most farmers in GBC remain locked in subsistence-oriented production, relying on low-input field crops and traditional varieties that offer limited commercial returns. Production decisions are largely driven by household consumption needs and very basic market signals, with minimal fertilizer use, limited diversification, and widespread dependence on self-saved or locally exchanged inputs. Although semi-subsistence and commercial farming have emerged in a few pockets, mainly due to development programs introducing training, inputs, and market linkages, these gains have remained limited and crop-specific. Even relatively functional value chains such as potatoes and peas failing to scale and upgrade.

This stagnation reflects deeper systemic issues: farmers lack adequate information, risk-mitigation tools, and institutional support to transition to commercial agriculture, while past experiences reinforce risk averse behavior. As a result, despite clear motivation for higher incomes, most farmers are unable to transition into more profitable commercial horticulture.

6.1. Functional Description of the Value Chains

Figure 6-1 shows market value chains through which farmers in GBC are linked to input and output markets. It illustrates the flow of inputs, products, and market connections throughout the horticulture value chain, highlighting how farmers connect with a broad range of upstream suppliers and downstream buyers, with varying strengths of connections and quantities of produce moving through these chains.

Input supply Chains: The input supply consists of agricultural inputs such as fertilisers, seeds, equipment, and nursery plants supplied by various types of input producers who deliver inputs to farmers through distributors and dealer networks. In GBC, there are small input supply shops with limited product ranges that cater to farmers' input needs.

Output/Produce Supply Chain: The produce market is primarily national, with some local and export components. GBC's farmers are linked to national markets through seasonal aggregators operating in the region.

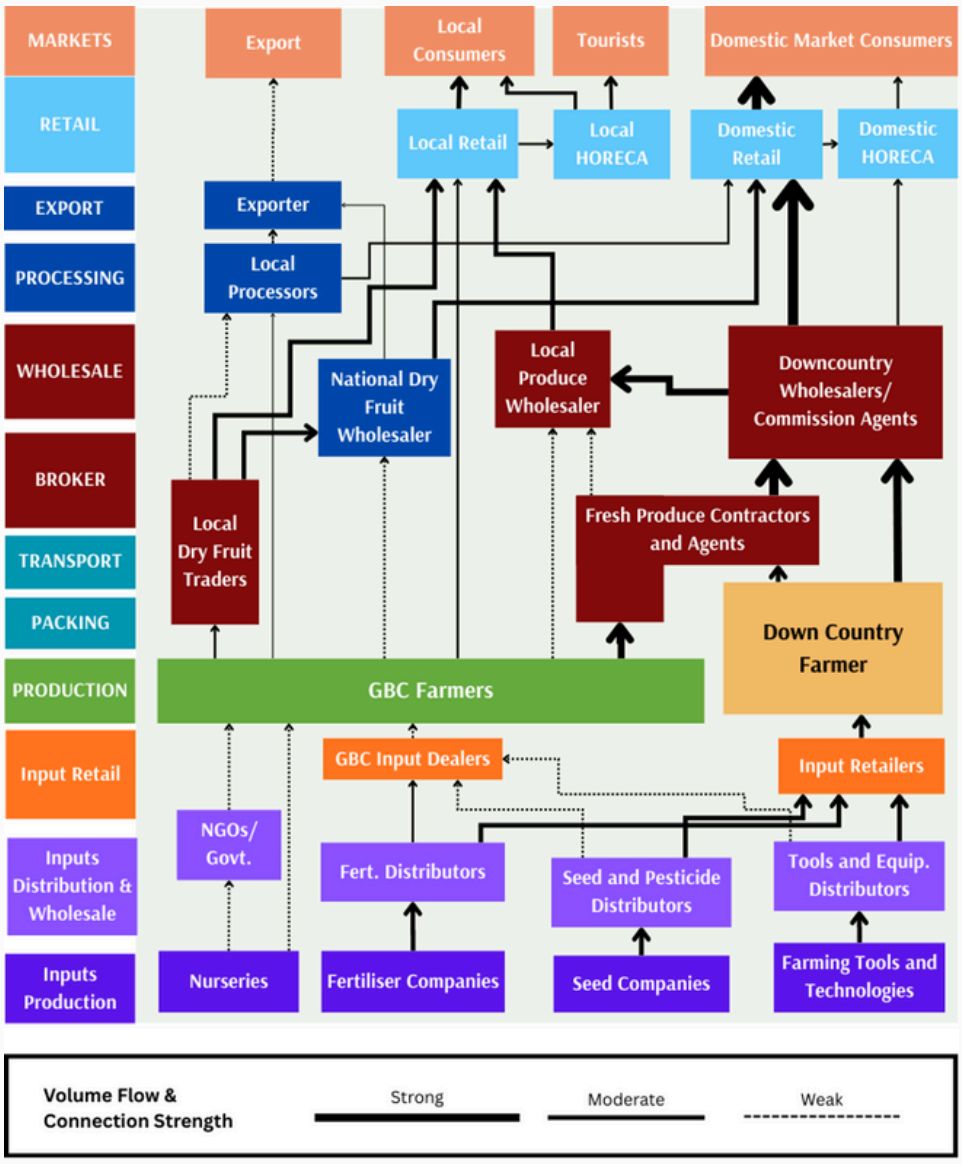
The local markets consist of retailers and wholesalers. Local wholesalers mainly deal in dried fruits and nuts, while local wholesale of fresh produce is available for imported items. Locally, produce is mostly sold directly to retailers. This has been discussed in section 2 with greater detail.

Farmers are dependent on aggregators to market their produce, and farmers play minimal or no role post-harvest activities of fresh produce chains. Most of the dry fruit that is purchased is marketed by wholesalers in the down-country markets, targeting the winter season window. These wholesalers also import from importers for stocking non-local dry fruits and nuts to cater to summer tourist demand as local produce stock falls short.

The input and output markets function as interconnected systems, where effective "push" from input suppliers and strong "pull" from output buyers are both necessary for farmers to adopt improved practices, invest in modern technologies, and align production with market demand. To understand why farmers remain locked out of commercial opportunities, this assessment analyzes systemic constraints on both sides of the market and examines the underlying structural patterns that shape overall performance.

In particular, it evaluates market breadth, the extent to which a market is thin or thick in terms of the number and diversity of actors, and market depth, the degree to which a which a market is shallow or

Figure 6-1: Integrated Crop Supply Chains of GBC



deep in terms of the range, quality, and complexity of services and transactions. These dimensions can combine in different ways; a market may be thick yet shallow[1], or thin[2] yet deep, each scenario carrying different implications for investment, growth, and value chain development. Understanding these patterns enables more targeted, context-specific interventions and investment strategies tailored to the structural realities of each sector.

1] A shallow market is a market with limited set of potential counterparties, restricted technological or contractual match space while a deep market is characterized by broad participation with transactions representative of underlying economic activity.

[2] Thin markets are market that have few buying or selling offers, low trading volume, low liquidity, high bid-ask spreads while thick markets are characterize by many participants, high trading volume, easy matching and price discovery.

6.2. Mapping Approach

A market functionality assessment was conducted to identify gaps in how each market operates, using two key constructs: market depth and market breadth. To apply these constructs consistently, a multi-criteria weighted evaluation tool was developed to position all markets within a standardized framework, enabling an objective comparison of market functionality.

For each construct, specific sub-criteria and measurable indicators were established, allowing for structured, evidence-based scoring using the data collected during the study. The results were compiled and visualized through a matrix scatter chart, offering a clear and intuitive representation of how markets compare in terms of depth and breadth. In this analysis, the deeper and thicker the market, the better its overall functionality. This visualization generated deeper insights into relative market performance and helped identify priority areas for intervention.

To enhance clarity, separate mapping and analysis were conducted for input and output markets, recognizing the distinct dynamics and performance patterns within each category.

6.3. Input Market Mapping

The agricultural input markets across the region exhibit mostly thin-shallow and thick-shallow patterns. The boundary of analysis of the input market is from upstream input production by companies to down stream input purchase by farmers. More focus is on input distribution and the retail side at the GBC level.

These markets are unable to meet farmers' evolving needs or enable them to transition to market-oriented production. Figure 6-2 maps the core input markets and their supporting functions, revealing that, aside from relatively better-developed macro-fertiliser channels, most input markets remain thin and shallow, constrained by both supply- and demand-side failures. This means there are limited input suppliers and active buyers (farmers) of modern agricultural inputs. The dotted links in the figure above also show this gap. Let's discuss each category of these markets.

6.3.1. Thin and Shallow Input Markets

a. Seeds, and crop protection chemicals

The seed and crop protection chemical market in GBC is thin and shallow, shaped by both supply- and demand-side constraints. Few suppliers serve the region, buyers are highly fragmented, and product quality and information on proper use are limited. As a result, farmers have restricted access to reliable inputs, and the market remains underdeveloped.

Input suppliers primarily operate from town centers, with almost no physical distribution or marketing presence in rural areas. Their reach is limited, product ranges are narrow, and most offerings consist of low-cost generic inputs with affordability and high trade margins.

These limitations are symptoms of a deeper structural issue where input companies view GBC as a low-potential and costly market to develop. Fragmented production, small landholdings, traditional farming systems, and dispersed demand reduce expected returns. As a result, companies hesitate to invest in supply chain development, dealer capacity, or farmer-facing services in the region, services they commonly provide down country.

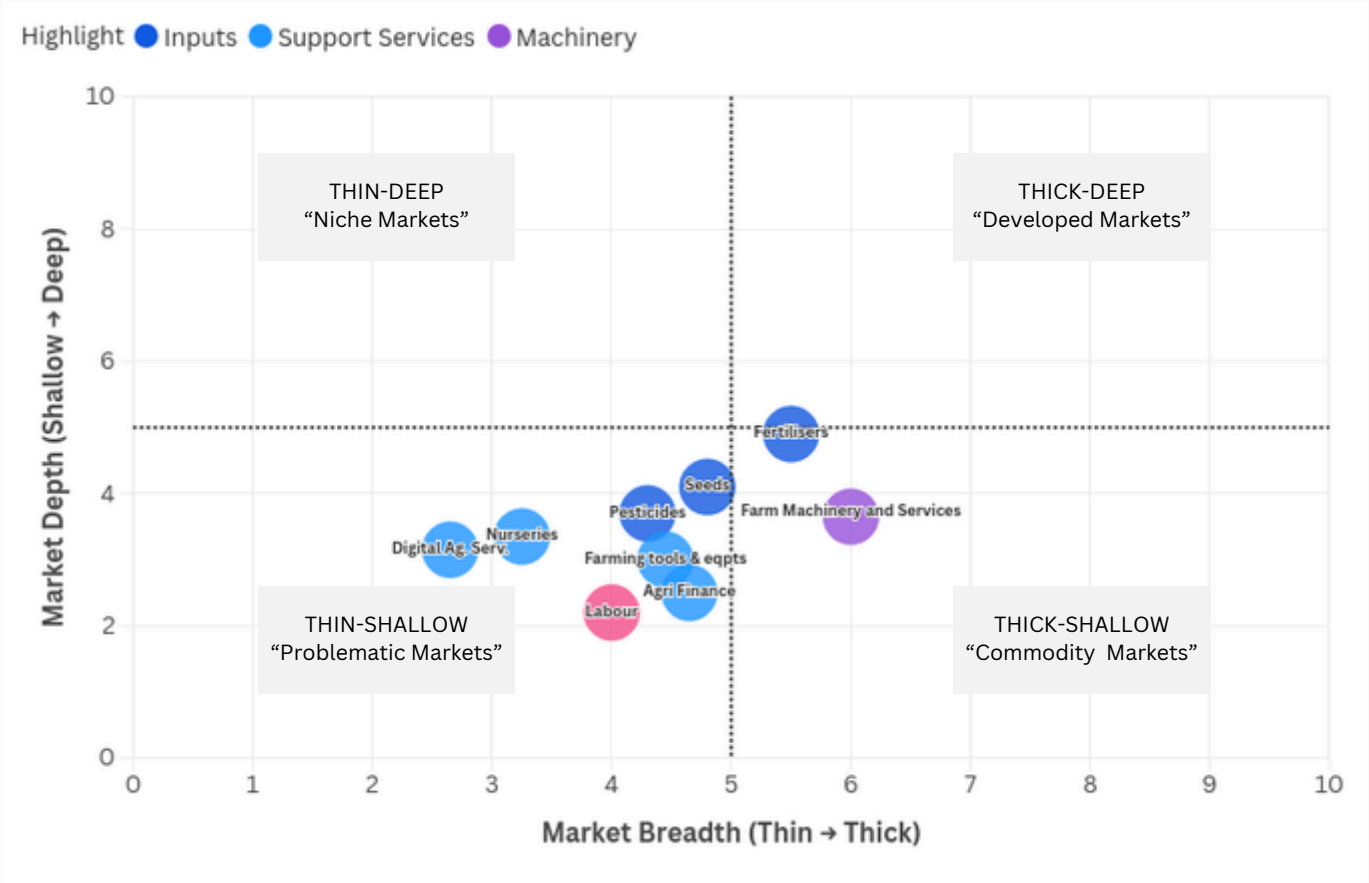
This lack of investment contributes to a broken relationship chain between companies and local dealers. Most dealers are not directly linked to input companies but instead rely on sub-regional distributors or traders. Companies provide little to no after-sales or marketing support, no embedded advisory services, and no field staff to engage dealers or farmers. Without corporate engagement, dealers operate independently and lack the technical capacity, incentives, and knowledge required to promote improved farming practices.

Consequently, nearly all local dealers in GBC function purely as passive resellers or shopkeepers rather than agricultural service providers. Their business model revolves around serving walk-in customers, supplying small quantities for kitchen gardening or limited-scale production. They do not conduct on-farm trials, provide production advice, or facilitate the transition toward higher-value commercial production. Most dealers also operate without linkage to extension systems or microfinance providers and cannot extend input credit.

These upstream and midstream weaknesses have direct consequences for farmers:

- **Low awareness and skills:** Farmers remain largely unaware of the potential of vegetable production or modern input use. Even when they understand the benefits, their confidence in adopting new crops or varieties is low due to the supply side offers little technical support.

Figure 6-2: Mapping of Input Markets



- **Inaccessible or limited input options:** Narrow product ranges and rigid input-provisioning terms limit farmers' ability to obtain high-quality inputs. Good quality hybrid vegetable seeds are often not available in smaller towns.
- **Low trust in formal channels:** The presence of low-quality or counterfeit seeds and chemicals erodes farmer trust in dealers and discourages adoption of improved practices.
- **Lack of financial flexibility:** With most dealers unable to offer credit or bundled services, farmers face additional barriers in acquiring timely and appropriate inputs.

Overall, the interaction of these constraints creates a self-reinforcing cycle that sustains a thin and shallow input market. Low commercial potential discourages companies from investing in market development and dealer support. Weak, poorly equipped dealers fail to deliver quality products or advisory services, which suppresses demand from farmers.

b. Fruit Nurseries and Seedlings

The fruit plant nursery market in GBC is similarly thin and shallow, characterized by a small number of under-regulated suppliers and weak quality assurance mechanisms. The market suffers from a lack of public investment in varietal research, limited institutional linkages, and minimal oversight, all of which restrict farmers' access to reliable planting material.

Most nursery operators function with weak technical capacity and little to no connection with public research institutions or certified mother blocks. Their operations are largely informal, seasonal, and opportunistic. Every spring, numerous sellers appear temporarily to market seedlings and saplings, only to disappear shortly afterward. They provide no guarantee regarding varietal authenticity, plant health, or survival rates.

This environment enables widespread sales of mislabelled or counterfeit plants, such as saplings promoted as "Qandahari Pomegranate or Sundar Khani Grapes" that later prove to be generic, low-quality varieties. Because fruit trees take years to bear fruit, farmers often discover the deception only long after the purchase, leading to financial losses and significant delays in orchard establishment. The inability to differentiate authentic plants from low-quality ones at the point of purchase further erodes farmer trust in nursery markets.

Another challenge arises from the dumping of saplings imported from adjacent regions such as Swat and Lower Dir. These plants are often unsuited to the climatic and agro-ecological conditions of GBC. Although readily available in bulk, they have low survival rates and poor long-term performance in the region's unique environment, undermining orchard productivity and discouraging farmers from investing in improved varieties.

The nursery market is further weakened by public and donor-funded programs that distribute free or subsidized plants. Although they are well-intentioned, such programs often procure large quantities of saplings from outside the region rather than from emerging local nurseries. This practice crowds out nascent commercial nursery businesses, preventing them from building the scale, skills, and business models needed to become reliable and competitive suppliers. Local nurseries remain nascent and unable to cater to large-volume demand because the market is distorted by periodic influxes of free plant material. establishment. The inability to differentiate authentic plants from low-quality ones at the point of purchase further erodes farmer trust in nursery markets.

c. Farm machinery, tools, equipment and technologies

The market for farm machinery, tools and modern agricultural technologies is also thin and shallow/underdeveloped, with limited local availability and almost no active presence of of suppliers in the region. Farmers or agricultural machinery services providers must source equipment from down-country markets. However, weak business relationships, lack of financing, high transaction costs, and limited local after-sales support make access difficult and unaffordable to introduce these technologies.

d. Digital agricultural services

Digital agricultural services virtually absent locally, and national platforms have poor coverage, restricting farmers' access to information, advisory services, and modern production tools.

6.3.2. Thick and Shallow Markets

a. Fertilizer Market:

Among all input categories, the fertilizer market is more developed, which is close to the thick-deep category. The fertiliser market in GBC is relatively thicker than other input markets, with designated company dealers supplying macro-fertilisers and demonstrating stronger commercial presence. However, this depth is concentrated mainly in larger towns and cities, leaving sub-towns and villages with limited access, particularly during peak sowing seasons. The market for micronutrient blends, precision foliar fertilisers, and crop-specific formulations remains thin, reflecting both low supplier capacity and weak incentives to diversify.

Although the region's soils contain healthy organic matter, key nutrient deficiencies are emerging, and traditional soil fertility practices are declining. Yet market-based solutions that align with the region's preference for natural or environmentally compatible fertilisers are largely absent.

Compounding these gaps is the fertiliser market's lack of embedded advisory services. Fertiliser companies and local dealers offer little to no guidance on soil nutrient management, proper fertiliser application, or crop-specific requirements. Farmers therefore have limited knowledge of how to correct nutrient imbalances or use modern fertiliser options effectively, which in turn suppresses demand for higher-quality products and keeps the market commercially shallow. Deepening the fertiliser market will require expanding product range, improving distribution beyond urban centers, and embedding soil nutrient advisory services within the supply chain to support more informed and productive fertiliser use.

b. Agricultural machinery Service

Agricultural machinery services such as tractors, threshers and spraying are available. However, horticulture specific services are entirely absent in this category making these services less sophisticated to the the emerging needs of farmers. More such machinery services are emerging which shall be addressed through specialised agricultural services.

6.3.3. Weak supporting functions

Weaknesses in input markets are further compounded by equally fragile supporting functions—such as extension, finance, risk management, labour, and information services—that are critical for enabling farmers to adopt improved technologies and transition toward more commercial farming systems. These weak support services also limit the ability of other market actors to effectively deliver inputs and complementary services to farmers, reinforcing the performance of the

agricultural market system.

1. **Agricultural Extension and Knowledge Services:** Public extension is underfunded and outdated, reaching only a fraction of farmers, while private input dealers provide little to no embedded advisory support, resulting in a pervasive knowledge vacuum that undermines confidence in new practices.
2. **Financial Services:** The agricultural credit market is thin and shallow. Commercial banks do not serve the sector, government schemes are limited, and existing loan products are poorly aligned with cropping cycles or capital investments such as orchards, leading to low uptake and frequent diversion of credit toward non-farm needs. Risk management systems are entirely absent, with no insurance or safety nets to buffer shocks, making farmers understandably risk-averse to adopting improved inputs or practices.
3. **Labor and Mechanization Services:** The labour market has become extremely thin, as traditional communal labour structures have eroded without the emergence of formal labour services or mechanization options; rising labour scarcity increases production costs, constrains the adoption of labour-intensive crops, and contributes to significant post-harvest losses.

Collectively, these dysfunctional supporting services deepen the information and capability gaps facing farmers, limit their ability to invest or experiment, and significantly hinder the transition from subsistence to market-oriented agriculture.

6.3.4. Rule Constraints

There is a critical role of formal rules such as regulation and standards and informal rules such as socio-cultural norms in agricultural markets. Both of these impose enabling and governing constraints on how market actors behave and invest. These rule-based dimensions shape the behaviors and incentives of market actors, often in ways that reinforce inefficiency and exclusion.

The following outlines how these rule affect the and actions affect the functioning of input market in GBC.

a. Formal Rules and Policy Frameworks

The outdated policy incentives continue to favor traditional crops such as wheat, discouraging diversification into higher-value, market-oriented production. Governance gaps and underinvestment, stemming from the absence of region-specific agricultural policies in GB and political marginalization in Chitral. These gaps weaken the desired support required for modernizing the agriculture sector.

Even where policies and regulations exist, their implementation is weak, enabling counterfeit inputs, substandard services, and ineffective credit systems to persist unchecked. For example, although regulations prohibit the sale of disease-affected or low-quality seed that fails to meet certification standards, almost all potato seed sold in GBC is non-certified, and no effective action is taken to curb the distribution of poor-quality seed.

b. Informal Norms and Social Structures

The collapse of communal labour systems has been accompanied by a growing stigma around agricultural wage labour, particularly among youth, constraining the emergence of labour or mechanization service markets.

In the same vein, gender norms limit women's access to inputs, decision-making, and control over agricultural income despite their central role in farm labour. This undermines productivity, erodes incentives to adopt improved practices, and suppresses a large segment of potential market demand.

Together, these rule-based constraints entrench inefficiencies, weaken trust, and reduce the effectiveness and sustainability of market facilitation efforts unless addressed through complementary strategies such as advocacy, coalition-building, and norm-shifting communication.

6.3.5. Strategic Implications and Recommendations

Market Type	Key Characteristics	Strategic Objectives	Potential Actions to Strengthen the Market

Thin–Shallow (Problematic)	Limited suppliers; limited buyers base and latent demand	Aim to transform into 'commodity' which is the adjacent possible zone in short-medium term and then to deep in the medium-long term market.	• Address demand side constraints through the following;
			  ◦ Facilitate entry of new actors cooperatives, producer organization and production clustering to reduce cost of input supply where input suppliers can work with a representative body to supply bulk inputs and offer advisory.
			  ◦ Improve access of farmers to input financing and orchard up-gradation finance. Partner with banks and community based financing products designed for the context financial services to local needs especially towards upgrading farm infrastructure
			  ◦ Provide training and advisory through demo plots and model orchards and promotion of lead farmers to stimulate adoption of modern technologies.
			• Address supply-side constraints through the following:
			  ◦ Promote collaboration between input suppliers and public agriculture extension leverage each others' expertise and networks.
			  ◦ Use media including social media and radio to promote good quality agricultural inputs and their benefit
			  ◦ Invest in bio-inputs, market development in partnership with input firms and local dealership networks.

Thick–Shallow (Commodity)	Many participants + Standardized products	Maintain competition and improve market functionality and focus on moving into deep developed category.	• Invest in fertilisers especially promotion of natural and micronutrient fertiliser use among farmers to adopt soil nutrient managent to maximize yield. • Invest in introduction of more advance machinery services services and tech enabled services through youth-led agribusiness services or cooperatives. • Invest in localised digital agricultural advisory services and social media content that can promote modern farming techniques in the local context.

6.4. Output Market Analysis

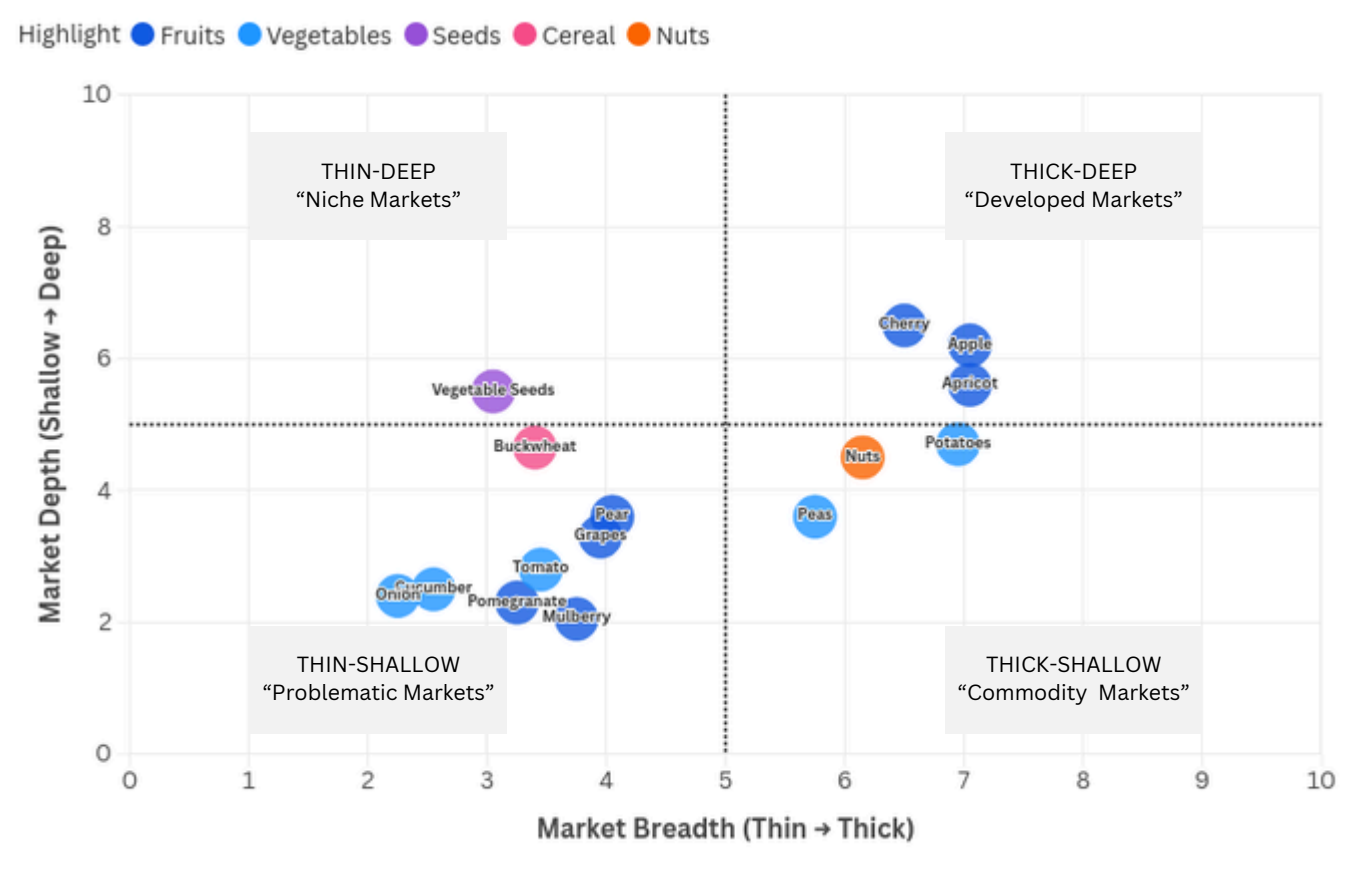
The functioning of input markets will also depend on the functioning of output markets, where farmers can access them and make money from farming by selling their produce. The boundary of analysis of the output market is the options for selling markets available to GBC farmers. More focus is on markets within GBC in the form of availability of buyers.

Due to fragmented farming and small landholdings, and to historically traditional farming and weak road infrastructure, farmers in GBC have limited access to markets. Figure 6-3 maps output markets for various crops produced in GBC. The mapping reveals that, except for potatoes, apples, and cherries, the rest of the markets are either in thin-shallow or thick-shallow quadrant. This means there are limited, fragmented suppliers/farmers and active buyers (aggregators) to off-take the produce. The dotted and think links in Figure 6-1 above also show this gap. The structural and functional patterns and characteristics of each market are discussed below.

a. Thick-Deep Output Markets - Apricot, Cherry, Apple

Apples, apricots, and cherries exhibit stronger systemic characteristics positioned in the THICK-DEEP quadrant of the market systems functionality matrix as shown in Figure 6-3, which characterizes them as "Developed Markets" than the peer crops. These markets have significant number of producers and intermediaries and exhibit relatively functional transaction flows over relatively longer periods, service access, and better coordination among buyers and sellers. Informal and semi-formal aggregation networks facilitate timely village-level procurement by allowing on-spot price negotiation. Apricots are mostly processed at farm (drying, preserves), while apples and cherries are traded sold fresh.

Figure 6-3: Output Market Mapping Matrix



While these markets demonstrate volume and reach, they remain trapped in a low-value transactional logic:

Buyer behavior is volume-driven and logistics-oriented. Most aggregators operate on spot terms, rarely invest in long-term supply relationships or embedded services.

Their focus remains more on downstream value chains and diversified trade than on quality- and value-based positioning.

- Transaction characteristics remain informal. Power asymmetries favor traders, who often provide credit or advances, reinforcing dependency and reducing farmer agency.
- Lead firm constraints: Niche buyers and processors seeking higher-quality inputs face high coordination costs and unreliable sourcing, limiting scale and system influence.
- Support systems such as cold storage, grading, and certification are either underdeveloped or not well-integrated with market actors. Traders/buyers try to embed some of these services to some extent; however, these services are largely missing.

These dynamics reinforce a "good enough" market performance, but constrain quality upgrading, formal trust-building, and investment in long-term value creation. More targeted investments and interventions are required to unlock the potential through targeted diversification of products in the downstream and alternative formal trading models targeting high-end and premium markets.

Leverage points for systemic change: Given the system's relative maturity, facilitation should focus on deepening value rather than expanding access. Potential leverage points include:

- Embedded service partnerships: Facilitate models where buyers offer pre-harvest support (authentic inputs, training) tied to post-harvest purchase commitments.
- Performance-based procurement: Introduce trust mechanisms (e.g., traceability, certification) to reduce information asymmetries and reward quality.
- Aggregation enhancement: Strengthen early-stage cooperatives or hybrid producer organizations capable of handling logistics, quality assurance, and buyer negotiations.

- Processor engagement: Co-create sourcing models with small processors that offer reliable channels for semi-processed or off-grade fruit.
- These interventions should aim to shift norms, reduce coordination failures, and create positive feedback loops where actors are rewarded for investing in upgrading.

b. Thick-Shallow Markets - Nuts, Potatoes, and Peas

Nuts, potatoes, and peas sit within the THICK–SHALLOW quadrant of the in Figure 603. These crops are widely produced by smallholders and many traders or aggregators are available for off-take. Trading is seasonal, with off-take assured through informal arrangements. However, this system is shallow due to weak enabling functions, limited quality standards, and minimal coordination and lack of depth of buyer seller relationships. Farmers often lack knowledge and resources for standardized grading, sizing, and packaging.

Core Market Functionality: Despite high volumes and regular exchange, the market system underperforms in value creation for farmers and significant performance gaps exist.

- Most transactions are spot-based, with prices negotiated at the point of sale. There is little to no premium for quality, and grades are often not enforced. There are no long-term relationships, and buyers and sellers change with the seasons.
- Flat-rate pricing discourages investment in quality, post-harvest handling, or packaging.
- Supporting functions are weak: Embedded services (such as transport, input bundling, or extension) are minimal or inconsistent. Where bundling exists, the quality of input/service provided by traders remains a challenge, and farmers lack direct access to the relevant inputs. Farmers rely on informal traders and aggregators with loose relationships for almost everything, including inputs, transport, and market activities. These traders often focus on earning from the input and output sides and do not frequently provide quality inputs.
- Scale disadvantages: Fragmented production means logistics and cold storage are inefficient, especially for small or remote producers.
- Coordination failures prevent buyers from consistently or reliably sourcing upgrades to their supply.

This leads to a system that functions efficiently but not effectively, exchange happens, but with limited learning, upgrading, or trust-building. Farmers have limited options to opt out of the system and continue producing and supplying, albeit with compromised performance, and benefit from their farming activity. Systemic interventions and investments are required to transition the system.

Potential Leverage Points: To deepen these commodity markets, facilitation should focus on reducing fragmentation and shifting the incentive structure for both producers and buyers:

- **Aggregation innovation:** Support adaptive aggregation models (e.g., light-touch cooperatives, aggregator networks) that build scale and trust while responding to buyer demand.
- **Differentiation mechanisms:** Introduce simple, enforceable grading standards and link these to rewards (e.g., tiered pricing, preferential off-take).
- **Buyer engagement:** Facilitate partnerships with mid-sized buyers or traders willing to pilot quality-linked procurement and bundled services.
- **Address "last-mile penalties":** Co-invest in local collection points, digital procurement tools, or embedded logistics to reduce exclusion of remote producers.

c. Vegetable Seed Market (In Chitral)

Across the three value chains analyzed, a distinct system dynamics along the depth continuum. The vegetable seed market in Chitral, while structurally thin with few buyers, demonstrates high depth across nearly all dimensions: it features highly differentiated products, bundled services, complex buyer–farmer matching, formalized allocation mechanisms, and national distribution of output. This thin–deep structure is beneficial for participating farmers, though participation is restricted to a limited number of farmers who ensure good performance and reliability.

Overall, this is a niche system with strong coordination and performance; however, the risk of becoming a monopoly exists unless pathways for inclusive expansion and competitive crowding-in are actively facilitated. In the early stages of development, such barriers help businesses make costlier investments in farmers' capacity-building to produce the desired quality, establish a supply chain, and market locally produced seeds. These embedded services are highly important in the context of Chirral, where limited market access makes marketing perishable crops challenging due to a lack of infrastructure.

Potential Leverage Points: This type of market shall be promoted protected and carefully scaled.
Expansion and stabilization: Invest in existing firms to stabilize the seed production models.

- **Managed Crowding-In:** Facilitate competitive replication (e.g., support 2–3 new firms with market research, quality standards, and service bundles).
- **Safeguards against Monopolization:** Encourage light-touch regulation or third-party facilitation of contract fairness and transparency.

d. Thin and Shallow Market for other Fruits and Vegetables

The market for other fruits and vegetables, such as pears, grapes, tomatoes, and pomegranates, is structurally thin and shallow, marked by low actor participation and underdeveloped exchange mechanisms. While national demand for these crops exists and often aligns with the GBC's production window, off-take from GBC remains limited. The core constraint lies in the fragmented, small-scale production of non-marketable traditional varieties that are highly perishable, poorly suited for transport, and prone to post-harvest loss. Trading in these crop increase high transaction costs and unattractive risk profiles for national traders, who prefer sourcing from regions with higher volume, quality, concentrated production and logistics.

The system is caught in a coordination stand-offs: traders lack the incentive to invest in upgrading or sourcing from Chitral, while farmers lack access to market information, buyer connections, packaging materials, and aggregation support. Without functional cooperatives or intermediaries willing to assume aggregation and marketing risk, producers are left isolated. As a result, these crops are sold largely in local markets, with only small volumes reaching down-country markets.

However, positive precedent exists: potato, peas, and apple chains once faced similar constraints, but targeted value chain interventions helped overcome fragmentation by supporting varietal standardization, improving aggregation, and building market access. Replicating these successes for other crops would require coordinated efforts across production upgrading, functional aggregation, and market linkage facilitation, especially for niche varieties with national demand potential.

Potential Leverage Points:

- **Production Clusters:** Invest in establishing concentrated production clusters.
- **Input–Market Synchronization:** Improve access to high-performing seed varieties and cultivars suited to market demand and transport resilience and longer shelf life.
- **Invest in concentrated production or production upgrading:** co-invest with agribusinesses or cooperatives to develop specific areas based on production clusters for limited ranges of crops, reducing transaction costs for traders to off-take.
- **Aggregator De-Risking:** Co-fund logistics, cold boxes, or packaging for local aggregators willing to experiment with remote procurement or marketing of local produce by local agribusinesses.
- **Market Scoping for Niche Demand:** Use rapid buyer assessments to identify niche traders or retailers with interest in unique varieties.
- **Short-Term Coordination Platforms:** Enable seasonal trade fairs, mobile mandi models to link farmer and local traders with markets.

6.4.1. Dysfunctional Support Services

Critical support services that underpin functioning output markets remain largely missing, underdeveloped, or misaligned across the GBC region. Their absence contributes to persistent inefficiencies, low returns for producers, and limited access to higher-value domestic and export markets. These gaps entrench short-term, transactional relationships and inhibit the transition to commercial agriculture.

a. Market Information Systems – Opaque and Reactive

Farmers in the region operate in a context of high uncertainty. Key output markets lie outside the region, and farmers lack access to reliable, real-time information on prices, demand trends, and buyer preferences. Without trusted and timely market signals, producers are reluctant to invest in higher-cost inputs or adopt quality-enhancing practices. This not only reinforces risk aversion but also perpetuates dependence on spot-market traders.

b. Financial Services – Present But Do not Cater Financing Needs

Despite the presence of over two dozen banks in GB and several in GBC, access to finance for farmers and agribusinesses remains negligible.

Commercial banks focus primarily on saving deposits and general banking services, while subsidized agricultural loan schemes are few and largely inaccessible to the average producer or SME. Agribusinesses, especially processors and traders, face a significant credit gap, particularly during harvest, when working capital is critical for aggregating and storing produce. This financial exclusion limits their ability to invest in stocking, packaging, or distribution systems required to access premium markets, where upfront investment in compliance and consistent supply is essential.

c. Transport and Logistics – Fragmented and Costly

Road infrastructure is poor, especially in remote production areas, making first-mile transport to market centers both difficult and expensive. Seasonal accessibility issues further compound this, particularly during harvest periods. For perishable produce such as fruits and vegetables, the lack of appropriate transport solutions, such as cooling-enabled vehicles, results in significant post-harvest losses and missed market opportunities during peak summer production.

d. Storage and Post-Harvest Handling – Inadequate and Risk-Prone

Most farmers have no access to cold storage facilities, except for limited government-managed grain storage. As a result, perishable horticultural produce is harvested and sold immediately, often under distress conditions. Storage decisions are largely driven by traders who purchase the harvest and transport it to down-country facilities for controlled release into the market. Farmers are effectively excluded from this value capture. The absence of temperature-controlled storage in GBC also means premium varieties such as Shoghori pear are offloaded immediately, forfeiting the price premium available during the lean season.

e. Packaging and Branding – Missing Value Addition

Packaging services, whether for fresh or semi-processed products, are absent in the region. Down-country traders bring in basic packaging and is typically limited to generic formats aimed at wholesale markets. There is virtually no branding or product differentiation, which constrains access to value-added outlets such as premium retailers, institutional buyers, or export markets. Without packaging and branding, local produce competes solely on price, typically at the lower end.

f. Food Safety and Certification Services – Incomplete and Exclusionary

While some certification standards, such as HACCP, are available at the national level, key services, such as organic, Fair Trade GlobalG.A.P., and food safety protocols, remain largely unavailable or inaccessible, particularly for medium-sized agribusinesses in GBC. Local consultants to facilitate access to such services are also limited. The absence of these systems excludes regional producers and processors from premium domestic and international value chains, which increasingly demand verifiable safety, traceability, and compliance.

g. Digital Market Platforms – Limited Reach and Integration

Digital platforms for agricultural marketing are emerging in Pakistan, but their footprint in GBC remains minimal. A few entrepreneurs use these tools to market dried fruits, but connectivity issues, trust deficits, and the absence of integrated logistics and payment systems constrain broader uptake. Without adaptation to local realities, digital marketplaces remain aspirational rather than transformative.

h. Cooperatives – Unclear Role and Weak Capacity

Most cooperatives in the region are supply-driven and established by development programs, often without a clear business model or governance framework. While some have attempted to negotiate prices with traders, they often overlook the underlying transaction costs and constraints on the buyer's side. Their role in addressing systemic constraints, such as aggregation, input access, or market linkage, is minimal. In their current form, cooperatives lack both operational capacity and strategic direction.

i. Skilled labour

Skilled labor is a critical supporting function in the agricultural market system, yet it remains severely underdeveloped in GBC. Despite widespread shortages of technical, managerial, and post-harvest skills across the value chain, there are no dedicated agricultural or food industry workforce development programs in place. This gap constrains productivity, limits the adoption of improved practices, and weakens the overall competitiveness of the region's agri-food sector.

6.4.2. Policy, Regulatory and Social Constraints

a. Formal Rules: Policies and Regulations

- **Agricultural Policy:** GB's current agricultural policy demonstrates strong intent but suffers from critical strategic gaps. It lacks prioritization, a clear guiding vision, and coherence between proposed actions. Although the policy outlines numerous interventions, it does not define priority value chains or a transformation pathway for the sector. Foundational structural issues, such as land fragmentation, weak input systems, and limited private sector engagement, are not addressed systematically. Similarly, the policy does not articulate how major opportunities, including CPEC and organic agriculture, will be leveraged to build a competitive advantage. This results in fragmented, unsequenced policy actions that are insufficient to steer sustained, coordinated sector development.
- **Price Control Regulations:** Agricultural commodity prices are set by government are typically updated weekly. These official prices represent average benchmarks and do not account for quality, grade, production costs, or value-added differentiation. Such uniform pricing appears to reduce producers' incentives to improve quality or invest in premium products. Enforcement of these price caps is inconsistent, but branded or formal sector players face greater scrutiny. For instance, a large retail chain in Lahore was initially penalized for selling higher quality produce at prices above the government administered rates, thereby limiting modern retailers' ability to premiumize. Variations in district-level price ceilings also distort incentives; for example, mutton prices in Chitral are set well below national averages, discouraging investment in herd quality and local production.
- **Contract Enforcement:** Contract laws in agriculture are weakly enforced. Farmers frequently side-sell when spot market prices rise, leaving buyers exposed to high supply risks. Retailers and agribusinesses prefer price-locking arrangements for planning and consistency, but poor contract enforcement undermines such coordination and discourages long-term commercial relationships.

b. Informal Rules

- Gendered Benefit Distribution: Women perform a substantial share of agricultural labor across GBC, particularly in production and post-harvest activities, yet men often control market transactions and financial returns. This unequal distribution of benefits reduces women's incentives to increase productivity, especially as higher production volumes translate into greater labor demands without corresponding rewards. Evidence across GBC shows that areas where women have more agency over agricultural income tend to experience stronger agricultural development.

6.5. Strategic Implications and Actions

Market Type	Key Characteristics	Value Chains	Strategic Objective	Key Actions
Thin–Shallow (Problematic)	Few participants + Standardized products	• Buckwheat (niche potential)- • Grapes, tomatoes, pears, pomegranates (commodity or niche pathways)	Transform into niche or commodity zones depending product type which are adjacent possible pathways and focus on bringing more actors both producers and buyers.	• Facilitate farmers to re-orient production and grow market-aligned varieties and increase volume of production • Identify high-potential crops for tailored intervention • Facilitate entry of traders through farmer market linkages. • Build cooperative/cluster models- Pilot niche branding initiatives for unique varieties • Promote niche potential products through exclusive contract production models. • Support infrastructure for aggregation, post-harvest handling.
Thick–Shallow (Commodity)	Many participants + Standardized products	Potatoes, peas, nuts have potential to transition to developed market zeone.	Maintain competition and improve market functionality and focus on moving into deep/developed zone	• Scale out production and develop more production clusters • Strengthen pricing transparency via cooperative-led aggregation • Upgrade seed access and quality • Encourage value addition to improve value chain sophistication • Link with market-responsive inputs and services
Thin–Deep (Niche)	Few participants + Diverse products	• Vegetable seeds such as onion, okra seeds, french beans seeds • Organic and natural certified apricots, branded dry fruit products • Healthy snack bars	Deepen and stabilize niche markets without overcrowding market actors.	• Expand seed production selectively (e.g., okra, potato) • Develop quality certification (GAP, Organic) • Strengthen contracting and input credit linkages • Support lead firms in dried apricot/value-added chains with working capital and branding capacity
Thick–Deep (Developed and Diversified)	Many participants + Diverse products	• Apricots, Cherries, premium apples, off-season vegetables	Make these value chain resilient, and deepen systemic health of the value chains by invest in quality upgrading, premiumization and diversify products and develop new product markets and move the to niche category.	• Promote value addition and product differentiation- Foster inclusive trading models • Support innovation and modern services • Improve input systems such as plant nurseries and promote modern production such as medium to high density planation, planned orchards, etc. • Reduce variety diversity to focus on a limited (6-10) high marketable variety and prolong supply window. • Build alternative value chains beyond spot market to target premium positions in teh supply chains • Invest in planned production and premiumisation strategies

7. Strategic Assessment and Programmatic Recommendations

To achieve transformative impact, investment must target high-leverage "system anchors"— ventures that bundle solutions such as demand-aligned varietal upgrading, labor-saving mechanization, and embedded finance to address multiple constraints simultaneously.

This market systems assessment has mapped the agri-food and agri-tech landscapes of GBC, highlighting both systemic constraints and emerging opportunities. As AP operates at the intersection of finance, entrepreneurship, and systemic change, the findings suggest a high-leverage moment to shape inclusive, sustainable, and tech-enabled sustainable and inclusive agricultural futures.

7.1. Summary of Insights

The findings highlight a dual reality. On one hand, GBC benefits from unique ecological advantages, a growing pool of entrepreneurial youth, and rising domestic and export demand for its high-altitude, organic, and niche produce. On the other hand, systemic weaknesses continue to constrain the region's agricultural transformation, including fragmented landholdings and value chains, limited local processing, weak access to inputs and technology, and the absence of tailored finance for early-stage ventures. These constraints are further compounded by broader structural threats such as climate volatility, youth outmigration, and policy uncertainty.

Across the studied value chains and regions, systemic underperformance is driven by several interconnected factors:

- **Weak intermediation:** Thin, fragmented service and input markets, especially upstream, create systemic stand-offs that prevent actors from upgrading or adopting improved practices.
- **Information Gaps:** Critical information on prices, quality standards, and high-end market requirements rarely reaches farmers due to fragmented and transactional relationships along the chain.
- **Capacity gaps across all market actors:** Input suppliers, farmers, aggregators, traders, and local processors lack the technical, business, and financial capacity needed to grow, upgrade, and capture higher-value positions in the value chain. Access to such services is minimal due to weak or absent supporting functions.
- **Low risk tolerance and fragmented capital:** Early-stage agri-SMEs face a shortage of risk-tolerant finance aligned with innovation cycles, limiting their ability to test, scale, or commercialize new ideas.
- **Mismatched incentives:** There is limited alignment between the quality demanded by end markets and the production practices of local farmers, resulting in inconsistent supply and missed market opportunities.

- **Underpowered support functions:** Inadequate R&D, weak extension systems, and limited embedded services constrain innovation, scaling, and replication of successful practices.
- **Exclusion:** Gender norms, youth outmigration, and geographic remoteness combine to restrict participation in viable growth opportunities and reinforce unequal access to resources and markets.

7.2. Assessment of Strategic Options

In this strategic option analysis, a Strength, Weaknesses, Opportunities and Threats (SWOT) summary analysis is presented followed by a Threats, Opportunities, Weaknesses and Strengths (TOWS) analysis which informs programmatic actions.

Strengths	Weaknesses
• Agro-climatic advantage: high-altitude, cool climate supports premium fruits (cherries, apricots, walnuts) and off-season vegetables. • Organic image: minimal chemical use appeals to health-conscious and premium markets. • Traditional crop-livestock integration and ecological knowledge allow resilient practices. • Youth engagement: returnee and educated youth showing entrepreneurial interest in agri-tech and high-value crops. • Social capital: strong producer groups and cooperatives in some areas. • NGOs and development partner presence (AKRSP, AP, IFAD-ETI) has improved irrigation, skills, and market links).	• Land fragmentation: small, scattered plots (<0.5 ha) limit economies of scale and mechanization. • Thin, fragmented value chains with weak vertical/horizontal coordination. • Weak supporting functions and services and incoherent policy support and regulations. • Poor infrastructure: cold storage, transport, and local processing facilities are lacking. • Low productivity due to traditional practices and weak extension services. • Limited access to climate-smart inputs, agri-tech, and financial products, especially for women and youth. • Lack of market orientation of current crops resulting in watage and low pricce. • Short growing season, gluts and perishability reduce market returns. • Limited value addition, branding, and packaging infrastructure. • Lack of localized tech fabrication, maintenance, and repair services.
Opportunities	**Threats**
• Expanding demand from national and diaspora markets for traceable, organic, high-altitude produce. • **Export momentum:** cherry exports, dry fruit an nut exports • Agri-tourism and hospitality sectors create niche B2B channels. • Improved connectivity (e.g., CPEC roads and other infrastructure projects) enabling wider market access. • Digital platforms could bundle inputs, finance, extension, and market access services. • Branding and value-addition: potential for GI tags, organic labels, fair trade, and small-scale processing (jams, herbal teas) targeting high end domestic and export markets as demand for such products is growing. • Government policy momentum on digital agriculture, youth entrepreneurship, and climate adaptation. • Growing health-conscious urban consumer base and demand for sustainable products. • NGOs and development partners' presence and availability of grants and patient capital.	• Climate risks: glacial lake outbursts, erratic rainfall, and droughts threaten crops and infrastructure. • Youth outmigration and aging farmer population could reduce future workforce. • Political instability and export route uncertainties (esp. via Kashmir, China, Afghanistan). • Risk of donor and government distortion through free distribution or uncoordinated tech pilots. • Digital divide limits reach of innovations to remote communities. • Market volatility and price fluctuations from larger competing regions. • Unresolved land tenure issues and weak policy enforcement discourage private investment. • Risk of policy reversals or over-regulation (e.g., price controls).

Building on the SWOT analysis, a TOWS analysis is presented here to translate SWOT insights into actionable strategies:

1. Strengths and Opportunities align with areas where AP can quickly scale impact (e.g., organic branding, youth innovation, agri-tourism).
2. Weaknesses and Threats inform areas that need mitigation (e.g., climate risks, fragmented plots, digital divide) and point to systemic risks in scaling efforts.
3. WO and ST strategies suggest where AP's capital and TA can be best applied to bridge system gaps and offset constraints.

By situating the TOWS matrix here, we clarify the strategic logic underpinning the conclusions and provide AP with a tool for portfolio planning, partnership alignment, and risk-informed intervention design.

a. Strengths–Opportunities (SO Strategies): Leverage strengths to capture opportunities

1. **Promote organic and high-value branding:** Combine GBC's organic/natural/pure image and unique agro-climatic advantages with rising demand for traceable produce and export interest (e.g., dried cherries, trout fillets, herbal teas).
2. **Invest in youth-led innovation hubs:** Tap into the tech-savvy youth and NGO-supported training systems to develop agri-tech platforms and bundled service ventures.
3. **Scale value-added production:** Leverage horticultural shift, ecological knowledge, and producer groups to scale up local processing aligned with tourism and urban health trends.
4. **Mobilize digital solutions for input access:** Build on social capital and community groups to pilot bundled services platforms (finance + inputs + market info), especially in semi-remote hubs.
5. **Invest in high market potential crop:** Develop production clusters of high market potential crops taking the advantages of newly build road infrastructure.

b. Strengths–Threats (ST Strategies): Use strengths to counteract threats

- **Community-based climate resilience hubs:** Use traditional ecological knowledge and strong producer groups to pilot local adaptive innovations (rainwater harvesting, climate forecasts, regenerative practices).
- **Anchor ventures near road corridors:** Combine improved logistics and AP's investment tools to back SGBs in secure areas.
- **Youth attraction campaigns:** Address outmigration by linking youth entrepreneurs with viable agri-tourism and high-value agriculture ventures via AP's capital and TA. Also, leverage reverse migration and attract returnee youth in business opportunities in agriculture.

c. Weaknesses–Opportunities (WO Strategies): Overcome weaknesses by leveraging opportunities

1. **Finance and TA for value chain upgrading:** Pair poor infrastructure and limited value addition with AP investments in small-scale cold chains, branding, and certification.
2. **Build decentralized tech-fabrication services:** Address weak local maintenance capacity by supporting local repair shops and maker labs through AP TA and partnerships.
3. **Use policy windows to improve finance access:** Work with national and regional schemes to de-risk lending for women/youth tech adopters.

d. Weaknesses–Threats (WT Strategies): Minimize weaknesses and avoid threats

1. **Promote aggregation platforms and cooperatives:** Use AP's facilitation to reduce land fragmentation and coordinate production to reduce gluts and increase bargaining power.
2. **Design exit and sustainability plans for all interventions:** Address dependency on donor support by embedding sustainability and local ownership from the outset.
3. **Co-develop climate-smart business models:** Avoid exposure to climate and market shocks by investing in models with diversified income streams, post-harvest resilience, and protected agriculture, medium density planation and orchard protection nets.

7.3. Programmatic Recommendation for AP

This market assessment has provided a deep dive into the agri-food and agri-tech sectors of GBC, unpacking their performance, constraints, and opportunities from a systemic perspective. As an investor and facilitator, AP is uniquely placed to not only nurture SGBs but also to influence broader market dynamics toward inclusivity, climate resilience, and economic transformation.

AP's ability to blend catalytic capital with technical assistance gives it a distinctive advantage. As GBC moves from subsistence to semi-commercial and export-oriented agriculture, AP can influence the trajectory of this transformation through:

- Targeted investment in anchor SGBs that catalyze improvements in input delivery, output aggregation, and market linkages;
- Support for bundled business models (e.g., agri-tech + finance + advisory) that address multiple constraints in a commercially viable manner;
- Co-creation of localized, tech-enabled solutions that de-risk smart farming for smallholders and promote climate resilience;
- Co-design Incentive-Aligned Support: Deliver TA that strengthens business models while enhancing systemic functions, such as finance access, information flows, or standards compliance. Such TA support shall be instituted with a clear exit plan to flourish market based services.

7.3.1. Intervention Priorities

Based on market analysis and TOWS synthesis, AP should prioritize:

- **Bundled Agri-Tech Services:** Pilot digital platforms that combine precision agriculture tools with input finance, climate forecasts, and extension.
- **Bundled Agri-Tech Services:** Invest in input supply in collaboration with local dealers and input companies piloting and scaling innovative models such as mobile input services embedded with digital advisory for farmers.
- **High-Value Processing and Branding:** Co-invest in ventures with potential to establish regional brands for dried fruits, jams, herbal teas, building on the organic, high-altitude identity of the region. Prioritize the thick-deep markets and value chains for these investments.
- **Strengthen nurseries enterprieses:** Invest in establishing new and strengthening existing nursery enterprises to develop a strong supply of authentic plant materials to cater growing local demand. Collaborate with local stakeholders to curb sale of poor quality unsuitable nursery plants.
- Climate-Smart Business Models: Invest in enterprise that integrate regenerative practices, post-harvest resilience, and diversified cropping.
- **Facilitated Aggregation and Cooperative Platforms:** Support collective marketing, contract farming, and smallholder aggregation to overcome land and volume constraints.
- **Invest in inclusive trading models:** Invest in local formal agribusinesses that offer a combination of input, finance, information and market access targeting high end value chains or address inefficiencies in the current trading chains.
- **Youth-Driven Innovation Spaces:** Experiment with youth-led fabrication, repair, and adaptation hubs for agri-tech, building local capacity and retaining talent.
- **Embedded Financing Mechanisms:** Design blended finance facilities with MFIs or banks to offer tech-linked loans, lease-to-own models, and working capital to SGBs.
- **Promote protected agriculture:** Promote protected farming focussing on vine crops in vegetable segment that will extend season and address local supply demand gaps. Invest in building support and input services for such farming.
- **Experiment and Localising Tech and Talent:** Support IoT solutions, and input innovations that are adapted, fabricated, and maintained locally, especially by youth or women-led SGBs.
- **Finance for Resilience:** Develop blended finance mechanisms with local MFIs or banks to offer tech-linked loans, invoice discounting, or asset-backed financing.
- **Market Connectivity:** Back ventures that act as market integrators, linking fragmented producers to value-added or export channels through aggregation, branding, or cold chain solutions.
- **Establish Agri-innovation hubs:** Establish regional agri-innovation hubs to scaffold facilitation towards product innovation and commercialisation and market access support to local agribusinesses and partner SGBs.

7.4.5. Innovation Challenge Themes

As AP runs regular innovation challenge calls from startups and SGBs, the following innovation tracks and themes shall be prioritised to ensure coherent investments to drive systemic change.

Track 1: Smart Production & Climate Resilience	Focus: Boost farm-level productivity and resilience in GBC's challenging environments.	• **Modern Nurseries & Grafting Services:** Solutions offering certified planting material, modern propagation techniques, or grafting expertise for fruit and vegetable production. • **Protracted and Protected Farming:** Innovations enabling off-season cultivation or winter farming through low-cost greenhouses, tunnels, or early seedling technologies. • **Land-Saving Technologies and Production Methods:** High-density planting systems, vertical farming models, or intercropping methods suited to small, fragmented plots. • Innovative inputs and inputs distribution embed with advisory.
Track 2: Value Addition & Market Access	Enhance the market appeal and profitability of GBC products.	• **Premiumization of Horticultural Products:** Ventures adding value through branding, packaging, organic certification, health-focused formulations, or storytelling. • **Agribusiness Services (Marketing, Inputs, Certification):** Models offering traceability, bulk input procurement, mobile inputs, branding services, or access to organic/GI standards for SMEs and cooperatives. • **Digital Marketplaces for Authentic GBC Products:** Region-specific e-commerce platforms, trust-building tools (e.g., QR verification), or online branding innovations.
Track 3: Tech-Enabled Services for Smallholders	Increase access to timely information, finance, and productivity tools for dispersed farmers.	**ICT for Agriculture:** Mobile-based advisory, drone-enabled crop monitoring, AI weather forecasting, pest alerts, or decision-support systems. Bundled Advisory + Finance Platforms Concepts that combine inputs, credit, and advisory into affordable, scalable service bundles.

7.5. Final Word

This report provides a strategic blueprint for Accelerate Prosperity's role in shaping the agricultural future of GBC. Through thoughtful investment, partnership brokering, and adaptive facilitation, AP can enable a new generation of agri-entrepreneurs and systemic solutions. The pathway from here is not about scaling up projects; it is about scaling up system responsiveness, actor coordination, and the incentives that make inclusive agri-transformation viable.

With the right combination of capital, creativity, and catalytic engagement, AP can move from identifying opportunities to orchestrating systemic change.

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Annexes

A. Market Size Calculations

A1. HH Food Market Demand Calculation

According to national household consumption surveys, Pakistani households spend approximately **45–50%** of their monthly income on food. Applying a conservative estimate of **45% food expenditure,** we can derive a baseline market size for agricultural produce GBC.

- **Average Monthly Household Income in GBC: PKR 15,000**
- Estimated Monthly Food Expenditure per Household (45%): **PKR 15,000 × 0.45 = PKR 6,750**
- Total Estimated Households in GBC: Assuming a total population of 2,150,000 and an average household size of 7, **2,150,000 ÷ 7 = 307,143** households
- Total Monthly Food Expenditure in GBC: **307,143 households × PKR 6,750 = PKR 2.073** billion/month
- Annual Food Market Size (Local Household Market): PKR 2.073 billion × 12 = PKR 24.88 billion/year This PKR 24.88 billion/year represents a conservative baseline for GBC's local food market size, assuming minimal price variability and stable household consumption behavior.
- Urban-Rural Market Split: According to population distribution data, approximately 17% of GBC's population lives in urban areas, while 83% resides in rural areas. Applying this distribution:
- Urban Households (17%): 307,143 × 0.17 = 52,214 households Urban Market Size: 52,214 × 6,750 × 12 = PKR 4.23 billion/year
- Rural Households (83%): 307,143 × 0.83 = 254,929 households Rural Market Size: 254,929 × 6,750 × 12 = PKR 20.65 billion/year

Table 7-4: Summary Table of the Food Industry

Segment	Households	Monthly Spend (PKR)	Annual Market Size (PKR)
GBC Urban	52,214 (17%)	6,750	4.23 billion
GBC Rural	254,929 (87%)	6,750	20.65 billion
Total (GBC)	307,143 (100%)	6,750	24.88 billion

A2. Tourists Market Estimation

Table 7-7: Tourists' Consumption Impact on Horticultural Commodities (During Stay)

Crops/Commodities	Average Daily Consumption	Consumption During Stay Per Capita Daily Consumption x # Tourists x Average number days stayed			Market Size Total Quantity Consumed x Price Per Qty		
		Chitral	GB	GBC Total	Chitral	GB	GBC Total
Fresh Fruits		**58.79**	**112.28**	**171.07**	**12.3**	**21.5**	**33.8**
Apricot	0.01	18.18	34.72	52.9	0	3.3	3.3
Apples	0.01	19.68	37.58	57.26	5.7	6.4	12.1
Cherries	0	4.98	9.51	14.49	1.5	3.6	5.2
Grapes	0.01	12.48	23.83	36.31	4	6.3	10.3
Pomegranates	0	1.67	3.19	4.85	0.6	1.1	1.7
Peaches	0	1.5	2.86	4.36	0.4	0.6	0.9
Pear	0	0.3	0.57	0.87	0.1	0.2	0.3
Mulberries	0	0.01	0.01	0.02	0	0	0
Dry Fruits and Nuts		**1.7**	**3.25**	**4.95**	**1.1**	**2.3**	**3.4**
Dried Apricot	0	1.01	1.93	2.95	0.6	1.3	1.8
Dried Apples	-	0.08	0.14	0.22	0	0.2	0.2
Dried Cherries	-	0.05	0.09	0.13	0.1	0.1	0.2
Dried Persimmon	-	0.05	0.09	0.13	0	0.1	0.1
Mulberries	-	0.38	0.72	1.1	0.2	0.4	0.5
Walnut	0	0.05	0.1	0.16	0	0.1	0.1
Almond	0	0.05	0.09	0.14	0.1	0.2	0.3
Apricot nuts	0	0.04	0.08	0.12	0.1	0.1	0.2
Vegetables		**611.58**	**1167.96**	**1779.55**	**79.1**	**154.6**	**233.7**
Potato	0.08	178.97	341.79	520.76	19.1	35.1	54.2
Tomato	0.06	128.09	244.63	372.72	17.6	33.6	51.2
Onions	0.06	121.85	232.71	354.57	13	30.1	43.1
Peas	0.03	73.86	141.05	214.9	16.7	31.6	48.3
Cucumber	0	0.09	0.17	0.26	0	0	0
Green Leafy Vegetables	0.02	39.66	75.74	115.4	2.2	4.1	6.3
Bitter Gourd, Lady finger, Brinjal, Cucumber	0.01	31.38	59.92	91.3	6.2	11.8	18
Cabbacge, Cauliflower	0.01	20.16	38.5	58.66	2.2	4.2	6.5
Tinda, Pumpkin, Bottle Gourd	0.01	17.52	33.46	50.98	2.1	4.1	6.2
Grand Total		672.07	1283.49	1955.56	92.55	178.41	270.96

Table 7-6: Tourist Segment Size

Type of Consumption	Estimated Spending	Share of total Spending (Category spend/total Spending)	Estimate Size based on spending (PKR Billion) # of tourists x Per Capital Spending			Assumptions
			Chitral	GB	Total	
Local Consumption of Food	1000/day Per Capita x 5 days = 5000	5000/38,000 = 11%	**2.74**	**4.18**	**6.92**	Each tourists spends approx. PKR 1000 on food and beverage
Takeaway of Local Dry Fruits & Products	2,500	2,500 / 38,000 = 6.6%	**1.37**	**2.05**	**3.42**	Assume ~85% of tourists purchase takeaways; each buying tourist spends PKR 2,500

Table 7-8: Dry Fruit Takeaway Demand

Crops/Commodities	Take Away Volume (MT)			Market Size (Million PKR)		
	Chitral	GB	GBC Total	Chitral	GB	GBC Total
Dried Apricot	326	597	923	181.3	386.8	568.1
Dried Apples	37	68	105.48	8.6	85.3	93.9
Dried Cherries	37	68	105.48	50.3	85.3	135.6
Dried Persimmon	23	4	26.82	16.6	2.4	18.9
Mulberries	116	213	329.62	15.3	104.7	120
Walnut	163	299	461.47	285	299.9	584.9
Almond	186	341	527.4	465.4	637.2	1102.5
Apricot nuts	70	128	197.78	97.7	192.1	289.8
Grand Total	**958.6**	**1718.4**	**2677**	**1120.1**	**1793.7**	**2913.8**

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start@accelerateprosperity.org
pk.accelerateprosperity.org

Accelerate Prosperity Office, Level 9, Serena Business Complex, G-5/1, Islamabad