
Evolution and Spatial Distribution of the Cold Storage Industry in Jammu and Kashmir: A Geographical Analysis

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ABSTRACT

Industrialization is recognised as a crucial and enduring method for attaining strong growth. Countries worldwide have achieved desirable economic results by executing well-designed and planned industrialization strategies. Post-colonial countries have started similar initiatives inspired by this worldwide trend. India has pursued planned industrialization with an emphasis on decentralised growth throughout its states and territories in line with its developmental goals. Jammu and Kashmir (J&K) is focusing on industrialising, namely targeting the horticulture sector and its related connections. The cold storage business has emerged as a significant development in this area. This research project intends to investigate the nature, features, prospects, and connections of the cold storage business in Jammu and Kashmir using field-collected data. The report provides policy suggestions to improve the industrialization process in the area, thereby boosting its overall economic growth.

Introduction

The transition from an agrarian-based society to one dominated by industry and urban development is termed industrialization. This transformation represents a fundamental shift in the socio-economic



structure of human societies and is historically associated with the onset of the Industrial Revolution. The First Industrial Revolution, which originated in England during the eighteenth century, marked a turning point in global economic history by altering production systems, labour relations, and patterns of consumption. It introduced mechanized manufacturing, factory-based production, and technological innovation, leading to unprecedented increases in productivity and economic output (Deane & Deane, 1979).

Industrialization is commonly defined as the large-scale manufacturing of goods through specialization, division of labour, and mechanization of production processes. Waged labour emerged as a core feature of industrial economies, enabling the optimization of production systems and facilitating capital accumulation. Over time, successive industrial revolutions further transformed manufacturing techniques, each introducing new technologies and organizational structures. Empirical research consistently highlights the crucial role of industrial revolutions in fostering long-term economic growth and development by improving efficiency, expanding production capacity, and enhancing technological capability (Stearns, 2020).

Since the emergence of the First Industrial Revolution, the world has experienced several waves of industrial transformation. As industrialization spread beyond Europe, an increasing number of countries adopted industrial modes of production, resulting in substantial gains in global economic growth and development (Cobb, 2014). These revolutions reshaped economies and societies by accelerating technological progress, diversifying production systems, and increasing labour productivity. However, the rapid pace of industrial expansion has also generated concerns related to environmental degradation, resource depletion, and widening social inequalities.

The contemporary phase, often referred to as the Fourth Industrial Revolution, is characterized by the integration of digital technologies, automation, artificial intelligence, and advanced computing into manufacturing and service sectors. Alongside technological change, this phase has brought significant structural transformations in societies, organizations, and labour markets. Production processes have diversified rapidly, resulting in changing consumer preferences, shorter product life cycles, and heightened market competition (Storm & Naastepad, 2005). Consequently, firms are compelled to invest heavily in research and development to maintain competitiveness and adapt to evolving global demand patterns.

Industrialization has profoundly altered the dynamics of demand and supply, including production routes, distribution methods, and consumer choices. The outcomes of early industrial revolutions differ markedly



from those of the recent ones. While production volumes have increased substantially, the cost of goods has declined due to economies of scale and technological efficiency. Simultaneously, improvements in product durability and the extended shelf life of perishable commodities have enhanced market efficiency and consumer welfare (Odhiambo, 2019). These changes have contributed to better resource allocation, increased consumer satisfaction, and overall industrial growth.

The introduction of mass production systems and technological advancements has significantly improved human living conditions. Successive industrial and technological revolutions have directly contributed to the advancement of healthcare facilities, improved medical technologies, and expanded access to essential goods and services. The availability of food, manufactured goods, and basic amenities has increased substantially, resulting in improved living standards and life expectancy. The interaction of these factors has led to a remarkable increase in the global population (Lucas, 2002). While population growth has stimulated urbanization and economic expansion, it has also placed immense pressure on natural resources and ecosystems, raising serious concerns regarding environmental sustainability and long-term development.

Industrialization has enabled many countries to achieve economic development and political independence while supporting domestic industries and labour markets. The cumulative effects of industrial revolutions have contributed to sustainable development by improving income levels, extending life expectancy, and enhancing overall quality of life (Crafts, 1997). These advancements have also expanded access to education, healthcare, and modern technologies, further strengthening human capital and social well-being. Additionally, industrial growth has generated employment opportunities and facilitated wealth creation across various sectors of the economy.

However, the timing and pace of industrialization have varied significantly across countries. Britain, as the pioneer of industrial development, experienced rapid economic growth and subsequently expanded its colonial influence across large parts of the world (Lee & Paine, 2019). Colonial expansion provided Britain with access to raw materials, labour, and markets, thereby accelerating its industrial growth and reinforcing global economic dominance. This historical process contributed to the categorization of countries into developed, developing, and underdeveloped regions. Colonized nations during the eighteenth and nineteenth centuries, including India, faced structural disadvantages that hindered their industrial progress (Haines, 2004). These historical inequalities continue to shape contemporary global economic disparities.



India's growth and development trajectory was significantly constrained by prolonged colonial rule, which lasted for more than a century and resulted in deep-rooted economic backwardness (Roy, 2011). Following independence in 1947, India embarked on its industrialization journey relatively late, a process often described as late industrialization (Amsden, 1991). The Indian state adopted a mixed economic model, combining public sector dominance in strategic industries with private sector participation governed by market mechanisms. This approach aimed to balance state intervention with economic efficiency and self-reliance, laying the foundation for gradual industrial growth in the post-independence period.

India's federal structure has further contributed to regional disparities in industrial development. Each state and union territory exhibits distinct economic characteristics influenced by geography, resource availability, infrastructure, and policy frameworks. Consequently, industrialization across India has followed diverse spatial trajectories, producing uneven development outcomes (Majeed et al., 2022). While lowland and coastal regions have experienced rapid industrial growth and modernization, hilly and mountainous areas have lagged behind due to physical constraints and limited infrastructure.

At one end of the industrial spectrum are states such as Maharashtra and Tamil Nadu, which have emerged as major industrial hubs, benefiting from favourable location, infrastructure, and policy support. At the other end are states like Himachal Pradesh and Jammu and Kashmir, where industrial development has progressed more slowly (Majeed et al., 2021). These regional disparities highlight the complex and multi-dimensional nature of industrialization in India, shaped by historical legacies, geographic conditions, and evolving policy interventions.

Research Objectives

1. To examine the growth and present status of the cold storage industry in Jammu and Kashmir.
2. To analyze the spatial distribution and infrastructure of cold storage units in the region.
3. To assess the sector's forward and backward linkages with horticulture, transport, and packaging.
4. To study the socio-economic profile of cold storage entrepreneurs in Jammu and Kashmir.
5. To identify major challenges, opportunities, and policy needs of the cold storage sector.

Research Questions

1. What is the current state and distribution of cold storage units in Jammu and Kashmir?
2. How has the cold storage industry evolved in response to the growth of the horticulture sector?



3. What are the demographic and socioeconomic characteristics of cold storage unit owners?
4. What challenges (financial, logistical, regulatory) do cold storage operators face?
5. What policy recommendations can be made to support the sustainable growth of this **industry**?

Research Methodology

This study adopts a descriptive and analytical case study approach to examine the cold storage industry in Jammu and Kashmir (J&K), with emphasis on its evolution, regional significance, and linkages with the horticulture sector. The research is based on primary and secondary data. Primary data were collected through structured field surveys of six cold storage units located in the Industrial Growth Centre (IGC), Lassipora, Pulwama, a major industrial hub in the region. The Annual Survey of Industries (ASI) questionnaire was used to obtain firm-level information on infrastructure, ownership, technology, capacity, and performance, along with the socio-economic profiles of entrepreneurs. Secondary data were sourced from government reports, policy documents, and academic literature related to industrial development, horticulture, and cold chain infrastructure. A purposive sampling method was employed. Data analysis involved descriptive statistics, supported by comparative and thematic analyses to examine technological adoption, operational linkages, and financial structures. Despite its limited geographical scope, the study provides insights into regional industrial dynamics and policy gaps in J&K.

Exploring the Cold Storage Sector in Jammu and Kashmir

Jammu and Kashmir (J&K), located in the northernmost part of India, is characterized by a rugged mountainous terrain interspersed with fertile valleys. Agriculture has historically been the backbone of the region's economy, providing livelihood to a majority of the population. The principal agricultural crops include rice, maize, millets, pulses, barley, and wheat, while vegetable and fruit cultivation play a vital role in the agrarian structure of the region (Hassan et al., 2021b). J&K is also known for sericulture, though its output has remained inconsistent over time. Among agricultural exports, apples, walnuts, pears, cherries, and peaches dominate, while saffron represents a unique and commercially significant crop exclusive to the region (Kafi et al., 2018).

Traditionally dependent on subsistence agriculture, the economy of J&K has gradually shifted towards horticulture, reflecting a broader process of agricultural diversification (Taufique & Khursheed, 2018). This transformation has been accompanied by increasing integration with allied sectors such as storage, transportation, packaging, and marketing. Government initiatives and policy interventions aimed at



strengthening agriculture and horticulture have further accelerated this transition (Dar et al., 2020). As a result, horticulture has emerged as one of the most dynamic sectors of the regional economy.

The horticulture sector in J&K has assumed substantial economic significance, generating an annual turnover exceeding ₹5,000 crores and offering foreign exchange earnings of nearly ₹160 crores from walnut exports alone (Qammer, 2018). Fruit production has expanded remarkably, rising from approximately 1.83 lakh metric tons in 1971–72 to over 21 lakh metric tons in 2017–18 (Akmali, 2021). This growth has necessitated institutional and infrastructural expansion, particularly by the Department of Horticulture Planning and Marketing, which has adapted its operations to changing production volumes and market dynamics. With India's integration into global trade frameworks under the World Trade Organization, horticultural marketing in J&K has undergone notable restructuring.

Initially, fruit transportation from J&K was largely confined to northern Indian markets, particularly Delhi (Alaie, 2020). Over time, the department expanded its outreach to nearly 225 markets across various states. The establishment of terminal markets, satellite markets, and APNI-mandis throughout the region has significantly improved market access, reduced transaction costs, and enhanced marketing efficiency (Ghuman, 2000). These developments have enabled producers and traders to connect with wider consumer bases, thereby strengthening the horticultural value chain.

The expansion of horticulture has produced strong multiplier effects across the regional economy by generating forward and backward linkages with multiple sectors (Mittal, 2007). Horticulture has absorbed surplus agricultural labour and redirected it towards more productive activities, thereby improving labour efficiency and income levels (Majeed & Mushtaq, 2022). Empirical studies indicate that farmers engaged in horticulture exhibit higher productivity and efficiency compared to those dependent on traditional agriculture (Giannakis & Bruggeman, 2018). The sector has also enhanced access to knowledge, innovation, and market information, contributing to broader economic diversification.

A critical outcome of horticultural expansion in J&K has been the development of cold storage infrastructure. Cold storage facilities have played a pivotal role in reducing post-harvest losses, extending the shelf life of perishable commodities, and stabilizing prices for both producers and consumers. By ensuring year-round availability of fruits, particularly apples, these facilities have strengthened supply chains and enhanced food security. Moreover, the growth of cold storage has created new employment opportunities, reinforcing its positive impact on regional development.



In recent years, J&K has witnessed a substantial increase in the establishment of cold storage units, leading to the gradual expansion of the cold storage industry. These facilities aim to preserve perishable commodities by maintaining optimal temperature and humidity conditions, thereby preventing spoilage and quality deterioration (Chakraborty, 2020). In India, the cold storage sector primarily caters to fruits, vegetables, and food items, though it has increasingly diversified to include processed foods, pharmaceuticals, and beverages (Salin, 2010). The industry functions as a critical intermediary service within the agri-food system and exerts wide-ranging economic, social, and technological impacts (Paul et al., 2018).

Cold storage facilities rely on advanced technologies to regulate environmental conditions, ensuring product quality for further processing or consumption. These technologies contribute significantly to waste reduction and sustainability within supply chains, while also facilitating domestic and international trade by maintaining quality standards during storage and transportation. However, the establishment of cold storage units requires substantial capital investment, ranging between ₹50 and ₹100 crores depending on size and capacity. Despite high initial costs, cold storage enterprises tend to generate higher returns compared to many other small and medium-scale industries (Subin, 2011).

National-level studies suggest that average capacity utilization in Indian cold storage units is around 75%, indicating strong demand and long-term growth potential (Anwer et al., 2019). Ownership patterns reveal that private individuals and firms account for nearly 90–93% of cold storage facilities, highlighting the dominance of private entrepreneurship in the sector. With rising demand for temperature-controlled logistics, the cold storage industry offers considerable opportunities for new investment, technological innovation, and efficiency enhancement.

Jammu and Kashmir have experienced a remarkable 700% increase in cold storage capacity over the past few years, enabling the storage of more than 2.5 lakh metric tons of locally produced apples (Hassan et al., 2021a). The state government has actively promoted private investment in cold storage infrastructure to address chronic post-harvest losses and enhance farmer incomes. These initiatives form part of broader efforts to develop agriculture and allied sectors in an inclusive and sustainable manner. Cold storage facilities allow orchardists to defer sales until periods of higher demand, thereby securing better prices and stabilising incomes throughout the year.

The Industrial Growth Centre at Lassipora (IGC-L), located in Pulwama district, represents a key hub of industrial activity in J&K. It is the second-largest industrial estate in the Union Territory and the largest in the Kashmir Valley. The estate hosts nearly 800 industrial units, including the largest concentration of



cold storage facilities in the region. Additional cold storage units operate in Anantnag and Shopian, while efforts are underway to expand capacity in North Kashmir. The total cold storage capacity in South Kashmir alone is approximately 2.5 lakh metric tons and continues to grow annually.

These facilities employ advanced controlled-atmosphere technology, regulating levels of oxygen, carbon dioxide, and nitrogen to preserve fruits over extended periods. At the national level, India hosts around 8,186 cold storage units with a combined capacity of approximately 374 million metric tons. In J&K, 69 cold storage units account for a total capacity of about 250,169 metric tons, reflecting the region's rapid infrastructural expansion.

In contemporary J&K, the Micro, Small, and Medium Enterprises (MSME) sector is expanding, though growth remains uneven across regions and industries. Increasing entrepreneurial engagement among youth reflects a gradual cultural shift towards enterprise development (Mehak, 2022a, 2022b, 2022c). Nevertheless, systematic data on industrial structure, growth dynamics, and constraints remain limited, underscoring the need for focused empirical research (Mushtaq et al., 2022). This study addresses this gap by examining the cold storage industry as a critical component of regional industrialization.

Results and discussion

Primary data for the study were collected from six cold storage units located within the Industrial Growth Centre, Lassipora. These units primarily store apples, though some chambers are also used for banana ripening through controlled temperature adjustments. The peak operational season extends from October to April. All sampled units rely on imported technology sourced mainly from Poland, France, and China, reflecting the technological lag in domestic cold storage R&D (Subin, 2011). For confidentiality, firm identities were anonymized and analyzed using serial identifiers. Despite dependence on foreign technology, these units play a vital role in sustaining horticultural growth and supporting the regional economy.

Table 1. Basic Information about the firm owners.

S. No	Age	Residence	Years of Education	Gender	Qualification
1	39	Urban	17	Male	B. tech
2	41	Semi-urban	17	Male	Graduate
3	54	Rural	16	Male	B.com



5	43	Urban	10	Male	10 th
6	36	Urban	15	Male	M.B. A
7	43	Rural	17	Male	Graduate
Average	36.5	Urban	14.4	Male	Graduate

An analysis of Table 1 reveals that the majority of cold storage unit owners in Jammu and Kashmir possess adequate skills and technical expertise to manage complex storage operations effectively. Only one proprietor meets the minimum educational qualification of matriculation, indicating a generally high level of human capital within the sector. A clear urban bias is evident, as all unit owners are based in urban areas, suggesting limited awareness, accessibility, or investment capacity in rural regions. The sector remains male-dominated, with no female ownership observed among the sampled units. The average age of proprietors is approximately 50 years, reflecting a blend of experienced and relatively younger entrepreneurs. Notably, two of the six units are very young—between three and five years old—indicating that the cold storage industry in J&K is still in its nascent phase. With adequate financial support, infrastructure, and policy backing, this sector has the potential to transform the regional economy by creating strong upstream and downstream linkages.

Field survey results indicate that for all sampled owners, cold storage represents their first entrepreneurial venture. Although many owners come from families with established business backgrounds, these units function as independent start-ups without prior industrial linkages. Prior to investment, owners conducted detailed market research, reflecting informed risk-taking despite limited direct entrepreneurial experience. This marks a significant transition from traditional business involvement to capital-intensive industrial entrepreneurship, suggesting growing confidence in the sector's future prospects.

Encouraging developments are visible in terms of forward and backward linkages. After operating cold storage units for some time, owners recognized the rapid expansion of horticulture and the derived demand for packaging materials, particularly corrugated boxes. Consequently, two units diversified by establishing corrugation plants within the same industrial estate. This strategic diversification has strengthened industrial interlinkages, supporting both horticultural and manufacturing activities. The emergence of such linkages signals a gradual structural shift in the J&K economy—from consumption-oriented to self-sustaining and eventually production- and export-driven. If sustained over the next few decades, these dynamics could generate employment, attract investment, and enhance regional economic resilience.

Table. 2. Immovable Properties of firm.

S. No	Land in Kanal	Building infrastructure	Machinery and Plants	Transport	Operating system
1	40	200,000,000	330,000,000	0	12,00,000
2	36	700,000,000	450,000,000	4,000,000	90,0000
3	29	400,000,000	240,000,000	0	33,00,000
4	43	100,000,000	550,000,000	0	23,000,00
5	37	60,000,000	150,000,000	3,000,000	43,00000
6	34	800,000,000	650,000,000	5,000,000	54,00,000

According to Table 2, the average landholding of a cold storage unit is approximately 31 kanal, with most units having storage capacities exceeding 31,000 metric tons, alongside scope for future expansion. Only one-unit (Business Serial No. 1) operates outside the Industrial Growth Centre (IGC) Lassipora and is situated on owned or inherited land. In contrast, units within the IGC operate on leased government land, typically for a period of 89 years. At the end of the lease tenure, the government retains the option to renew the lease or reclaim the land. Unit holders pay an average lease rent of ₹1.9 lakh per kanal and must comply with prescribed legal and administrative procedures. Strict adherence to regulatory guidelines is mandatory, as non-compliance can result in lease termination.

Transportation infrastructure is largely outsourced, as most cold storage units do not maintain their own vehicle fleets. This is primarily due to the seasonal nature of transportation demand, which is concentrated over two to three months annually and does not justify year-round fleet ownership. Only two units reported limited in-house transport facilities, while the majority depend on third-party logistics during peak seasons. This approach reduces fixed costs and enhances operational flexibility. Over time, the growth of cold storage and horticulture may stimulate the development of a robust transportation and logistics sector in the region. Such a sector could cater to horticultural exports during peak seasons and serve industrial needs during off-peak periods, generating employment and fostering economic diversification.

Table.3. No of chambers, bins and crates

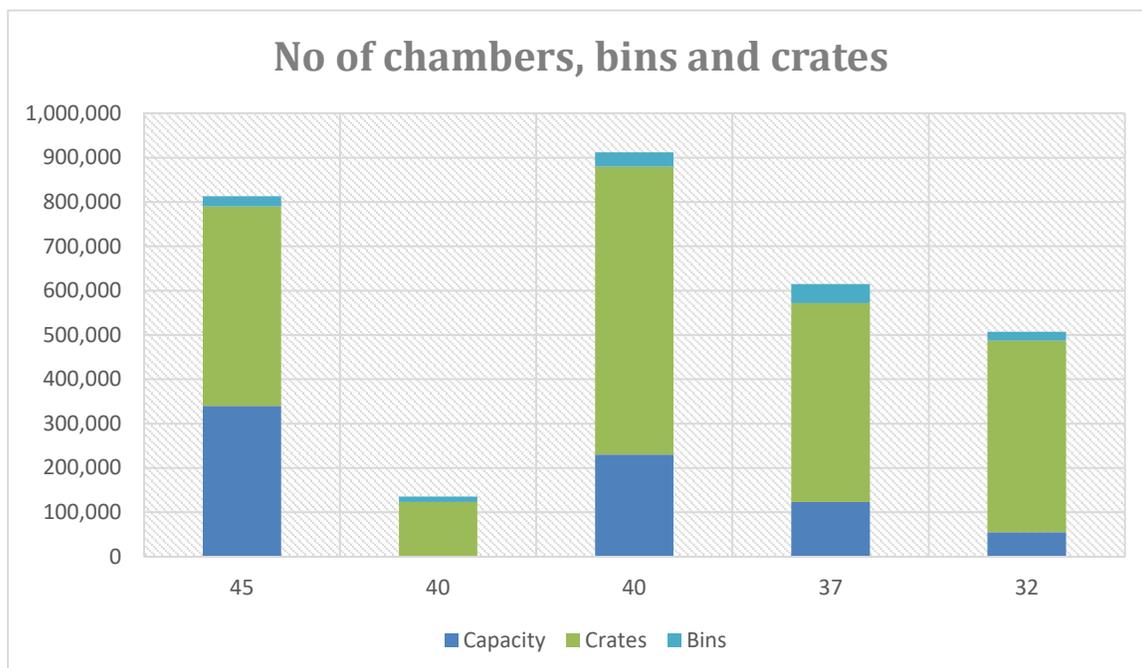
S.no.	Chambers	Capacity	Crates	Bins
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1	45	340,000	450,000	23000
2	40	120,000	123,000	12000
3	40	23,0000	650,000	32000
4	37	123,000	449,000	43000
5	32	55,000	432,000	20000

Table 3 outlines the internal capacity of cold storage units in the study area. On average, each unit comprises around 39 chambers with a storage capacity of nearly 340,000 crates. While this capacity appears substantial at the unit level, it remains insufficient when viewed against the current and potential horticultural output of J&K due to the limited number of operational units. Expanding both the number of cold storage facilities and the capacity of existing units is essential to meet future demand and reduce post-harvest losses.

There is considerable variation in the number of bins across units. One unit records the lowest number of bins, while another has the highest, reflecting differences in investment capacity and operational scale. The cost of storage infrastructure is notably high; crates alone cost approximately ₹1.5 crore, while bins are even more expensive due to their construction from imported Polish wood. These high input costs significantly increase operational expenditure. Optimizing bin utilization, improving allocation efficiency, and exploring alternative or locally sourced materials could help reduce costs and enhance sustainability.





On average, cold storage units charge around ₹160 per crate for a minimum storage period of four months. Depending on market conditions, annual gross profits may range between ₹6 crore and ₹20 crore, before accounting for expenses. However, profitability is constrained by high operational costs, particularly energy consumption. Units must maintain uninterrupted temperatures between 0–3°C and humidity levels of 90–95%, requiring continuous and reliable electricity supply. Power disruptions or price fluctuations pose serious risks to both operational efficiency and profitability.

Conclusion

In summary, while the cold storage industry in Jammu and Kashmir remains in an early stage of development, it demonstrates strong potential to support horticulture-led growth, industrial diversification, and regional economic transformation. Strategic investments in infrastructure, energy reliability, logistics, and policy support are critical to unlocking this potential and ensuring long-term sustainability.

India is the world's second-largest producer of vegetables and the largest producer of fruits. Owing to their highly perishable nature, fruits and vegetables require specialized preservation techniques to maintain quality and extend usability beyond the ripening stage. Cold storage has emerged as a scientifically proven solution that enables the storage of perishables at controlled temperatures, thereby reducing post-harvest losses, preventing distress sales, and allowing farmers to secure better prices. By stabilizing food supply and prices, cold storage contributes significantly to food security, farm income enhancement, and the long-term sustainability of the agricultural sector.

Fruits and vegetables account for nearly 18–20% of India's total agricultural and horticultural output, indicating substantial scope for improving storage efficiency and value addition through cold chain infrastructure. Investment in cold storage facilities not only extends the shelf life of produce but also promotes agribusiness growth, market expansion, and employment generation, particularly in rural areas. By facilitating access to wider markets, cold storage enhances revenue streams for farmers and distributors alike.

The economy of Jammu and Kashmir (J&K) has historically faced instability and limited growth. In response, both central and state governments have periodically introduced policies aimed at revitalizing economic activity and ensuring sustainable development. In recent years, there has been a notable shift from public-sector-led industrialization to private-sector-driven growth, alongside a transition from



traditional agriculture towards horticulture. This structural shift has resulted in sustained expansion of the horticulture sector, generating strong economic linkages across allied industries.

A major outcome of horticultural growth in J&K has been the emergence and expansion of the cold storage industry. Although still in its early stage of development, the cold storage sector holds considerable potential to strengthen horticulture and contribute to broader economic transformation. The limited availability of systematic information on this sector provided the primary motivation for the present study, which aimed to examine the structure, functioning, and economic linkages of cold storage units in J&K, while offering policy-relevant insights for future expansion.

Using primary data collected through the Annual Survey of Industries (ASI) questionnaire and supported by descriptive analysis and case study methods, the research provides new empirical evidence from the field. The findings indicate that cold storage entrepreneurs generally come from financially stable business families and possess adequate capital, networks, and, in some cases, political linkages that facilitate entry into this capital-intensive sector. Investment in cold storage units is largely financed through institutional loans and government subsidies, accounting for nearly 90–95% of total investment, while personal financial contributions remain substantial.

The cold storage sector in J&K is closely integrated with the horticulture industry, particularly apple production, making its profitability highly dependent on output levels, quality, and market conditions. Spatial concentration is evident, with nearly 80% of cold storage units located in Pulwama district, followed by Shopian and emerging investments in Anantnag. Significant potential exists for expansion into northern and central Kashmir, as well as districts in the Jammu region.

Overall, the study confirms the strong backward and forward linkages of the cold storage sector with agriculture, packaging, transportation, and marketing. Strengthening this sector through targeted policy support, infrastructure development, and regional diversification can play a transformative role in enhancing economic resilience, employment generation, and sustainable development in Jammu and Kashmir.



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