Role of Cold Chain in fostering Agribusiness in India: Prospects and Policy Insights

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Abstract

The prospects of agribusiness in the context of an emerging economy such as India are primarily subject to the degree of integration between farm activities on the one hand and secondary processing of farm produce in food processing units on the other. The diversification of farm activities and market for processed food items are greatly influenced by several economic and institutional factors. In this context, this study attempts to bring in to focus the critical role of cold chain (CC) which, as an infrastructural pre-requisite, has the potential of enhancing the degree of integration between the agricultural sector and the food processing industry (FPI). The performance of the FPI and cold storage (CS) sector in the Indian context is thus assessed using Annual Survey of Industries data at the four- and five-digit level respectively. Based on the empirical assessment of the performance of FPI over the period 1998-99 to 2014-15 and that of CS sector from 2003-04 to 2013-14, the study argues that one of the crucial factors behind the worsening structural and technical coefficients for the FPI is the existing capacity gaps in the infrastructural components constituting integrated CC and their lopsided development. The study thus highlights the limitations of the prevailing policy perspective that uses scheme-based incentives for securing private sector participation in the CC sector. Further, it underscores the need for a holistic policy framework and a national blueprint for the long-term development of CC sector given its far reaching implications for the dynamics of a primarily agrarian rural economy in general, and in promising reasonable returns to the small and marginal farmers in particular.

Keywords: Integrated Cold Chain, Food Processing Industry, lopsided development, farm-to-fork model.

1. Introduction

Agricultural sector and allied activities remain indispensable for the Indian economy. Since independence, the Indian agricultural sector has undoubtedly undergone transformation in terms of crop diversity and volume of food and non-food agricultural commodities produced. However, the structural issues constraining its growth such as average farm size and productivity, modernisation of farm practices, marketability/handling of post-harvest produce and sustainability of inputs-use continue to persist. In this backdrop, the slower growth of the agricultural sector in recent times, when the Indian economy has been experiencing higher rate of economic growth, remained a major cause of concern for Indian policymakers. Unless the structural issues pertaining to the agricultural sector are addressed through appropriate

measures, the higher rate of economic growth for India with the lacklustre performance of agricultural sector would have its own socio-economic implications, given the large population base, steady pace of urbanisation and land-use changes, changing dietary patterns and food habits, food inflation and other food/nutritional security related concerns.

In this backdrop, this study attempts to highlight the importance and role of *cold chain (CC)* (i) as an enabler in giving impetus to the transformation of the Indian agricultural sector and (ii) as a means of addressing the key issues of the agricultural sector, such as marketability/handling of agricultural produce, diversification and modernisation, enhancing farmers' earning through value addition, strengthening its inter-linkages with food processing industry and push to exports of horticulture and processed food items.[1] The *second* section of the paper brings into focus, the several dimensions of *CC* highlighting its role and importance while the *third* section examines in the Indian context the status of its integral infrastructural components – *static and mobile*. *CC* serves as an infrastructural pre-requisite for a strong base of the FPI. Given the availability of CC infrastructure in India, the performance of the FPI is assessed in the *fourth* section. The initiative of the Ministry of Food Processing Industries (MOFPI) towards CC development through its flagship scheme for "Cold Chain, Value Addition and Preservation Infrastructure" is evaluated in the *fifth* section. The performance of Indian cold storages (CSs) is analysed in terms of key structural ratios and technical coefficients (calculated using unit level Annual Survey of Industries data for the organised segment) and the findings for Indian states (classified in four zones namely North, East, South and West) are discussed in the *sixth* section. Finally, the concluding section summarises the major findings of the study.

2. Dimensions of Cold Chain: Role and Importance

Cold Chain (CC) refers to an *'environmentally controlled chain of logistics activities',* which largely constitute the *'modern agri-logistics services'*. Its key role is to allow transfer of value from producers of perishable products (horticulture and non-horticulture) to final consumers and enhancing the shelf life of the produce (or products) by meeting the requirements in terms of humidity, temperature and atmospheric conditions, suitable packaging etc. *CC* consists of (i) static infrastructure comprising of farm-gate pack houses, cold storage bulk and cold storage hub, ripening chambers etc., and (ii) mobile infrastructure comprising of refrigerated transport vehicles which connect different components of static infrastructures. Besides storage, *CC* doesn't allow any value addition to the fresh produce, except facilitating grading, sorting, precooling before packaging, and preconditioning of the produce for travel purpose. In this sense, they are quite distinct from the food processing industry (FPI) in terms of nature of activities. *FPI*, on the other hand, ensures that the fresh horticulture and non-horticulture produce undergo transformation for being converted into a new product. The processing carried out in these facilities thus involves changing physical and chemical properties of the fresh produce and involves the application of additives, ingredients, preservatives for obtaining the final product meant for sale in the market (NCCD, 2015).

The uptake of surplus agricultural produce, besides being directly supplied to consumers for final consumption, remains largely contingent upon the status of the FPI, whose development in itself remains conditioned by infrastructural facilities such as CC, as one of the primary factors amongst other economic and financial factors such as investment, profitability etc. *CC*

[1] In this context, it is emphasised here that the meaning and interpretation of the term *agribusiness* implied in this paper is used in a broader sense.

in this context has two-fold importance – (a) cleaning, sorting, grading, pre-cooling and packaging the agricultural commodities (such as fruits, vegetables etc.) which don't need any further processing and are meant for final consumption i.e. at the end of *farm-to-fork model* and (b) acting as a backward link for the FPI, supplying the raw material in terms of the agricultural produce meant for further processing or transformation before making them available to final consumers.

The final products of the FPI also remain susceptible to the atmospheric conditions (example, humidity/moisture) and temperature, necessitating storage in cold stores with suitable facilities such as mid chill, chill and frozen. This is crucial in ensuring that the food safety standards, quality, taste and nutritional value are kept intact while meeting the final demand for such processed food items, both domestically (i.e. local marketing) and internationally (i.e. global marketing). On the other hand, cold chain as a forward link between farm and processing facility also has a crucial role to play in the dynamics of India's rural economy : (a) it helps in addressing the problem of post-harvest losses, thus reducing the supply-side constraints for critical food supplies, especially perishable items such as fruits and vegetables; (b) ensuring greater prospects of reasonable returns to farmers as they would not be under pressure to sell their produce immediately in the post-harvest period, when the prices tend to be low; (c) allowing farmers to move up the value chain as they can avail the facilities offered by modern cold stores in terms of sorting/grading of their final produce; (d) encouraging crop diversification and thus making it feasible for an average Indian farmer to shift away from staple food crops and benefit from prevailing market conditions, and (e) maintaining stocks in storage facilities can in itself serve as a credit delivery mechanism within which farmers can pledge their stock as collateral for availing institutional finance, thereby reducing their dependence on private money lenders (Standing Committee on Agriculture, 2016-17a).

Hence, cold storage infrastructure constitutes important backward and forward linkages in the farm-to-fork model of integrated food production, processing, distribution and consumption. In addition, it has a crucial role to play in terms of reducing food losses in India which on account of lack of storage facilities in India, has increased from a level of Rs. 4,535 crores in 2005-06 to Rs. 5,238 crores in 2012-13 (at constant 2004-05 prices), registering an average annual growth rate of 2 per cent.[2] These food losses are not restricted to just cereals rather they are spread across food categories such as cereals, pulses, oilseeds, fruits, vegetables, plantation crops and spices. Such rising levels of food losses in storage channels of the overall value chain in the case of a developing economy like India, which is home to approximately 18 per cent of the world's population, are alarming for two key reasons: (a) it shows inadequate and ill-equipped infrastructural facilities for food storage and (b) it raises concern on food security aspects on account of the likely demand and supply mismatch of agricultural commodities and the concomitant socio-economic implications. The next section, thus, provides an overview of the status of cold storage infrastructure in India.

3. Cold Chain Infrastructure in India: An overview

The Government of India deregulated the refrigerated storage sector in the year 1997. Since deregulation, private participation in this sector has increased at a fast pace. At present, the private sector owns and operates approximately 92 per cent of the total installed capacity in the country. According to NHB (2014), there are a total of 6,586 cold storages in the country having an estimated installed capacity of 32.95 million MT. If one excludes the permanently

[2] Authors' calculations based on Nanda *et al.* (2012) and Jha *et al.* (2015).

closed *CSs*, the total number reduces to 5,367 with an installed capacity of 26.86 million MT. However, the installed capacity for operational *CSs*, as assessed, includes 1.83 million MT for temporarily closed and those units which refused to participate or could not be covered in the survey conducted by NHB, thereby implying an estimate of only 25.03 million MT as installed capacity for 5003 *CSs* in the country (**see Table 3.1**).

Table 3.1 Number and Installed Capacity of CSs in India

S. No.		No. of CSs	Average capacity (MT)	Million MT
a.	Completed full interviews	5003		25.03
b.	Temporarily closed	61		0.31
c.	Refused & Existing 7 CA stores not covered	303		1.52
	Operational CSs: *Sub-total (a + b + c)*	5367	5003	26.86
d.	Permanently closed (including address found but CS not there)	1219		6.09
e.	Total created capacity	6586		32.95

Source: NHB, 2014.

The following observations for these 5003 *CSs* remain noteworthy:

(i) The *state-wise distribution* of these *CSs* across India remains highly skewed and their concentration in two states - Uttar Pradesh and West Bengal taken together accounts for approximately 58 per cent of the total installed capacity (**see Table 3.2**).

(ii) Their *activity-based classification* reveals that there exists a very small percentage of *CSs* catering to animal husbandry-based, processed food based and pharmaceutical based products. *CSs* catering to horticulture produce at the farm gate remain the dominant category whereas those dedicated to *mandi* remain limited (**see Table 3.3**).

(iii) According to *storage-types based classification*, the bulk of *CSs* are single-commodity *CSs* which account for approximately 71 per cent and 76 per cent of the total number and installed capacity of *CSs* respectively, followed by the ones suitable for handling multiple-commodities. The modern *CSs* like the ones with *controlled atmosphere* and *modified atmosphere* remain very few in numbers (**see Table 3.4**).

Table 3.2 State-wise distribution of CSs in India

State	Number of CSs	% Share of Number	Storage capacity (million MT)	% Share of Storage capacity	Volumetric capacity (million cubic meters)	% share of Vol. Capacity
Uttar Pradesh	1371	27.4	8.99	36.74	30.57	36.74
Andhra Pradesh	600	11.9	2.3	9.40	7.82	9.40
Maharashtra	451	9	0.77	3.15	2.62	3.15
West Bengal	464	9.3	5.16	21.09	17.54	21.09
Gujarat	399	8	1.52	6.21	5.17	6.21
Punjab	402	8	1.36	5.56	4.62	5.56
Karnataka	188	3.8	0.27	1.10	0.92	1.10
Bihar	169	3.4	0.9	3.68	3.06	3.68
Haryana	185	3.7	0.45	1.84	1.53	1.84
Madhya Pradesh	156	3.1	0.85	3.47	2.89	3.47
Kerala	143	2.9	0.22	0.90	0.75	0.90
Tamil Nadu	102	2	0.21	0.86	0.71	0.86
Rajasthan	104	2.1	0.36	1.47	1.22	1.47
Chhattisgarh	76	1.5	0.43	1.76	1.46	1.76
Orissa	38	0.8	0.12	0.49	0.41	0.49
Delhi	35	0.7	0.1	0.41	0.34	0.41
Jharkhand	19	0.4	0.08	0.33	0.27	0.33
Assam	22	0.3	0.17	0.69	0.58	0.69
Jammu and Kashmir	16	0.3	0.04	0.16	0.14	0.16
Himachal Pradesh	14	0.3	0.02	0.08	0.07	0.08
Uttaranchal	12	0.2	0.07	0.29	0.24	0.29
Andaman & Nicobar	10	0.2	0	0.00	0.00	0.00
Goa	7	0.1	0.01	0.04	0.03	0.04
Tripura	9	0.2	0.04	0.16	0.14	0.16
Chandigarh	3	0.1	0.02	0.08	0.07	0.08
Sikkim	5	0.1	0.01	0.04	0.03	0.04
Pondicherry	2	-	-	-	-	-
Nagaland	1	-	-	-	-	-
Total	**5003**		**24.47**		**83.20**	

Source: NHB, 2014

Table 3.3 Activity-based Classification of Cold Storage Infrastructure in India

S. No.	Type of cold stores	% distribution*	Mean capacity (tonnes)	Capacity Utilization
i.	Farm gate CSs (horticulture) - Type H	68%	5,531	75
ii.	Pharma CSs - Type Q	1%	6,108	69
iii.	Animal husbandry – Type M	7%	1,681	74
iv.	Processed food – Type P	8%	4,043	71
v.	Dedicated to Mandi	8%	5,004	69
vi.	PCC - Port based infrastructure – include sea, air and railway	2%	2,405	60
vii.	Dedicated to pack houses – distribution hubs	0.50%	2,861	65
viii.	Part of network of cold stores – for distribution	1%	4,870	79
ix.	Dedicated to industrial facilities or own use	5%	4,624	68
	Total	5003 CSs	5,003	75

Source: NHB, 2014

Note: *% adds to over 100% as a few stock more than 1 type of product; H – Horticulture/ Agriculture Based Products, Q - Pharmaceutical Based Products, M - Animal Husbandry Based Products, P - Processed Food Based Products.

Table 3.4 Storage-type based classification of CSs in India

S. No.	Type of Cold Store	Number of CS's	Mean Capacity (in MT)	Total capacity (in million MT)	Total Capacity in Vol. Mln Cubic meters
i.	Single Commodity	3561	5372	19.13	65.0
ii.	Multi-commodity	1273	4089	5.21	17.7
iii.	Controlled Atmosphere (CA)	29	3073	0.09	0.3
iv.	Modified Atmosphere (MA)	8	2404	0.02	0.1
	All	5003	5003	25.03	85.1

Source: NHB, 2014.

(iv) Although *CSs* catering to horticulture produce remain the dominant category in India, the *product-wise classification* of *CSs* for the horticulture category reveals that the installed capacity is highly skewed in favour of handling raw potatoes alone, accounting for approximately 83 per cent of the total capacity. Consequently, there exists severe shortage of capacity for handling perishable commodities such as fresh fruits and vegetables (**see Table 3.5)**, also getting reflected in terms of their rising post-harvest losses already mentioned in the previous section. Similarly, in the case of processed food based products, the installed capacity is skewed towards handling processed potato (45 per cent) followed by butter (27 per cent), while the *CSs* dealing in animal husbandry based products remains limited in numbers as well as the installed capacity (**see Table 3.6 & 3.7**). Some *CSs* also cater to multiple product categories. However, share of such *CSs* remains marginal at approximately 21 per cent in the total installed capacity (**see Figure 3.1 & Table 3.4**).

Table 3.5 Product-wise Classification of Cold Stores Handling Horticulture Products

Products stocked by farm gate Horticulture	No. of CSs stocking	Total Installed Capacity (Tonnes)	Mean of installed storage capacity (Tonnes)	% of average capacity used
Apple	496	15,86,212	3,198	71
Banana	309	3,46,513	1,121	63
Cabbage	67	2,44,948	3,656	68
Carrot	132	4,60,039	3,485	74
Cauliflower	54	2,27,311	4,209	70
Flowers	101	4,66,420	4,618	71
Grapes	451	11,55,295	2,562	72
Guava	60	2,06,150	3,436	68
Kiwi	76	1,95,564	2,573	70
Litchi	80	2,16,182	2,702	73
Mango	141	2,88,839	2,049	73
Onion	92	2,66,708	2,899	71
Oranges	332	12,24,637	3,689	70
Peas	104	2,87,771	2,767	76
Pineapple	54	1,51,794	2,811	66
Potato (raw)	2,690	1,45,39,420	5,405	77
Pomegranate	85	2,50,940	2,952	78
Spices	711	25,22,482	3,548	81
Pulses	323	12,44,154	3,852	76
Seeds	280	10,62,340	3,794	75
Others	239	8,74,836	3,731	80
Total	3,874	1,75,55,168	4,532	76

Source: NHB, 2014

Table 3.6 Product-wise Classification of Cold Stores Handling Processed Food

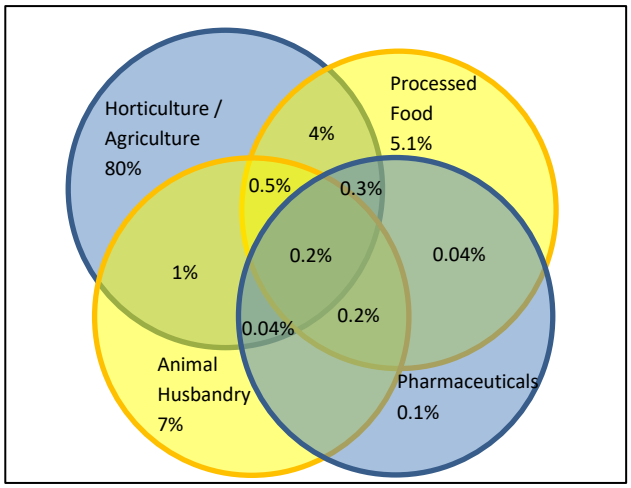
Products stocked by Processed Food CSs	No. of CSs stocking	Total Installed Capacity (Tons)	Mean of installed storage capacity (tonnes)	% of average capacity used
Butter	133	3,62,690	2727	80
Cheese	80	2,34,404	2930	78
Chocolate	56	2,24,634	4011	74
Fruit Pulp	54	1,61,974	3000	68
Milk	116	1,64,147	1415	79
Potato Processed	119	6,08,760	5116	66
Ready to eat food	49	1,33,274	2720	71
Wine	3	25,102	8367	40
Others	154	3,34,842	2174	84
Total	423	13,54,527	3,202	71

Source: NHB, 2014

Table 3.7 Product-wise Classification of Cold Stores Handling Animal Husbandry

Products stocked by Animal Husbandry CS's	No. of CSs stocking	Total Installed Capacity (Tons)	Mean of installed storage capacity (tons)	% of average capacity used
Fresh water fish	81	92,355	1,140	82
Seafood	237	1,58,436	669	75
Meats (Beef, Lamb, Mutton, Pork)	44	81,535	1,853	72
Poultry	44	2,04,426	4,646	74
Others	23	88,745	3,858	66
Total	341	4,63,907	1,360	74

Source: NHB, 2014



Source: Reproduced from NHB, 2014

Figure 3.1 Overlap of Product Categories in Indian CSs

(v) The *zone-wise classification* of these *CSs* helps in developing a perspective about their nature of spread. The four zones considered in this study – North, East, West and South are followed in principle on the basis of information obtained from NHB, 2014 (**see Table 3.8**).

Table 3.8 Classification of Indian States/UTs into Zones

S. No.	Zones	States/UTs
1	North	Chandigarh, Uttar Pradesh, Uttaranchal, Rajasthan, Punjab, Delhi, Haryana, Jammu and Kashmir, Himachal Pradesh
2	East	West Bengal, Chhatisgarh, Assam, Bihar, Jharkhand, Orissa, Sikkim, Tripura and Nagaland
3	West	Madhya Pradesh, Gujarat, Maharashtra, Goa
4	South	Andhra Pradesh, Tamil Nadu, Karnataka, Kerala, Andaman & Nicobar Islands, and Pondicherry

Source: Authors' own inference based on NHB, 2014

Table 3.9 Zonal distribution of CSs in India

	North	East	West	South	All
Number of CSs*	2142	803	1013	1045	5003
Storage Capacity (in million MT)*	11.41	6.91	3.15	3	24.47
Mean Capacity (tonnes)	5391	8543	3108	2850	5003
Mean Age of Chambers	13	14	11	8	12
Mean Cooling Capacity (in KW)	246	256	501	116	273
Capacity Utilization	75	78	71	76	75

Source: NHB, 2014
Notes: *These are authors' calculation based on information from NHB, 2014.

a. In terms of total installed capacity, the North-zone has the highest share followed by East, West and South-zones. However, in terms of total number of cold stores, the leading North-zone is followed by South, West and East-zones (**see Table 3.9**).
b. The majority of *CSs* across these zones store only single commodity. The maximum number of single commodity *CSs* is in the North zone (i.e. 1778 CSs), followed by West (i.e. 648 CSs), South (i.e. 585 CSs) and East (i.e. 538 CSs) (**see Figure 3.2**).
c. Electricity remains the principle source of final energy for these *CSs*. However, the quality of grid power tends to vary across zones. It is reported to be better in the case of East and South-zones, compared to North and West-zones (**see Figure 3.3**).
d. The *temperature-wise distribution* reveals that *CSs* in the North and East predominantly cater to products that require *chill* conditions (i.e. in the temperature range of 0 degree Celsius to 10 degree Celsius) whereas *CSs* in the West and south-zones are relatively more evenly spread across different temperature conditions – *mid chill*, *chill* and *frozen* (**see Figure 3.4**).

3.1 Capacity Gaps in the Infrastructural Components of Cold Chain (CC) in India

In the Indian context, several studies undertaken by different private agencies have estimated the installed versus required capacity of *CSs* in the country and have highlighted that (a) there exists severe shortage in the existing capacity and (b) the nature of installed capacity is inadequate in view of the kind of demand that exists for such refrigerated storage. The capacity gap as assessed in these studies lies in the range of 31 million MT to 37 million MT. It is noteworthy here that such assessments, which are based on estimation of production surpluses, are mostly supply-driven studies, conducted with an objective to assess the business opportunities for private sector investors in this fast growing infrastructure sector (**see Table 3.10**). As a result, the GOI felt the need for a more comprehensive assessment for this sector that would take into account not just the supply-side factors but also the demand-side factors. The GOI assigned the responsibility for undertaking such a study to the National Centre for Cold Chain Development (NCCD).[3]

[3] The GOI established the National Centre for Cold Chain Development (NCCD) in the year 2011, with a post facto cabinet approval on 9th February, 2012. It is an autonomous institution registered as a society under the Society Registration Act, 1860. The government also provided a one-time grant of Rs. 25 crores for the purpose of setting up of a corpus fund. The objective of setting up of NCCD has been "(a) *to provide an enabling environment for cold chain sector and facilitate private investment for cold chain infrastructure*, (b) *narrow down the gap in the supply and value chain from farm to fork including pre-harvest on-farm storage, specialised transport and scientific storage*, (c) *to address issues like standards and protocols related to cold chain testing,*

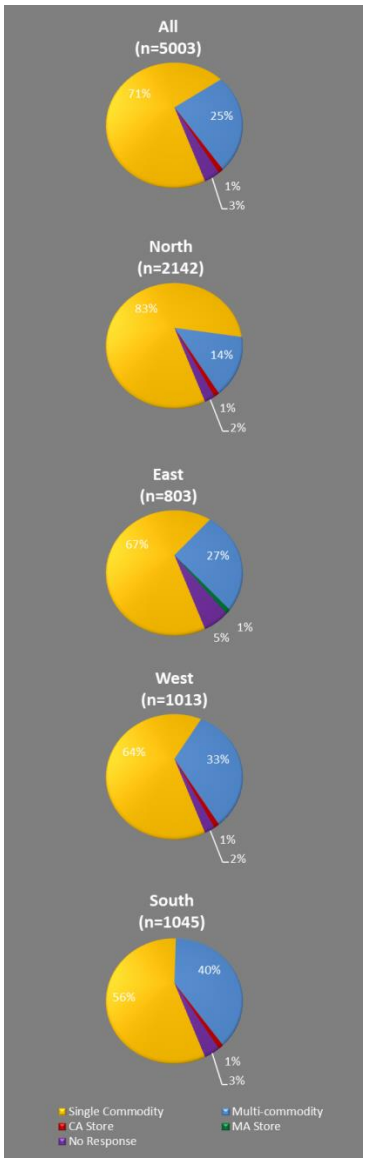


Figure 3.2
Zone-wise Storage-type Classification of CSs in India

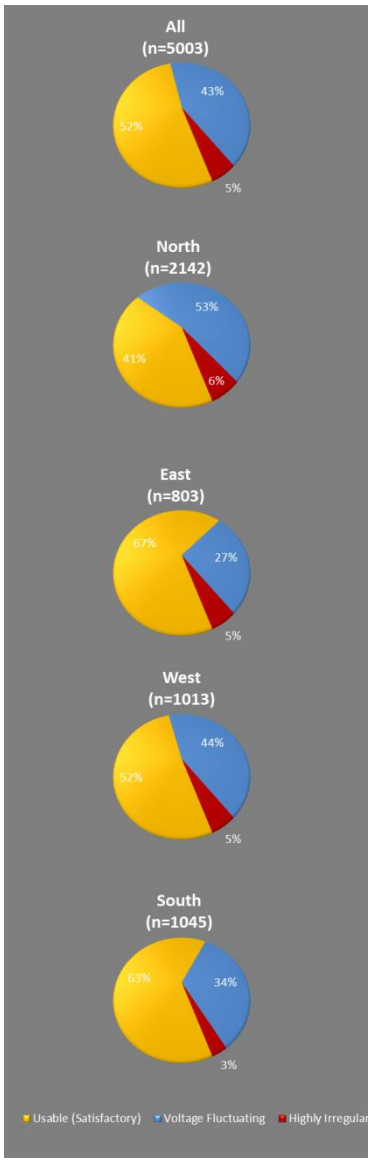


Figure 3.3
Zone-wise Quality Assessment of Grid-based Power Supply to CSs in India

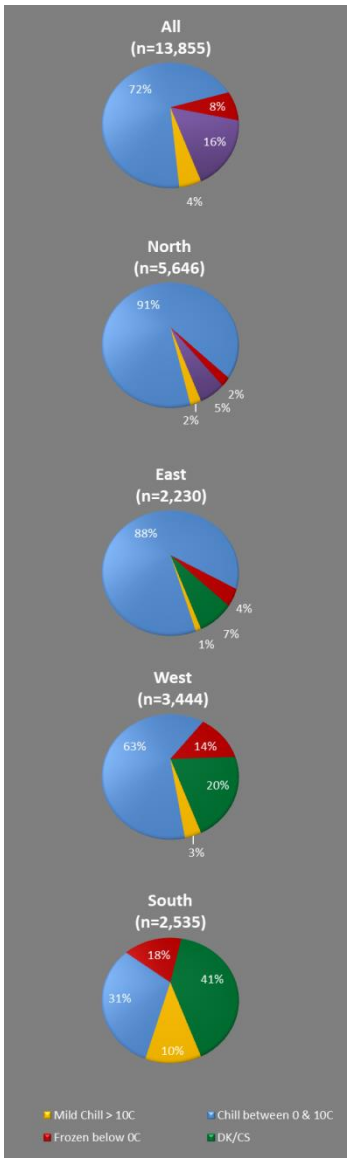


Figure 3.4
Zone-wise Temperature Based Distribution of CSs in India

Source: Reproduced from NHB, 2014

verification, certification and accreditation as per international standards, and (d) *to reduce the gap in skilled human resources required for cold chain sector*".

Table 3.10 Existing and Required cold storage capacity in India

Organization	Year and Title of study / Report	Existing Capacity (million MT)	Required Capacity (million MT)	Deficit in existing capacity (million MT)
National Stock Exchange Limited, December 2010	2010 study	24.29	61.13	36.83
Emerson Climate Technology, 2013	2013, The Food Wastage & Cold Storage Infrastructure Relationship in India	30.11	61.13	31.02
ASSOCHAM with TechSci Research	2013, Opportunities in Cold Chain-emerging Trends and Market Challenges	30.11	64 (Forecast for 2017)	36.83
YES Bank	2014, Cold Chain-Opportunities in India		61	30.98
National Horticulture Board through Hansa Research Group	2014, All India Cold Storage Capacity Survey	Operational existing capacity = 26.85		8.25
National Centre for Cold Chain Development (NCCD) and NABARD Consultancy Services	2015, All India Cold-chain Infrastructure Capacity (Assessment of Status & Gap)	31.82	35.10	3.28

Source: Compiled from sources quoted in NCCD (2015).

NCCD (2015) has estimated the capacity requirement for each of the infrastructural component of *CC* separately, using the demand-side projections along with the supply-side estimates of the baseline survey conducted by the NHB. It estimates a gap of 3.2 million MT (amounting to 10 per cent of the required capacity) in the installed capacity of *cold storage-bulk* and *cold storage-hub* taken together. There is an important caveat in the estimates of required capacity of cold storages – bulk and hub taken together. The gap of 10 per cent is valid based on the presumption that those *CSs* which are found to be temporarily as well as permanently closed by NHB (2014), can be made operational. It is further emphasised here that these required capacity estimates by NCCD (2015) can at best be considered as the minimum indicative level of capacity gap due to the limited scope of the study in terms of the product categories taken into consideration while arriving at the required capacity estimates.[4]

The gap in the case of other static infrastructural components such as *pack houses* and *ripening chambers* is assessed to be at alarming levels of 99.6 per cent and 91 per cent respectively. Similarly, in the case of mobile infrastructure i.e. *reefer vehicles*, the gap ascertained is about 85 per cent which in itself reflects the poor connectivity in the existing *CSs* in India (**see Table 3.10 & 3.11**). The static infrastructural component-wise total capacity requirement across Indian states is summarised in **Table 3.12**.

[4] The assumptions behind the required capacity estimates and the constraints limiting the scope of NCCD (2015) study in terms of the product categories included, are discussed in detail in the document available at: https://nccd.gov.in/PDF/FAQonAICICstudy2015.pdf (accessed on 24th May 2018).

Table 3.11 All India Cold Chain Infrastructural Gaps, 2014-15

S. No.	Type of Infrastructure	Infrastructure Requirement (A)	Infrastructure Created (B)	All India Gap (A-B)	% share of Gap to Required
	STATIC INFRASTRUCTURAL COMPONENTS				
i.	Pack-house (in numbers)	70,080	249	69,831	99.6
ii.	Cold Storage (Bulk), in million MT	34.16	31.82	3.28	10
iii.	Cold Storage (Hub), in million MT	0.94			
iv.	Ripening Chamber (in numbers)	9,131	812	8,319	91
	MOBILE INFRASTRUCTURE COMPONENT				
v.	Reefer Vehicles (in numbers)	61,826	9,000	52,826	85

Source: Based on Information from NCCD, 2015

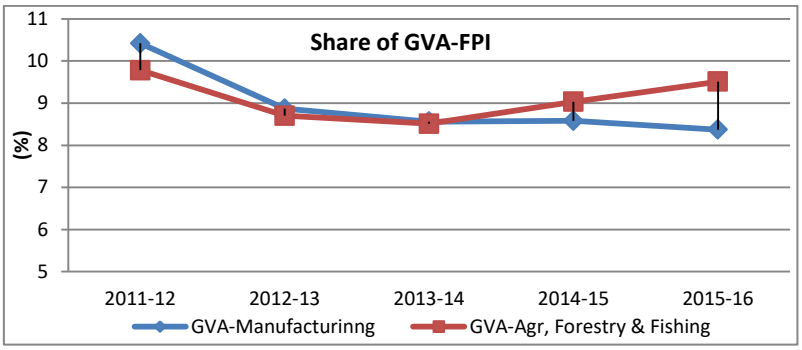
Table 3.12 State-wise breakup of Cold Chain Infrastructure Requirement

State	Urban Population (2014-15)	% Share Population	Pack-house (No)	CS Bulk (MT)	CS Hub (MT)	Ripening Chamber (MT)	Onion Storage (MT)
Andhra Pradesh	18428602	4.46	3124	489195	41730	4070	551273
Arunachal Pradesh	354419	0.09	60	6705	803	78	--
Assam	4774459	1.15	809	61185	10811	1054	--
Bihar	13008947	3.15	2205	5094524	29458	2873	155936
Chhattisgarh	6670958	1.61	1131	498724	15106	1473	--
Delhi	17718674	4.29	3003	--	40122	3913	--
Goa	1002786	0.24	170	--	2271	221	--
Gujarat	28523771	6.9	4835	2174886	64590	6299	305066
Haryana	9998498	2.42	1695	217754	22641	2208	305686
HP	722662	0.17	122	304511	1636	160	--
J&K	3807726	0.92	645	899220	8622	841	--
Jharkhand	8710072	2.11	1476	5228	19723	1923	--
Karnataka	25886395	6.26	4388	151695	58618	5717	809817
Kerala	19831340	4.8	3361	968	44906	4379	--
MP	21658925	5.24	3671	1818134	49045	4783	1130550
Maharashtra	54543414	13.19	9245	34200	123509	12045	3063522
Manipur	943761	0.23	160	2925	2137	208	--
Meghalaya	651738	0.16	110	17228	1476	144	--
Mizoram	623469	0.15	106	7508	1412	138	--
Nagaland	676818	0.16	115	7142	1533	149	--
Odisha	7583316	1.83	1285	288328	17172	1675	--
Punjab	11227754	2.72	1903	1667984	25424	2479	--
Rajasthan	18558887	4.49	3146	11370	42025	4098	337343
Sikkim	210234	0.05	36	2145	476	46	--
Tamil Nadu	37817826	9.15	6410	109005	85635	8351	--
Telangana	12806317	3.1	2171	248130	28999	2828	442517
Tripura	1161198	0.28	197	5925	2629	256	--
Uttar Pradesh	48414644	11.71	8206	10565506	109631	10691	72945
Uttarakhand	3410752	0.82	578	65208	7723	753	273893
West Bengal	31729218	7.67	5378	9409081	71848	7007	--
UT & Others			340	--	4539	443	--
All-India Urban	**413461936**		**70080**	**34164411**	**936251**	**91306**	**7448545**

Source: Based on Information from NCCD, 2015

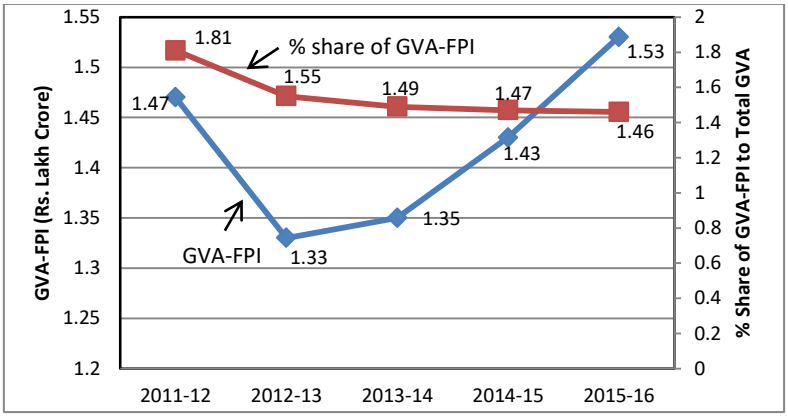
4. Performance of the FPI in India (1998-99 to 2014-15)

The FPI represents the link between industry and agricultural sector. Hence, investment in the FPI is likely to improve production and returns from agriculture, generate more employment in agriculture and industry, and reduce food losses. The growth in the FPI has remained sluggish over the last decade. While gross value added (GVA) in FPI has grown[5] in real terms by 1.53% over the quinquennium (2011-12 to 2015-16), its share in total GVA has dropped from 1.81% in 2011-12 to 1.46% in 2015-16 (**figure 4.1)** declining at the rate of 5% per annum. Its share in manufacturing sector's GVA has also dropped by 5% per annum, while its share in agriculture, forestry and fishing sector's GVA has dropped marginally by 0.2% per annum over the same quinquennium (**figure 4.2).**



Source: Based on data from the Standing Committee Report on Agriculture (2016-17a), Report number 38

Figure 4.1 Gross value added in FPI and percentage share in overall GVA



Source: Based on data from the Standing Committee Report on Agriculture (2016-17a), Report number 38

Figure 4.2 Share of GVA in FPI in GVA of Manufacturing sector and GVA of Agriculture, Forestry and Fishing sector

In this backdrop, this section briefly explores the performance of the organised FPI in India over a period of sixteen years from 1998-99 to 2014-15 (2014-15 is the latest year for which ASI data at four digit level of classification is available at the time when this study is undertaken). The period under consideration had three revisions in the National Industrial Classification (NIC) codes formulated in 1998, 2004 and 2008. Concordance between different NIC codes is carefully done in line with the composition of FPI sector used in other studies (USDA, 2016 and Kumar, 2010). Eighteen sub-sectors classified at four-digit level constitute the FPI (see Appendix 1). All values are expressed in 2004-05 constant prices

[5] All growth rates in this section are estimated as trend growth rates over the concerned period.

using the wholesale price index for food articles (including food grains, fruits, vegetables, meat, spices etc.) as the deflator.

Analysis of time series data for the FPI reveals that certain critical structural ratios and technical coefficients have worsened over the period 1998-99 to 2014-15 (see **table 4.1**). In fact, on most counts, the performance has been worse in the last ten years (2005-06 to 2014-15). Labour intensity has declined by 3% per annum over the last decade, whether measured in terms of number of persons engaged per unit value of output, or per unit fixed capital or per factory. Such a trend presents a cause for concern, since the FPI is usually looked upon as a sector whose growth spurs employment opportunities. A similar trend for the 'food products and beverages' sub-sector in rural India is observed in Aayog, N.I.T.I (2017), which focuses on the changing structure of rural employment in India, and finds that employment share of this sector in total manufacturing sector's employment in rural India dropped from 12.3% in 2004-05 to 11.8% in 2011-12, with employment in absolute numbers remaining stagnant at 3.4 million. Further exploration of the extent of employment generation in the various sub-sectors of the FPI will provide useful insights. However, such an exercise goes beyond the scope of work set for this study.

Table 4.1 Growth* in Structural ratios and Technical coefficients of the Food Processing Industry (1998-99 to 2014-15)

Period ==>	1998-99 to 2014-15	1998-99 to 2004-05	2005-06 to 2014-15
Labour intensity related ratios			
Total persons engaged to Fixed Capital	-4.4%	-6.2%	-2.8%
Total persons engaged per factory	-1.2%	-0.7%	-3.0%
Workers per factory	-1.1%	-0.2%	-3.2%
Total persons engaged to Value of Output	-4.5%	-5.9%	-3.3%
Total persons engaged to GVA	-3.1%	-2.4%	-3.3%
Capital intensity related ratios			
Fixed Capital per factory	3.3%	5.9%	-0.3%
Fixed Capital to Output	-0.2%	0.4%	-0.6%
Productivity related ratios			
GVA to Output	-1.5%	-3.6%	-3.4%
GVA per person engaged	3.2%	2.4%	-0.1%
GVA to Fixed K	-1.3%	-4.0%	-2.9%
NVA to Output	-1.5%	-4.6%	-3.8%
Net Value added per person engaged	3.2%	1.3%	-0.5%
Net Value Added per factory	1.9%	0.6%	-3.6%
Output to Input	-0.2%	-0.5%	-0.5%
Profit to Output	1.9%	-10.7%	-6.7%

Note: * All growth rates in this table are estimated as trend growth rates over the concerned period.
Source: Based on data from ASI 1998-99 to 2014-15

An equally worrying trend is the simultaneous decline in the rate of growth of gross fixed capital formation (GFCF) in the FPI. Capital intensity in the FPI measured in terms of fixed capital per person engaged, has grown over the last decade. However, when measured in terms of the ratio of fixed capital to output and fixed capital per factory, it is seen to have

declined, albeit marginally. Both labour and capital productivity (GVA or net value added (NVA) per unit labour or fixed capital) have also declined, particularly over the last decade. With rising capital intensity (measured in terms of fixed capital per person engaged), a decline in capital productivity is an indication of the fact that increased application of capital is not being used productively and optimally. It may be an indication of less than optimal utilisation of existing capital assets in the presence of structural bottlenecks within this sector or those posed by lack of appropriate infrastructure such as integrated *CC* that form a part of forward and backward linkages for FPI.

Finally, profitability (profits per unit output) has declined at the rate of nearly 7% per annum over the last decade. A more detailed analysis of capital and labour costs will shed more light on factors that may be responsible for the sluggish performance of the FPI sector. This, however, remains an area of future research.

5. Appraisal of MOFPI's Schemes for Cold Chain Development in India

Since 2008-09, the Ministry of Food Processing Industries (MOFPI) has been implementing a central sector scheme for *"cold chain, value addition and preservation infrastructure"*.[6] The Ministry under this scheme provides assistance for setting up integrated cold chain infrastructure for both horticulture and non-horticulture produce. This scheme covers both - urban as well as rural areas and spans across all states and Union Territories. Its focus is mainly on securing private sector participation and thus entities such as individuals or group of entrepreneurs, self-help groups, cooperative societies, non-governmental organisations, farmer producer organisations etc. are eligible for availing financial assistance under this scheme. Since its inception, the guidelines for this scheme have undergone several revisions and as per the recent revision dated 29th August 2016, it is now called *"scheme for integrated cold chain and value addition infrastructure"*. The upper bound of the financial assistance is pegged at a maximum grant-in-aid of Rs. 10 crores per project. The pattern of financial assistance provided varies depending on (a) *type of facility* – storage infrastructure (including pack houses, precooling unit, ripening chamber and transport infrastructure), (b) *value addition and processing infrastructure* (including frozen storage/deep freezers), (c) *irradiation facilities*, and (d) *location of the project* – general areas and difficult hilly areas such as North-Eastern states, Himalayan states, Integrated Tribal Development Project (ITDP) areas and islands (Standing Committee on Agriculture, 2016-17b).

During the period from 2008-09 to 2016-17, the MOFPI has sanctioned a total of 236 *CC* projects in six phases announced under this scheme. Of these 236 cold chain projects, 102 projects have been completed so far whereas the remaining 134 are at different stages of implementation. It is noteworthy here that 100 of these 134 projects have been approved by the Cabinet Committee on Economic Affairs (CCEA) during the financial year 2016-17 itself. The total project cost for these 236 projects stood at Rs. 6274.98 crore, involving private investment of Rs. 4408.65 crore and the grant-in-aid amounting to Rs. 1866.33 crore.

[6] Other schemes aimed at the development of CC/CS in the country includes – (a) Centrally sponsored scheme on *"Blue Revolution: Integrated Development and Management of Fisheries"* by the Department of Animal Husbandry, Dairying and Fisheries (DADF) with a focus limited to the fisheries sector; (b) *"Capital Investment subsidy scheme for construction/expansion/modernization of cold storage and storages for Horticulture Products"* by the National Horticulture Board (NHB); (c) Central sponsored scheme of *"Mission for Integrated Development of Horticulture (MIDH)"* by the Department of Agriculture, Cooperation and Farmer's Welfare. In this paper, however, the focus remains limited to the MOFPI's scheme since its implementation is likely to influence the outcome of other schemes being implemented for the development of food processing sector in general.

It is expected that the completion of these 236 *CC* projects will bring on-board a total of 0.767 million MT of cold chain capacity (inclusive of cold storage units, controlled atmosphere, deep freezer storage), 215 MT per hour of individual quick freeze, 11.05 million litres per day of milk processing/storage and a total number of 1400 reefer vehicles (*ibid.)*.

The two impact assessment studies conducted for this scheme by the NABARD Consultancy Pvt. Ltd. (NABCONS) on the behalf of MOFPI finds that the *CC* projects operationalised under this scheme have a positive impact on *value addition*, *farm gate prices* and *employment generation*, besides linking farmers. The first study involving the assessment of 20 *CC* projects carried out in the year 2014 found the average employment generation per project to be 600 persons (direct employment of 100 persons and in-direct employment for 500 persons). In the second study conducted during 2017, in which 65 *CC* projects have been analysed, the average employment generation per project is estimated at 555 persons (involving direct employment of 201 persons and in-direct employment of 354 persons) and securing on an average a linkage of 9329 farmers per project. On an average, the value addition increased 24 per cent for fresh fruits and vegetables, 18 per cent for frozen meat and meat products and 12 per cent for fish sector. Farm gate prices also registered an impressive increase of 34 per cent across sectors (such as fruits and vegetables, meat, marine, fish, poultry and dairy) and across *CC* projects. The *CC* projects handling fruits and vegetables are found to have the potential of linking on an average 500 farmers per project whereas the number increases to 5000 per project in the case of dairy, fishery and marine sector (*ibid.)*.

Despite the above achievements of the *CC* projects as implemented under the MOFPI's scheme, there are several concerns[7] that call for immediate attention:

(i) The overall pace of project completion under this scheme remains slow. Since 2008-09, only 103 *CC* projects have reached an operational stage. This highlights the impending inability to bridge the demand - supply gap for this critical infrastructural sector in the near future.
(ii) Besides linkage of farmers, the impact from *CC* projects for the betterment of vulnerable farming community i.e. small and marginal farmers remains limited. Further, it is observed that the small and marginal farmers remain exposed to the unfavourable marketing conditions prevailing in the rural India and are often found gullible to the complexities of *mandis* in getting fair price for their produce immediately in the post-harvest period.
(iii) In the absence of credible rural footprints for these *CC* projects, the very purpose of such schemes would remain unrealised.
(iv) The lopsided development of cold chain on the one hand and lack of approach towards maintaining regional balance on behalf of the implementing agencies on the other, are considered as one of the critical gaps in the current design of the scheme.
(v) The different components that are now covered as per the revised guidelines (dated 29th August 2016) for the scheme include (a) *farm level infrastructure*, (b) *distribution hub*, (c) *refrigerated/insulated transport* and (d) *irradiation facility*. It is now mandatory for an applicant to set up a farm level infrastructure component and combine it with either (b) and (c) or both, to be eligible for availing financial assistance as per the provisions of the scheme. This farm level infrastructure can include a processing centre but compulsorily has to be in the catchment area of the targeted produce under the project applied for. The potential outcome from such guidelines remains uncertain as their ultimate impact is likely to unfold in the times to come.

[7] These are primarily based on the observations of the standing committee on agriculture, 2016-17b.

Given these concerns for the development of cold chain, the next section discusses the results of zone-level performance analysis of existing *CSs* using ASI data.

6. Performance Assessment of the Indian Cold Storage sector (2003-04 to 2013-14)

This section assesses the performance of the cold storage sector over a decade based on unit level data from the *Annual Survey of Industries* (ASI), brought out by the Central Statistics Office, Government of India. Unit level data for the financial years 2003-04 and 2013-14 at five-digit level are used for the cold storage sector (NIC-2004 code = 63022 and NIC-2008 code = 52101 for the years 2003-04 and 2013-14 respectively). The cold storage sector corresponds to the Warehousing and Storage (refrigerated) sub-sector of the Warehousing and Storage Industry (NIC 2004 code = 6302 and NIC 2008 code = 5210). All values are expressed in 2004-05 constant prices using the wholesale price index for primary articles (including food articles such as food grains, fruits, vegetables, meat, spices etc., and non-food articles such as oil seeds, flowers, fibres etc.) as the deflator. For the sake of analysis, a sample of only those units that were in operation is taken in to consideration. Those that were 'closed' or 'not in operation' have been dropped. Based on this criterion, the sample size is ascertained as 350 and 439 units for the years 2003-04 and 2013-14 respectively. Definitions of variables used in this section are as per those given in ASI supporting documents and the tabulation procedures laid out are strictly adhered to in arriving at certain aggregates. These definitions and concepts as reported in ASI supporting documents and the definitions of derived ratios used in this study are given in **Appendix 2**.

Critical financial and economic ratios are estimated for the four zones (corresponding to the categorization of zones in the NHB report), based on unit specific information in ASI datasets in order to assess:

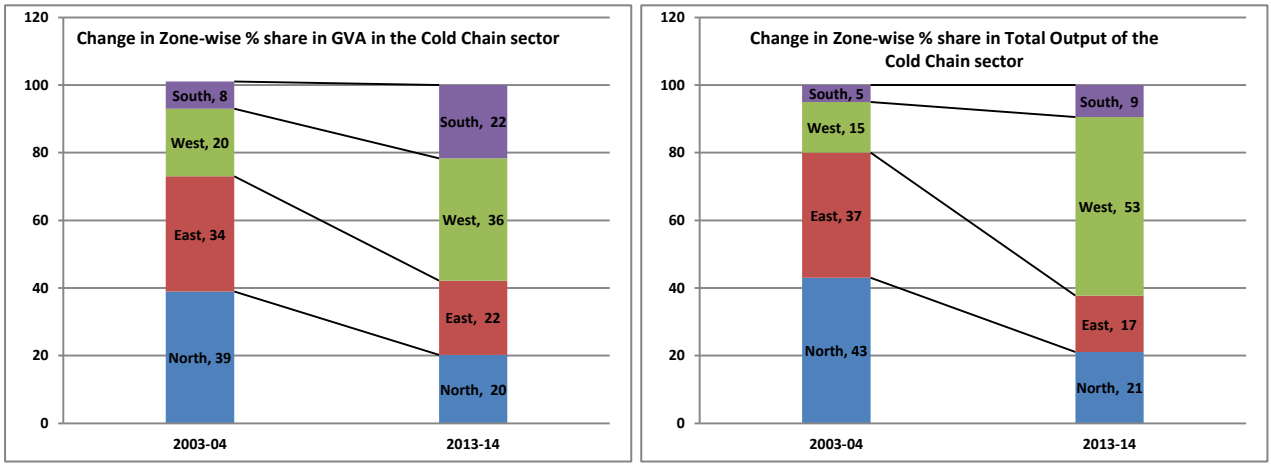
(i) the extent of resource use efficiency and overall productivity,
(ii) change in input intensities and input productivity,
(iii) share of various inputs in total cost of production,
(iv) the financial performance of the sector in terms of measures such as the Debt rate and Profit rate, and
(v) other measures that capture the overall business environment and sectoral efficiency.

Such an analysis is useful in view of the lopsided development of cold storage capacity and infrastructure.

6.1. Gross Value Added and Value of Output of the cold storage sector: The changing dynamics

In a period of ten years, the dominance of the North and East zones which prevailed until the early 2000s (with their combined share in overall sectoral GVA, as well as value of sectoral output exceeding 75%) has been reduced with their combined share now down to nearly 40% (see **figure 6.1**). Uttar Pradesh in North zone and West Bengal in East zone together accounted for nearly 65% of total GVA in 2003-04, which has reduced to 30% in 2013-14. The West-zone has seen considerable increase in its share in total GVA, driven primarily by rapid increase in Maharashtra's overall share in GVA, which now stands at 30.8%. The

South-zone is also catching up, more so in terms of its share in total GVA. This change may be an outcome of faster expansion in capacity creation in the West and South-zones and this will help in addressing the concerns of infrastructural gaps that exist in these zones.



Source: Based on data from ASI 2003-04 and 2013-14.

Figure 6.1 Zone-wise share in GVA and Value of Output in Cold Chain Industry

6.2. Overall productivity and resource-use efficiency

Overall productivity (measured in terms of GVA per unit output) in the sector has gone down[8] marginally (-0.41% per annum) while resource-use efficiency (measured in terms of GVA per unit input) has improved marginally (0.94% per annum). See **Table 6.1** for zone-wise distribution of GVA, overall productivity and resource use efficiency and their growth rates.

Table 6.1 Zone-wise Gross Value Added, overall productivity and Resource use efficiency in Cold Chain Sector (2003-04 to 2013-14)

Zone	GVA (2013-14)	GVA / OUTPUT (2003-04)	GVA / OUTPUT (2013-14)	CAGR	GVA / INPUT (2003-04)	GVA / INPUT (2013-14)	CAGR
	(Rs. Lakhs)	(%)	(%)	(%)	(%)	(%)	(%)
Zone 1 (NORTH)	8,997	38%	37%	-0.28	71%	76%	0.75
Zone 2 (EAST)	9,812	34%	35%	0.34	82%	74%	-0.95
Zone 3 (WEST)	16,115	41%	49%	1.76	102%	163%	4.81
Zone 4 (SOUTH)	9,655	54%	27%	-6.72	276%	162%	-5.17
All India	44,579	38%	37%	-0.41	94%	104%	0.94

Note: CAGR stands for compound annual growth rate
Source: Authors' calculations

At the zonal level, marginal changes are observed for the North and East zones. However, the West-zone shows growth in overall productivity of 2% per annum and an improvement in resource-use efficiency by 5% per annum. The picture is different for the South-zone, which shows a decline both in the rate of growth of productivity (-7% per annum) and resource-use efficiency (-5% per annum).

[8] All growth rates in this section are estimated as compound annual growth rates (CAGR).

6.3. Changing composition of total cost of production

Share of wages and salaries (WAGES) in total cost of production has registered an increase of 1.3%, **(table 6.2)** with most rapid increase in the West-zone followed by the South-zone. Shares of material cost (MATERIALS) and capital cost (measured in terms of ratio of interest paid (INTEREST) to cost of production) also register an increase of 1.4% and 2% per annum respectively. The most dominant component of overall cost of production is expenditure on fuels (FUELCONS), comprising primarily of electricity. The cold storage sector is capital and fuel / energy-intensive. The fuel-mix used comprises predominantly of electricity, followed by diesel (used to generate electricity), gas, coal etc. The percentage of electricity cost to total fuel expenditure varies from a maximum of 96% in Delhi to a minimum of 57% in Bihar. *CSs* in regions with irregular electricity supply are forced to resort to other means of ensuring constant supply of energy. Share of expenditure on fuels in total cost of production has registered a negative growth of 1.3% per annum.

Table 6.2 Composition of total cost of production

Percentage Share in Cost of Production

Zone	WAGES (2003-04)	WAGES (2013-14)	CAGR	MATERIALS (2003-04)	MATERIALS (2013-14)	CAGR	INTEREST (2003-04)	INTEREST (2013-14)	CAGR	FUELCONS (2003-04)	FUELCONS (2013-14)	CAGR
Zone 1 (NORTH)	18%	18%	0.1%	4%	7%	6%	8%	9%	1.1%	55%	49%	-1.2%
Zone 2 (EAST)	19%	17%	-0.9%	3%	5%	8%	10%	13%	2.9%	43%	43%	0.0%
Zone 3 (WEST)	14%	26%	6.3%	17%	5%	-10%	12%	14%	1.4%	39%	29%	-2.9%
Zone 4 (SOUTH)	15%	22%	4.1%	2%	3%	6%	22%	19%	-1.6%	41%	35%	-1.6%
All India	17%	20%	1.3%	5%	6%	1.4%	10%	12%	2.0%	48%	42%	-1.3%

Source: Authors' calculations

6.4. Factors of production: Costs and Returns

Wages per worker have increased across board, barring states of Punjab and Odisha which have experienced a decline in real wage rate (**see table 6.3**). This increase in country-wide level of real wages by nearly 7% per annum is accompanied by an increase in labour intensity as well as labour productivity (**see sub-sections 6.5 and 6.6**). Cost per unit electricity (ELEC_RATE) on the hand has registered a decline in almost all states, declining at the rate of nearly 2% per annum at country-wide level. This may partly explain the increased share of electricity in total fuel-mix of the sector over the concerned period.

Debt rate is defined as the ratio of outstanding loans to the sum of invested capital and current assets. It indicates the level of indebtedness of an organisation/entity. A lower debt rate implies greater share of owned funds in a unit's invested capital as opposed to borrowed capital for financing the investment. The debt rate is found to decrease for all zones, declining at the rate of 2.4% per annum at All India level.

The profit rate is defined as ratio of profits to the difference of invested capital and outstanding loans. It serves as a measure of returns to the owned component of capital in the total invested capital of an organisation. Except for the South-zone, profit rate has increased for all zones, registering an impressive growth rate of nearly 22% per annum at All India level. Firms in Uttar Pradesh and West Bengal have registered an increase in their profit rates by 18% and 25% respectively. The North- and East-zones have experienced phenomenal growth in their profit rates by 200% and 22% respectively over the decade of 2003-04 to

2013-14. Such trends in profit rates are likely to discourage the flow of new capital to the West- and South-zones, which have greater infrastructural gap in the cold storage sector. The lopsided development of cold storage sector is driven by and can be partially explained by the differential profit rates across states and zones.

Table 6.3 Factors of production: Costs and Returns

Zone	WAGES / WORKER (2003-04)	WAGES / WORKER (2013-14)	CAGR	ELEC_RATE (2003-04)	ELEC_RATE (2013-14)	CAGR	DEBT RATE (2003-04)	DEBT RATE (2013-14)	CAGR	PROFIT RATE (2003-04)	PROFIT RATE (2013-14)	CAGR
	(Rs.)	(Rs.)	(%)	(Rs.)	(Rs.)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Zone 1 (NORTH)	1,86,225	3,35,753	6.1	17.20	13.72	-2.2	39%	26%	-3.9	46%	200%	15.9
Zone 2 (EAST)	1,36,317	2,37,210	5.7	11.39	11.85	0.4	43%	34%	-2.2	-20%	22%	
Zone 3 (WEST)	2,76,496	3,72,195	3.0	15.55	8.60	-5.7	43%	33%	-2.7	-17%	-2%	
Zone 4 (SOUTH)	3,20,366	5,71,365	6.0	14.78	11.56	-2.4	42%	42%	-0.1	14%	4%	-11.0
All India	1,87,593	3,56,141	6.6	14.69	12.07	-1.9	41%	32%	-2.4	12%	87%	21.5

Source: Authors' calculations

6.5. Analysing change in factor intensity

At All India level, there is evidence of further capital deepening in this capital intensive sector, whether measured in terms of the capital-labour ratio (see FIXEDK / WORKER in **table 6.4)** or in terms of capital-output ratio (FIXEDK / OUTPUT), both of which have increased at the rate of 5% and 20% per annum respectively. This trend is observed despite an increase in cost of borrowed capital (see **table 6.3).** Likewise, an increase in the real wage rate has not deterred an increase in labour intensity in this sector, measured in terms of number of workers per unit output produced (WORKERS / OUTPUT).

Fuel-use intensity (measured in terms of expenditure on fuel per one rupee worth of output: FUELCONS / OUTPUT) has declined across all zones (except South-zone) and has dropped at All India level at the rate of 1.3% per annum. This trend can be explained in terms of increased use of electricity in the total fuel-mix encouraged by the reduction in real electricity rates (see **table 6.3**) and the fact that electricity is comparatively a more efficient source of energy as opposed to others such as diesel etc.

Table 6.4 Factor Intensity

Zone	FIXEDK / WORKER (2003-04)	FIXEDK / WORKER (2013-14)	CAGR	FIXEDK / OUTPUT (2003-04)	FIXEDK / OUTPUT (2013-14)	CAGR	WORKERS / OUTPUT (2003-04)	WORKERS / OUTPUT (2013-14)	CAGR	FUELCONS / OUTPUT (2003-04)	FUELCONS / OUTPUT (2013-14)	CAGR
	(Rs.lakhs per wkr)	(Rs.lakhs per wkr)	(%)	(Rs.)	(Rs.)	(%)	Wkrs per Rs. 1 crore	Wkrs per Rs. 1 crore	(%)	(Rs.)	(Rs.)	(%)
Zone 1 (NORTH)	22.18	34.58	5%	1.19	1.25	1%	12.85	16.85	3%	0.45	0.41	-1%
Zone 2 (EAST)	10.64	28.22	10%	1.11	1.17	0%	24.88	16.27	-4%	0.40	0.32	-2%
Zone 3 (WEST)	39.18	35.13	-1%	1.67	3.06	6%	10.09	21.33	8%	0.31	0.21	-4%
Zone 4 (SOUTH)	79.40	80.15	0%	2.90	39.28	30%	10.29	37.36	14%	0.29	0.40	3%
All India	24.05	40.98	5%	1.34	8.12	20%	16.85	20.93	2%	0.40	0.35	-1.3%

Source: Authors' calculations

6.6. Analysing change in Factor Productivity

Productivity of labour, capital and fuel (measured in terms of GVA per unit input or output per unit input) have grown in most zones over the concerned period (see **table 6.5**). At All India level, an increase in both the capital-labour ratio and capital productivity has fuelled an impressive growth in labour productivity. An increase in both the capital intensity and capital productivity is an indication of more efficient utilisation of capital. Further, a drop in fuel intensity accompanied by an increase in fuel-productivity is an indication of increase in fuel-use efficiency (see **tables 6.4 and 6.5**).

The growth in labour and fuel productivity has particularly been impressive in the West-zone. This explains the phenomenal growth in overall productivity and resource-use efficiency attained by this zone over the same period **(see table 6.1)**. However, an increase in capital intensity (**table 6.4**) accompanied by a decline in capital productivity (**table 6.5**) in this zone is an indication of non-optimal use of exiting capital assets. Thus, in the West-zone, emphasis on fuller utilisation of existing capital is called for before any further capital deepening.

Table 6.5 Measures of Factor Productivity

Zone	OUTPUT / WORKER (2003-04)	OUTPUT / WORKER (2013-14)	CAGR	OUTPUT / FIXEDK (2003-04)	OUTPUT / FIXEDK (2013-14)	CAGR	OUTPUT / FUELCONS (2003-04)	OUTPUT / FUELCONS (2013-14)	CAGR
	(Rs.lakhs per worker)	(Rs.lakhs per worker)	(%)	(Rs.)	(Rs.)	(%)	(Rs.)	(Rs.)	(%)
Zone 1 (NORTH)	18.35	31.67	5.6%	2.02	4.57	8.5%	2.66	3.79	3.6%
Zone 2 (EAST)	11.51	35.94	12.1%	3.22	3.27	0.2%	4.48	6.71	4.1%
Zone 3 (WEST)	28.90	105.04	13.8%	3.14	2.71	-1.4%	12.48	34.40	10.7%
Zone 4 (SOUTH)	45.15	37.77	-1.8%	0.54	1.29	9.1%	7.45	8.33	1.1%
All India	19.03	44.76	8.9%	2.47	3.37	3.2%	4.72	9.98	7.8%

Source: Authors' calculations

Based on the estimation of zone-wise financial and economic ratios for the cold storage sector, this study finds that resource-use efficiency (GVA per unit input) is much higher for the states in West- and South-zones, whose combined share in overall GVA has increased from 28% to 58% over the period 2003-04 to 2013-14. Their share in total value of output increased from 20% to 62% (**see Figure 6.1**). This may be a result of greater capacity expansion in these zones, as already observed in the section 6.1. However, the firms in these zones have cost structures dominated by relatively higher labour and capital costs, along with significantly higher rates of indebtedness on the one hand (**see table 6.3**) and employment of relatively more capital intensive production techniques on the other (**see table 6.4**). In view of the low factor substitution possibilities which characterises this sector (Singhal and Saksena, 2017), the advantage on account of greater resource-use efficiency is lost and hence profitability continues to be low for these zones. Profitability continues to be the highest in the North-zone, which is bound to attract most of the new investment in cold storage infrastructure.

7. Concluding Observations

Given the mismatch between demand and supply of infrastructural components, it is obvious that the approach adopted towards development of cold chain has been *narrow* in the Indian context. Moreover, the official estimates of the existing capacity gap in the case of *CSs* (bulk

and hub taken together) of mere 10 per cent, represents only the minimum indicative level of capacity gap. Besides *CS*s, there exists large capacity gap in the case of the other infrastructural components such as pack houses, ripening chambers and reefer vehicles. As long as these gaps continue to exist, it is expected that the potential benefits from integrated cold chain infrastructure, providing backward and forward linkages between the agricultural sector and the FPI, would remain largely unexploited. The findings from the performance analysis of the Indian *FPI* indicate sluggish growth experienced by this sector in recent years. The structural ratios and technical coefficients calculated for this sector show clear signs of stagnation. The slowdown in the FPI can also be attributed to the infrastructural bottlenecks posed by the slow and lopsided development of integrated CC infrastructure. In such a situation, the much needed impetus for realising higher rate of growth for the Indian agricultural sector would remain weak, especially due to the lack of synergy between the agricultural sector and the *FPI* owing to the lack and lop-sidedness of *CC* infrastructure. It is now a forgone conclusion that a sound base of the FPI remains the key for raising farmers' income and increasing their share in the value addition.

Government's financial support for cold chain development has been predominantly in the form of scheme-based incentives for securing private sector participation. In this context, it is argued that investment decisions for private entrepreneurs are influenced primarily by financial and economic factors and to a large extent on the prevailing market conditions. This remains validated by the findings from the performance assessment of *CSs* across zones. In such a scenario, observations such as lopsided development of *CC* across Indian states and lack of benefits for the small and marginal farmers owing to their limited rural footprints remains noteworthy. In this backdrop, an important inference would be that the longer-term development of integrated cold chain, while strengthening its inter-sectoral linkages, can't be realised given the current support mechanism. Since the inception of the "Scheme of Cold Chain, Value Addition and Preservation Infrastructure" in 2008-09, the MOFPI has carried out six phases of Expression of Interest (EOI) for *CC* projects and has sanctioned a total of 236 project till date under the scheme, which when completed would add only close to half a million MT in terms of capacity. At best, the MOFPI can aim to achieve some regional balance in the final projects approved and sanctioned under this scheme for financial assistance but would be unable to secure application for states/zones where significant capacity gap exists. Moreover, the revised guidelines for the scheme which makes it mandatory for an entrepreneur to have the farm level infrastructure in the catchment area of the targeted produce, though well-intentioned, can act as a deterrent to private investment and shall be seen as something that needs to be addressed at policy level and not via a scheme. This tantamount to misplaced emphasis on scheme-based approach, while the situation at hand calls for a policy to address such fundamental issues. It is thus argued that there would be certain outcomes (such as pace of additional capacity generation, regional cum rural-urban spread etc.) that are likely to remain unrealised on the basis of sole reliance on the scheme-based approach to the development of *CC* in the country. Thus, the fundamental issues pertaining to this critical infrastructural sector having far reaching implications for the dynamics of primarily agrarian rural economy in general and in promising reasonable returns to the small and marginal farmers in particular, need to be addressed through a holistic policy framework and a national blueprint.

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Appendix 1

Registered Manufacturing units in the Food Processing Industry in India (2014-15)

Sr.No.	Industry Code (4-Digit NIC, 2008)	Items	Number of Factories	Number of Persons Engaged
1	1010	Processing and preserving of **Meat**	170	30,000
2	1020	Processing and preserving of **fish**, crustaceans and molluscs and products thereof	427	53,202
3	1030	Processing and preserving of **fruits and vegetables**	1133	60,803
4	1040	Manufacture of vegetable and animal **oils and fats**	3240	1,06,290
5	1050	Manufacture of **dairy** products	1783	1,43,824
6	1061	Manufacture of **grain** mill products	18,953	3,05,004
7	1062	Manufacture of **starches and starch products**	699	21,754
8	1071	Manufacture of **bakery** products	881	64,636
9	1072	Manufacture of **Sugar**	1613	1,00,155
10	1073	Manufacture of cocoa, chocolate and sugar **confectionery**	763	2,39,978
11	1074	Manufacture of **macaroni, noodles**, couscous and similar farinaccous products	594	44,190
12	1075	Manufacture of **prepared meal** and dishes	91	7,831
13	1079	Manufacture of **other food products** n.e.c.	277	19,896
14	1080	Manufacture of prepared **animal feeds**	5765	4,15,755
15	1101	Distilling, rectifying and blending of **spirits**; ethyl **alcohol** production from fermented materials	395	53,501
16	1102	Manufacture of **wines**	74	7,160
17	1103	Manufacture of malt **liquors and malt**	153	29,745
18	1104	Manufacture of **soft drinks**; production of mineral waters and other bottled waters	159	70,217
	Total	**Food Processing Industry**	**38,608**	**17,73,941**

Source: Annual Survey of Industries (ASI), 1998-99 to 2014-15.

Appendix 2
Concepts and Definitions[9]

Variable Name used in the paper	Corresponding Variable name and definition in ASI supporting document OR Definition of derived variables
Cost of Production	**COST OF PRODUCTION**is the sum total of expenses incurred on employees in the form of wages/salaries, bonus, contribution to provident & other funds, workman & staff welfare, operating expenses, non-operating expenses (excluding insurance charges), insurance charges, rent paid for building, plant & machinery and other fixed assets, land on lease or royalties on mines, quarries and similar assets, interest paid, repair and maintenance of building, plant and machinery, pollution control equipment, other fixed assets, work done by others on materials supplied by the industrial undertaking, total indigenous items consumed as inputs (i.e. total basic and non-basic items from block H of ASI schedule), total imported items consumed as inputs (from block I of ASI schedule).
FIXEDK	**FIXED CAPITAL** represents the depreciated value of fixed assets owned by the factory as on the closing day of the accounting year. Fixed assets are those that have a normal productive life of more than one year. Fixed capital includes land including lease- hold land, buildings, plant and machinery, furniture and fixtures, transport equipment, water system and roadways and other fixed assets such as hospitals, schools etc. used for the benefit of factory personnel.
FUELCONS	**FUELS CONSUMED** represents total purchase value of all items of fuels such as coal, liquified petroleum gas, petrol, diesel, electricity, lubricants, water etc. consumed by the factory during the accounting year but excluding the items which directly enter into the manufacturing process.
GVA	**GROSS VALUE ADDED** is arrived at by deducting total input from total output.
INPUT	**TOTAL INPUT** comprises total value of fuels, materials consumed as well as expenditures such as cost of contract and commission work done by others on materials supplied by the factory, cost of materials consumed for repair and maintenance work done by others to the factory's fixed assets, inward freight and transport charges, rate and taxes (excluding income tax), postage, telephone and telex expenses, insurance charges, banking charges, cost of printing and stationery and purchase value of goods sold in the same condition as purchased. Rent paid and interest paid is not included.
Interest paid	**INTEREST PAID** includes all interest paid on factory account on loans, whether short term or long term, irrespective of the duration and the nature of agency from which the loan was taken. Interest paid to partners and proprietors on capital or loan are excluded.
MATERIALS	**MATERIALS CONSUMED** represents the total delivered value of all items of raw materials, components, chemicals, packing materials and stores which actually enter into the production process of the factory during the accounting year. It also includes the cost of all materials used for the construction of building etc. for the factory's own use .It, however, excludes all intermediate products consumed during the accounting year. Intermediate products are those products, which are produced by the factory but are subject to further manufacturing.
OUTPUT	**TOTAL OUTPUT** comprises total ex-factory value of products and by-products manufactured as well as other receipts from non-industrial services rendered to others, work done for others on material supplied by them, value of electricity produced and sold, sale value of goods sold in the same conditions purchased, addition in stock of semi- finished goods and value of own construction. Rent received and interest received is not being included from ASI 2001-02.
Profits	**PROFITS** = Net Income – (Wages + Bonus + Contribution to provident and other funds + Workman & Staff welfare expenses) Where **NET INCOME** = GVA – Depreciation – (Rent paid + Interest paid).
WAGES	**WAGES AND SALARIES** are defined to include all remuneration in monetary terms and also payable more or less regularly in each pay period to workers as compensation for work done during the accounting year. It includes (a) direct wages and salary (i.e., basic wages/salaries, payment of overtime, dearness, compensatory, house rent and other

[9]Sourced from ASI supporting documents provided with ASI unit level data. There is a standardized methodology for arriving at estimates of relevant variables and the tabulation procedures have been strictly adhered to.

	allowances) (b) remuneration for the period not worked (i.e., basic wages, salaries and allowances payable for leave period, paid holiday, lay- off payments and compensation for unemployment, if not paid from sources other than employers) (c) bonus and ex-gratia payment paid both at regular and less frequent intervals (i.e., incentive bonuses, productive bonuses, profit sharing bonuses, festival or year-end bonuses etc.) It excludes lay off payments which are made from trust or other special funds set up exclusively for this purpose i.e., payments not made by the employer. It also excludes imputed value of benefits in kind, employer's contribution to old age benefits and other social security charges, direct expenditure on maternity benefits creches and other group benefits Travelling and other expenditure incurred for business purposes and reimbursed by the employer are excluded. The wages are expressed in terms of gross value i.e., before deduction for fines, damages, taxes, provident fund, employee's state insurance contribution etc.
WORKERS	**WORKERS** are defined to include all persons employed directly or through any agency whether for wages or not and engaged in any manufacturing process or in cleaning any part of the machinery or premises used for manufacturing process or in any other kind of work incidental to or connected with the manufacturing process or the subject of the manufacturing process. Labour engaged in the repair and maintenance or production of fixed assets for factory's own use or labour employed for generating electricity or producing coal, gas etc. are included.
Derived Ratios and other variables	
DEBT RATE	OUTSTANDING LOANS / (INVESTED CAPITAL + CURRENT ASSETS) Where **OUTSTANDING LOANS** represent all loans whether short term or long term, whether interest bearing or not, outstanding according to the books of the factory as on the closing day of the accounting year; **INVESTED CAPITAL** is the total of fixed capital and physical working capital; **CURRENT ASSETS** is the sum total of raw materials & components, packaging materials, fuels and lubricants, spares, stores and others, semi-finished goods/ work in progress, finished goods, cash in hand and at bank, sundry debtors and other current assets.
FixedK / Output	FIXED CAPITAL / TOTAL OUTPUT
FixedK / Workers	FIXED CAPITAL / WORKERS
GVA / Fixed K	GROSS VALUE ADDED / FIXED CAPITAL
GVA / Input	GROSS VALUE ADDED / TOTAL INPUT
GVA / Output	GROSS VALUE ADDED / TOTAL OUTPUT
INTEREST	INTEREST PAID / COST OF PRODUCTION
Output / FixedK	TOTAL OUTPUT / FIXED CAPITAL
Output / Workers	TOTAL OUTPUT / WORKERS
PROFIT RATE	PROFITS / (INVESTED CAPITAL + CURRENT ASSETS – OUTSTANDING LOANS)
Wages / Workers	WAGES AND SALARIES / WORKERS
Workers / Output	WORKERS / TOTAL OUTPUT