

Adequacy of Cold Storage Capacity in India: A State-Level Analysis

Dr Gaganpreet Kaur Kaushal*

¹Assistant Professor, PG Department of Economics, Sri Guru Gobind Singh College, Chandigarh

*Corresponding author: Dr Gaganpreet Kaur Kaushal

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Abstract: Addressing agricultural issues is the foremost requirement for the socio-economic development of masses in India. With rising agricultural production, it has become increasingly important to provide adequate infrastructure to support pre- and post-harvest agricultural operations in rural India. Availability of adequate cold storage facilities is such requirement that can save farmers from post-harvest losses due to spoilage of perishable farm and non-farm produce during transit and storage. Using secondary data for 2022-23, 2023-24 or 2024-25, the present study assesses variation and adequacy of cold storage facilities across 15 major states of India by using descriptive statistics along with the adequacy ratio. Using production of fruits, vegetables, milk, meat, fish, and cold storage capacity across states, the study calculates cold storage adequacy ratios across states. The cold storage capacity and adequacy ratio showed greater variation across states compared to the production of perishable produce. The study shows that even the top-performing state of Uttar Pradesh has an adequacy ratio of 16% (less than 20%), followed by West Bengal at around 12%.

Keywords: Cold Storage, Adequacy Ratio, Descriptive Statistics, Horticulture.

1. INTRODUCTION

India is predominantly an agricultural nation, accounting for nearly 18% of GDP and providing livelihoods to around 46% of the population. Low productivity and heavy dependence of population make agriculture a central focus for addressing the issue of poverty in India at regional and national level. Agricultural production in India is consistently on the rise along with an appreciable rise in agro-processing industry. Apart from foodgrains and other cash crops, India's horticulture production has grown tremendously during the last decade. India's horticulture production increased from 280.70 million tonnes in 2013-14 to 367.72 million tonnes in 2024-25, representing 31% rise in production of fruits, vegetables and other horticulture products, with fruits recording the production of 114.51 million tonnes, vegetables recording 219.67 million tonnes and other horticulture crops recorded the production of 33.54 million tonnes in 2024-25. Currently, horticulture accounts for nearly 33% of GVA in agriculture, making it prominent driver of agricultural growth in India. Besides, India is the world's largest milk producing nation with 247.9 million tonnes production in 2024-25. Poultry is also the fastest growing sector of India, providing eggs and meat to India's growing population along with appreciable rise in poultry exports. Fast-paced life in cities has increased the demand for frozen and ready to eat processed food in urban India.

The trends seem encouraging but require efficient handling of horticulture, dairy and poultry produce at all levels of agricultural marketing to reflect in terms of increased agricultural incomes and reduced rural poverty.

Efficient storage of agricultural produce is vital for addressing poverty in India, as large share of rural households depend on agriculture for their incomes and livelihood. Sound agricultural marketing infrastructure can help farmers to earn more income from their produce and generate employment opportunities beyond cropping activities. Better storage, processing, transportation and market facilities can improve farmers' income by reducing post-harvest losses. Such facilities save farmers from the plight of distressed sale of their produce to middlemen or commission agents within the village, thereby helping them fetch better price for their crops. Although each component of agricultural marketing is equally important, present study focuses on cold storage by conducting a spatio-temporal analysis of the cold storage facilities across Indian states and assessing the adequacy or inadequacy of this facility across states during the period. The study covers fifteen Indian states for the years 2022-23, 2023-24 and 2024-25 according to availability of data. The top fifteen Indian states in terms of their Net State Domestic Product (NSDP) in

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agriculture have been chosen for the purpose of present analysis.

India's need for cold storage is consistently rising because agricultural production in India is rising faster than the supply chain capacity to preserve, transport and market perishable agricultural produce in a timely and efficient manner. Cold storage helps to preserve perishable horticulture, poultry, seafood and dairy produce, making processing and marketing of agricultural produce more efficient. Inefficient handling and storage of fruits, vegetables, dairy, poultry and fish produce cause heavy losses to the producers due to loss of freshness, quality and nutritional value, calling for strong emphasis on improving cold storage facilities. Cold storage allows producers to hold their produce when prices are unfavourable or market demand is low. Cold storage also improves export competitiveness by maintaining the temperature and quality of perishable agricultural produce from the farm to port. Adequate cold storage facilities can stimulate expansion of other productive economic activities in rural India, such as grading, processing, freezing, packaging and transporting, which may help to generate additional employment opportunities for the rural population and address rural poverty. Cold storage helps low shelf-value products to be marketed over a longer period, reducing the time sensitivity of agricultural produce, while adding value to it.

2. REVIEW OF LITERATURE

Joshi & Jain (2026) emphasised that cold-chain infrastructure is necessary for reducing post-harvest losses and improving agricultural supply chains. In another study, they held that cold-chain infrastructure can help improve market access and participation, along with improvements in post-harvest management of agricultural produce. Using primary data from 45 operational cold-storage warehouses, Andukuri, Mahendran & Choyal (2025) examined how effective cold storage facilities can eliminate risk in the Chilli Value Chain of Guntur, Andhra Pradesh. The study demonstrated that small warehouses had better capacity utilisation and profitability than medium and large units.

Patowary, S. & Sarma, A. (2024), in their study on the economics of cold storage facilities in Assam, assessed issues related to the availability and requirement of cold storage facilities in the northeastern state of Assam. After examining existing cold-storage facilities, the availability of cold storage versus the requirement, farmers' access to storage facilities and operational costs of cold storage in Assam, the authors found that despite an increase in the capacity of cold storage infrastructure in Assam, farmers continue struggling to get the required space for storing their produce at the right temperature. The study also highlighted the non-functionality of government cold storage facilities and over-reliance on private-sector cold-chain infrastructure in Assam.

Singh, H.P., Singh, B. & Kumar, R.K. (2023), in their study on approaches to sustaining potato production in India, found that the cold-chain economy of Uttar Pradesh, Bihar and West Bengal revolves primarily around potato production and storage. The authors recorded that Uttar Pradesh, Bihar and West Bengal accounted for a very large proportion of India's overall potato storage infrastructure. Mohan *et al.*, (2023) identified inadequate storage and long-distance transportation as important sources of postharvest losses and wastages in Tamil Nadu's tomato supply chain. The study suggested that establishing temperature-controlled storage facilities closer to farms is essential for creating a sound supply chain in India. However, it was a single-crop and single-state study, which was generalised at all-India level.

Using the primary data from 10 cold storage facilities in 3 districts of Gujarat, Panigrahy & Kalamkar (2021) studied the issues concerning cold storage of potatoes in the state. Electricity accounted for the highest operating cost of cold storages in Gujarat, followed by labour payments. The study showed that large capital investments and operating costs are the primary constraints in cold-storage development in Gujarat. Joshi & Joshi (2020) found that a large proportion of small and marginal farmers, low literacy and deficiency of funds are the major constraints in the adoption of cold-chain practices in rural India. The study highlighted the importance of making farmers aware of the benefits of preserving perishable produce at controlled temperature.

Singhal & Saksena (2018) statistically analysed the prospects of integration between the food processing industry and cold-storage sectors in India. The study showed that strengthening the integration between the cold chain and food processing industry can create more value for the customers, benefiting both farmers and agribusinesses. Miglani & Malu (2017) assessed the status and functioning of cold storage infrastructure in India by studying Jai Jinendra Cold Storage of Maharashtra. The study found substantial demand-supply gaps, low diversification with varying temperatures, large concentration in single-commodity storage, i.e., potatoes and high capital requirements as the major bottlenecks.

Paul, Ezekiel & Pandey (2016), using descriptive and secondary-data analysis, studied the status of cold storage in India. The authors highlighted the issue of low diversification in cold-chain infrastructure across varying temperature levels, along with limitations in effective utilisation. Sivaraman (2016), in his study on India's cold storage sector, examined the government's role and national policy concerning the development of cold-storage infrastructure in India. The author identified inadequate investment and poor national policy as important constraints on cold-storage development in India.

Negi & Anand (2015), in their study on cold chain infrastructure, identified inadequate and poor-quality cold chain infrastructure as a major bottleneck in India's fruits and vegetables supply chain. However, the study did not systematically assess cold-storage adequacy compared to production at the inter-state level. National Centre for Cold-chain Development and NABARD (2015) studied the status, gap and requirement of cold-chain infrastructure capacity against the existing infrastructure at all-India level. The study recorded the bulk cold storage capacity of 31.82 million metric tonnes against the requirement of 34.16 million MT, showing a gap of nearly 3.28 million MT. However, the study was primarily based on horticultural products and excluded the cold-storage requirements for dairy, poultry, marine and processed products. Mehta & Ezekiel (2010) studied the storage issues and practices for storing potatoes in northern states of India. The study found inadequate cold-storage capacity in the states, contributing to seasonal gluts and lower prices. However, the study focused on potatoes and excluded all other perishable products that require controlled temperature for preservation and safety.

3. OBJECTIVES AND METHODOLOGY

The study is carried out with the following objectives in mind;

1. To assess the level of cold-chain infrastructure in the top 15 agricultural states of India.
2. To measure inter-state variations in the cold storage capacity across states.
3. To measure the adequacy of cold storage capacity compared to the production of milk, eggs, fish and meat across states.
4. To make policy recommendations.

The study covers the top 15 states in India, selected on the basis of their ranking by horticultural produce at the state level in 2024-25. The states included in the study are; Uttar Pradesh, Madhya Pradesh, Maharashtra, West Bengal, Andhra Pradesh, Gujarat, Bihar, Tamil Nadu, Odisha, Karnataka, Punjab, Chhattisgarh, Kerala, Assam and Haryana. The study uses secondary data published in the RBI's Handbook of Statistics on Indian States. The data on selected variables pertain to 2022-23, 2023-24 or 2024-25, depending on availability. The following variables have been studied to achieve the set objectives;

1. State-wise production of fruits
2. State-wise production of vegetables
3. State-wise production of milk
4. State-wise production of meat
5. State-wise production of fish
6. State-wise cold-storage capacity

The arithmetic mean is used to assess the relative performance of each individual state vis-à-vis the average value of all states. The coefficient of variation is used to measure the degree of variation in the production of perishable agricultural produce and available cold storage capacity across states. In order to assess how well a state's cold-storage infrastructure can handle its perishable agricultural produce, the study makes use of the cold storage capacity to perishable agricultural production ratio, which measures the adequacy of cold-storage infrastructure in the state relative to its amount of perishable agricultural produce.

$$\text{Adequacy Ratio} = \frac{\text{Cold Storage Capacity}}{\text{Perishable Agricultural Production}}$$

A high ratio means more cold-storage capacity relative to perishable produce, whereas a low ratio means a greater adequacy gap and higher risk of post-harvest losses. However, each perishable agricultural product has varying storage requirements and cold-storage facilities can be reused throughout the year, the ratio can only be used as an indicative measure of cold-storage adequacy rather than a definitive measure.

4. RESULTS AND DISCUSSION

Table 1 suggests that fruit production in Bihar, Odisha, Karnataka, Punjab, Chhattisgarh, Kerala, Assam and Haryana is below the states' average, whereas Uttar Pradesh, Madhya Pradesh, Maharashtra, West Bengal, Andhra Pradesh, Gujarat and Tamil Nadu produce more than the states' average. Among the fifteen states, Andhra Pradesh had the highest fruit production, while Haryana recorded the lowest. Similarly, Andhra Pradesh, Odisha, Tamil Nadu, Karnataka, Punjab, Chhattisgarh, Kerala, Assam and Haryana recorded below-average vegetable production, while Uttar Pradesh, Madhya Pradesh, Maharashtra, West Bengal, Gujarat and Bihar recorded above-average vegetable production. Uttar Pradesh recorded the highest vegetable production, while Kerala recorded the lowest. In the production of milk, Uttar Pradesh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Gujarat and Bihar performed above the average, whereas West Bengal, Tamil Nadu, Odisha, Karnataka, Punjab, Chhattisgarh, Kerala, Assam and Haryana recorded below-average milk production, with Uttar Pradesh recording the highest and Assam recording the lowest. In terms of meat production, Maharashtra recorded the highest production, whereas Andhra Pradesh recorded the lowest. As a coastal state, West Bengal recorded the highest fish production, followed by Maharashtra.

Table 1: Production of Fruit, Vegetables, Milk, Meat and Fish across States (in 000' tonnes)

State	FRUITS	VEGETABLES	MILK	MEAT	FISH
Uttar Pradesh	14716	38322	38780	152	382
Madhya Pradesh	10207	24223	21326	1157	702
Maharashtra	16841	17023	16045	1294	2202

State	FRUITS	VEGETABLES	MILK	MEAT	FISH
West Bengal	4290	29134	7650	1068	5158
Andhra Pradesh	19350	8310	13994	37	908
Gujarat	9348	16501	18312	404	873
Bihar	4656	16688	12853	768	884
Tamil Nadu	7833	9651	10808	242	1124
Odisha	3029	9704	2636	454	1131
Karnataka	5327	7091	5997	263	184
Punjab	2618	7246	10011	61	781
Chhattisgarh	2060	5721	1209	518	832
Kerala	4117	2769	2655	69	499
Assam	2701	3901	815	691	215
Haryana	957	5229	7442	1260	116
SD	5556.37	9931.828	9510.517	436.677	1200.009
Mean	7203.333	13434.2	11368.87	562.5333	1066.067
CV	0.771361	0.739294	0.83654	0.776269	1.125642

Source: RBI's Handbook of Statistics on Indian States; 2022-23, 2023-24 & 2024-25

Table 2 shows that Uttar Pradesh, Madhya Pradesh, Maharashtra, West Bengal and Gujarat are the top five states in overall production of fruits, vegetables, milk, meat and fish, whereas Madhya Pradesh could not make its place among the top five states in terms of cold

storage capacity. However, Punjab, despite not being among the top 5 producing states, ranks 5th in cold storage capacity, with Uttar Pradesh, Maharashtra, West Bengal and Gujarat being the other four states in the top five.

Table 2: Total Production of Fruits, Vegetables, Milk, Meat, Fish and Cold Storage Capacity (in 000 tonnes)

States	Total Production	Cold Storage Capacity	Adequacy Ratio
Uttar Pradesh	92352.4	14875.987	0.16108
Madhya Pradesh	57614.8	1331.532	0.02311
Maharashtra	53404.2	1047.676	0.01962
West Bengal	47299.6	5948.316	0.12576
Andhra Pradesh	42599.5	1703.321	0.03998
Gujarat	45437.2	3888.425	0.08558
Bihar	35849.3	1475.667	0.04116
Tamil Nadu	29657.8	395.941	0.01335
Odisha	16953.8	576.688	0.03402
Karnataka	18861.4	709.991	0.03764
Punjab	20716.7	2451.501	0.11833
Chhattisgarh	10340.7	487.263	0.04712
Kerala	10109.9	96.4050	0.00954
Assam	8322.5	202.096	0.02428
Haryana	15004.3	853.329	0.05687
SD	22491.4	3662.002	0.04429
Mean	33634.9	2402.943	0.05583
CV	0.66869	1.523966	0.79343

Source: RBI's Handbook of Statistics on Indian States; 2022-23, 2023-24 & 2024-25 and Author's own calculations

As given in Table 2, Uttar Pradesh recorded the highest adequacy ratio of cold storage capacity to perishable agricultural produce, followed by West Bengal, Gujarat, Punjab and Haryana. The cold storage capacity and adequacy ratio showed greater variation across states compared to the production of perishable produce under study. The study shows that even the top-performing state has the adequacy ratio of 16% (less than 20%), followed by West Bengal with an adequacy ratio of around 12%.

5. CONCLUSION

Agriculture is the most dominant sector of the Indian economy with around 46% of the population depending on it for income and livelihood. Overdependence of the population on agriculture makes it important for other sectors and sub-sectors too. With rising agricultural production, it becomes essential for the country to provide required infrastructure to ensure efficient post-harvest management of farm and non-farm produce to minimise post-harvest losses. Sound post-harvest management assists farmers in fetching the right price for their produce, adding more value to agricultural

operations. Adequate cold storage facilities for perishable farm and non-farm produce are essential to raise farmers' income by minimising post-harvest losses. The study aimed to assess the adequacy of cold storage facilities across 15 Indian states, based on data for 2022-23, 2023-24 and 2024-25. The study uses descriptive statistics and the adequacy ratio to achieve the set objectives. The results showed greater variation across states in cold storage capacity and adequacy ratio than in perishable farm and non-farm produce.

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