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Growth and Interstate Disparities in Cold Storage Infrastructure in India: An Empirical Assessment

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Abstract

Considering the importance of the cold storage in the agriculture marketing; the present study attempts to analyse the growth, and examine the interstate distribution of the cold storage in India from 2015 to 2023. The study has used analytical tools like; CAGR, CV, and CR5 for the study. The study found that, the number and capacity of cold storage in India has recorded a CAGR of 2.52 and 2.35 percent respectively, reflecting a moderate growth. However, the growth pattern remains uneven across the states. It is observed that the concentration ratio of top five states is 74.71 percent, which indicates that the cold storage capacity is concentrated mostly in few states. Uttar Pradesh holds the largest share of cold storage capacity, followed by West Bengal, Gujarat, Punjab and Andhra Pradesh. These states together hold the maximum proportion of the cold storage infrastructure in the country. The coefficient variation is found to be 237.83 percent, which indicates a considerable interstate disparity in the cold storage infrastructure. Therefore, government initiatives and policy interventions should focus on expanding cold storage facilities evenly.

Keywords: Cold storage, growth, distribution, disparity.

Introduction:

Agriculture is the important source of livelihood in India. As per Census 2011, 54.6 percent of the total workforce depend on the agriculture and allied activities (Ministry of Agriculture & Farmers Welfare, 2020). Agriculture and allied activities account for 18.8 percent of the country's GVA at current prices (National Statistical Office, 2022). India is the world's second largest producer of fruits, vegetables, groundnut, rice, wheat, sugarcane and cotton. Moreover, India is also one of the leading producer of fish, livestock, poultry, spices and plantation crops (FAO, 2023), (Ministry of Agricultre and Farmers Welfare, 2022). The total horticulture production in 2021-22 is estimated to be 346.63 million tonnes and production of fruits and vegetables are 107.10 and 204.61 million tonnes respectively (National Horticulture Board, 2022).

The horticulture produces, particularly the fruits and vegetables are highly perishable in nature, and therefore, it is prone to early spoilage which leads to huge post-harvest loss. For reducing the spoilage or the loss as a whole, the shelf life of the produce has to be increased. The shelf life of the produces can be increased if these are handled through a proper cold storage facility. In the cold storage facilities, the produce is stored in a specific range of temperature and humidity, which slows down the spoilage rate. As a result of which, the produce can be marketed for a longer period of time, thereby reducing the losses (Sivaraman, 2016).

In India, the estimation of post-harvest loss of fruits and vegetables are 15%, oilseeds are 10%, pulses are 8% and cereals are 6% of their total production (Central Institute of Post-Harvest Engineering and technology, 2019).

Moreover, according to (Committee on Doubling on farmer's Income, 2017) report Volume-III, the farmers cannot sell 34% of fruits and 44.6% of vegetables of their total production in the market. In order to understand the factors contributing to the post-harvest losses of various agricultural produces, many studies have been conducted, wherein the cold storage facilities have been considered as an important factor for the losses suffered by farmers (Maheshwar & Chanakya, 2006), (Paul, Ezekiel, & Pandey, 2016), (Arivazhagan, Geetha, & Parthasarathy, 2012).

The agriculture produces are mostly harvested at one particular season or time. This leads to heavy flow of produce in the market and creates a glut situation, resulting in the price fall of produces in the market. Due to the perishable nature of the produces and lack of suitable cold storage facilities, farmers are forced to sell at a very low price in the market. The farmers are the more vulnerable in comparison to middleman and retailer, since they have a very little control over the prices in the market. This results in less earnings or sometimes no earning for the farmers.

The cold storages have a huge potential to reduce post-harvest loss, maintain price stability, facilitates regular supply to the market and assist in the growth of food processing units. Additionally, cold chain infrastructure will also benefit the farmers in creating timely marketing connections, thereby reducing their crop loss and increasing their net profit (Gupta, Garg, Kumari, & Kumar, 2021) (Devi & Singh, 2015).Therefore, the present study examines the growth and interstate distribution of cold storage capacity in India.

Literature Review

Several studies have highlighted the role of inadequate post-harvest infrastructure in causing significant agricultural losses. (Parimi & Chakraborty, 2022) while assessing factors affecting the post-harvesting wastage of fruits and vegetables along food supply chain; highlighted lack of cold chain infrastructure as one among the important factors contributing to the loss. Moreover, (Maheshwar & Chanakya, Postharvest Losses due to Gaps in Cold Chain in India-A Solution, 2006) expressed that, around 30 per cent of the total fruits and vegetables are lost annually. Which results in the farmers inability to obtain fair prices of their produce; affecting the farmers income, and sometimes even leading to farmers' suicide. Similarly, (Cardoen, Pant, Sharma, Joshi, & Diels, 2015) estimated that around 92 million tonnes of agriculture produce are lost annually in the post-harvest stage in India, due to poor storage system. This also results in the huge financial loss to the farmers, and the resources like; land, water and other inputs, overall causing a huge financial loss for the country. The study highlighted for the need of improved storage and supply chain facilities to mitigate the losses.

(Chakraborty, 2020) elaborated that, agriculture is no longer limited to food grains, but has diversified into horticulture, medicinal and other allied activities. However, the post-harvest loss still remains as a concern to the farmers. Therefore, proper post-harvest management practices have to be adopted for the benefit of the farmers. The study also highlighted that despite the growth, number of cold storages is still inadequate while compared to its requirement. Therefore, the study suggests the development of proper postharvest management infrastructure, to reap the maximum benefits out of the scarce resources. Moreover, (Deka, Mukhopadhyay, & Kumar, 2014) suggested the provision of cold storage facility at approachable distance from the farm.

(Kader, 2005) emphasised that, the developing countries experienced higher losses than the developed one. Further, it stated that the poor postharvest infrastructure, not only cause loss of fruits and vegetables; but also results in the reduction of availability of food. Moreover, (Hossain & Bepary, 2015) opines that that reduction of post-harvest loss is a key issue to ensure the future global food security.

(Kitinoja , 2013) stated that proper use of the cold chain can enhance the shelf life of the fresh produce and reduce the perishable food losses. The study also highlighted that, most developing countries lacks the basic infrastructure

required for the development of cold chain, and also highlighted lack of cold chain in developing countries; which leads to loss of market value and results in little profits left for the producers. The study also emphasised the use simple, low-cost technologies like zero energy cool chambers; with limited investments, to enhance the profits. Most producers avoid the use of cold chain due to its complexities and logistic challenge; therefore, the study suggested to promote awareness about the proper use of cold storages; with a means to prevent wastage of the limited resources.

(Devi & Singh, 2015) opined in their study that Northeaster states have a huge potential for fruits and vegetables production. However, the lack of postharvest management; adequate and proper storage and processing units have resulted in the low rate of return. The study suggests a use of low-cost affordable technology to farmers like Zero energy cool chamber to enhance the durability of the fresh produces.
From the above studies, it is evident that lack of cold chain facilities, and as a whole lack of post-harvest infrastructure are major contributors to post-harvest losses in India. Although several studies have examined the extent of post-harvest losses and the importance of cold storage infrastructure, limited attention has been given to distribution and growth pattern of cold storage facilities across Indian states. Therefore, the present study attempts to analyse the growth and interstate disparities in cold storage infrastructure in India

Objectives:

To analyse the growth and examine the interstate distribution of cold storage infrastructure.

Research Methodology:

The present study is descriptive and analytical in nature, and is based on the secondary source of information. The data is collected from the published and statistical database of Directorate of Economics and statistics, Department of Agriculture and Farmers Welfare, Government of India and documents from Press Information Bureau. The analysis covers the period 2015 to 2023. The study has employed several statistical tools such as Compound Annual Growth Rate (CAGR), Percentage share, Coefficient of Variation (CV), Concentration Ratio of the top five states (CR5) to analyse the growth and interstate disparities in cold storage infrastructure. The scope of the study is limited to the analysis of state-wise cold storage infrastructure in India and is wholly dependent on the accuracy and availability of published data.

Analytical tools used for the study:

1. Compound Annual Growth Rate (CAGR):

$$CAGR = \left(\frac{V_f}{V_i}\right)^{\frac{1}{n}} - 1$$

Where:

V_f= Final Value

Vi= Initial Value

n= number of years

2. Coefficient of Variation (CV):

$$CV = \frac{\sigma}{\bar{X}} \times 100$$

Where:

CV= Coefficient of Variation

σ= Standard Deviation

$\bar{X}$= Mean (Average)

3. Concentration Ratio (CR_5):

$$CR_5 = \sum_{i=1}^{5} S_i$$

Where:

CR_5= Concentration ratio of top five states
S_i= Percentage share of i^{th} state

Results and discussion:

This section presents the discussions on results and findings of the empirical analysis of cold storage infrastructure in India. It focuses on the growth pattern and interstate distribution of the cold storage infrastructure in the country. It also identifies the imbalance and degree of disparities in the cold storage infrastructure among the states.

Growth of Cold Storage Infrastructure in India:

Table 1: Growth (CAGR) in number and capacity of Cold storage in India (2015-2023).

Sl. No	States/UTs	Number of cold storages			Capacity of cold storages (MT)		
		Year		CAGR	Year		CAGR
		2015	2023	2015-23	2015	2023	2015-23
1	Andaman and Nicobar Islands	2	4	9.05%	210	2210	34.21%
2	Andhra Pradesh	413	467	1.55%	1622320	1893071	1.95%
3	Arunachal Pradesh	2	2	0.00%	5000	6000	2.31%
4	Assam	35	45	3.19%	126179	216388	6.97%
5	Bihar	304	313	0.37%	1411395	1476557	0.57%
6	Chandigarh	7	7	0.00%	12462	12462	0.00%
7	Chhattisgarh	97	120	2.70%	470546	553832	2.06%
8	Delhi	97	97	0.00%	129857	129857	0.00%
9	Goa	29	29	0.00%	7705	7705	0.00%
10	Gujarat	625	1014	6.24%	2323175	3974593	6.94%
11	Haryana	307	382	2.77%	638601	867884	3.91%

12	Himachal Pradesh	34	89	12.78%	53009	174072	16.02%
13	Jammu and Kashmir	29	89	15.05%	69769	341515	21.96%
14	Jharkhand	56	60	0.87%	221680	248629	1.44%
15	Karnataka	192	250	3.35%	536333	838940	5.75%
16	Kerala	197	202	0.31%	78355	96655	2.66%
17	Lakshadweep	1	1	0.00%	15	15	0.00%
18	Madhya Pradesh	275	315	1.71%	1168321	1364003	1.95%
19	Maharashtra	555	656	2.11%	762798	1176499	5.57%
20	Manipur	1	2	9.05%	2175	4500	9.51%
21	Meghalaya	4	4	0.00%	8200	8200	0.00%
22	Mizoram	3	3	0.00%	3931	4071	0.44%
23	Nagaland	2	5	12.14%	6150	8150	3.58%
24	Odisha	120	182	5.34%	366699	579321	5.88%
25	Puducherry	3	4	3.66%	85	185	10.21%
26	Punjab	617	761	2.66%	2051377	2588686	2.95%
27	Rajasthan	157	191	2.48%	490888	652879	3.63%
28	Sikkim	3	2	-4.94%	2100	2100	0.00%
29	Tamil Nadu	165	188	1.64%	304771	399690	3.45%
30	Telangana	-	108	13.43%	0	541397	9.63%
31	Tripura	14	14	0.00%	45477	46354	0.24%
32	Uttar Pradesh	2209	2472	1.42%	13807762	15045874	1.08%
33	Uttarakhand	30	60	9.05%	89689	206621	11.00%
34	West Bengal	506	515	0.22%	5912237	5948316	0.08%
All India (Total)		**7091**	8653	2.52%	**32729271**	39417231	2.35%

Source**:** Author's compilation from (Ministry of Agriculture and Farmers Welfare, 2015) (Ministry of Agriculture and Farmers Welfare, 2016) (Ministry of Agriculture and Farmers Welfare, 2018) (Ministry of Agriculture and Farmers Welfare, 2019) (Ministry of Agriculture and Farmers Welfare, 2020) (Ministry of Agriculture and Farmers Welfare, 2022) (Ministry of Agriculture and Farmers Welfare, 2017) (Ministry of Agriculture and Farmers Welfare, 2021) (Press Information Bureau, 2023)

Growth in Number of Cold Storages:

From the table 1, it is evident that the number of cold storages in India has increased from 7091 in 2015 to 8653 units in 2023, recording a Compound annual growth rate (CAGR) of 2.52 percent. This indicates a moderate growth in the number of cold storages in the country during the study period.

It can also be observed that among all the states, Jammu & Kashmir has recorded a highest growth (CAGR) of 15.05 percent. Followed by Telangana and Himachal Pradesh with the growth of 13.43 and 12.78 percent respectively. The CAGR of Telangana is calculated from the year 2020, as the data is available from that year. Though Telangana as a state was created lately, yet it has achieved a huge growth during the short period. States and UTs such as Nagaland, Manipur and Andaman & Nicobar Island has shown a growth ranging from 12.14 to 9.05 percent, however it can be stated that it is due to their low initial base.

States such as Uttarakhand, Gujarat and Odisha has recorded an impressive growth ranging from 9.05 to 5.34 percent. States such as Karnataka, Assam, Haryana, Chhattisgarh, Punjab, Rajasthan, Maharashtra has recorded a moderate growth of 2.11 to 3.35 percent. Madhya Pradesh, Tamil Nadu, Andhra Pradesh, Uttar Pradesh has registered a minimum growth of 1.42 to 1.71 percent. And other remaining states such as Jharkhand, Bihar, Kerala, West Bengal has recorded a growth less than 1 percent. Moreover, states and UTs such as Arunachal Pradesh, Chandigarh, Delhi, Goa, Lakshadweep, Meghalaya, Mizoram, Tripura and Sikkim has recorded a nil growth during the study period.

Overall, observations are that, the cold storage units in India have reported a moderate growth during the study period. However, the growth pattern among the states and the Union Territories have not been uniform. While certain states have recorded a high growth, some has recorded moderate growth, moreover some has recorded minimum and nil growth. This indicates a disparity in the growth of the cold storage units among the states in India.

Growth in capacity of Cold storage:

From the table 1, it is observed that, the total cold storage capacity in India has increased from 3,27,29,271.00 MT in 2015 to 3,94,17,231.00 MT in 2023, registering a compound Annual Growth Rate (CAGR) of 2.35 percent, indicating a moderate growth during the studied period.

Jammu & Kashmir has recorded a highest growth rate of 21.96 percent, followed by Himachal Pradesh (16.02%), Uttarakhand (11.00%). It is observed that the Andaman & Nicobar Islands, Puducherry and Manipur have also recorded impressive growth, however this growth is due to their low initial base.

States such as Gujarat, Odisha, Karnataka, Maharashtra and Assam has also recorded a relatively high growth in cold storage capacity ranging from 6.97 to 5.57 percent. States such as Haryana, Rajasthan, Nagaland, Tamil Nadu, Punjab, Kerala, Arunachal Pradesh, Chhattisgarh have recorded a moderate growth ranging from 3.91 to 2.06 percent. Andhra Pradesh, Madhya Pradesh, Jharkhand and Uttar Pradesh have achieved a minimum growth of 1.95 to 1.08 percent. States like Bihar, Mizoram, Tripura, West Bengal has recorded a negligible growth of below 1 percent. Moreover, Chandigarh, Delhi, Goa, Lakshadweep, Meghalaya and Sikkim have recorded nil growth during the period. Telangana though established lately, it has achieved an impressive growth of 9.63 during three years period.

Observations:

It is observed that, the cold storage infrastructure in India is expanding at a medium pace with a growth rate (CAGR) of 2.52 percent for the units and 2.35 percent for the cold storage capacity. This clearly indicates a moderate growth of overall cold storage infrastructure in India. It also evident that, the growth in terms of both number and capacity of cold storages are uneven among the states. Therefore, this depicts an imbalance growth in the cold storage infrastructure in India.

Interstate distribution of cold storage infrastructure in the country

Table 2: State-wise distribution of cold storage capacity (in MT) in India (2023).

Sl. No	States/UTs	Capacity (in MT)	
		Year (2023)	Share percent (%)
1	Andaman and Nicobar Islands	2210	0.01
2	Andhra Pradesh	1893071	4.80
3	Arunachal Pradesh	6000	0.02
4	Assam	216388	0.55
5	Bihar	1476557	3.75
6	Chandigarh	12462	0.03
7	Chhattisgarh	553832	1.41
8	Delhi	129857	0.33
9	Goa	7705	0.02
10	Gujarat	3974593	10.08
11	Haryana	867884	2.20
12	Himachal Pradesh	174072	0.44
13	Jammu and Kashmir	341515	0.87
14	Jharkhand	248629	0.63
15	Karnataka	838940	2.13
16	Kerala	96655	0.25
17	Lakshadweep	15	0.00
18	Madhya Pradesh	1364003	3.46
19	Maharashtra	1176499	2.98
20	Manipur	4500	0.01
21	Meghalaya	8200	0.02
22	Mizoram	4071	0.01
23	Nagaland	8150	0.02
24	Odisha	579321	1.47
25	Puducherry	185	0.00
26	Punjab	2588686	6.57
27	Rajasthan	652879	1.66
28	Sikkim	2100	0.01
29	Tamil Nadu	399690	1.01
30	Telangana	541397	1.37
31	Tripura	46354	0.12
32	Uttar Pradesh	15045874	38.17
33	Uttarakhand	206621	0.52
34	West Bengal	5948316	15.09
All India (Total)		39417231	100.00

Source: Authors compilation from (Press Information Bureau, 2023)

Note: CR5 (Top five states share) = 74.71 per cent.

Observations:

The table 2 presents the distribution of Cold storages among the state in the year 2023. It is evident that among all the states, Uttar Pradesh dominates in the share of storage capacity accounting for 38.17 percent of the total national capacity. It is followed by West Bengal (15.09 percent) and Gujarat (10.08 percent). Punjab (6.57 percent) and Andhra Pradesh (4.80 percent) have also a major share in the total capacity.

On the other hand, several states and Union territories have limited share in the total capacity. States such as Bihar, Madhya Pradesh, Maharashtra, Haryana and Karnataka possess share of only 3.75 to 2.13 percent. Moreover, states such as Rajasthan, Odisha, Chhattisgarh, Telangana, Tamil Nadu possess the share ranging from 1.66 to 1.01 percent. It is also evident that, states and UTs such as Jammu & Kashmir, Jharkhand, Assam, Uttarakhand, Himachal Pradesh, Delhi, Kerala and Tripura possess a negligible share of below 1 percent.

The combined share of the top five states such as Uttar Pradesh, West Bengal, Gujarat, Punjab, and Andhra Pradesh accounts to 74.71 per cent (CR5 %) of the total cold storage capacity, indicating a high degree of concentration. This high concentration ratio suggests that, cold storage infrastructure in India is largely concentrated only in few states, while many other states remain underserved in terms of storage facilities. Overall, it can be concluded that there is significant interstate disparity in the distribution of cold infrastructure in India.

Interstate disparities in the cold storage infrastructure in India

Table 3: Interstate variation in cold storage capacity in India

Year	Mean Capacity (MT)	Standard Deviation (MT)	Coefficient of Variation (%)	CR5 (%)
2015	991796.10	2566707.43	258.80	78.57
2016	1031829.07	2597786.88	251.77	77.45
2017	1050723.82	2628321.40	250.15	77.48
2018	1097256.98	2699435.19	246.02	77.31
2019	1114261.73	2714927.61	243.66	77.29
2020	1100738.15	2700227.27	245.32	75.80
2021	1106884.59	2714838.04	245.27	75.80
2022	1124235.47	2728016.05	242.66	75.52
2023	1159330.32	2757227.55	237.83	74.71

Source: Author's compilation

Observations:

Table 3 presents the statistical indicators such as mean capacity, standard deviation, coefficient of variation (CV), and the concentration ratio of the top five states (CR5) to measure the extent and trend of interstate disparity in the cold storage capacity during the period 2015-2023.

It is evident from the table 3 that, the mean cold storage capacity has gradually increased from 9,91,796.10 MT in 2015 to 11,59,330.32 MT in 2023. This reflects that, on average, the available cold storages capacity available across state has improved. And also indicating the overall expansion of cold storage capacity in country during the study period.

Despite this increase in average cold storage capacity, the standard deviation (SD) remains very high throughout the period, increased from 25,66,707.43 MT in 2015 to 27,57,227.55 MT in 2023. This high value of standard deviation indicates a substantial difference in cold storage capacity across states; some states possess significantly higher capacity while many other possess limited capacity. It also suggests that the cold storage infrastructure is not evenly distributed.

The coefficient of variation (CV), which measures relative disparity, shows a gradual decline from 258.80 per cent in 2015 to 237.83 per cent in 2023. This indicates a marginal reduction in interstate disparity over time. However, the cv values remains extremely high, which signifies a significant disparity in the distribution of cold storage infrastructure among the states in India.

It is evident that, the concentration ratio of the top five states (CR5) shows a slight decline from 78.57 per cent in 2015 to 74.71 per cent in 2023; indicating a slight decline in the dominance of leading states. However, the CR5 value still remains significantly high (74.71 percent); This demonstrates the high concentration of cold storage infrastructure in the top five states. In other words, it can also be said that the disparities among the states in terms of cold storage infrastructure is persistent, with a large share of infrastructure remaining concentrated in a few states.

Conclusion

In the present era, Cold storage has become an important component in the agriculture marketing system. It helps in increasing the shelf life of the agriculture produce, as a result the produce can have a longer period for marketing; and hence, reducing the postharvest loss and assist in maintaining price stability in the market. Moreover, it ensures the food security by making it available round the year.

The present study examined the growth, interstate distribution and disparities of cold storage infrastructure in India during the period 2015–2023, using the analytical tools; such as compound annual growth rate (CAGR), percentage share, coefficient of variation (CV) and concentration ratio (CR5).

The analysis reveals that, the number and capacity of cold storages have increased during the study period, indicating a moderate growth. However, the growth across the states have not been uniform. It is also found that, Uttar Pradesh holds the largest share of cold storage capacity, followed by West Bengal, Gujarat, Punjab and Andhra Pradesh. These states together account for a significant proportion of the total capacity in the country. The concentration ratio (CR5) confirms that cold storage infrastructure in India is highly concentrated in few states, reflecting a strong imbalance across the states. Moreover, the coefficient of variation (CV) also indicates considerable interstate disparity in the cold storage infrastructure in India.

The findings suggest that despite the overall growth of cold storage infrastructure, the interstate disparity exists as a major concern. Therefore, government initiatives and policy interventions should focus on expanding cold storage facilities in underserved states. Developing the cold storage infrastructure will not only reduce post-harvest losses, but also enhance farmers' income, improve market efficiency, and support the overall development of the agricultural sector in India.

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