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Ministry of Agriculture &
Farmers Welfare

Report of the Committee for Doubling Farmers' Income

Volume III

"Post-production Agri-logistics: maximising gains for farmers"

Agricultural Logistics is the Backbone of Agri-Business
Agricultural Marketing is the Brain behind Value Realisation

Document prepared by the Committee for Doubling Farmers' Income,
Department of Agriculture, Cooperation and Farmers' Welfare,
Ministry of Agriculture & Farmers' Welfare.

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Foreword

The country has witnessed a series of concerted discussions dealing with the subject of agriculture. In 1926, the Royal Commission of Agriculture was set up to examine and report the status of India's agricultural and rural economy. The Commission made comprehensive recommendations, in its report submitted in 1928, for the improvement of agrarian economy as the basis for the welfare and prosperity of India's rural population. The urban population was about 11 per cent of the whole, and demand from towns was small in comparison. The Commission notes, that communication and physical connectivity were sparse and most villages functioned as self-contained units. The Commission encompassed review of agriculture in areas which are now part of Pakistan, Bangladesh and Myanmar. The net sown area in erstwhile British India was reported as 91.85 million hectares and cattle including buffaloes numbered 151 million. Almost 75 per cent of the cultivated area was under cereals and pulses, with rice and wheat occupying 46 per cent of the net sown area. The area under fruits and vegetables was about 2.5 per cent and that under oilseeds and non-food crops was about 20 per cent. In the ensuing years, as well known, the country underwent vast changes in its political, economic and social spheres.

Almost 40 years later, free India appointed the National Commission on Agriculture in 1970, to review the progress of agriculture in the country and make recommendations for its improvement and modernisation. This Commission released its final report in 1976. It refers to agriculture as a comprehensive term, which includes crop production together with land and water management, animal husbandry, fishery and forestry. Agriculture, in 1970 provided employment to nearly 70 per cent of the working population. The role of agriculture in the country's economic development and the principle of growth with social justice, were core to the discussions. The country was then facing a high population growth rate. After impressive increase in agricultural production in the first two Five Year Plans, a period of stagnancy set in and the country suffered a food crisis in the mid-1960s. The report in fifteen parts, suggested ample focus on increased application of science and technology to enhance production.

Thirty years hence, the National Commission for Farmers was constituted in 2004 to suggest methods for faster and more inclusive growth for farmers. The Commission made comprehensive recommendations covering land reforms, soil testing, augmenting water availability, agriculture productivity, credit and insurance, food security and farmers competitiveness. In its final report of October 2006, the Commission noted upon ten major goals which included a minimum net income to farmers, mainstreaming the human and gender dimension, attention to sustainable livelihoods, fostering youth participation in farming and post-harvest activities, and brought focus on livelihood security of farmers. The need for a single market in India to promote farmer-friendly home markets was also emphasised.

The now constituted DFI (Doubling Farmers' Income) Committee besides all these broad sectoral aspects, invites farmers' income into the core of its deliberations and incorporates it as the fulcrum of its strategy. Agriculture in India today is described by a net sown area of 141 million hectares, with field crops continuing to dominate, as exemplified by 55 per cent of the area under cereals. However, agriculture has been diversifying over the decades. Horticulture now accounts for 16 per cent of net sown area. The nation's livestock population counts at more than 512 million. However, economic indicators do not show equitable and egalitarian growth in income of the farmers. The human factor behind agriculture, the farmers, remain in

frequent distress, despite higher productivity and production. The demand for income growth from farming activity, has also translated into demand for government to procure and provide suitable returns. In a reorientation of the approach, this Committee suggests self-sustainable models empowered with improved market linkage as the basis for income growth of farmers.

India today is not only self-sufficient in respect of demand for food, but is also a net exporter of agri-products occupying seventh position globally. It is one of the top producers of cereals (wheat & rice), pulses, fruits, vegetables, milk, meat and marine fish. However, there remain some chinks in the production armoury, when evaluated against nutritional security that is so important from the perspective of harvesting the demographic dividend of the country. The country faces deficit of pulses & oilseeds. The availability of fruits & vegetables and milk & meat & fish has increased, thanks to production gains over the decades, but affordability to a vast majority, including large number of farmers too, remains a question mark.

The impressive agricultural growth and gains since 1947 stand as a tribute to the farmers' resilience to multiple challenges and to their grit & determination to serve and secure the nation's demand for food and raw material for its agro-industries.

It is an irony, that the very same farmer is now caught in the vortex of more serious challenges. The average income of an agricultural household during July 2012 to June 2013 was as low as Rs.6,426, as against its average monthly consumption expenditure of Rs.6,223. As many as 22.50 per cent of the farmers live below official poverty line. Large tracts of arable land have turned problem soils, becoming acidic, alkaline & saline physico-chemically. Another primary factor of production, namely, water is also under stress. Climate change is beginning to challenge the farmer's ability to adopt coping and adaptation measures that are warranted. Technology fatigue is manifesting in the form of yield plateaus. India's yield averages for most crops at global level do not compare favourably. The costs of cultivation are rising. The magnitude of food loss and food waste is alarming. The markets do not assure the farmer of remunerative returns on his produce. In short, sustainability of agricultural growth faces serious doubt, and agrarian challenge even in the midst of surpluses has emerged as a core concern.

Farmers own land. Land is a powerful asset. And, that such an asset owning class of citizens has remained poor is a paradox. They face the twin vulnerabilities of risks & uncertainties of production environment and unpredictability of market forces. Low and fluctuating incomes are a natural corollary of a farmer under such debilitating circumstances. While cultivation is boundarised by the land, market need not have such bounds.

Agriculture is the largest enterprise in the country. An enterprise can survive only if it can grow consistently. And, growth is incumbent upon savings & investment, both of which are a function of positive net returns from the enterprise. The net returns determine the level of income of an entrepreneur, farmer in this case.

This explains the rationale behind adopting income enhancement approach to farmers' welfare. It is hoped, that the answer to agrarian challenges and realization of the aim of farmers' welfare lies in higher and steady incomes. It is in this context, that the Hon'ble Prime Minister shared the vision of doubling farmers' income with the nation at his Bareilly address on 28th February, 2016. Further, recognizing the urgent need for a quick and time-bound transformation of the

vision into reality, a time frame of six years (2016-17 to 2022-23) was delineated as the period for implementation of a new strategy.

At the basic level, agriculture when defined as an enterprise comprises two segments – production and post-production. The success of production as of now amounts to half success, and is therefore not sustainable. Recent agitations of farmers (June-July 2017) in certain parts of the country demanding higher prices on their produce following record output or scenes of farmers dumping tractor loads of tomatoes & onions onto the roads or emptying canisters of milk into drains exemplify neglect of other half segment of agriculture.

No nation can afford to compromise with its farming and farmers. And much less India, wherein the absolute number of households engaged in agriculture in 2011 (119 million) outpaced those in 1951 (70 million).Then, there are the landless agricultural labour who numbered 144.30 million in 2011 as against 27.30 million in 1951. The welfare of this elephantine size of India's population is predicated upon a robust agricultural growth strategy, that is guided by an income enhancement approach.

This Committee on Doubling Farmers' Income (DFI) draws its official members from various Ministries / Departments of Government of India, representing the panoply of the complexities that impact the agricultural system. Members drawn from the civil society with interest in agriculture and concern for the farmers were appointed by the Government as non-official members. The DFI Committee has co-opted more than 100 resource persons from across the country to help it in drafting the Report. These members hail from the world of research, academics, non-government organizations, farmers' organizations, professional associations, trade, industry, commerce, consultancy bodies, policy makers at central & state levels and many more of various domain strengths. Such a vast canvas as expected has brought in a kaleidoscope of knowledge, information, wisdom, experience, analysis and unconventionality to the treatment of the subject. The Committee over the last more than a year since its constitution vide Government O.M. No. 15-3/2016-FW dated 13th April, 2016 has held countless number of internal meetings, multiple stakeholder meetings, several conferences & workshops across the country and benefitted from many such deliberations organized by others, as also field visits. The call of the Hon'ble Prime Minister to double farmers' income has generated so much of positive buzz around the subject, that no day goes without someone calling on to make a presentation and share views on income doubling strategy. The Committee has been, therefore, lucky to be fed pro-bono service and advice. To help collage, analyse and interpret such a cornucopia of inputs, the Committee has adopted three institutes, namely, NIAP, NCAER and NCCD. The Committee recognizes the services of all these individuals, institutions & organisations and places on record their service.

Following the declaration of his vision, the Hon'ble Prime Minister also shaped it by articulating 'Seven Point Agenda', and these have offered the much needed hand holding to the DFI Committee.

The Committee has adopted a basic equation of Economics to draw up its strategy, which says that net return is a function of gross return minus the cost of production. This throws up three (3) variables, namely, productivity gains, reduction in cost of cultivation and remunerative price, on which the Committee has worked its strategy. In doing so, it has drawn lessons from the past and been influenced by the challenges of the present & the future.

In consequence, the strategy platform is built by the following four (4) concerns:

- Sustainability of production
- Monetisation of farmers' produce
- Re-strengthening of extension services
- Recognizing agriculture as an enterprise and enabling it to operate as such, by addressing various structural weaknesses.

Notwithstanding the many faces of challenges, India's agriculture has demonstrated remarkable progress. It has been principally a contribution of the biological scientists, supplemented by an incentivizing policy framework. This Committee recognizes their valuable service in the cause of the farmers. It is now time, and brooks no further delay, for the new breed of researchers & policy makers with expertise in post-production technology, organization and management to take over the baton from the biological scientists, and let the pressure off them. This will free the resources, as also time for the biological scientists to focus on new science and technology, that will shift production onto a higher trajectory - one that is defined by benchmark productivities & sustainability. However, henceforth both production & marketing shall march together hand in hand, unlike in the past when their role was thought to be sequential.

This Report is structured through 14 volumes and the layout, as the readers will appreciate, is a break from the past. It prioritizes post-production interventions inclusive of agri-logistics (Vol. III) and agricultural marketing (Vol-IV), as also sustainability issues (Vol-V & VI) over production strategy (Vol. VIII).The readers will, for sure value the layout format as they study the Report with keenness and diligence. And all other volumes including the one on Extension and ICT (Vol. XI), that connect the source and sink of technology and knowledge have been positioned along a particular logic.

The Committee benefited immensely from the DFI Strategy Report of NITI Aayog. Prof. Ramesh Chand identified seven sources of growth and estimated the desired rates of growth to achieve the target by 2022-23. The DFI Committee has relied upon these recommendations in its Report.

There is so much to explain, that not even the license of prose can capture adequately, all that needs to be said about the complexity & challenges of agriculture and the nuances of an appropriate strategy for realizing the vision of doubling farmers' income by the year of India's 75th Independence Day celebrations.

The Committee remains grateful to the Government for trusting it with such an onerous responsibility. The Committee has been working as per the sound advice and counsel of the Hon'ble Minister for Agriculture and Farmers' Welfare, Shri Radha Mohan Singh and Dr. S.K. Pattanayak, IAS, Secretary of the Department of Agriculture, Cooperation and Farmers' Welfare. It also hopes, that the Report will serve the purpose for which it was constituted.

12th August, 2017

Ashok Dalwai
Chairman, Committee on
Doubling Farmers' Income

About Volume III

The third volume of the Report of the Committee on Doubling Farmers' Income (DFI) examines the status of post-production operations, with the perspective that a farmer's produce must connect with multiple avenues to obtain value at each place, across time & space and in various forms. Physical connectivity to markets is the primary medium by which farmers can access the opportunity to exchange the produce for money. Any lack of logistics connectivity to convey their harvest to markets, results in a lowering of the farmers' ability to monetise their produce.

The Committee recognised that in the strategy for doubling farmers' income the major challenges lie in the post-production domain. Given that farmers have demonstrated their ability to produce as targeted, it is the monetisation phase that should now support them in capturing optimal value. In this context, it is generally seen that marketing comes into discussion immediately. In the opinion of the DFI Committee, an efficient marketing system is only a necessary condition, and does not ensure that the higher price discoveries are automatically transferred to the farmer-producers. It therefore concluded, that monetisation and not marketing alone should form the fulcrum of post-production phase. It logically decided to consider a complement of agri-logistics, value addition and agri-marketing as integral to an efficient monetisation system. In fact, the Committee also recognised that monetisation has to be supported by appropriate farm harvest practices.

This volume focuses on agri-logistics, which enables connectivity between production and consumption zones over both space and time with minimal loss of quality and quantity. It considers various aspect of agri-logistics, with primary focus on preconditioning, storage and transportation of farm produce. The farmer requires improved logistics to move the harvest; to choose the time of transaction, they need the cold-chain for perishables, or safe storage for foodgrains; and for a change in form, they need near-farm processing facilities to feed the raw material. These aspects are discussed in this volume, riveted to a demand driven approach. The focus is kept farmer-centric, so as to enable them with choice and connectivity to immediate market opportunities, to minimise food loss and recover maximum value from the produce. Other developments required over the longer term, are also indicated. However, this volume emphasises on the immediate need to ensure that farmers as primary actors, get connected to existing demand and available opportunities, to extract value from every grain, every ounce and every drop they produce.

The guiding and governance aspects of the system of agricultural marketing is discussed in detail in Volume IV that follows. There exists an organic link between agri-logistics and markets, which entails a seamless transfer of produce to complete the monetisation process.

Ashok Dalwai

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Doubling Farmers' Income

Volume III

"Post-production Agri-logistics: maximising gains for farmers"

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Chapter 1
Introduction

In an effort to boost socio-economic growth in the agriculture sector, the Government has set the goal of doubling farmers' income by 2022-23. To achieve this, government support and policy interventions need to shift from a production-driven approach to a demand-driven value system. While other incremental efforts to optimise production continue, focus on the post-production logistics connectivity is needed as a key transformation to redefine agriculture from cultivation alone, to gainful agriculture.

1.1. About the Report

Taking into consideration the target period to double farmers' income, the Committee to Double Farmers' Income has assigned highest priority to interventions that will transform the way the existing production can realise the maximum value for farmers. To achieve the desired income growth, every grain, every ounce, every drop produced must connect with all market avenues to reach gainful-end-use. This compels the need to direct immediate attention to the post-production activities and marketing system for farmers produce.

Volumes III and IV of the report by the Committee, focus on the strategies to eliminate the constraints faced by farmers and other players in the value system and to improve access to agricultural markets, and for farmers' produce to find full value. The analysis and strategies for expanding agricultural trade in the country, with a focus on infrastructure creation, enhanced access to marketing information, efficient flow of produce to markets, lowered transaction cost and reduced food loss is among the topics covered in these volumes.

Volume III lays emphasis on the post-production activities that safeguard agricultural produce, transfer the harvested value to markets, and allow to connect with markets across place, time and form. The deliberations have been kept farmer-centric, concentrating on the capabilities needed, such that the full quantity of production is monetised and delivered to their consumers safely, in quantity and quality. Preparing the farmers' produce for next stage handling after harvest, connecting to their points of sale, storage where necessary, and other options to maximise value gain for the farmers is discussed in this volume.

Volume IV of this report deliberates on the desired improvement and reforms in the agricultural marketing system. The post-production activities need to be market linked and hence, marketing is approached as a market intelligence function, to provide vital information of consumer demand to the farmers, so as to direct their activities towards the relevant market channels. Expanding the market breadth for farmers so as to promote competition and transparency is another function of marketing. To capture greater value for farmers, also requires a regulatory environment that works to increase alignment and collaboration with the private sector and other stakeholders in the food system. Strategies to make the marketing system demand linked and more relevant to farmers is discussed in Volume-IV.

The distinction is made, that from the famer's perspective, post-production activities are those that empower their access and physical connectivity with available market channels. Here, agri-

logistics is the backbone that connects the produce to destination points, where they can conclude a desired transaction. The marketing system on the other hand, provides information to direct the flow of produce to points of demand and facilitates the transaction. Marketing is therefore expected to be the brain that ensures production and post-production activities are appropriately market linked, and that markets channels are expanded to absorb future growth in production.

To maintain a demand linked agenda, an inverse approach is needed, to work backwards from Fork-to-Farm, to ensure that demand is integrated with supply side, rather than only selling at a convenient market at available prices or pushing production into storage merely for unplanned and deferred returns. A fork-to-farm approach has to be adopted, whereby the reverse flow of information from markets to farmers would also enable the farmer to take informed decisions about what to market, when to market and to whom. For connecting with markets, logistics is the backbone, and functions to bridge supply to consumption centres.

Avoiding food loss in the post-harvest supply chain to result in an increase in the saleable quantity of produce is vital towards fulfilling this agenda. It also requires integration of the value chain segments that connect fork to farm, while providing farmers the options to take part in post-production activities.

India's food security concerns had focused on maximising production. The Green Revolution resulted in achieving not only food security but also generated large surpluses. However, this has not always translated into equivalent economic development for the farming community.

The "Green Revolution" as was implemented all over the world, had focused on increasing farm yields, especially in developing countries, with aim to cope with growing demand from an increasing population. The green revolution involved use of agro-technologies on the production side of the value cycle – improving quality of seeds including hybrids, promoting double cropping and the increased use of fertilizers, irrigation and farm mechanisation. Expanding the area under farms was also a thrust area and entire agenda was to produce more.

At Independence in 1947, the country's population was about 335 million and many doubts were expressed on India's self-sufficiency to feed its rapidly growing masses. The farmers responded robustly in past decades by producing ever more - as a result, with a population about four times in size since independence, today the concerns are no longer about production but about marketing the surplus, besides the cost effectiveness of production.

By the start of 1980, having benefited from initiatives taken under ambit of the green revolution, the country transformed itself from a food deficit zone to become an exporter of food. In addition, 'Operation Flood' fronted India's white revolution in agriculture, wherein the country is today the world's largest producer of milk and dairy products. Today, India is shifting focus from a purely production bias, towards market linked agriculture for realising gains to farmers' for their greater wellbeing and income.

1.2. Agriculture Production in India

Compared with farm production at the start of the 1960s, India now harvests 40 times as much tomato, 14 times more potato, 8 times more wheat, thrice as much in poultry and meat, 13 times more fish, 8 times more milk and almost 40 times more eggs. The scaling up of our food production far surpassed the growth in population (which grew about 2.8 times from approx. 460 million in 1961). India is a net exporter of agricultural products and 7th largest globally.

India's success in production manifests across various agrarian sectors. In some sectors like milk, the country tops in the world production ranking with an output of 164 million tonnes in 2016-17.

Table 1.1 Production figures - India (annual 2015-16)

Horticulture	(million tonnes)		Livestock	(million tonnes)
Potato	*43.42*		*Inland Fish*	*7.21*
Onion	*20.93*		*Marine Fish*	*3.58*
Tomato	*18.73*		Fish	10.79
Mango	*18.64*		Butter & Ghee	5.4
Citrus	*11.58*		Meat & Poultry	7.02
Banana	*29.14*		Milk	155.5
Brinjal	*12.52*		Egg	83929 million pcs
Aromatics, Cashew, Flowers, Honey, etc.	19.95		Field Crops	(million tonnes)
Spices	6.99		Wheat	92.29
Fruits	90.18		Rice	104.41
Vegetables	169.06		Pulses	16.35
Total Horticulture	286.19		Sugar cane	348.45

Source: MoAFW

Advance estimates for 2016-17 indicate that foodgrains output is to touch 275 million tonnes with pulses at a record 22.95 and cereals at 252.73 (rice, wheat, maize, millets, etc.) million tonnes. Oilseeds production is estimated at 32.1 million tonnes in 2016-17 and in horticulture the production is reported to touch 300 million tonnes. Sugarcane, cotton, jute, tea, coffee, tobacco, meat, fish, wool, etc. will add another 330-350 million tonnes to the farm produce.

India produces far more than one billion tons of agricultural produce. Agriculture can no longer be viewed from the narrow prism of foodgrains alone. Today, horticulture, combined with produce from fisheries, dairy and livestock, captures almost 70 per cent of agriculture's contribution to national GDP, making these sectors the prime drivers for rural wealth and economic productivity. For example, horticulture utilises only 24.5 million hectares (approx. 16 per cent of total area under agriculture), yet contributes the highest (almost 38 per cent) to agricultural GDP. The billion plus tonnes, has to be differentially addressed post-production, and linked to multiple markets. Investments in post-production and market connectivity are key to advancing agricultural growth, as well to ensure the resilience of the sector.

Public sector contribution in gross capital formation (GCF) in agriculture remains important, though private sector share of GCF in agriculture is more than 80 per cent. However, it mostly

comes from farmers' investment and not the corporate sector. During 2011-12, GCF in agriculture was 7.7 per cent of total gross capital formation in the country.

Having almost 141 million hectares under agriculture (second largest globally), India's concerns today, are about empowering farmers with greater market connectivity to achieve greater value realisation. Producing food in sufficient quantity is no longer the immediate concern; instead now, apprehensions relate more to minimising post-harvest losses, securing of easy and affordable access to the food and in improving resource use and input management.

The country produces multiple crops across many States and production is being increasingly developed in clusters so as to promote economy of scale at the farm-gate. This transformation is expected to grow as more Farmer Producer Organisations (FPO) are created and through impetus from Cooperatives or other collaborative farming practices. There is a likelihood that entire villages will collaborate as farmer groups and operate farms collectively in the shape of Village Producer Organisations (VPOs).

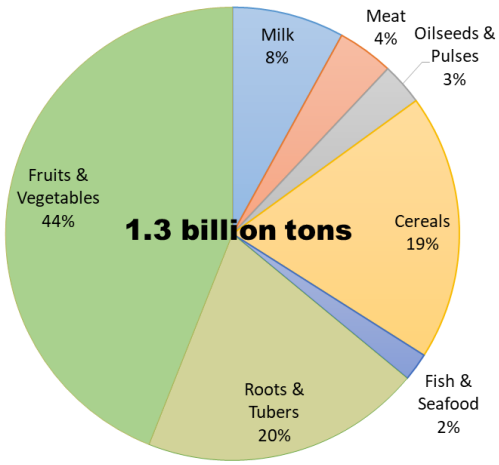
Modernisation of farming practices have led to the production of substantial surplus of produce, concentrated at the cultivating region. This surplus is local to the producing area and there is need to connect with consumption at urban clusters, which are concentrated at a distance from the producing areas. In case of foodgrains, the surplus is captured by private sector (milling units) and through procurement by FCI, NAFED and State government agencies. However, in case of perishable produce, such as fruits, vegetables and others with lower holding life, the surplus when not procured, tends to go waste causing a loss to farmer and of national resources.

1.3. Food Loss Concerns

Globally accepted reports of the Food and Agriculture Organization (FAO) of the United Nations, state that 1.3 billion tonnes of food incurs loss and waste, with the highest share in case of fruits, vegetables and tuber crops.

Internationally, various food loss studies are done, though these were not structured under common metrics and parameters, making comparisons impractical. However, with greater understanding of food loss and food waste, a harmonised interpretation has emerged.

Figure 1.1 Global Food Loss & Waste by Produce



Source: FAO. 2011. Global food losses and food waste—*extent, causes and prevention*. Rome: UN FAO

Food loss is now understood to occur when the food produced for human consumption is discarded or suffers a reduction in quantity, or is diverted for non-food purpose. The cause is primarily the miscarriage in post-harvest connectivity to markets, i.e., **failure in the handling and connecting of food produced to consumption points.**

Food waste, on the other hand, is understood as the waste that occurs in the hands of consumers, conscious or unconscious due to habitual excesses or other rejection factors, i.e., f**ood discarded at consumer-end, after monetisation of the farmers' produce**. Both food loss and food waste are unproductive and constitute a measure of the physical mass squandered.

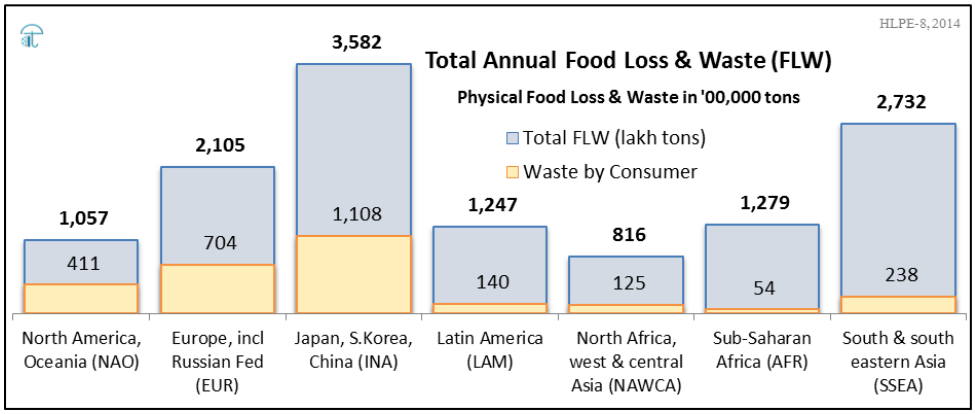
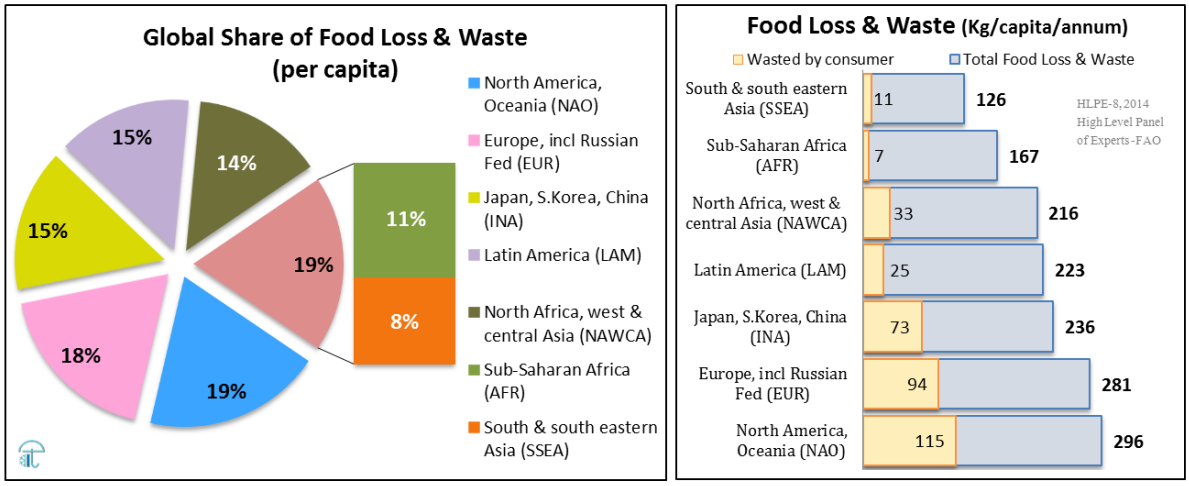


Figure 1.2 Food Loss & Waste by Region



Extracted from - HLPE, 2014. Food losses and waste in the context of sustainable food systems. (High Level Panel of Experts on Food Security & Nutrition of the Committee on World Food Security, Rome.

Globally, food loss is far higher than the waste that is incurred after monetisation. The food loss that occurs post-harvest and before connecting to markets, is effectively a loss of saleable volume and value, and is an economic burden on the food supply system. It is obvious, that for the purpose of doubling farmers' income, mitigating food loss in the supply chain is a first priority. The need for scientific post-production management is obligatory to ensure that maximum quantum of production can reach and fulfil market demand, and thereby add to farmers' income.

Food Loss: post-harvest, in-transit, pre-consumer **|** **Food waste:** consumer-end, post-monetisation, post-retail

Food losses must be understood in the light of frequent reports of unfulfilled demand of certain vegetables in large cities, while the same crop is discarded alongside farms, for want of effective market linkage. Coincidentally, most high perishable crops are also high nutrition foods and comprise the bulk of high-value-agriculture (HVA).

The Ministry of Food Processing Industries (MoFPI) had commissioned the Central Institute of Post-Harvest Engineering and Technology (CIPHET) of ICAR to evaluate the food loss in India and the most recent report was published in 2015. The CIPHET study indicates, that the post-harvest loss incurred, in per cent of production, in cereals is in the range of 4.65 to 5.99, in oilseeds & pulses 3.08 to 9.96, in spices 1.18 to 7.89, in livestock produce (milk, meats, fish) 0.92 to 10.52, and in fruits & vegetables at 4.58 to 15.88. However, it was observed that the study had not considered the losses that may occur in the course of long haul transport to terminal markets, having assessed only the first mile transport.

Table 1.2 CIPHET 2015 report on Post-harvest Loss of Food Produce (%)

Agricultural Produce	During Transportation	Farm operations (and first mile)	During Storage	Overall Total Loss
Milk	0.02	0.71	0.21	0.92
Meat	0.00	1.99	0.72	2.71
Marine Fish	0.91	9.61	0.91	10.52
Inland Fish	0.17	4.18	1.05	5.23
Egg	0.36	4.88	2.31	7.19
Poultry Meat	0.66	2.74	4.00	6.74
Cereals	-	-	-	4.65-5.99
Pulses	-	-	-	6.36-8.41
Oilseeds	-	-	-	3.08-9.96
Fruits & Vegetables	-	-	-	4.58-15.88

Source; Report on assessment of quantitative harvest and post-harvest losses of major crops - CIPHET 2015 study

The losses in India, reported by CIPHET, are far lower than those reported globally by FAO. However, other estimates in documents of Indian Council of Agricultural Research (ICAR), state that the Indian agriculture sector incurs 18 to 25 per cent losses in the entire supply-chain.

Studies by other organisations also indicate a variance in the losses assessed. The Small Farmers' Agri-Business Consortium (SFAC) also conducted a value chain assessment[1] in the North Eastern region in 2012, which reported higher per cent loss in the vegetables produced. The data was collected from a primary field survey, and the losses reported ranged from 9 per cent for potato to 32 per cent for chick pea. Other crops like cucumber, onion, chilli, ginger, pumpkin and bitter gourd were also reported with losses in the range of 20-25 per cent of production. Another study, on the banana supply chain was also undertaken by Food and Agriculture Centre of Excellence (FACE of CII), where physical loss was assessed at 20-25 per cent when handled without access to modern supply chain in the form of integrated cold-chain.

Yet another assessment was undertaken by the National Centre for Cold-chain Development (NCCD) in 2015-16, of the losses incurred on fruits & vegetables, conducted with Amity International Centre for Post-Harvest Technology & Cold-Chain Management. The team carried out a sampling survey, at various stages to market, to measure the physical food loss.

[1] Value Chain Analysis of Select Crops in the North Eastern States, SFAC

The study was limited regionally to Uttar Pradesh, Uttarakhand and Haryana to evaluate for a basket of 29 fruits and vegetables. Based on field visits by the study team, the study observed the highest loss in case of pears (22 to 44 per cent) and lowest in case of water melon (7 to 11 per cent). Losses measured though this sampling study for each selected crop are tabulated below:

Table 1.3 Food Loss measurement - sampling study

Losses at different stages in per cent age (%)										
	Harvest Farm-gate		**Post-harvest handling**		**Transport-ation**		**Wholesale point**		**Total**	
Vegetable Crops	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
Peas	4	8	4	8	6	10	5	7	**19**	**33**
Okra	2	3	2	3	3	4	5	10	**12**	**20**
Cruciferous crops										
Cauliflower	2	4	6	13	2	4	5	7	**15**	**28**
Cabbage	1	3	5	8	4	6	8	10	**18**	**27**
Solanaceous crops										
Tomato	2	3	9	13	2	4	5	7	**18**	**27**
Brinjal	5	7	3	4	2	4	5	8	**15**	**23**
Potato	5	8	4	6	1	2	8	10	**18**	**26**
Cucurbitaceous crops										
Bottle gourd	5	7	7	12	4	6	8	10	**24**	**35**
Bitter gourd	3	7	4	5	4	6	4	5	**15**	**23**
Sponge gourd	2	5	3	8	3	4	2	4	**10**	**21**
Water melon	1	2	1	2	4	5	1	2	**7**	**11**
Musk melon	1	2	2	3	5	7	2	3	**10**	**15**
Pumpkin	2	4	3	4	4	6	2	3	**11**	**17**
Fruit Crops										
Mango	2	4	8	12	5	10	3	5	**18**	**31**
Papaya	2	4	4	6	2	3	2	3	**10**	**16**
Litchi	15	20	5	7	3	4	2	3	**25**	**34**
Guava	4	8	5	10	5	8	5	6	**19**	**32**
Peach	10	25	2	4	1	2	2	3	**15**	**34**
Pear	10	15	10	25	1	2	1	2	**22**	**44**
Apple	5	7	4	8	1	2	1	2	**11**	**19**
Sapota	8	10	10	12	2	4	3	5	**23**	**31**
Root crops										
Carrot	2	4	4	10	3	5	2	4	**11**	**23**
Radish	3	5	7	10	4	5	4	5	**18**	**25**

Source: NCCD

The physical losses (weight loss and discards) were appraised at varied stages of movement to market of the selected produce. Each stage of measure was where a change in custody occurred and the produce entered the next step in its post-harvest journey to market.

a) At farm-gate (point of harvest);
b) At collection point (aggregation);
c) On loading onto transport;
d) During transportation;
e) On receiving at Wholesale point

Inclement conditions and poor handling results in loss of saleable quantity from farm to market. The losses beyond point of wholesale or the waste in hands of the consumers were not assessed in this study. The instances where post-production surplus could not even enter the market supply chain, due to non-availability of logistics connectivity, were not evaluated. Unable to be directed

towards a market, much of such surplus is not even evacuated from farms and this quantity is incurred as added total food loss.

A more comprehensive study of post-harvest food loss, under a harmonised yardstick, in all regions of the country is indicated.

This Committee reviewed the unit level information from NSSO 70th round (refer Chapter-4, Volume-II of the DFI report), to estimate that losses in case of fruits and vegetables are 34 and 44.6 per cent respectively. Grain inventory in central pool also incurs food loss when its usable life expires within warehouses, due to an inadequate delivery and distribution mechanism.

The loss in the farm-to-market link segment, whether at 15 per cent or 40 per cent, is an unmistakeable opportunity to add to farmers' income. The physical loss of produce, denies revenue off the production and detracts any motivation to produce more. Such high loss can be averted with better physical connectivity, post-production. To ensure that the infrastructure development is market linked, the planners can benefit from adopting an inverse approach, working backwards from consumption to farms. Produce that reaches points of demand is less likely to result in food loss. Lack of a delivery system, is the leading cause for recurring losses.

1.3.1. Food Loss and Sustainability

It worth mentioning that food that is lost and wasted, converts into greenhouse gases and has a direct impact on global warming, besides resulting in loss of water used during cultivation.

On the basis of global food loss and waste (FLW), reported by FAO at 1.3 billion tons of physical loss, the equivalent in CO2 emissions is assessed at 4.4 billion tons per annum.

This raises acute concern that food loss and waste has a major contribution to climate change from greenhouse gases.

Addressing food loss therefore also takes importance in context of environment sustainability.

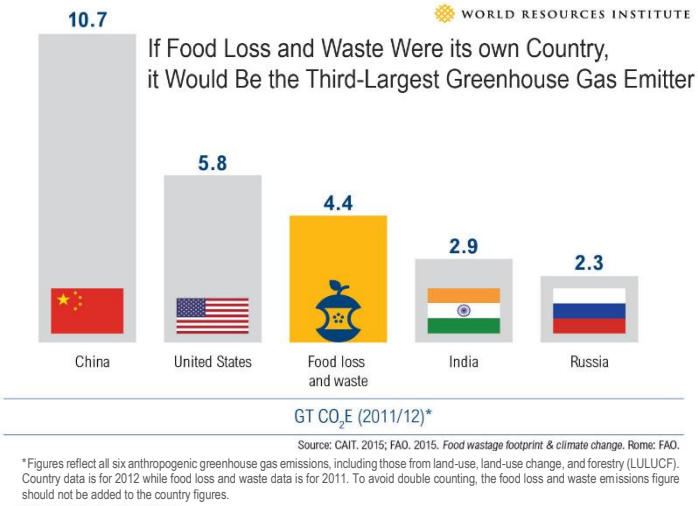


Figure 1.3 Greenhouse gas emissions from Food Loss & Waste (FLW)

Food loss is not necessarily due to lack of technology; **a large quantum of food loss occurs from a lack of access to the national markets, resulting in localised surplus and discards in the hands of farmers.** The answer to food loss, is market linkage and effective logistics. Especially in view of the fact, that many a time, there remains unfulfilled demand, while the surplus is discarded due to inability to connect with that demand.

1.4. Connecting with Consumers

Traditionally, agriculture production was met by ready demand, proximate to farms, which allowed for quick evacuation of the output for use by local consumers. The consumer base originally included the farmers themselves, the local populace and the local traders. Similarly, in case of milk and other perishable produce, the farmer or his associated market retailer would directly aggregate, select and retail the produce locally.

Decades ago, the flour millers were small scale service providers for the end consumer - the consumers themselves carrying the whole grain to the local mill and paying for grinding service to convert it into consumable flour. In effect, the number of actors between farmer and consumer were at a minimum. In that same period, the selling range for the majority of the crops was also limited and mainly local for perishable items like milk, fruits and vegetables.

In time, the increases in the volume being traded attracted the growth of intermediary traders and processors. Initially this was more evident in the trade of jute, cotton and foodgrains, and subsequently in case of other farm produce. With urbanisation resulting in mega population centres, the city consumer became more remote from farming communities, in terms of physical access as well as in terms of the pricing mechanism. This lack of connectivity, allowed for the shift in control of the supply side into the hands of intermediaries, with increasingly non-transparent monopolies surfacing in the demand side of agri-produce.

Further, as demand and the quantity being traded increased, the market attracted bigger scale in food processing units. These units became another demand option for the farmers for selling their primary produce. In consequence, the flour grinding service provider, became the large flour miller who also became the branded product owner. This transformation of a service into a market intermediary, delinked the farmer from direct consumer interface. For all intents and purposes, the processing units became another wholesale buyer for certain primary produce.

The consolidation and organisation of the market linkages, resulted in the farmers being more reliant on traders or intermediaries to connect with the markets. The system is expected to bring efficiencies and improvement in market access, allowing for more productive use of the yield.

However, the system also tended to give rise to multiple intermediaries and positioned the farmer at a disadvantage, by relegating control over the primary pricing to the intermediary procurement level. This changed dynamics is a necessary aspect of supply chain, when needing certain vertical integration for connecting with large demand that is remote to the production area. Such vertical integration helps mitigate price risk for the farmers and the first consumer.

There are two major methods for price risk management in the agriculture sector. One is by locking the price of the harvest in advance through contracts and/or by using the harvest as collateral for credit. This option is discussed in other Volumes of this report. The traditional method for farmers is to enter pre-harvest agreements at a specific price for future delivery. Also known as forward contracts this allowed producers to lock-in at a predetermined price, thus

reducing risk, but also foregoing the possibility of benefiting from positive price deviations.

The other route to manage price risk, is developing a marketing network with the logistics ability to link the harvest with multiple markets. The opportunity from price variation that arises from demand-supply gaps, can then be taken advantage of, provided the capability to deliver the harvest to markets is made possible, starting at village level. The advantage of agri-logistics is that it allows for more immediate value realisation prospects, and in turn also helps smoothen market fluctuations by directing produce to where demand remains unfulfilled.

To help in doubling farmers' income and to make agriculture more viable and sustainable, there is a need to develop holistic post-production management to enable efficient market connectivity for perishable and semi-perishable produce. Such connectivity would entail cross-geographical flow of fresh foods and preferably involve multi-modal transport connectivity.

There is also need to empower the farmers to develop horizontal integration with multiple market channels and not remain restricted to only one market avenue. This is most relevant in case of perishable produce where the consumer preference for fresh whole farm produce continues to prevail. Direct access to multiple markets is most beneficial in case of perishables, as time is of essence and the high quality produce can rapidly downgrade into non-saleable discards or a depletion in the quantity. The marketing system also plays an important role in opening up markets, and to ensure it also opens farmer's options for crop diversification and crop planning.

1.5. Marketing Evolution

An important landmark in the agricultural marketing scene was the establishment of regulated markets and advent of regulating the market practices in the country. Its roots were the first legislation was the Berar Cotton and Grain Market Act of 1887 and the recommendations of the Royal Commission on Agriculture 1928, which empowered the British Resident to take measures to regulate the trade practices and to establish market yards in the countryside.

After independence, during the sixties and seventies, most of the States enacted and put into operation the Agricultural Produce Markets Regulation (APMR) Acts. All primary wholesale assembling markets were brought under the ambit of these Acts. Well laid out market yards and sub-yards were constructed and for each market area, an Agricultural Produce Market Committee (APMC) was constituted to frame the rules and enforce them. Thus, a form of organised agricultural marketing came into existence through the regulated markets.

The main objective to regulate the practices at primary agriculture market yards was to protect the interests of farmers by providing an environment of fair play and transparency in transactions. The focus crops for these markets were mainly cotton and foodgrains.

The APMC regulated marketing system was more suited to the premise that the buyers would transact at these yards for their primary requirements, with farmers. A principle understanding was that the ensuing transactions would be a reflection of the demand and could be suitably

monitored for future growth and regulated for other development purposes. The markets were designed to provide trading platform for farmers and to facilitate short supply chains to nearby users, next stage terminal markets, or agro-processors.

At that time, the concept of population migration and urbanisation, leading to demand from cross regional markets (pan-India) was not built into the mechanism. The mandatory physical flow of produce through the designated markets, became a bottleneck when the produce needed to move to remotely located demand. Also, as the amounts and demographics of the produce changed, it was observed that the regulations had not considered any future changes in post-production handling and the specific logistics of certain produce types. The established system of markets could no longer efficiently cater to changed demand patterns from across the nation.

In order to overcome the shortcomings and challenges of traditional regulated marketing system (APMCs), Government of India initiated reforms, the Model APMC Act of 2003 and the Model APMC Rules 2007. A comprehensive review was undertaken in 2016-17, of the Model Acts & Rules, which showed, that the market reforms at best had turned out to be patchy and incomplete.

The Department of Agriculture, Cooperation & Farmers' Welfare (Ministry of Agriculture & Farmers' Welfare) thereafter formulated recommendations known as the Model Agricultural Produce and Livestock Marketing (Promotion & Facilitation) Act, 2017 (APLM), which incorporates changes to reflect the agenda of a unified national market for agriculture, besides facilitating alternate market channels, including alternate online marketing platform. This Model APLM Act recommends, inter-alia, establishing of markets in the private and cooperative sectors, direct marketing and farmers markets and not only provides a level playing field to existing stakeholders, but opens the marketing arena to new stakeholders. These initiatives will introduce competition for fair play and transparency in price discovery.

The various aspects of the agricultural marketing system and its next level evolution and implementation are discussed in detail in Volume IV of this report.

1.6. Focus on Post-production Activities

Greater value to farmers will arrive through assigning emphasis on post-production activities that connect the farm harvest to markets for value realisation. This will include expanding the marketing range of the farmers. Importance on reducing losses in the post-harvest supply chain and providing pan-India marketing options will be part of this agenda.

The key strategy behind policy interventions that aid post-production market linkages, are:

i) to promote direct access by farmers to all avenues to monetise their produce;

ii) to organise post-harvest aggregation activities at farm-gate (village/gram panchayat level) so as to build capacity to minimise handling loss and convert would-be-loss into value;

iii) to modernise the agricultural logistics infrastructure to support safe-keeping of the produce and fast-track the delivery to markets;

iv) to promote private sector participation in expanding the reach and range of farm produce into consumption centres, both domestic and international.

Doubling real income will require the doubling the selling volume of farmer's produce, expanding links with markets, including alternate marketing channels, while adding to near-farm earning opportunities. In the first instance, provision of physical access from farms to point of sales will be an important empowering capability.

For purpose of maximising the gain to farmers, the strategy indicates that fice pillars be adopted to direct the post-production activities:

Figure 1.4 Pillars for post-production activities – maximising farmers gain as outcome

Market Expansion & Access	Promote the range & reach of farmers into multiple markets, including alternate channels for greater selling choice and to increase selling volumes; in turn promote greater farm yields.
Reducing Produce Wastage	Maximise the volume of farm produce that reaches gainful end-use and reduce the dilution of input resources; especially due to food loss in the output supply chain.
Upgrading Agri-Logistics	Improve inventory management in warehouses, enhance post-harvest care to retain quality; to empower farmer groups with physical connectivity to lead to scale in cultivation and post-harvest.
Enabling Reforms & Investment	Unified market for agricultural produce, to support cross-regional agricultural trade. Promote alternate marketing channels including online marketing platforms with greater role for private sector.
Enabling Trade Regime for Exports	Maintaining a steady long term trade regime and ease of business at plant quarantine stations so as to promote international trade and long term export contracts.

This ability for farmers to directly deliver to a range of wholesale markets or to an allied industry, requires farm-gate (village level) aggregation capabilities in large scales, along with transport integration. The ability to assemble and move their produce to markets of choice, will improve the farmers' access to each avenue, where their produce is monetised. Enhanced and independent access to markets is expected to motivate and justify increase in production and improved farm productivity.

This document lays emphasis on the post-production activities that advance the farmers immediate access to avenues that monetise his/her produce, in more quantum, to capture greater value. Post-harvest market links are presented as a key accelerator for doubling farmers' real income. Post-production activities improve handling, management, marketing and processing of the produce. It also means infrastructure investment, as well as job creation, both of which are allied to the core business of farming.

1.7. Annotation

Through policy measures initially adopted in mid-1960s, such as input subsidy, minimum support price, public storage, procurement and distribution of foodgrains, trade protection measures and regulation of markets, India has witnessed the transition from subsistence to situation of surplus production. The policy interventions from 1960s, were primarily meant to avert situations which may again lead to a deficit.

India's agriculture has travelled a long way from the period of subsistence farming to that of surplus output, calling for a paradigm shift in the management of the agricultural marketing system. It emerges that agriculture markets established in 1960 to handle the deficit are now required to undergo a paradigm shift to handle marketable surplus efficiently e.g provisioning alternative marketing channels, participation of private sector and providing an enabling environment to achieve faster growth including using e-platforms for market expansion.

Gross Capital Formation in the economy (in 2010-11) was Rs. 26,80,579 crore with public sector share of 25 per cent. In agriculture and allied sector, GCF was Rs. 1,97,364 crore with public sector share at 16 per cent. Future spend in agriculture and allied sectors, can look to aim at suitably enhancing the market linkage and connectivity of farmers.

Business practices have undergone changes and old concepts or regionally isolated production for a regions local consumption have been laid aside. For example, textiles can source raw fibre competitively from any location in the world, process into products under large economy of scale to sell to consumers worldwide, using supply chains having a global foot print. This practice is most prevalent when raw produce and final product has longer and easily managed holding life.

In case of perishable produce, the saleable life cycle is short and the serviceable range of farmers is normally restricted to local demand, within their delivery range. The lack of physical connectivity with non-local (distant) domestic demand, is evidenced by produce being discarded in growing regions, while high price situations are seen at consumption points in other States. This food loss is due to unfulfilled demand in presence of available supply, and is an indicator of shortfall in logistics. As a result, the resources that go into producing such high value crop, perish with the food item adding more pressure on the pricing mechanism.

The reach of the post-production supply chain is decided by the usable and manageable life cycle of the material. Any shortfall in market connectivity fails to bridge the gap between demand and supply and this in turn detracts from the income of the farmer.

India has shifted direction to strategically drive a change that brings its harvest to more gainful end-use, and to make its agriculture sustainable on both commercial and environmental terms. Hence, the need for an inverse approach that works backwards from Fork-to-Farm, and ensures that demand is integrated with supply side, rather than pushing production into storage merely for unplanned and deferred (uncertain) returns.

Therefore, rushing to the conclusion of large scale diversification into high value crops would amount to jumping the gun, in the absence of demand assessment over distance & time and concurrently putting in place the attendant agri-logistics. From a post-production marketing perspective, the key accelerator to reduce the time to double farmers' income, is greater physical access to a unified nation as one market. Enhanced physical connectivity from farms to markets will enable farmers to trade with wholesale buyers of choice and capture more equitable value.

To double farmers' income, the gains from productivity and production need to translate into revenue generation. Augmenting direct connectivity to multiple market channels, so as to reduce losses and increase the volume of produce sold, is an immediate opportunity.

Key Extracts

- This volume focuses on post-production activities from the farmer's perspective, and the methods for farmers to connect with various market channels to realise maximum value from the production.
- Volume IV focuses on the agricultural marketing, to systemically direct the production and selling activities in the right direction, and bringing growth in markets.
- Indian agriculture has changed from a state of deficit into one of the world's top producers, generating on-farm surpluses in various crop segments.
- Globally, and in India, there remains a high burden of Food Loss that happens in the food distribution chain, from farm-to-consumers. Sustainability concerns arise.
- Inefficient practices in the logistics chain, and restrictions to cross-national connectivity contribute to food loss and detract from farmers' income.
- Single market concept of unified agricultural market is impeded by rules and regulations that were not designed to expand agricultural marketing as one country.
- Consumption has consolidated in dense pockets at cities and marketing rules need to amend and adapt to the changed practices in the supply chain.
- Globalisation allows certain hardy commodities to be sourced from across the world. Price discovery is impacted by global signals for certain commodities.
- Consumer preference, with growing affluence, shifts towards high nutrition foods. Diversification into high-value agriculture will need high-technology logistics chains.
- Farming will see transformative changes if empowered with organised logistics starting at farm-gate with information that makes the activities become market linked.

Chapter 2
Post-production Activities and Infrastructure

Cultivators have mainly focused on production activities and the path to monetise the produce is primarily through regulated markets. The changed dynamics in consumer preference, shifting from hardy staple crops to more perishable high value and high nutrition foods has raised the need to revisit the scope of agriculture, from cultivation alone into managing the overall agri-business eco-system.

A few decades ago, our cities adjoined lush fertile farmlands; whose farmers would harvest their produce in morning hours, and aggregators would rush the produce to the local wholesale centres. The normal practice for fresh food supply (to reach our homes), was quite simple and a matter of routine. By the time the consumer visited to buy his/her daily basket, the local grocer or street vendor was ready with that day's fresh supply. This was an effective food supply system, even though highly fragmented, which ensured that each morning's harvest was at the tables well within 24 hours. There were those awkward vagaries of weather and unbalanced supply, but the consumer too was a friendly and understanding stakeholder.

Urbanisation has ensured that farmlands are distanced very many kilometres away, entry points into our cities are becoming bottlenecks and transit time to reach markets is ever increasing. No more can the harvest reach the consumer within its natural life cycle. What now reaches the consumers' homes, was harvested a previous couple of days or more ago! This extended 'in-transit' time is compounded by the perpetually growing demand, wherefore the increase in handling volume adds to the delays. In case of perishable produce, the marketable life cycle is under pressure, and food quality is degraded rapidly without recourse to enablers such as cold-chain. Lack of cold-chain systems force farmers to monetise their produce at first instance by selling into food processing units, inefficient wholesale markets; and these sales are the only opportunity, low down in the value chain system, and do not empower the farmers

In case of cereals and grains, the post-production life cycle of the produce is naturally lengthier. The foodgrains are procured and stored in godowns and warehouses, for the near future requirements. These requirements can be consumption demand or as assessed for national security purposes. The market tends to rely only on cues from ongoing government interventions, by way of Minimum Support Price (MSP) and procurement targets of the government, or Minimum Export Price (MEP) to arrive at the associated market value.

It seems that demand is not clearly established or regularly monitored in a fashion that provides easily accessible market intelligence that informs market differentiated demand. With currently established methods for price signals, the concerned farmers are influenced by the price information that prevailed during the previous crop season. The infrastructure required to market or monetise their produce, is also effected by the unstructured market environment.

2.1. Farmer's Market Channels

Post-production, the farmers monetise their produce and, across agricultural produce segments, having a series of market avenues as their selling points. These can be itemised to the following,

each being a destination of the first stage evacuation, where the primary monetisation of farmers' produce occurs:

a. Near-farm mandis, where farmers deliver produce for local buyers – for primary assembly and wholesale transaction.

b. Near-farm 'Farmers markets', where farmers can sell to consumers – retail transaction.

c. Government procurement of foodgrains – a controlled and limited market avenue.

d. Near-farm processing units where farmers can deliver produce as raw material for new product creation – contracted or wholesale transaction.

e. Near-farm aggregation points, such as milk-chillers and pack-houses, for extending onwards market connectivity – very few developed for horticultural crops.

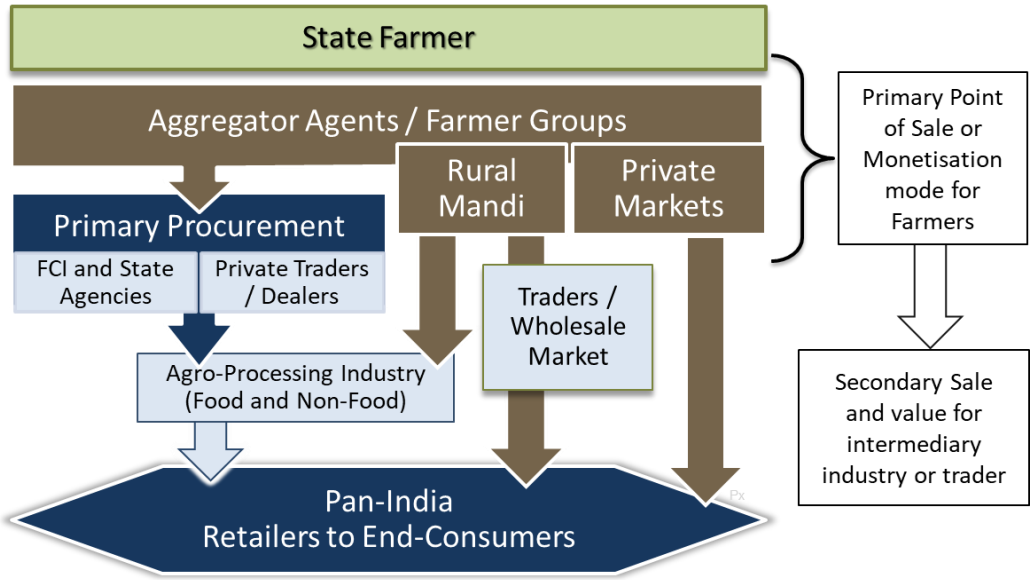


Figure 2.1 Primary Points for Farmers to Monetise Produce

Farmers perforce sell their produce at first points of evacuation, to local intermediaries (at-farm or near-farm), constrained and limited in their selling range, and thereby have no further direct role in the overall value system. Lack of logistics connectivity with farmer groups, effectively means that the markets are getting farther away from the reach of most villages, and therefore, the small and medium farmers find it technically and economically unviable to directly access various markets. Currently, intermediaries as aggregators step in to complete the logistics link for farmers, at times even upto the first level assembly markets (local mandi).

On the basis of produce type, the primary selling avenues for farmers are as follows -

- Foodgrains
    a. Central and State government procurement
    b. Wholesale markets – local and APMC including eNAM
    c. Private procurement by traders, milling factories and food processors

- Perishable food (horiculture, fish, meats)
    d. Wholesale mandis – local and national
    e. Farmers markets for retail to local consumers
    f. Private procurement by organised fresh food retailers
    g. Private procurement by food processing units
- Milk produce
    h. Village level collection (pooling and cooling) – local collection
    i. Local fresh to region – local retail
    j. Private procurement – by cooperatives or private dairy processors
- Non-Food produce
    k. Wholesale mandis – local and APMC including eNAM
    l. Private procurement by traders and manufacturers
    m. Government Boards for Rubber, Silk Coffee, Tea, etc.

In case of foodgrains, the government procurement system is an important mode of monetisation where implemented. Yet, further growth in this mode is linked to the capacity of the exchequer to continue to spend on such procurement and develop a robust disposal mechanism like public distribution system, sale in the markets, etc. Lack of secondary encashment or proper liquidation of the surplus stocks held in inventory, eventually result in physical loss of the food stored and amount to a waste of national resources. Expanding access of farmers to other market channels is needed, to avoid wasteful procurement taking up the inefficient role of a market surrogate.

Depending on the crop type grown, farmers have more than one avenue to sell into, provided there are options at hand to connect to each opportunity. However, between the farmer and each primary user of the produce, there exists the need to aggregate/pre-condition/prepare the farm-produce for the transaction, which the farmer is currently not empowered for. This inability to manage the produce for market linkage, allows for intermediary players to step in as facilitators. However, when there are too many intermediaries with too little facilitation, such mediation cost detracts from the total value realised per unit of produce that was made available at farm-gate.

At first instance, from the perspective of empowering farmers, it is obvious that this warrants focus on building their capacity as groups or individually, at farm-gate, to directly connect their produce with their primary buyers – each one in effect, being the first instance for farmers to monetise their produce.

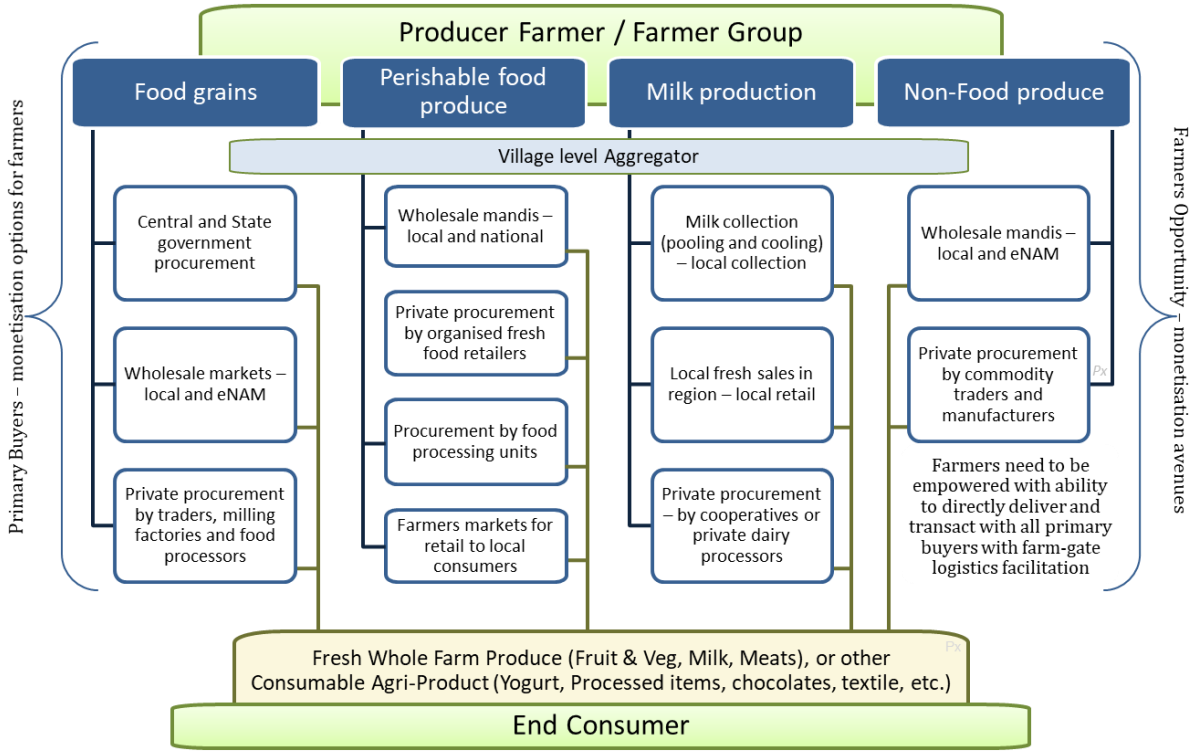
Currently, the farmer is not even directly linked with his/her primary buyer and this transaction is subject to multi-layered interfaces between the farmer and primary buyer. Any intermediary between first level consumer or primary buyer, is an unproductive interface and damaging to the farmer business dealing. Though the primary buyer is also an intermediary between the end-consumer and farmer, he provides material linkage with the end-consumer.

There is also the option for farmers to directly connect with end-consumer though peri-urban

farmers markets and similar, but these only provide a short term gain on price point and do not fully contribute to overall growth that can be harnessed by connecting and expanding their reach to other markets. Holistically, farmers' need the empowering ability to deliver to every market channel for monetising all of their production.

The organised intermediary either safe-guards the harvested value on its passage to end-consumer, or converts the raw produce into a more consumable format before selling to end-consumer. At a policy level, the farmer needs to be empowered with ability to directly connect with the primary buyer, and not necessarily with the end-consumer.

Figure 2.2 Produce-wise primary channels to monetise output



In most of the above market opportunities, the farmer is de-linked from the end-consumer at first instance, and is not provided opportunity to scale his/her growth independent of these established market channels. The ensuing business models tend to force the farmers to be subservient and integrate vertically with a trader or marketer as fixed rate suppliers.

To transform the farmers' income, models that promote their integration horizontally across multiple avenues or consumption markets also need to be strengthened. This will empower farmers with the ability to choose across multiple channels to sell. In practice, farmers would be guided to partake in both, i.e. vertical and horizontal integration with market opportunities.

- Horizontal integration expands links with multiple markets, encourages competition and entrepreneurship, mitigates risk from localised demand fluctuations, offers access to other earning options, and results in greater transparency in agricultural trade; but requires associated development of suitable logistics capabilities and services.

- Vertical integration with a single buyer, provides an assured off-take, mitigates risk from price fluctuations from external factors, promotes fixed specified quality for processors, and builds long term business interdependences… but limits farmers' growth linked to the growth of the buyer.

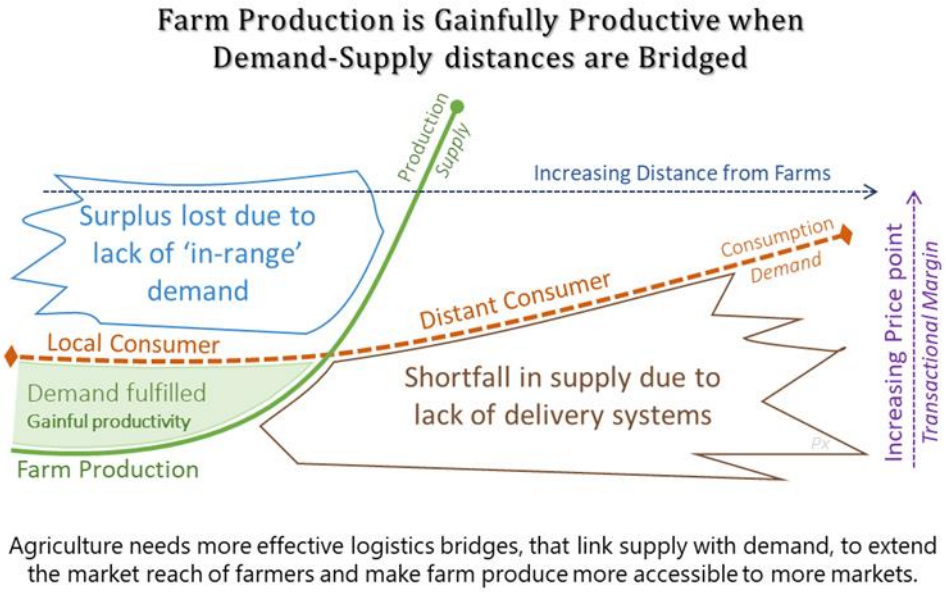


Figure 2.3 Supply is wasted unless linked with Demand

2.2. Infrastructure status

The primary development focus for agricultural post-production infrastructure, has been in the form of warehousing and cold stores, for holding inventory for extended durations. The infrastructure needed to connect with markets after the storage phase may not have found strategically linked policy support.

2.2.1. Warehousing for non-perishable produce

The country has established widespread godowns and storage for foodgrains, including cereals and pulses. The Warehousing Development & Regulatory Authority (WDRA) estimated that storage capacity of 126.96 million tonnes was available in the public, cooperative and private sectors in the form of godowns and warehouses, in 2016.

Table 2.1 Status of available storage capacity in warehouses

SN	Organisation / sector	Storage Size (in million tonnes)
1	Food Corporation of India (FCI)	35.92
2	Central Warehousing Corporation (CWC)	11.72
3	State Warehousing Corporations (SWCs) and State agencies	45.28
4	Cooperative Sector	15.07
5	Private Sector	18.97
	Total	**126.96**

2015-16 Annual Report of the Warehousing Development and Regulatory Authority

On the basis of estimates by the National Institute of Agricultural Economics and Policy Research (NIAP - ICAR) that foodgrain demand will reach 281 million tonnes by 2020-21 (179 for direct household consumption and 102 in indirect demand like fodder, seed, industrial use, etc.), a need for approx. 196 million tonnes of warehousing (about 70 per cent of production) is frequently projected. However, interventions to improve inventory turn-ratios will free warehousing space, and should be kept in mind when planning new capacity.

In addition to capacity under FCI, Central and State agencies, 65.9 million tonnes of new capacity has been sanctioned since 2001, under the Integrated Scheme for Agricultural Marketing (ISAM), of which about 58 million tonnes is the new capacity created as of 31 March 2017. An estimated 7 million tonnes in new capacity remains under construction.

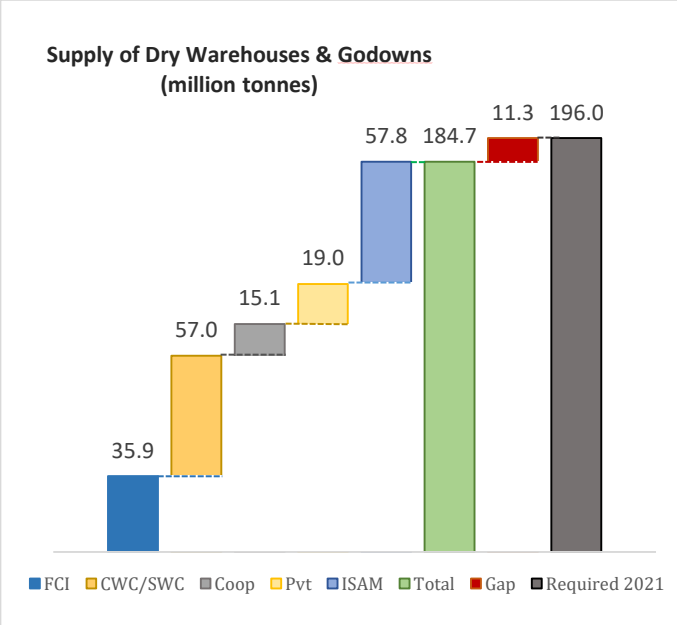


Figure 2.4 Availability of godowns & warehouses

Including estimations by WDRA, that about 18.97 million tonnes capacity is with the private sector, it can be concluded that the current available storage capacity is about 185 million tons, almost equal to the capacity required in 2021 (projected need of 196 million tons).

It is observed that ISAM sanctions capacity to cooperatives and private sector and some duplication in data is likely. But even if the entire capacity under private sector has been duplicated, the available storage capacity would still be 165 million tonnes of storage as of March 2017. However, inputs from private sector inform this Committee, that there exists unutilised storage capacity in the country. WDRA has also confirmed that many States have excess warehousing capacity, and that the data on warehousing under private sector (18.97 mill tons) is not verified and this could be more. These indicators suggest that storage availability may be higher than assessed and the projected gap in storage may be far less than estimated.

A large share of the warehousing capacity is for use of central and state procurement agencies. The storage capacity includes storage of type 'Cover and Plinth' (CAP), besides covered warehouses and/or silos. CAP storage is more liable to incur losses and upgradation is required.

The storage with FCI, and a part of warehousing capacity with the Central Warehousing Corporation (CWC) and the State Warehousing Corporations (SWCs) is used for storage of foodgrains procured for Central Pool. The capacity under FCI comprises 15.43 million tonnes owned by FCI, and the balance is hired from private sector, CWC, SWC and state agencies. As

on February 2017, the total capacity available for storing Central Pool Stocks was 77.625 million tonnes, with average utilisation of 66 per cent of capacity. This comprises covered godowns of 62.608 million tonnes and CAP storage of 15.017 million tonnes. The idle capacity, 34 per cent in February, would vary through the year, depending on the cyclic procurement and release patterns.

From 2013 to 2015, Central Pool held an average stock of 52 million tonnes of rice and wheat, ranging from a low of 43.9 million tonnes in April 2014 to a peak of 77.7 million tonnes in June 2013. The warehousing capacity in use by Central Pool in previous 6 years is tabled:

Table 2.2 Warehousing capacity used for Central Pool (2011 to 2017)

As on	Capacity under FCI	Storage with other State Agencies	Total (million tonnes)
01-04-2011	31.61	29.13	60.74
01-04-2012	33.60	34.14	67.74
01-04-2013	37.74	35.44	73.16
01-04-2014	36.89	37.93	74.81
01-04-2015	35.66	35.26	70.92
01-04-2016	35.79	45.70	81.84
01-03-2017*	35.51	42.45	77.63

**estimated* *Source: Food Corporation of India (FCI)*

In case of foodgrains and similar commodities, a modern warehouse is a safe supply point for onwards distribution to points of consumption (food processors, consumers). The forward connectivity to destinations, from the source warehouse, is possible by ordinary trucks and/or rail wagons. Since this raw produce is amenable to bulk storage, the lots are stored in bags or in bulk format (silos, etc.). The infrastructure in the form of transport and storage for foodgrains is well recognised and future development is to modernise and follow advancements in storage technology. The required capacities may be reassessed, incorporating stock liquidation cycles.

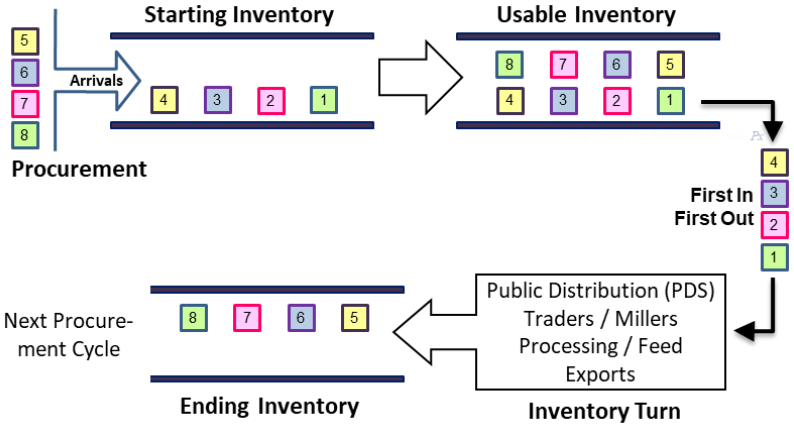
It may be noted, that warehousing infrastructure is a mode of temporal storage of non-perishable raw produce, and it does not lend towards expanding the market footprint of the producer; the treatment of the inventory is on patterns of commodity trade, with price arbitrage as the core business model for farmers' purpose. Surplus grain stocks still need to be linked to end-user markets to be make the inventory viable. The infrastructure is to be a tool for enabling the trade and not an end unto itself. Too often, the infrastructure model relies on rentals alone.

Holding inventory, only to counter surplus supply, does not transform the trading status and is normally linked to local demand patterns. As a result, growth in the trade can only be incremental in nature, depending largely on incremental change in population (demand). To change the situation, the need is to open trade with new markets, especially exports. Losses also need to be minimised by modernising the existing infrastructure. With loss reduction, there is greater saleable volume and opportunity. Future policies may look at modernising infrastructure and decentralised storage, for cereals/foodgrains, in the hands of farmers.

Though foodgrains are referred to as non-perishable produce, all agricultural produce is perishable and the qualification in only the comparative differential of the time taken to perish. In case of foodgrains, each harvest cycle should trigger an inventory replacement process instead of building new storage to allow larger unfruitful procurement. This only leads to non-productive inventory and cost overruns for the exchequer.

The government is the largest buyer of wheat and rice, and reforming the operations of procurement agencies is indicated. The inventory held by procurement agencies, should be cycled into the distribution system at planned schedules (before next harvest is available), before replenishing the strategic reserves with the fresh stock. Recommendations of the High Level Committee[2] on FCI operations is highlighted and can be implemented by other agencies.

Figure 2.5 Managing Inventory in Foodgrains



Manging inventory-turns in Strategic Reserves will mitigate loss of inventory and safeguard value. The predetermined quantity held in reserve should be cycled into consumption, so that aged inventory need not be discarded or disposed at a total loss. A first-in-first-out (FIFO) procedure can be implemented. The available storage capacity (CAP storage, closed Warehouses or Silos) can be optimised by improving inventory distribution and management.

2.2.2. Buffer and Strategic Reserve norms

In order to ensure supply of quality foodgrains to consumers and to minimize storage losses caused due to long period of storage, Government has adopted policies to optimize the level of procurement of wheat and paddy/rice and to liquidate old stock in such a manner, that FCI does not carry any issuable stock of more than 2-years of age at the end of any year.

With effect from 22 January 2015, the nomenclature of buffer norms was changed to "Foodgrain Stocking Norms for the Central Pool". These norms are expected to lead to better management of foodgrain stocks while meeting the requirements for food security, monthly release of foodgrains for supply through the TPDS and other welfare schemes, for price

[2] Report of the High Level Committee on Reorienting the Role & Restructuring of FCI, 2015

stabilisation in the open market and to combat emergency situations arising out of unexpected crop failure, natural disasters etc.

The Foodgrain Stocking Norms for the Central Pool, which include Strategic Reserve of 3 million tonnes of wheat and 2 million tons of rice, are:

Stock in million tonnes)

Stock date	Wheat	Rice	Total
1 April	7.46	13.58	21.04
1 July	27.58	13.54	41.12
1 October	20.52	10.25	30.77
1 January	13.8	7.61	21.41

Table 2.3 Foodgrain Stocking Norms for the Central Pool

Procurement of foodgrains is done through FCI and State agencies at Minimum Support Price (MSP) declared by Government of India for the marketing season. Currently, MSPs are announced for 23 commodities, but price support is effective only alongside procurement, which is primarily for wheat and rice, in selected States.

For the first time, procurement of pulses was also initiated under the Price Stabilisation Fund (PSF), to check price increase with consumers' interest in mind. Keeping the farmers' interests in mind, purchase under PSF was carried out at MSP. This along with procurement made under Price Support Scheme (PSS) let to a stock build-up of 2 million tonnes of pulses for the year 2016-17.

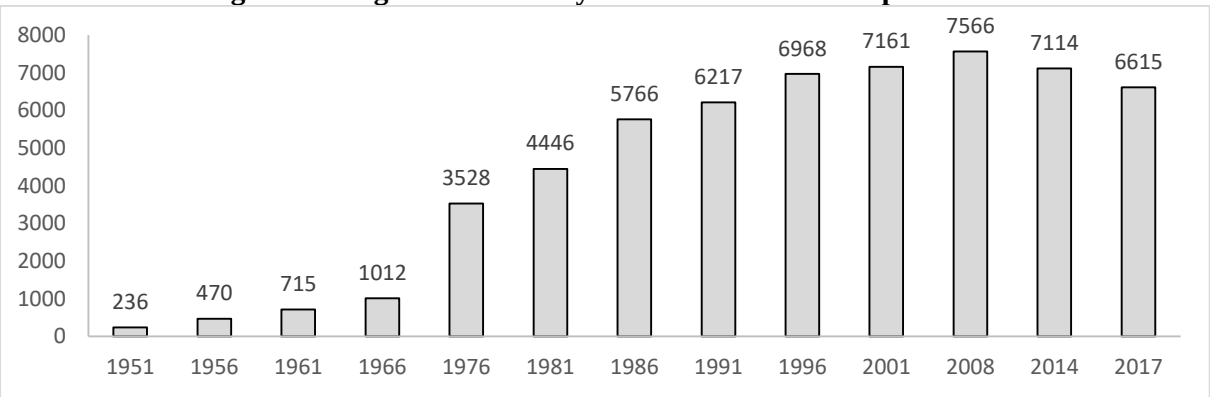
2.2.3. Market infrastructure

Market infrastructure is an important tool to facilitate the trade of harvested produce. The National Agricultural Commission, 1976, reported the existence of 22,000 *haats* or shandies, where farmers exchanged their produce for cash. On average, these shandies serviced an area in a radius of 8 to 16 kms.

The Commission informed there existed 4145 larger markets at tehsil headquarters, large villages and towns. These were at that time variously classified as secondary markets or wholesale markets or assembling markets. The Commission took into account ongoing development and projected that there would be about 30,000 assembly markets and sub-markets in the country by the year 2000. It envisaged each having minimum physical facilities to handle and arrange the marketing the produce at the next point.

Today, agricultural marketing is serviced through a network of regulated market yards, from 286 at the time of India's independence to 6,615 (as of 31.03.2017) comprising about 2339 principal markets with remaining 4276 being their appended sub-market yards. There are a more than 22,000 Rural Periodical Markets (RPMs), i.e. the *haats*.

Figure 2.6 Regulated Market yards in India since independence



Data includes APMC markets plus their sub-market yards *Source: DMI*

With a few states having deregulated their markets, the total number of regulated yards has reduced of late. Market yards have been mostly developed by the government and more details are discussed in DFI Volume-IV on agricultural marketing. The majority of the markets have godowns or warehouses and very few have cold stores. The markets were originally conceived as nearby trading platforms, for cotton originally, and then for other hardy crop types. Scientific assaying, packaging and pre-conditioning of produce, is not readily possible at these centres. The situation is more acute in case of perishable produce, which are also traded at these markets. Milk is one of the produce types not handled at such markets.

The market being a channel to the end-consumer, a more dynamic understanding on the essential infrastructure, as a tool to link with the consumer is needed. For example, majority of perishable produce such as fresh fruits and vegetables need handling similar to fast moving goods, as is visible in case of fresh milk. In most of fresh fruits and vegetables trade, the market cannot treat the commodity at leisure, with the same concepts that are applied for foodgrains or fibre crops which can be held for a long term. There is, therefore, the need to revisit the concepts and policies that were previously formulated with a non-differentiated understanding of the post-harvest management of farm produce. This is discussed further in DFI Volume IV.

2.2.4. Cold-chain for market access

Horticultural and livestock produce are clearly established as future drivers of agriculture. The majority of such produce is perishable and therefore, the marketing range of the farmers is primarily limited to a small radius from the place of harvest. However, with cultivation practices having developed to produce in excess of local consumption demand, the limitation of the selling radius of the farmer is leading to greater waste, more discards and a distressful environment. The answer is not to produce less, but to develop cold-chain systems that link the perishable produce with existing, ready, markets.

In the past, cold storage was understood to be synonymous with the cold-chain. All government subsidies had mainly focused only on supporting the development of refrigerated warehouses. The cold store, and its function, actually varies depending on its positioning in the overall movement of perishable products. A cold store can be a long term storage or act as distribution

points in the cold-chain, defined by the type of produce it is intended to handle. The primary function of a cold store is to provide a platform for safe handling, pending further connectivity. Without inter-connectivity, they are relegated to function merely as warehousing and not serve as intended, except for a limited number of produce. This has happened as other options such as integrated pack-houses at farm gate and refrigerated transport were largely ignored.

It is also understood, that all whole food will eventually perish, even within the confines of a cold store. Therefore, the main function of any food supply system is to reach the food to point of consumption, and not merely to store it. A cold store, merely defers the eventual loss, temporarily, unless the produce is marketed before it is discarded. A well designed cold-chain buys the produce owners some time, which should be used fruitfully, to connect the produce with markets, much before its final expiry.

This latter connectivity or linkage was not applied in the Indian backdrop. This suggests that at the concept level, a paradigm shift in understanding the cold-chain as a system is needed. Cold-chain has to be looked upon afresh as a mode that extends the selling range of the produce, and thus expands the farmers' market footprint. This extended marketing range allows for a higher throughput or traffic to the consumers and a matching growth in value realisation and socio-economic development.

As global population increases & nutritional security comes to the fore, making environmental security imperative, cold-chain helps to battle these concerns. Cold-chain ensures that fresh whole produce reaches gainful end-use and therein mitigates food loss, minimising thereby the negative impact on the earth's depleting natural resources. Efficient agri-logistics, enhances market linkage and justifies efforts to produce more and brings overall growth to agriculture.

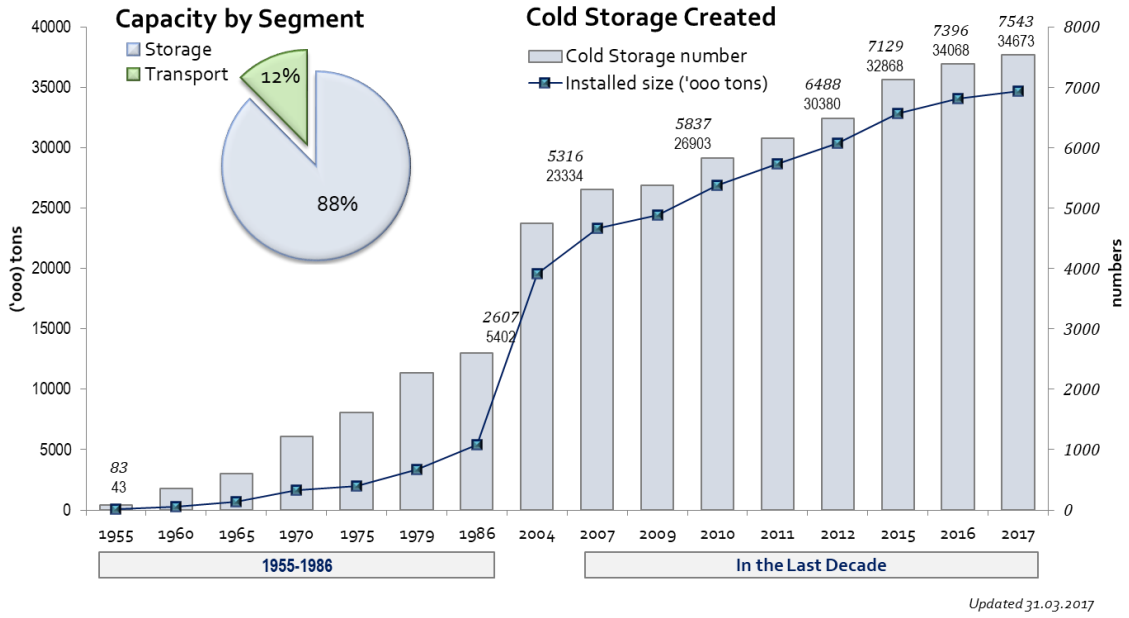
- **Logistics Infrastructure for perishable Produce**

In case of perishable food crops, the involved logistics chain is known as the cold-chain which comprises allied infrastructure components in the form of cold warehouses and specialised transport. Refrigeration on its own cannot reduce food loss, but market connectivity allows the produce under care to reach gainful use. Mere refrigerated warehousing cannot fulfil the purpose for the larger basket of fruits and vegetables. Just as milk needs to undergo rapid chilling prior to subsequent market movement, produce like meats, fish and most horticultural crops also require first-stage pre-conditioning to prepare them to connect to market channels.

Horticulture, animal husbandry and fisheries are particularly suitable to small and marginal farmers who have less land. The post-production link to markets for such produce requires cold-chain as a facilitator, especially when growth is desired through market expansion.

The cold-chain is a logistics chain that intrinsically and directly impacts on value of cargo, whether in cold storages or en-route in transport. For such sensitive fresh produce, cold-chain counters perishability only temporarily, and this transient extension in saleable life needs to be directed for the sake of expanding range and access to markets. Therefore, integration with refrigerated transport is important – India mainly built capacity in storage only.

Figure 2.7 Infrastructure Status for Cold-chain



Source: DAC&FW, MoFPI, NCCD

An estimated 34 million tonnes of storage capacity in cold storages (as of March 2017) has been created, but with allied development of only about 11,000 refrigerated transport units. The transport units are exclusively as trucks, as there are no multi-modal reefer containers for domestic use (rail shipment) of temperature sensitive fresh produce or processed products.

As per a comprehensive study conducted by National Centre for Cold-chain Development (NCCD) undertaken with Nabard Consultancy Services (NABCONS) in 2015, the existing trade in perishable food items suffers a lack of market connectivity from shortfall in infrastructure. This shortfall directly impacted the income capabilities of farmers as they remained limited in their market reach, restricting the selling range of their produce. The study evaluated the entire chain of logistics needed for perishable crops. The study did not focus on requirements for liquid milk as these are well exemplified in the supply chain network developed through the National Dairy Development Board (NDDB).

The report[3], validates the well-known fact that the infrastructure developed in cold-chain, has so far been mostly restricted to cold storages (refrigerated warehouses). Importantly, the report highlights that unlike in case of foodgrains and other non-perishable agricultural produce, where a vast array of existing transport links (via rail wagons and ordinary road transport) is availed, the associated transport link for perishables from cold warehouse onwards, has not been appropriately developed. Despite having created almost 34 million tonnes in cold storage capacity, the associated capacity in actively refrigerated transport capacity is estimated at about 4 million tons only. Estimates do not include all storage captive to hotels, processors, etc.

The mismatch between storage and transport capacity results in an incomplete solution; in

[3] NCCD.2015 "All India Cold-chain Infrastructure Capacity – Assessment of Status & Gap" (AICIC 2015).

addition, infrastructure necessary for safe handling of fruits and vegetables (such as pack-houses to precondition the fresh produce for long distance travel) were not a focus area until 2014. As the source points, in form of integrated pack-houses are minimal, this in turn limited the availability of horticultural goods and discouraged any need for reefer transport capacity.

The incongruity in capacity integration, is related to the fact that the majority of the cold stores were designed to service crops like dried chillies, potato and seeds, which do not require onwards cold-chain transport as a necessary intervention to reach the markets. As the entire chain was not addressed, it resulted in a vast preponderance of fruits and vegetable finding no recourse to market connectivity, which is the primary value gain enabled by the cold-chain.

Table 2.4 Cold-chain infrastructure - Status & Gap

Type of Infrastructure	Infrastructure Requirement	Infrastructure Created	All India Gap	% share Shortfall
Integrated Pack-house	70,080 nos.	249 nos.	69,831 nos.	**99.6**
Reefer Transport	61,826 nos.	<10,000 nos.	52,826 nos.	**85**
Cold Storage (Bulk)	*341,64,411 MT*	318,23,700 MT	32,76,962 MT	**10**
Cold Storage (Hub)	*9,36,251 MT*			
Ripening Units	9,131 nos.	812 nos.	8,319 nos.	**91**

Infrastructure in number, refers predefined unit size; in MT denotes metric tonnes *Source: NCCD 2015 Study*

A highlight of the AICIC 2015 study is, that the country has very few integrated pack-houses, which necessary for assembling and preparing the fresh produce to enter the cold-chain. Without these assembly and preconditioning units, the farmer cannot take advantage of the national market and is forced to limit his/her selling range to the limits imposed by the natural holding life of the produce. The limitation in selling radius of the farmers is not only reflected in their lowered income, but also dissuaded efforts for achieving higher farm level productivity.

The National Commission on Agriculture set up in 1970, had also observed that "the perishable nature of fruits and vegetables is a risk that tended to discourage most of the farmers from taking their produce to marketing centres for sale. However, with the development of the assembly/aggregation market centres the collection of the produce, its grading, packaging, transport, storage and sale in consuming markets will be greatly facilitated." The Commission had envisaged that by the year 2000, the country would have 30,000 assembly markets. Each assembly market was expected to have grading, weighing and storage, and in case of stated fruits and vegetables would require special attention as regards packaging[4].

The cold-chain infrastructure assessment by NCCD adopted an inverse approach, evaluating the demand backwards from markets to farms. The study, evaluated the set of vital infrastructure types, to link existing urban demand with production clusters. The study stated that some fruits & vegetables could be routed to markets, without using cold-chain, if the final

[4] Report of National Commission on Agriculture, 1976 Part-XII, (Ch56 - Marketing, Transport, Storage)

consumption was within their normal holding life (e.g. less than 300 kms distance or about 24 hours of travel time). However, to grow, cold-chain would be needed to expand market reach.

The study also considered and categorised the cold storages by their function and location in the supply chain, in terms of bulk holding stores and cold stores used as distribution hubs at the last mile. Perishable produce is governed by a first-expire-first-out (FEFO) stocking procedure, different from first-in-first-out (FIFO), usually practised with other goods.

The report also assessed that a total of about 7.45 million tonnes of storage capacity for onions is the required capacity. As onion has two or three harvest cycles, this could be short term storage using simple-technology ('*jaali*' type) for on-farm storage, in the hands of farmers.

In case of the milk supply chain, an existing network of approximately 35,000 milk tankers and other small transport units feed the dairy supply chain. Being highly perishable, the milk trade is inherently market linked and has the benefit of growing demand. In 1995 there were about 70,000 dairy cooperatives in the country and these have increased to about 171,000 in 2016. There are 5.01 million women members of these dairy cooperative societies, with a total member base of 15.83 million farmers. There are 32,092 all-women dairy cooperative societies[5]. The success of a dairy cooperative is most apparent when it functions with efficient first mile logistics, in the form of village level procurement or pooling systems.

Cold-chain requires a series of activities where a common chain of custody is maintained of the produce being handled. Any activity in isolation will not typically meet the necessary objectives. Cold-chain therefore is spoken of as an integrated chain of logistics activities.

2.2.5. Agro-Processing

Agro-processing industry refers to the subset of manufacturing that processes raw materials and intermediate products derived from the agricultural sector. Agro-processing industry thus means transforming products originating from agriculture, forestry and fisheries. The associated processing infrastructure is multifarious in nature and the range of processing factories include any industrial procedure that converts raw agri-produce into a product that is more readily consumable.

Agro-processing is a necessary intervention where the farm produce cannot be consumed in its natural format. Examples are the processes that convert fibre crops like cotton into usable textiles, where homespun clothing was consolidated into the textile industry. The leather and paper/pulp industry is another example, where traditional methods was converted into industry. Similar mediation of a processing unit is seen in oil extraction, the milling units that process grains into consumer ready flour, the units that harvest and make meats and fish into consumer ready food products and others.

The processing industry, is not only an intermediary between farmer and consumer, but

[5] NDDB Annual report 2015-16

becomes the producer/initiator of a new value system, as the manufacturer/producer of a new product. The harvested produce changes form and value, and the farmer producer is delinked after having supplied the raw produce. Competition among agro-processors ensures that the farmer, as raw material supplier, gets market linked price for the supply of produce.

Agro-processing can be classified by end-product usage, as: non-food and food products. The first will include industries dealing in wood, paper, rubber, industrial oil, apparel, tobacco, etc. These normally engage in multi-level industrial activities, such as saw milling, pulping & pressing, moulding, oil pressing, cotton ginning, tanning, shredding, etc. to prepare a second rung raw material. This output is vertically integrated with the secondary process, next stage manufacturing, to feed functions like furniture making, printing, tyres, lubricants & soap, clothing & footwear, cigarettes, etc.

Secondary processing also add non-agricultural materials, like synthetics, chemicals and biotechnical inputs. The complexity of inputs in the second stage, sometimes makes it difficult to distinguish between agro-industry and other industry. These can have a variety of end uses and have multi-faceted supply chains, ranging from handicraft to industrial organisations.

The latter class of agro-processing transforms raw produce into food products. In contrast, the food processing industry is more homogenous, as its output has a common end-use. In India, a very large part of agricultural produce goes into food processing. The bulk of foodgrains and pulses already undergo dry or wet milling processes (de-husking, pitting, powdering or polishing, etc.) and are converted into flour or other consumer ready products. Technological advances in milling can include chemical or enzymatic treatment and the scale of operations can be cottage scale or large commercial scale.

Value addition in the form of fortification, flavours or creating ready-to-eat products like biscuits, mixtures, confections, etc. is also evidenced. Beverages, processed fats and oils, baked goods, dairy products, pickles, jams, sauces are some other categories of processed food items. In case of perishable produce the processing involved can involve food grade preservatives besides other additives for colour and taste.

Increasingly, processing of more perishable produce is aimed at keeping the product as natural as possible, using deep freezing or flash drying processes. Juice making has also progressed to cold press techniques which is perceived to safeguard the inherent nutritional value. Food processing is not always organised in large commercial scale, and homestead units for jaggery, honey, pickling sorbets, *kulfi*, etc. are common. Small scale food processing for pickling, jamming, dehydrating are suited methods to regain value from leftover produce and optimally attached to modern pack-houses.

Indian consumers have a comparatively frequent buying cycle, and daily purchase of fresh staple food items is common. This also stems from the fact that India is the largest concentration of vegetarians in the world. The bulk of food consumed is foodgrains with a preference for fresh fruits and vegetables. In the fruits and vegetable segment, the food

processing industry, is therefore subject to steady competition from the fresh format market, besides the consumers' predilections for a specific taste or brand of processed products.

From the perspective of a farmer, an agro-processing unit is yet another primary market or a consumer and is one of the media to realise value. Wherever quality parameters are dictated by the processing unit, vertical integration of the cultivator with the processing factory is possible, through contractual or other arrangements.

Agro-processing infrastructure is key to bringing many agricultural output to markets and is another avenue for farmers to monetise their production. Within the agro-processing industry, food processing industry also helps in minimising food loss by utilising non-table variety produce and transforming it into consumer foods.

Table 2.5 Gross Value Add (GVA) by Food Processing Industries

Economic Activity - FPI*	2011-12	2012-13	2013-14	2014-15	2015-16
GVA (in Rs. Lakh crore)	1.47	1.33	1.35	1.43	1.53
(%) Growth	1.18	-9.69	1.91	5.78	6.71

-at Constant 2011-12 Prices

**Calculation of GVA-FPI for 2015-16 is based on the assumption that the per cent age share of GVA from FPI in total GVA from Food Products, Beverages and Tobacco for 2015-16 is same as the per cent age share of GVA from FPI in total GVA of Food Products, Beverages and Tobacco for 2014-15*

Source: MOFPI Annual Report, 2016

During 2015-16, the food processing industry as a component of manufacturing and agriculture sectors, contributed 9.1 per cent and 8.6 per cent of gross value added (GVA), respectively.

The infrastructure needs of individual processing units are both crop and procedure dependent, while the common intervention of warehouses and transport, either dry or refrigerated, are a universally shared resource. Various industrial processes are undertaken in processing units which may include multiple activities for milling, cooking, manufacturing, weaving or those that are preservative in function.

2.2.6. Previous Reports

A series of studies have assessed the infrastructure status, especially in respect of cold-chain for perishable produce.

- **High Level Expert Committee (1998)**

The then Department of Agriculture & Cooperation had constituted the High Level Expert Committee in 1998, under then Additional Secretary Shri JNL Srivastava. The committee assessed an infrastructure gap of 3.9 million tonnes in cold storage capacity for horticultural crops as in 1998. At that time, when the horticultural production stood at 130 million tonnes, the total available cold storage capacity was 11.1 million tonnes.

In case of onions, this Expert Committee reported that the country had about half a million tonnes (4.6 lakh tons) at hand in form of market godowns and on-farm storage.

Since 1998, horticultural production has more than doubled to about 300 million tonnes (in 2016-17) and the cold storage capacity has tripled to about 34 million tonnes of space. However, a running gap of about 3 to 5 million tonnes is expected to remain as old cold stores are shut down and replaced. This Expert Committee also observed, that besides cold storages for potatoes and chillies, the concept of cold-chain, for the horticulture sector, had yet to make headway. The report stated that a holistic approach to ensure appropriate supply chain management from farm to consumer needed to be studied for appropriate development.

- **Planning Commission Committee (2012)**

The erstwhile Planning Commission setup a Committee under Dr. Saumitra Chadhuri to evaluate steps to encourage and strengthen supply chains for farm produce. The Committee submitted its report[6] in May 2012, laying special emphasis on integration of logistics activities for more efficient market linkage. The Committee recommended modernising the grain storage system by promoting modern grain silos.

A key recommendation was that the cold-chain system would expressly not follow a pure price arbitrage business model, but should have objective to smoothen episodic output with regular demand, to result in greater price stabilisation and market connectivity. The Committee recommended the National Centre for Cold-chain Development (NCCD) be operationalised and strengthened. This Committee also remarked, that the past push to build up cold storage capacity had not borne successful results, especially in case of vegetables and most fruits. It also inferred, that this was on account of large deficiencies in the logistics system between the farms to the final consumers.

This Committee had made references to a primary review of cold storage capacity, by National Spot Exchange Ltd. (NSEL) in 2010, and to the earlier report of the High Level Expert Committee set up under Shri JNL Srivastava in 1998. There was no prior baseline study or comprehensive infrastructure assessment available for perusal of this Committee for assessing the state of integration of the distribution chain with the associated logistics infrastructure. Nevertheless, the Committee emphasised on integration of logistics and food processing units for more effective market linkage.

- **Baseline Survey of Cold storages (2014)**

The National Centre for Cold-chain Development (NCCD), made operational under DAC&FW, recommended carrying out a baseline survey of existing cold storages in the country as a precursor to further assessment on status and gaps in the infrastructure. This survey was conducted by National Horticulture Board (NHB), undertaken by Hansa Research Group and completed in Dec-2014.[7] The survey brought out that the recorded capacity created in the country was 32.9 million tonnes (6586 units). Some capacity was not traceable or found operational, which counted to 1219 units or approx. 6 million tonnes.

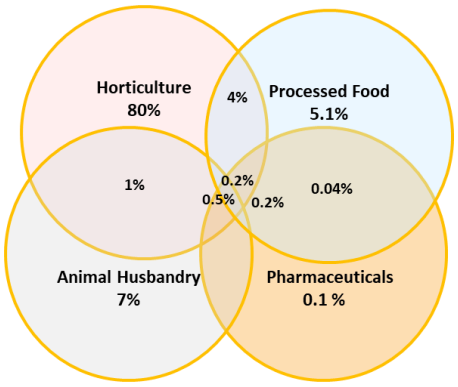
[6] Planning Commission- The Committee on Encouraging Investments in Supply Chains Including Provision for Cold Storages for More Efficient Distribution of Farm Produce (May 2012)
[7] All India Cold Storage Capacity and Technology - Baseline Study; NHB-2014

Table 2.6 Baseline Survey of Cold storages

Type of cold store (CS)	Distribution (%)	Mean Size (tons)	Mean age (years)	Mean Cooling (KW)	Capacity Utilisation (%)
Farm-gate CSs	68	5,531	11.64	250	75
Dedicated to Mandi (wholesale markets)	8	5,004	12.29	476	69
Dedicated to pack-houses	0.5	2,861	11.12	124	65
PCC - port based – includes sea, air and railway	2	2,405	10.46	1,606	60
Part of network of cold stores – for distribution	1	4,870	7.27	85	79
Dedicated to industrial facilities or own use	5	4,624	10.52	227	68
Pharma use CSs	1	6,108	15.91	429	69
Animal husbandry CSs	7	1,681	12.57	232	74
Processed items only	5.1	4,043	12.64	209	71
Total		**5,003**	**11.79**	**273**	**75**

Source: All India Cold Storage Capacity & Technology – Baseline Study (NHB-2014)

The baseline survey included physical visits and geo-tagging of each cold store unit and the information was collected through questionnaires served to each manager/owner. The data collated included information on overall energy costs, manpower used, technology in use, etc. Further, only 17 per cent were pre-engineered constructions.



Product-wise use of cold stores

The majority of cold stores are stand-alone units and do not own direct connectivity in the form of refrigerated transport. Overall, good capacity utilisation of 75 per cent every year over the previous 3 years was reported. A product wise segmentation of the cold stores showed that more than 80 per cent was used for horticultural crops but only 0.5 per cent had any link with a pre-conditioning pack-house, thus limiting their utility to a few crops only. Essentially, the majority of cold stores in horticulture were planned for warehousing the more hardy crops types like potato and dried chilly.

The survey was designed only for cold storages, and hence similar comprehensive querying of other cold-chain assets is unavailable.

- **Task Force for Cold Chain Projects (2014)**

In September 2014, a Task Force for Cold Chain Projects was set up by the Ministry of Food Processing Industries. This Task Force put aside the NSEL report which had recommended the creating a total of 61 million tonnes in cold storages. The Task Force reported, that in discussions it emerged that the gap in cold storage capacity, earlier assessed at 29 million tonnes on the basis of the NSEL review, may not be required and recognised the need for a more realistic assessment of cold storage/cold-chain capacity[8].

[8] Task Force for Cold-chain Projects – MoFPI – September 2014.

However, at that stage the Task Force agreed to target additional capacity of 7.5 million tonnes over the next 5 years (2015-2020). The Task Force recommended to await the findings of a more comprehensive assessment being undertaken by the NCCD [9].

- **Assessment of Cold-chain Status & Gaps (2015)**

In 2015 the "All India Cold-chain Infrastructure Capacity - Assessment of Status & Gap" (AICIC, 2015), was completed and the key findings are listed in table 2.4. This was the first scientific assessment to evaluate the status of the entire chain of logistics for perishable crops. The study segregated the infrastructure on the basis of categories and from a supply chain perspective. The evaluations were made backwards from 'Fork-to-Farm' for short holding life produce, and in case of long holding items, it assessed the need for storable surplus. The assessment also took to differentiate between size and throughput capacity of the cold-chain, by taking into consideration the total holding life of individual items in the cold-chain.

This study highlighted that the space available as cold storages was not as much in shortfall as earlier felt, though a far larger gap remained in the form of village level modern pack-houses, refrigerated transport units and ripening units. The report emphasises that lack of allied infrastructure components, left the cold stores for the use of a limited number of produce types. The associated inefficiencies in the supply chain meant that the majority of perishable produce could not avail the benefits from the cold supply chain. Notwithstanding the world's largest capacity in refrigerated warehouses, India was falling far short of integrating the cold-chain.

2.3. Inefficiencies in the Infrastructure

Over the years, a number of organisations and institutions have been established with a mandate to develop one or more areas of agricultural marketing such as procurement, storage and warehousing, credit, co-operative marketing, exports, food processing, agricultural prices, marketing training, research and extension. In infrastructure terms, special focus was given to creating storage capacities both dry and refrigerated as well as market yards.

The essential activity of physically transporting the farm produce to buyers' destination was largely left to individual commercial interests, which has then developed in a fragmented fashion. Neither was attention paid to provision of farm-gate or village level centres, in the hands of the farming community, to aggregate and prepare the produce for subsequent post-production market linkage.

The private sector participation in agribusiness trade also developed, given the opportunities from government's initiatives as well as the near perpetuity of demand for food and agri-based products. However, the various control orders to regulate and manage the market, did not allow more holistic and larger private enterprise to develop infrastructure for all aspects of agricultural produce in the country.

[9] All India Cold-chain Infrastructure Capacity (Assessment of Status & Gap); NCCD 2015

2.3.1. Integration in the logistics chain

The farmers who grow foodgrain or fibre crops are integrated through auction at market yards or collaborative arrangements with their primary consumer, the processing units. Such consumers can be non-food (e.g. textiles) or food processors (e.g. flour mills). The primary produce is not consumed in its natural format but undergoes processes to make it ready for consumers. This includes treatment to grain, cereal, pulse, extracting oils, and other forms. The procurement is in bulk lots to meet the processing unit's capacities. Typically in these cases, a farmer cannot sell to the end-consumer and the linkage to the primary consumer is short, usually via the nearest mandi.

The procurement by processing units is more efficiently linked to consumer demand as they are usually better organised, with their capacity linked to their marketing capabilities and retail channels. In effect, a pull mode from the market is serviced, which translates into the procurement strategies of traders and processing units. The market pull that is directed at farmers, is derived from the secondary demand for processed products from the end-consumers. The farmers' growth, is hereafter linked to the market growth of processors. This vertical integration is increasingly organised, especially for crop types, with long holding capability and simpler to handle and manage in the post-harvest stage.

The 'difficult' crop types - those that are more perishable and sensitive to handling - need special logistics and this may have deterred equal interest from large players, except a few in the last decade. The expected scale of private sector involvement has been slow to develop in post-production activities in perishables. Barring the success in managing and marketing of milk, the bulk of other perishable farm produce remains subject to poor post-harvest management. Yet, consumer demand for fresh produce is seeing rapid growth in the country, and this needs to be preferred over their processed form, to the extent that agri-logistics can support extension of the food mile. From nutrition perspective, fresh food formats are considered far superior.

To strengthen the marketing reach of the farmers producing perishable food, cold-chain is needed, lack of which is a major inefficiency. The cold-chain has an empowering impact if developed as an agri-logistics mechanism, in allowing the farmers to safely convey the value as harvested into a choice of markets. The cold-chain is a market channel that allows the harvest to access far away demand, and greater development of the relevant infrastructure is needed.

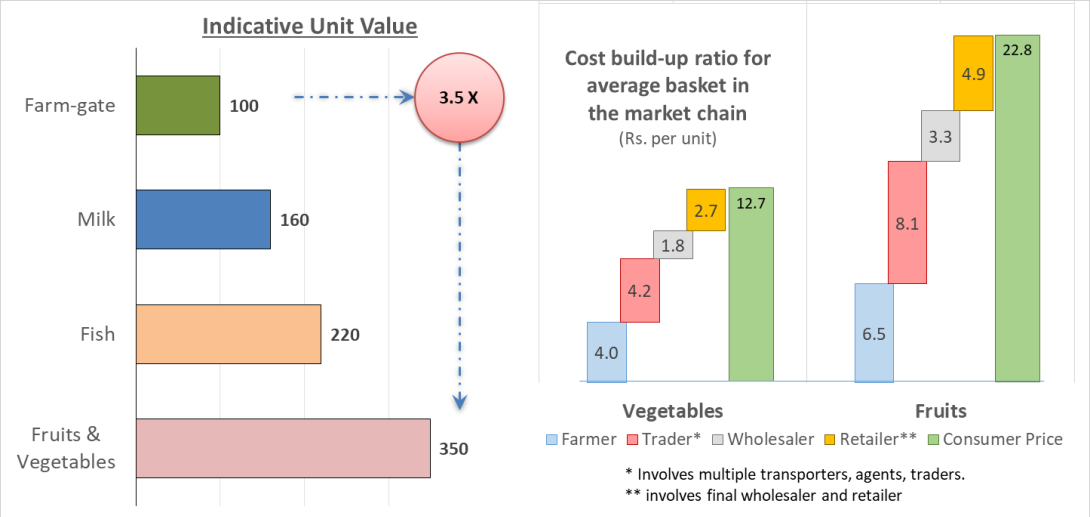
2.3.2. Cost build up

The intermediate cost build-up as a produce moves to market is related to the scope of logistics care involved and the physical losses incurred due to inefficiencies.

However, where inefficiencies in the infrastructure channel to market exist, there are multiple steps of aggregation for logistics purpose and added mark-up at each such interface. Single stop aggregation close to farms will reduce the need for multiple stages of handling and allow a larger share of the produce's value to accrue to the farmers. In commodities where the supply

chains are comparatively advanced (as in milk), the reduction in operating inefficiencies (energy, scale, manpower) will allow for a greater share of consumer's cost to the farmers.

Figure 2.8 Indicative Cost Build in the supply of Agri-Produce



Source: Planning commission, CII-FACE, Analysis

Assuming a farmer produces 100 kgs of produce at a cost of Rs 20/-, because of ineffectual logistics, the retailer may receive only 60 per cent of the total quantity produced. However, cost of storage, transport and basic transactions keep adding to the initial input costs.

-Eg.: Cost plus assumptions-

A. Farm-gate total Cost = Rs. 20
B. Output quantity = 100 kg
C. Cost per Qty output = Rs. 0.20 *(A ÷ B)*
D. Logistics costs = Rs. 20
E. Transaction costs = Rs. 6
F. Quantity retailed = 60 kg *(B – handling loss)*
G. Cost of Qty retailed = Rs. 0.77 *(A+D+E ÷ F)*

Total sales revenue = (logistics costs + input costs + intermediary profits) x quantity sold. When quantity sold is less than quantity produced, it translates in lower unit price at farm-gate.

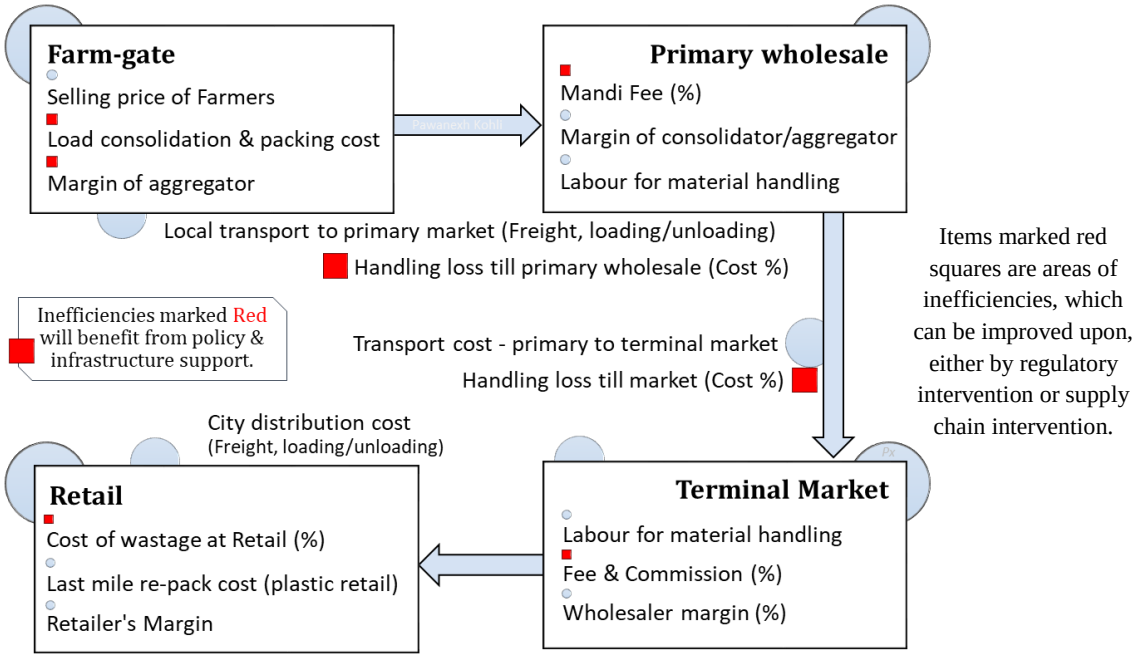
As outcome, though the unit cost at retail totals to three and half times the cost of cultivation, the incremental cost of connecting with market is not shared with the original quantity produced (100 kgs), but is to finally recovered from a much lower saleable quantity (60 kgs). The depleted saleable quantity detracts from the value due to the farmer. This simple example does not incorporate profit mark-ups on the intermediary transactions or the other variable costs that contribute to the eventual price a consumer has to pay. The actual costs assigned and final value recovered depend on many variables, specific to region, crop, market and yield.

The proportionately higher increase in the consumer prices of horticultural and other perishable produce also suggests, that **(a)** there is excess demand from the domestic consumer, and **(b)** higher output levels will indeed be absorbed by domestic demand. **This indicator encourages efforts to strengthen the post-production supply chain for horticulture, animal husbandry and fisheries, in order to service the growing domestic demand.**

2.3.3. Market linkage

The main challenge in realising higher farm level productivity is post-production market linkage that can economically connect the produce to gainful end-use. The need to connect the entire quantity of farm production to various markets or avenues of monetisation is important, for farmers to recover full value of the quantity produced. This alone can incentivise the farmer to adopt improved farm technology and management practices for higher productivity.

Figure 2.9 Inefficiencies in Logistics chain



Any cost mark-up and/or the losses that occur in the logistics chain to market, impacts upon the overall price discovery mechanism. At time of physical settlement, since the total quantity or quality faces shortfall, the initial costs plus logistics costs have to be recovered from the defrayed quantum and this typically translates into a higher price to consumer and lower rate for the farmer in the first instance. Losses in the supply chain are an indicator of inefficiency.

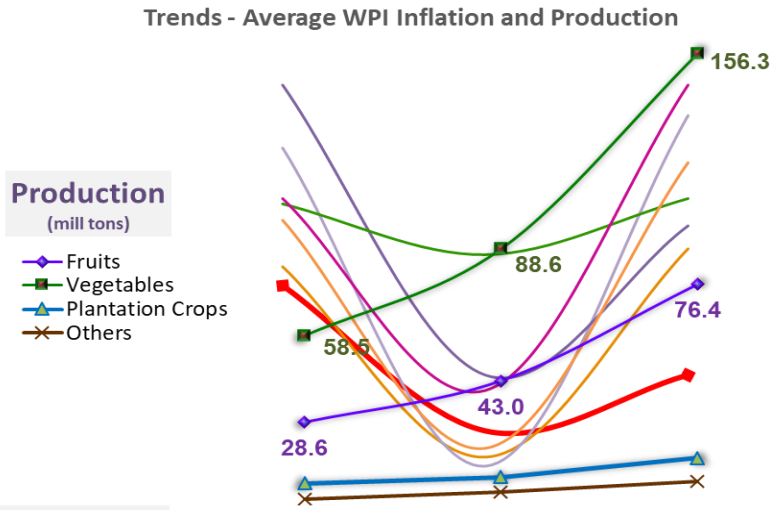
The inefficiencies are loaded onto the final price including the hidden cost of physical loss of the produce. The added cost is recovered from the reduced quantity at destination and trickles down to weakest link in the value system, the farmer.

An effective marketing and logistics network requires developing an efficient link between an Origin (farm-source) with Destination (consumer-market) - '*OD pair*'. In case of high value produce, specifically horticultural items, the infrastructure created so far was primarily in the form of refrigerated storage, which as a stand-alone facility failed to incentivise desired improvement in post-harvest handling of fresh produce. Lack of modern pack-houses at points of origin, deflected the existing refrigerated transport and cold storage distribution hubs into the limited role of aiding the marketing of certain processed foods and the fresh imports arriving in the cold-chain.

A common example of efficient source level aggregation is the milk pooling or collection point. This is the first step to value-realisation though a chain of market linking logistical activities. Post-production activities that safe-guard the value of the harvest and deliver the maximum quantity of produce to end-consumers without degradation of quality, would have a positive trickledown effect on farmers' income.

An effective agri-logistics infrastructure network design is required for perishable produce, at first instance needing source points, as pack-houses to serve as aggregation or pre-conditioning centres, normally developed at village or farm-gate level.

Figure 2.10 Inflation alongside Growth in Production



WPI	1982-83 to 1993-94	1995-96 to 2004-05	2005-06 to 2011-12
All Commodity	7.9	5.9	6.6
Cereals	8.2	5.6	8.5
Pulses	10.4	5.5	11.1
Vegetables	11.8	6.6	8.9
Fruit	9.3	8.4	9.4
Milk	9	5.7	10.1
Eggs, Meat, Fish	9.4	6.4	11.8

The graph on illustrates 10 year trends of Wholesale Price Index (WPI) from 1993-94 to 2011-12; overlaid with the production trend of horticultural crops.

Despite the increase in production every decade, the initial drop in WPI reversed around 2004-05. It is indicator that the surplus production could no longer be efficiently connected with demand, leading to food loss and associated price increase.

Robust growth in production, balanced demand and inflation showed a downwards trend in food items. However, it can be inferred, that when production continued to grow and was in excess to what the supply chain system could handle, the surplus added to food loss, with the losses adding to production costs and triggering inflationary pressure in food items. The losses in the supply chain detracted from expected value gain, and demand was no longer fulfilled, despite higher production at farms.

Markets are not just a channel for produce to consumers, but the channel for the reverse flow of value to the producers. Any activity at farms and the forward linkage, when done without due consideration of the ensuing reverse flow of value, is an added cost and not value linked. Therefore, market intelligence and information has to dictate the activities for optimal gains.

2.4. Monetisation of Agricultural Produce

Monetisation is traditionally described as the conversion of an object into a medium of exchange, such as metal into coins. In economic terms, monetisation refers to converting a non-revenue generating asset – investment, asset, event, debt, etc. – into a source of revenue. From the perspective of this Doubling Farmers' Income Report (DFI), agricultural produce is a unit of value, which via a liquidity event (sale transaction) is converted into currency. Farmers' produce undergoes the process of monetisation, via various market channels (explained in section 2.1). The total value monetised is also dependent on the extent of food loss mitigated and the magnitude of value captured from every grain, drop and ounce produced. The process is expected to be transparent, equitable and assign the most appropriate price to the unit of value (produce). This is enabled better, by gaining access to a choice in markets, balancing supply with demand and by appropriate governance mechanisms.

The purpose of monetisation in the context of income approach to agriculture is to capture the best possible value of the produce for the farmer, once harvested. While market is a place where an appropriate value is discovered on the produce offered for sale, the share of the farmer in the consumer's rupee is predicated upon the market structure. It would, therefore, be necessary to not only maximise the price discovery through an efficient marketing system, but also enable the farmer to benefit from as large a share as possible in the end consumer's rupee. This depends upon dis-intermediation or when intermediaries share in margins is proportionate to the service offered in the marketing chain.

The related issue is the extent to which the volume of produce harvested is monetised. Higher the food loss that occurs between the farm gate and market place, lower is the quantum of produce monetised. This is a function of agri-logistics including harvest practices, storage, handling, transportation, etc.

In sum, monetisation of farmer's produce is dependent upon several factors, inclusive of agri-logistics, marketing system, marketing efficiency etc. It must be appreciated that marketing efficiency, though very important, is only one of the many factors influencing monetisation efficiency of the farmer's produce.

In this context, the DFI Committee defines 'Monetisation Efficiency' as:

> *"It is the ability of the system to enable the farmer to capture and accrue the best possible value out of all that is produced, supported by both marketing and non-marketing sub-systems that operate at different stages of the integrated value chain."*

2.5. Annotation

Notwithstanding the robust performance of the farmers, in producing large quantity of produce and facilitating higher growth rate of supply than population, there is a seemingly disassociated inflationary pressure, especially for fresh food items and it is obvious that all was not well.

The cost added on account of inefficiencies, including handling loss, is non-productive and affects the farm-gate price to the farmer. The resultant impact of reduced quantum of production reaching retail, is that the food item becomes more expensive for consumer, in turn limiting the growth in demand.

A major learning arises, that no matter how much produce is harvested, if the associated post-production market linkage is incapable to cope with the flood of farm produce, the food loss incurred nullifies the benefits that ought to accrue. Inefficiency in post-harvest supply systems results in a mismatch between supply and demand. The demand supply mismatch contributes to food loss and inflationary pressures.

Value is a manifestation of demand and the price realised from any unit of value (in this case agricultural produce) depends on a number of factors. In some cases, demand is correlated to administered and allocated prices, and in some instances, despite untapped demand, the terms of trade many not be favourable. However, demand needs to be fulfilled through physical delivery, for effectively monetising agricultural produce. The efficiency in such monetisation depends on the how agricultural logistics bridged the distance and time involved.

A missing piece is the physical and effective market reach and effective food or agricultural produce distribution mechanism. The population needs to have affordable access to food and farmers need to have efficient supply channels to reach the consumers of agricultural produce. In effect, production alone is not sufficient to ensure availability of food to India's dispersed sub-continental footprint.

The problem is more acute for farmers having perishable harvests, such as fruits, vegetables and meat products. All produce cannot be held in storage endlessly and the faster value is realised the better. There is the next harvest to attend.

Efficient post-production logistics improves the supply quantity and may reduce cost to consumer, but accordingly will drive demand upwards. The main impact from efficient supply chain is that, with full quantity of produce reaching markets, increased quantity gets monetised, and this provides suitable cause to enhance productivity and production.

Production is no longer the causal factor for demand-supply gaps. It is the post-production supply chain. There is need to bridge demand with supply (production) through a comprehensive and holistic logistics network for agricultural produce, especially in current day scenario because of some of the following reasons:

- Advances in farming practices have resulted in high production, intended to assist a move away from subsistence farming towards creating marketable surplus.
- The licensed yards having agents as nodal actors for transactions, have shifted the control into the hands of cartels with political affiliations.

- The market regulations dissuaded the development of direct access supply chain systems and proved a bottleneck to post-harvest practices to service a pan-India market.
- Fragmentation of the logistics chain hinders the movement across States, having multiple handling points which results in an increased loss of the produce.

Large number of perishable produce, such as spinach, okra, brinjal, tomato, banana, mango, etc., do not have the luxury of time to be retained and disposed off at convenience, forcing the farmers into a push mode of marketing. The push is hastened because of reduced saleable timelines, leading to frequent situations like distress sale or roadside discards.

The gaps in the required infrastructure are higher in case of perishable supply chains, especially the starting points in form of modern pack-houses for post-production aggregation, pre-conditioning and market dispatch. The next missing link is in the form of specialised transport systems for perishables. In the milk procurement and distribution chain, these are evident in the form of pooling centres and connectivity to processing units.

In case of horticulture, the farmers do not have sufficient assembly or aggregation points to prepare the produce for onwards market connectivity. Hence, they have to off-load their production at the first point of sale, usually at decentralised locations, to an intermediary aggregator entrepreneur, who in turn rushes the produce to the closest market. A targeted push by farmers to the principal markets or to the large demand centres is not prevalent. The good quality table variety produce that fetches better market value, requires differentiated agri-logistics components to connect to markets.

In case of processing industry, feedstock requirements are specific, in terms of type and quality of the raw material. Such commodities are cultivated especially for the processing channel (cotton, oilseeds, sugar cane, processing variety potato, etc.) – there is normally little other use of such commodities. However, food processing is also possible on some table variety cultivars, provided the culled produce is captured at first mile. For food processing to minimise food losses, it is important that small sized processing units, co-located at village level aggregation points, are developed so as to utilise the handling waste generated at the start of the output supply chain for fresh produce. Food processing will not minimise wastage, unless such food waste is captured at first handling instance.

In case of foodgrains, the warehousing infrastructure would benefit from modernisation and from promoting better inventory management to reduce losses. The produce has a more favourable stocking cycle and modern inventory management, linked to markets is needed. Inventory management should target a time based cycling of the stored grains into consumption or markets. This will add to availability in the public distribution system and also open procuring agencies to the opportunity to monetise surplus inventory. A mind set change is needed – one does not cultivate or harvest for the sake of storing, but for bringing the produce into consumption. Storage is only a means to achieve supply and not the end aim in itself.

Modernisation of warehousing is needed to extend the holding life of the foodgrain inventory. This extended inventory holding period, needs to be fruitfully utilised, or else the stock will still perish at the end of holding period. Along with infrastructure modernisation, efficient stock rotation into markets / distribution system has to be upgraded to ensure that the investment in modernisation has a gainful outcome.

Building capability of famers as groups to partake in the first stage of post-production activity, i.e. aggregation and delivery to market will add immediate gains to their income.

Key Extracts

- A long history of accessing the markets, post-harvest, at the closest regulated yard, left a mind-set to dispose the produce, at first instance in the marketing chain.
- States mainly developed infrastructure designed for local self-sufficiency, instead having a strategy to link to the larger opportunity, the unified national market.
- Selling avenues for farmers remained the near-farm markets, leaving them little scope to integrate with the larger marketing chain or to take up added value chain segments.
- The infrastructure & associated logistics that would handle a wider bouquet of produce and empower farmers to directly connect with other markets, was largely ignored.
- Consolidation of produce, for next level connectivity to larger markets, was left in the hands of regulated markets only, independent of strategic development focus.
- Farmers became more reliant on largesse of procurement agencies or the transactions afforded and centred at the regulated mandis.
- High value produce from farms, without onwards connectivity, did not realise high value but suffered distress sales, while far away consumers faced a supply deficit.
- Infrastructure development be strategically directed, to promote and link with pan-India markets and shorten the existing supply & cash flow cycles.
- Agriculture now has a cosmopolitan basket of produce, with large value output from horticulture, dairy, poultry and fisheries, besides customary produce like cereals, pulses, oilseeds cotton, sugarcane, etc.
- The existing marketing and logistics system requires to adapt and become future ready.

Chapter 3
Value System in Agriculture

Marketing system is the platform that facilitates the post-production supply chain of farm produce. This chain of logistics activities, comprises multiple actors to constitute the overall agricultural value system. In modern day scenario, working for the inclusion of farming communities and farm operations into other segments of the marketing chain will help capture a larger share of the final value realised.

3.1. "Agri -Value Chain" System

There is increasing emphasis on the development of efficient agricultural value chain system in India. A "**Value Chain**" is strictly understood as a process view of the set of operations and procedures, internal and in control of an individual business unit. The term was conceived to represent the linear operations that create value for a business unit, and to provide decision supporting analysis of the primary activities and secondary support in a firm. A value chain analysis allows the individual firm to identify unit cost of operations and make systemic changes to reduce internal inefficiencies and wasteful expenditure. These interventions are desired so that the business entity can accumulate more value. The analysis helps to refine its procedures, so as to improve its competitiveness and efficiency. The value chain does not define the business model, but details the internal operations of an individual entity.

A value chain is appropriately constructed at the level of individual business unit. Each such unit has a set of activities to create and sell its product or service. The desired outcome in value comes from the core operations, and in managing raw materials, manpower, credit, equipment and the administration. Each activity is expected to add value to the business, more than the sum of costs of all activities. Value chain is not necessarily about value-added products, but about optimising value for a business.

However, market linkage may not develop in a linear fashion, and multiple firms (each an individual value chain) function to integrate into a sectoral or industry level value system. The industry value system is a model where multi-stakeholder activities integrate, to produce goods and in delivery of the final product to end-consumer. This integration is commonly known as the supply chain (the supply chain is not a value chain). As a number of value chain entities collaborate, each firm intercedes to vertically integrate their activities into the external supply chain, to target a market. The ensuing value based supply system, is also at times misread as an incremental build-up of costs, across the activities from first source to end-market.

In a value system, the cost of a set of linked activities in the supply chain, is expected to capture value equal to, or greater than the sum of costs incurred. For e.g., the aggregation and transport activities are expected to carry the produce to a higher paying market. Balancing supply with demand is another key factor in discovering value. Therefore, the value finally realised will not always be equal to a value evaluated at source or where surplus exists. If the systemic costs incurred, detract from final value realised, then the industry level value system is considered inefficient. The system depends on how effectively each entity optimises its own functions (reduces costs and losses) in supplying the target market. An entity can also choose to internalise external activities, and thereby expand its scope in the larger supply chain.

The supply chain can be product agnostic, and relates to the agricultural produce marketing system. For example, a cultivator's value chain includes the primary functions of input procurement (inbound logistics), the sowing, cultivation and on-field care of the crop (production), the harvesting and carrying of produce to a local market (outbound logistics) and the primary sales (marketing). The support activities in this value chain are the acquiring and managing of tools, equipment and manpower involved in the primary activity (deploying farm labour, weeding, pumps, tractor, harvester, etc.). The farmer can shift crops, can transact with another firm, the aggregator, transporter, wholesaler or processor. The transporter, wholesaler, or processer are separate value chains, if not under umbrella of a single capital or management, each constantly tweaking their internal competences and procedures to compete with others in their trade. They however, form a part of the larger value system that directs the value first produced, to point of final consumption.

A **supply-chain** is the integration of the individual activities undertaken by multiple value chains, each an actor in the supply chain, with the purpose to manage the flow of the materials and

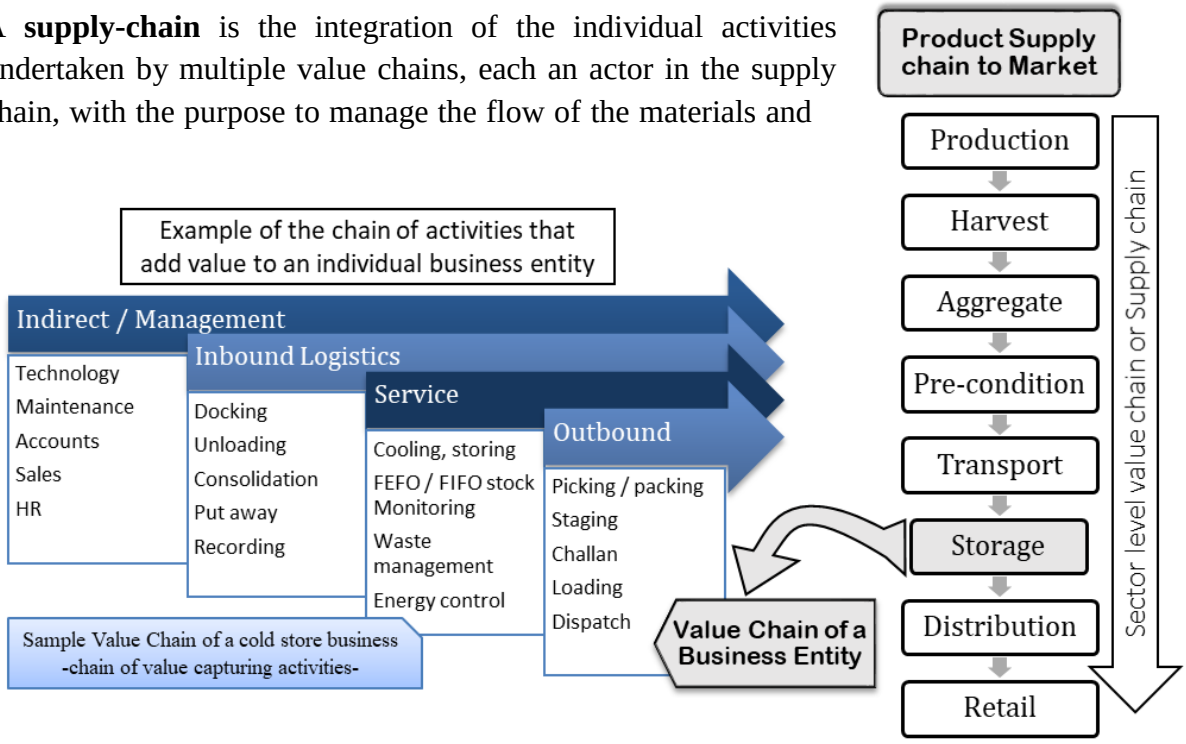


Figure 3.1 Individual Value Chains integrate into the Sectoral Value System

goods, starting from raw inputs to supply of final value at last mile. In a supply chain, a series of enterprises systemically integrate their operations. Though the actors can be transient; together the value chain actors coalesce into the overall supply chain to ensure that system-wide, value based outcomes are effected. The business scope of a firm, is directly linked to how well it integrates into the market linked system. A single business entity rarely internalises the entire supply chain, ranging from inputs, production to final end-consumer retailing, though many may undertake supply chain management. Simply put, **'value chain' is the operations of an individual business entity; 'supply chain' refers to the business model.**

The term '**Agri-Value Chain**', therefore, refers to the value based system at a combined level, to the overall system-wide correlation between value chains of the producer, market channels, retailer and consumer (each a value chain segment). Hence, the agri-value chain represents the

agricultural supply chain in the country. The industry or sector level value system, also includes secondary activities such as research, development, front line demo, extension work and all others support that addresses the core activity of producing and marketing the produce.

Expanding a farmer group's operations to the immediate post-production aggregation and handling activities helps capture greater value and has happened on occasion. Even the transport link can be integrated into operations by farmer groups and/or by involving the rural youth as driver entrepreneurs, to assure that more value is captured at the village level.

3.1.1. Value System Template

A sector level analysis, requires cross functional know-how, to evaluate each value chain segment. A short template to evaluate each segment of the value system is suggested below.

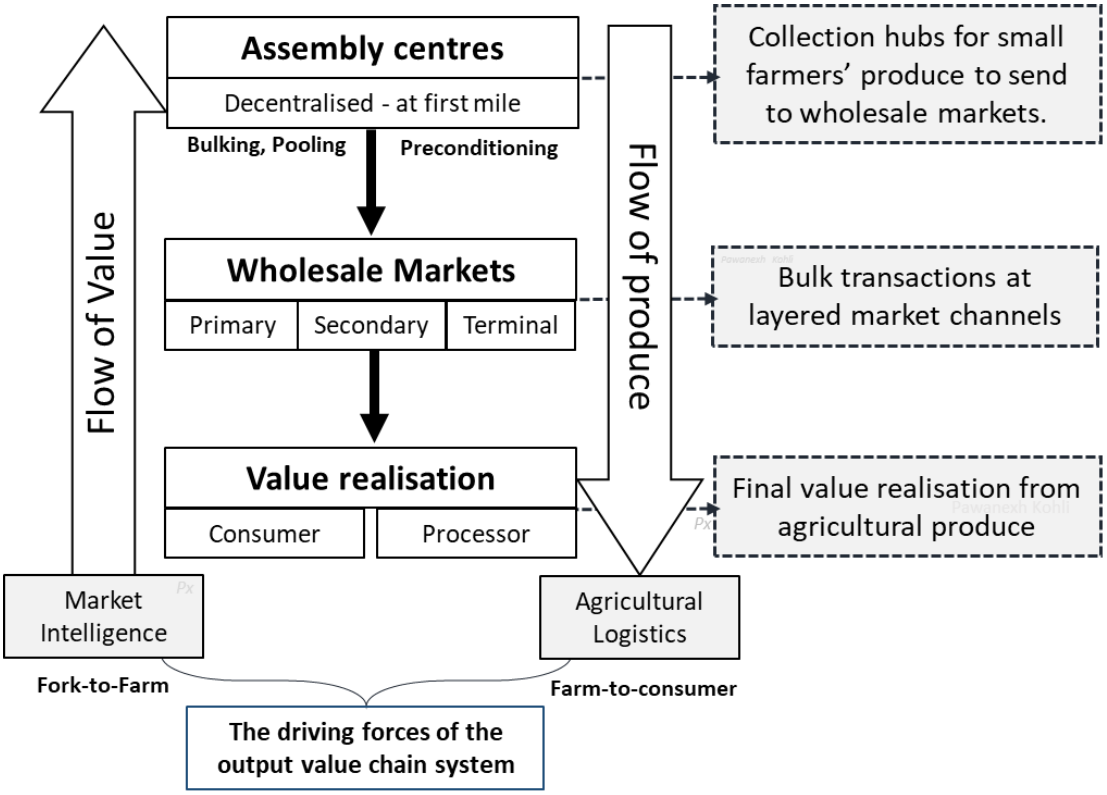
Table 3.1 Range of segmented activities in the agri-value chain system

Primary inputs: • **Source** • **Quality** • **Quantity** • **Price**	Planting/Feedstock: Availability of (a) Seed (b) Planting material (c) Livestock (d) feed, (e) others
	Expected yield: match advance information on market demand
	INM/IPM: Fertiliser/pesticides/organic manure/feed
	Irrigation: Micro or conventional
	Soil health, water quality
Cultivation or Production	Cultivation practices: Open field, protected, orchard, others.
	INM/IPM application practices, veterinary practices
	Livestock management: monitoring, feeding, health
	Harvesting produce: HAACP, assembling/pooling/collection
	Technology adopted: ICAR package of practices, others
Post-production Practices	Aggregation, staging and dispatch to local or wholesale markets
	Preconditioning: Need based cleaning, sorting & packaging
	Transport and/or Storage facilities, linked to holding life of produce
	Market Linkages: Where and when to send the produce
	Market channels: distance, access, local and terminal market demand
	Food or agro-processing: for the processing variety produce
Institutional input • **Credit** • **Insurance** • **Extension** • **Markets**	Organisation of farmers into FPOs and other producer groups
	Collaboration / Partnership / Services models
	Skill Status, front line demos, program awareness
	Lab to Land, capacity building, others
	Market to facilitate exchange, price transparency, market demand
Infrastructure for operations	Infrastructure for irrigation/fertigation, plant or animal health, farm mechanisation, on-farm handling, on-farm storage
	PHM infrastructure: produce transport, warehousing/cold storage, pooling/assembly/pack-house, preconditioning lines, ripening units Market channels: market yards, processing units, alternate channels, farmer markets, e-NAM, institutional markets, others.

In considering the overall, vertically integrated series of activates, in the agri-business value system, there is opportunity for farmers or farmer groups to partake in additional activity segments. Farmers as groups or as individuals, can be empowered to take on the next level of activity in the post-production supply chain and thereby capture more value for themselves within the larger marketing system. Otherwise their value chain ends at their first customer.

In evaluating a value system, observing one entity's activities alone is not sufficient. The value gained from each activity in the supply chain has to be assessed. Therefore, a value chain assessment is incomplete unless market demand and total value to be realised are not part of the agenda. When optimisation of backend activities is undertaken, without associated value to be gained in mind, it only adds to the costs, without the intended realisation in value.

Figure 3.2 Value chain system must consider both flow of value and flow of produce



The marketing structure has usually limited its focus on enabling the forward flow of produce. However, for every value chain, the driving information should be demand from its target customer or market, which determines the reverse flow of value. Prior demand information, applied judiciously, makes each activity, from pre-production to production to post-production, market-led and market linked. This helps to make any business model effective and efficient.

Demand projection is vital to any value based system, so as to avoid cost over-runs and make the venture profitable. Understanding market demand includes measures of quantity, quality, food safety, and effects price discovery at time of transaction. This matter is also discussed in DFI Volume IV.

3.1.2. Agri-business options

The strategic business interest & capability of each concerned enterprise would define the scope and extent of the value chain segments they develop. Primarily the involvement would preferably extend to manage a chain of activities, differentiated two primary business models:

a) Uninterrupted farm-to-market sourcing and distribution of agricultural produce. This is globally seen in the fresh whole food trade.

This value chain system benefits from direct out-reach into multiple market locations, empowered through the intervention of agri-logistics. This model allows farm produce to directly access markets to generate a revenue stream linked to the quantum sold. Improved market access and selling quantities, in turn support a resultant increase in productivity, and also offer scope to stabilise demand-supply fluctuations. This intervention benefits from procedures that lead to a seamless supply chain, having minimal intermediate handling and low losses in the chain. The operation relies majorly on activities that entail aggregation and transportation networks. The entire logistics chain should preferable extend from farm-gate to consumption centres across regions, wherein the produce does not undergo any change to its essential or natural characteristics

The produce handled is whole food as there is no real change to its intrinsic value through any transformative value-addition to the goods. The value-add is to the farmer and it comes from being able to access to destinations where demand dynamics offer a higher price than the collective cost of production and cost of logistics.

This model allows to capture greater value by reaching out to markets, and akin to the marketing chain of a finished product (e.g. packing and transporting coal to a point of consumption). This is effectively distance based price arbitrage. Without such supply connectivity, the product being handled has a limited market range, limited close to producing region, and cannot capture optimal value. Collaboration among multiple logistics asset owners is a norm for this system of value chain integration to operate.

In this model, the individual value chain of a farmer, group of farmers or farming company, can be extended to partake in some of the aggregation and connectivity functions for enhanced gains. The business growth is linked to the capability to expand reach to more markets and market capture. The operational risks involved for the produce owner are based on the speed and integrity of the handling in the supply chain.

At price discovery level, the demand supply dynamics will effect value at destination – this model can profit greatly from spot market prices and can equally, suffer losses if produce is directed to markets having surplus. The latter risk can be mitigated with advance market information and with the ability to divert the supply to other markets. This sort of supply chain is most applicable in case of perishable fruits & vegetables and high-value produce where storing for a deferred sales would only add to storage linked risks, without any assurance of an associated gain at the delayed date.

b) The interrupted market chain of agri-produce, which primarily can be of two types:

i. Suitable raw material is sourced by industrial processing units for transforming into a manufactured food item. An interruption in the above chain occurs by way of an agro-factory, wherein, the primary natural characteristics of raw produce is effected through ingredient additives, physical or chemical change, etc. In this system, value-addition to the produce is done in direct terms. The result is a new product with revised value. The product is subject to labelling and other compliance, and can have a predetermined expiry. The raw materials used can be multiple produce, by-products of other processing, additives or non-agri-products like minerals, chemicals, polymers, colouring, etc.

This value chain system typically relies on sourcing special variety crops, through contractual arrangements, and/or sourcing culled produce in case of some perishables. The initial logistics intervention is mainly in the form of primary storage which can be captive to an industrial facility, to feed the processing line(*s*). The output from the production lines then utilise post-production market channels to reach end-consumers.

To a large extent, this value chain model is market linked or demand driven, highly competitive and established at industry level. The scope of famers' involvement is as a vertically integrated supplier, growth being linked to the growth of the raw material purchaser. The final product is no longer categorised as farm produce, but is a product of industry. This agri-value chain system is unmistakably the most prevalent worldwide and involves the agro-processing industry such as for cotton, cereals, medicinal products, beverages, tea / coffee, and similar sectors. For the majority of this industry, they need not purchase raw materials directly from farmers and can source the same on demand from inventory held by traders or wholesalers. However, direct purchase from farmers can be more beneficial, provided there is reasonably priced agri-logistics for conveyance of the produce. In case of perishables like processing tomato or peas, the industry needs to source more immediately from farms, as the raw material has a short holding life and needs to be processed soon after harvest.

ii. Bulk inventory holding of farm produce for delayed or timed liquidation. The intended model is to buffer against episodic production. This model is used when storing Central Pool Stocks, where inventory is held to stock surplus produce for food security, and consequently for timed public distribution.

The model is also in play for feeding processing units and for opportunistic trade. Stored inventory allows produce owners to take advantage of timed price arbitrage, making it partisan to any propensity to control supply to markets. Time based price arbitrage is a waiting game, when delayed demand outstrips supply and also has various involved risks.

In both above business options (a & b), the primary value engaged is the farm produce, with logistics is the tool that facilitates both the initial and final transaction/trade. To unlock the

agri-value chain system to its fullest extent, the strategic business interest has to consider encompassing multiple activity components in the involved supply chain.

In cases where an infrastructure is not integrated with the produce-centric agri-value chain, the business is automatically limited in scope, to realisation from rental or service fees on the logistics infrastructure created. This approach is distinct from businesses that take ownership of the produce and capture greater value by taking part in other value chain segments in the overall supply chain.

The incentives by the government are designed to encourage wilful entrepreneur participation, across the multiple infrastructure components that are understood to be necessary for building integrated logistics chains in the output supply chain. Integration of value chains into a value system, entails a common chain of custody across all logistics activities and necessitates collaboration among existing activity owners. Increasingly, wholesalers are directly taking up aggregation and transport to capture a larger share of value, resulting from their onus in improving efficiencies.

To develop the entrepreneurial ecosystem further, so as to unlock value to its fullest extent and to make it attractive without taking recourse to financial support from government, there is also the need to make associated reforms to alleviate the compulsory physical movement of harvested produce through '*mandis'*, as well to address the correlated base infrastructure (road and power connectivity). DFI Volume 4 discusses desired changes in the market architecture.

3.1.3. Adding activities to capture value

The supply chain integrates value chain segments. When inefficient, the chain of activities results in non-productive and incremental cost to the product. This adds-up and detracts from the total value recovered from end-consumer. The inefficiency is loaded as an unnecessary cost on the producer, the most vulnerable link in the chain.

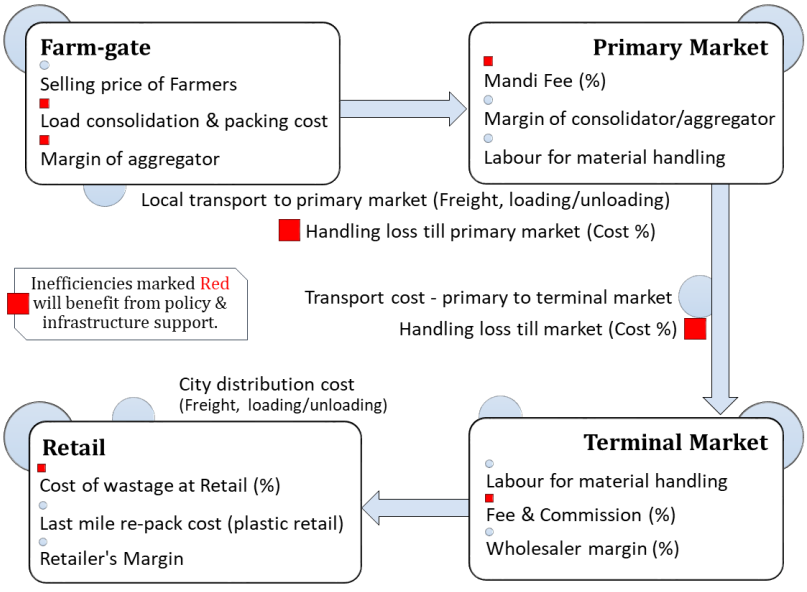


Figure 3.3 Post-production cost inefficiencies in Agri-Supply chain

Some of these inefficiencies can be mitigated by farmers, as produce owners, expanding their range of activities, to include allied operations, such as aggregation, packaging and pre-conditioning, and as far as practicable transportation. For this, development of suitable modern assembly or aggregation centres at village level are needed. Individual on-farm units can supply the village level aggregation hub, where larger loads are assembled and produce can be efficiently

communicated to distant markets of choice.

There is empirical evidence that establishes that successful coordination across the various value chain segments, as partners in the overall supply chain, has significant impact on cost reduction and farm-income enhancement. Involving producers in more value chain segments by providing logistics, machines and tools, credit, information, and training can bring better returns to them. Producers and farmers will gain by in three ways:

i. ***By increasing the selling quantity, which results in increase in absolute income.***
ii. ***By improving the margin per unit, which adds to their absolute income.***
iii. ***By expanding their range, to reach more markets, to allow future growth.***

The Agri-value system approach, will therefore, include expanding the range of operations of a cultivator or group of farmers into other activity segments, especially in post-production phase of the produce's life cycle to market.

3.1.4. Price versus Volume

The value realised is a multiple of two factors, the price and the total selling volume. Value is not equal to price in isolation, especially, if outcome includes discarded produce (wasted input). Therefore, value chains also need to target growth in total sales, not just a higher price.

Growth in total income is a result of growth in volumes sold through increased market capture, or from transacting at higher price per unit, or from both. In simple terms,

Value realisation = Volume x Price *(influenced by demand-supply status)*
Final Value realised > Production cost + Supply chain costs + transaction costs

For purpose of doubling farmers' income, placing singular aim to obtain a higher price for the produce, may be a short-sighted strategy. The agri-value system must take aim to balance both the selling volume and the unit price; they are inversely proportional and may not necessarily move in tandem. Growth in selling volumes also results in higher productivity in the supply chain and at farms, bringing down production costs and supply chain costs. An added aspect to value chain efficiency is sustainability, of economic growth and environment.

3.1.5. Cost increments in the Agri-Supply chain

Greater involvement of the producer-owner, further up the agri-value chain system, adds onus for better handling and mitigates losses in the supply chain. Expanding market reach implies tapping unfulfilled consumer demand, and means more quantity of produce to monetise.

Long supply chains result in inefficiencies, where the sum total of the costs to deliver the produce to markets, eat into the final value realisation of the produce. Shortening the supply chain, does not mean shortening the distance to market, but be inferred as shortening the chain of custody and reducing the physical handling of the produce.

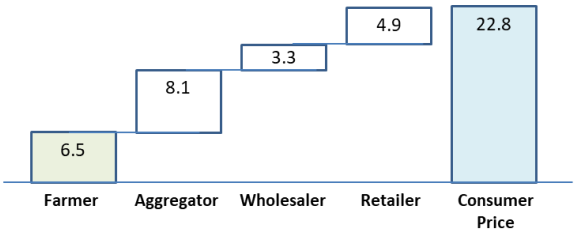
The price build-up in marketing chain in case of fruits and vegetables is normally higher, given the perishable nature of the produce and the higher handling losses in the chain.

The Farmer Producer Organisations (including farmer producer companies/ groups/associations/cooperatives, etc.) are expected to deal with a range of challenges that confront individual farmers.

FPO members are expected to leverage collective bargaining power to access financial and non-financial services and appropriate technologies, reduce transaction costs, tap high value markets and enter into partnership in the agri-value chain.

Figure 3.4

Price build up for one kilogram of average basket of fruits

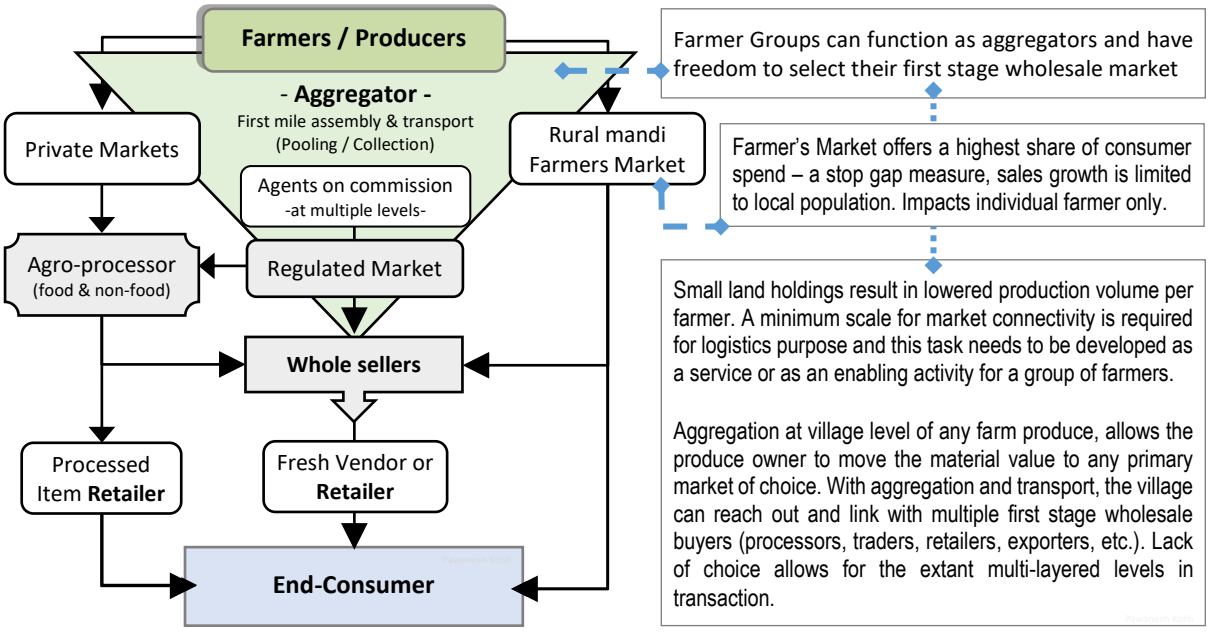


Sample Extracts from CII-FACE Faida report

Price build up for one kilogram of average basket of vegetables

Institutional support through SHG based shareholding, provides access to working capital which is in line with the business interests of the enterprise, public expenditure and government support to set up medium scale infrastructure is needed.

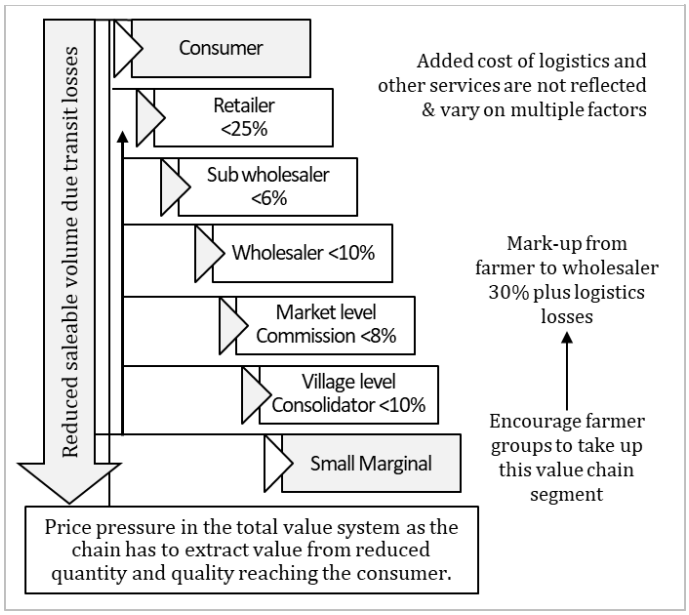
Figure 3.5 Aggregation & preconditioning for more value to Farmer Groups



Finally, strong market linkages with private enterprises are some of the pivotal challenges to ensure that FPO/VPO get integrated with agri-value chains. Case studies in the next section indicate differing price versus volume outcomes, resulting in higher income and value to farmers.

As seen in Figure 3.6, there are a number of intermediary functions in a 'farm-to-fork' supply chain, operating on individual mark-ups. The final mark-up can be more than 60 per cent to 75 per cent, out of which the margin mark-ups between farmers to wholesaler can be 30 to 35 per cent or even more.

Figure 3.6 Price pressure from Margin Seekers



To increase the relative income of the farmers, this 30 per cent margin could be captured by upgrading the role & responsibility of the farmers in the overall supply chain.

This added responsibility can happen through FPOs (including farmer groups/associations /cooperatives, etc.) and VPOs (Village Producer Organisations).

One of the ways of realising this is by integrating the farmer's own value chain into the next value chain segment, by him/her owning up the next level of operations, that will take him/her to the wholesaler stage and not by limiting himself/herself to the role of passive producer at the bottom of the system.

3.2. Case Studies

This section describes the various ways of expanding producers operations into other value chain segments. The cases described below demonstrate how value chain interventions at bottom of the pyramid, impacts favourably by improving organisational and marketing efficiency to maximise gains to producers.

A. Intervention of Pradan NGO in transforming traditional backyard value chain to a smallholder cooperative value chain

B. Aggregation and direct Marketing by FPO.

C. Intervention of Jeevika for linking Women farmers of Bihar to trade Maize on Electronic Market

D. Spices Board in Sikkim in Procurement and Price Discovery of Organic Large cardamom

A. Smallholder Cooperative Model for Poultry[10]

PRADAN's intervention to enhance income from backyard poultry in Kesla block of Madhya

[10] Case Studies of Successful Pro-poor Models in India, The World Bank, September 2015

Pradesh has successfully enhanced the income of the small holder tribal household by linking and upgrading their role in the poultry value chain system.

The efforts led to the establishment of a model for small holding broiler farms, which is now also being replicated in other states such as Jharkhand, Chhattisgarh and Orissa.

PRADAN has been working with more than 5,306 women broiler-farmers, organised into 15 Cooperatives, and one Producer Company, with a collective turnover of about Rs. 400 million. This is the largest conglomeration of small-holder poultry farmers in India.

The beneficiaries of this intervention were predominantly poor smallholder tribal households. Traditional backyard poultry farms were chosen as the area of intervention because of its livelihood and social importance as described below:

a) The activity provided Rs. 1,200–1,800 of income in a good year, mainly meeting requirements for emergency cash.

b) The activity has social significance as the country fowl was mainly reared for festive occasions, ceremonial purposes and celebration.

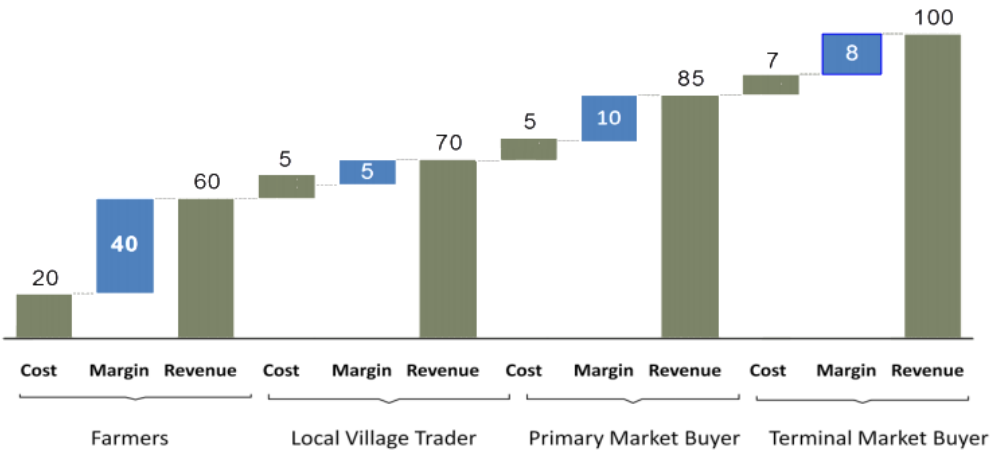
Inefficiencies at farmer level	Inefficiencies at local village trader level	Inefficiencies at primary market trader level	Inefficiencies at terminal market buyer
No breed improvement activity	Commission charged	Commission charged	
No veterinary services			
Absence of quality poultry infrastructure			
No specialised feed prepared			

Figure 3.7 Poultry - smallholder generic value chain

Prior to the intervention, the tribal household were involved in traditional backyard poultry, maintaining about 10-15 birds. The value chain was characterised by low productivity. In this, the birds attain the weight of 800-900 gm in six to seven months and lay 30 to 50 eggs a year.

A distinctive feature of the traditional backyard value chain is the scarcity of supply in a small, niche market. Therefore, the revenue per bird to the farmer is high, and the farmer's share in of final price at market was the highest, at about 60 to 63 per cent. However, the annual earning for a family is Rs 1,200–1,800, representing only about 10-12 per cent of the annual income.

Figure 3.8 Cost and Margin of traditional poultry backyard (before the intervention)

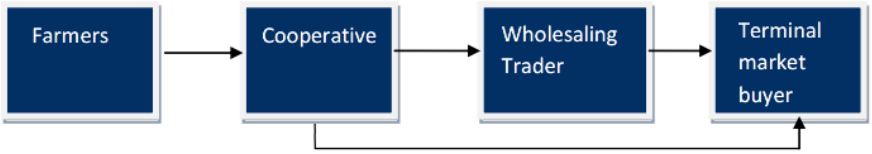


Transformed Model and the intervention: keeping the weaknesses in mind, intervention was planned to address the inefficiencies of backyard chain and increase the scale of poultry production of the small farmers. The interventions are listed below:

a. Decentralized production infrastructure with 300-400 birds in the homestead backyard, which could fit into the daily life of the tribal women was introduced
b. Rigorous training of producers, intensive production support was organised
c. A cooperative model was used to conduct collective purchase of inputs and for the sale of birds, to achieve economies of scale in backward-forward transactions
d. Market volatility was addressed by de-linking production efficiency from enterprise efficiency, and collective operations for dealing with markets was created
e. Customized financial and MIS software was introduced for decentralized operations
f. On-call referral veterinary services was organised, chargeable on production output parameters
g. Larger market capture for chicken meat was developed in the nearby areas like Sami Pathakheda, decreasing local consumers' dependence on the far away Bhopal supply

The interventions resulted in the farmers developing a more organised back-end, and increased their poultry production. The enhanced output meant that the farmers had more saleable harvest and were also able to link with larger markets. The enhanced supply resulted in rationalisation of the selling price and the proportion of a farmer's income reduced to about 44 per cent of the price at terminal market (lower than the 63 per cent share of market price in earlier traditional backyard poultry value system). However, the there was a large increase in the absolute income of the farmer, ranging from Rs. 15,000-18,000 (compared to Rs. 1,200-1,800 under the traditional backyard value chain). The value chain intervention resulted in greater volumes being sold and a ten-fold increase in income to the farmers.

Figure 3.9 Re-engineered Poultry Value Chain system



Efficiencies at farmer level	Efficiencies at cooperative	Efficiencies at wholesaling trader	Efficiencies at terminal market buyer
Breed improved	No commission charged	Volume made it viable to trade with smallholder cooperatives	Volume made it viable to trade with smallholder cooperatives
Economies of scale exploited by linkages to cooperatives	Delinked the market risks by offering fixed price to smallholders		
Poultry infrastructure improved to house 300- 400 hens	Veterinary service provided		
Specialised feed prepared at the cooperative level			

The low-carrying capacity of the backyard value chain was hereby transformed into a high volume business that resulted in ten time higher returns, in absolute terms for the farmers, and more equitable prices for the consumers. The capacity to deliver to adjoining town also added to the marketing range of the erstwhile traditional homesteads.

The value chain optimisation had a larger and sustained impact of increased market capture, increase in the selling volumes and higher productivity at the back-end and across the supply chain. All of this was to the benefit of both farmer and consumer. Optimising and increasing the production, in tandem with market expansion, had a multiplier effect on income, even though lower share of consumer spend was captured.

Value chain interventions are **not necessarily for capturing a higher price or a larger share of the consumer spend**. Instead, value chain interventions can also aim to **optimise the productivity and capture a large share of market demand**.

B. Aggregation and direct marketing by FPO

Ram Rahim Pragati Producer Company Ltd (RRPPCL)[11] is based out of the Narmada Valley in Dewas District of Madhya Pradesh and owned by 162 self-help groups having 2,662 women of the Adivasi community. It has successfully tackled several institutional challenges of integrating small and marginal farmers, to capture a better share of agri-value chain, including aspects of innovation in operations, financing and forward market linkages.

RRPPCL wanted to look beyond the Mandi and expand their market frontiers. They took a

[11] The Case of Ram Rahim Pragati Producer Company Ltd: Review of Challenges Overcome to Showcase a Viable and Replicable Model for Farmer Owned Agri Value Chains

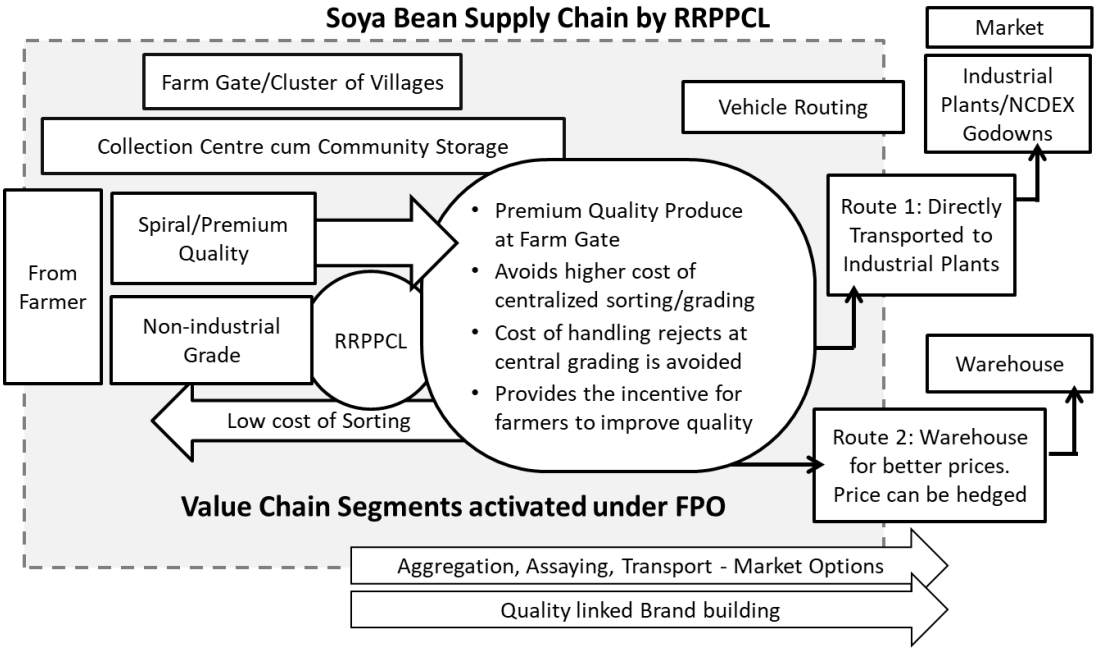
critical look at the existing supply chain, and realised it had no intervention other that primarily acting as a trading front for other market intermediaries. A decision was taken to take up tasks that would allow them to target later stage markets for its produce.

As part of a new strategy, after having identified the problem areas, RRPPCL sought to break this serially linked multi layered process of buying, third party centralised grading, storing and selling and assessed the activities that they could handle themselves.

In order to solve the problem of centralised grading, RRPPCL commissioned the use of Spiral Graders, a low cost machine costing less than Rs 6,000 which uses gravity to clean the harvested Soya Bean into industry accepted grades. This machine can be easily be operated and therefore can be used right at the farm-gate. Since majority of farmers were marginal farmers, the small quantities of less than 10 quintals could be effectively be graded by these low cost graders, as opposed to more capital intensive graders at centralised facilities. This intervention necessitated establishing village level collection, grading and sorting yards from which industry grade was output.

The produce could then be shipped directly by the producer group, to solvent extraction plants and institutional buyers, thus bypassing the mandi. In the traditional model, the farmers claimed they faced non-transparent price, and also had to pay a commission of 2 per cent.

Figure 3.10 Intervention in Soya value chain system



This changed mode of operations was piloted by RRPPCL in Kharif 2014-15 season and rapidly proved to be successful. Having taken custody of next level operations, resulted both in reducing operational costs and enabled RRPPCL to directly connect and market their produce to the primary consumers.

In other examples of farmer producer organisations having taken up activities other than cultivation, the Samarth Kishan Producer Company is another that has capitalised in seed production and certification business since 2006. Ajaymeru Kisan Samruddhi Producer Company of Ajmer in Rajasthan has also linked its production to forward trading.

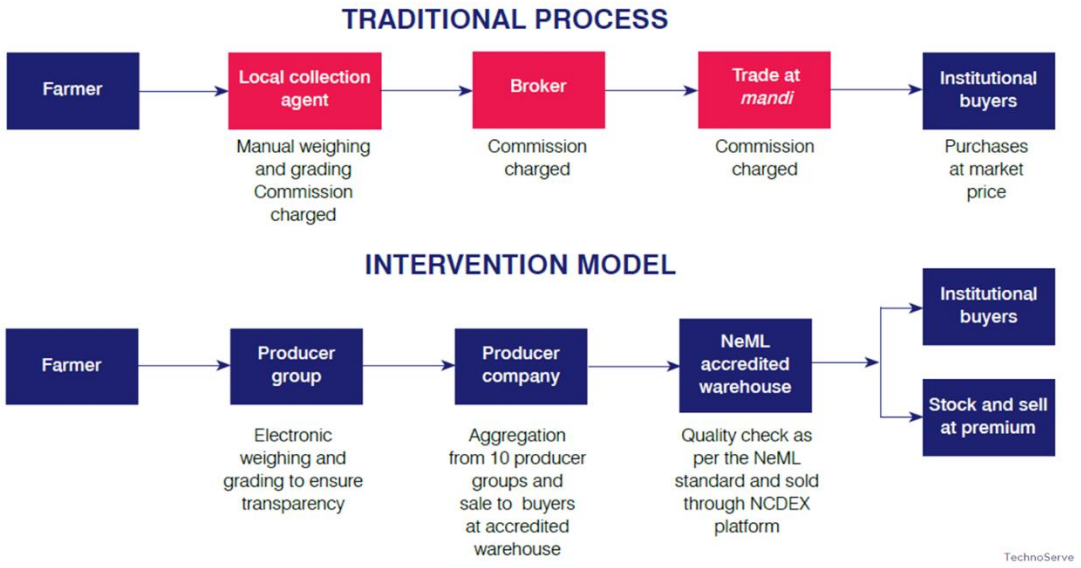
C. Electronic platform for small & marginal women farmers[12]

Integration of farmers with the Electronic trading platforms is finding participation of farmers. The example from Bihar, where pilot work was done by JEEViKA (a World Bank supported program for poverty alleviation) in partnership with Bill & Melinda Gates Foundation and Technoserve shows how famers benefited when they integrated into more segment of the agri-value chain for Maize through an electronic platform.

In this pilot, a shift from the traditional way of marketing was made, with the producer group taking up responsibility in next level value chain segments. The producer group upgraded the scope of their activities to include weighing, grading, aggregation and holding inventory in accredited warehouse.

At the warehouse, a second quality check was done on the delivered maize by NCDEX eMarkets Limited (NeML). The stock was then made available to institutional buyers via the NCDEX electronic platform.

Figure 3.11 JEEViKA intervention in Soya Marketing Model



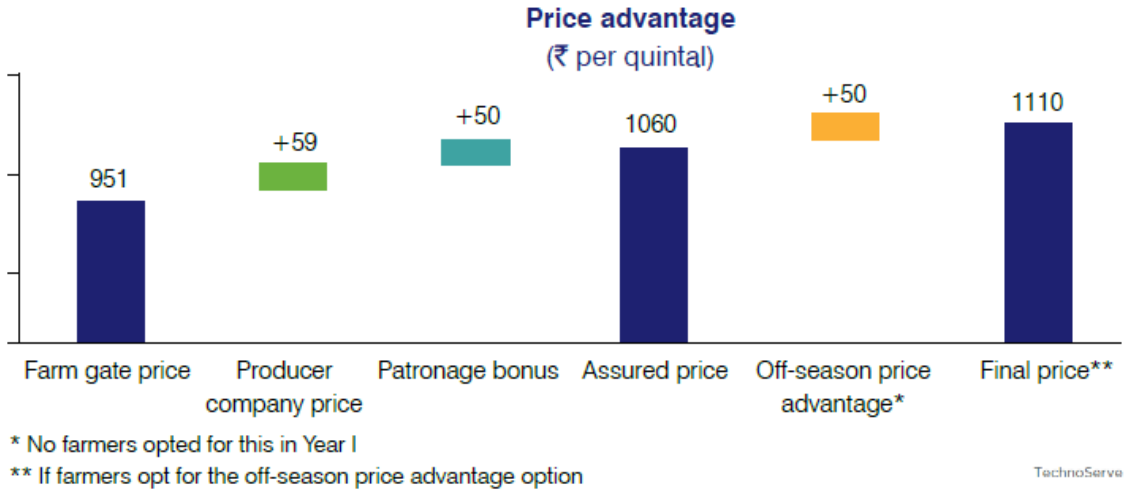
As many as 299 members belonging to 10 producer groups (32 per cent of the total maize growers) participated in this pilot by providing their maize produce to the producer groups. On an average, 78.5 per cent of their produce was transacted through the producer group, while the rest was sold to local collection agents, continuing to involve the traditional mode. In

[12] Creating Technology-Enabled Inclusive Markets Electronic Trading Platform for Small and Marginal Women Farmers in Bihar, India, Technoserve 2015

analysing the impact of the value chain intervention, multiple benefits are ascertained, including back-end organisation and collaboration between farmers. The data shows that price per quintal of maize rose from Rs. 951 to Rs. 1060 per quintal, an increase of 11.46 per cent.

This result is attributed to the taking up of activities earlier done by multiple layers of intermediaries, more transparent weighing and grading. Individual farmers also received a patronage bonus by the group. The farmers were more closely linked to market's quality feedback and having taken custody of the next level activities, besides cultivation alone.

Figure 3.12 Capturing greater Value for farmers



The farmers also had option to hold the stock for off-season transaction, but all of them opted out and preferred selling at the assured price.

Figure 3.13 Price advantage from intervention

Various price points		Price advantage	Total price received by the farmer (₹ per quintal)	Percentage increase in price
Farm gate price	Farm gate price is usually offered by the village collection agents who use fraudulent practices in price discovery		951	
Producer company offer price	Weighing transparency + commissions	+ 59	1,010	6.2
Patronage bonus	70% of the producer company's profit is distributed amongst members	+ 50	1,060	11.46
Off-season price advantage*	The project gives farmers an option to store their produce for sale at a higher price during off-season months. Farmers get a benefit of ₹50 per quintal if they choose to avail of this feature. In Year I, none of the farmers exercised this option.	+ 50	1,110	16.72*

* By availing of the off-season price advantage, farmers can earn up to 16.72% more on the price received per quintal of maize.

TechnoServe

The availability of moisture meters with every producer group helped the members to dry and clean the maize before sale, thus turning it into Grade-A maize. This is because the members

reacted to market feedback and planned for Grade A maize (locally known as Shalimar Calcutta Pass), which not only fetches a higher price but also comes with an option for future sales.

The producer company created a brand name 'JEEViKA Maize' and earned traction from buyers, because of the higher quality of produce. The effort of collective marketing has also built ownership among farmers and all the members acknowledge the same.

The report reveals, that this also resulted in **disrupting the business ecosystem locally**. Through interviews with existing collection agents, it was learnt that the pilot raised the competitive bar for them, and most incurred losses in their business (to the extent of 40%) compared to last year. This, in turn, prompted them to increase their initial offer price to farmers. A few of the collection agents have also started using electronic weighing scales as farmers are reluctant to sell produce using traditional weighing scales.

Value chain intervention also resulted in building a more equitable and competitive market environment.

D. Organic large cardamom[13]

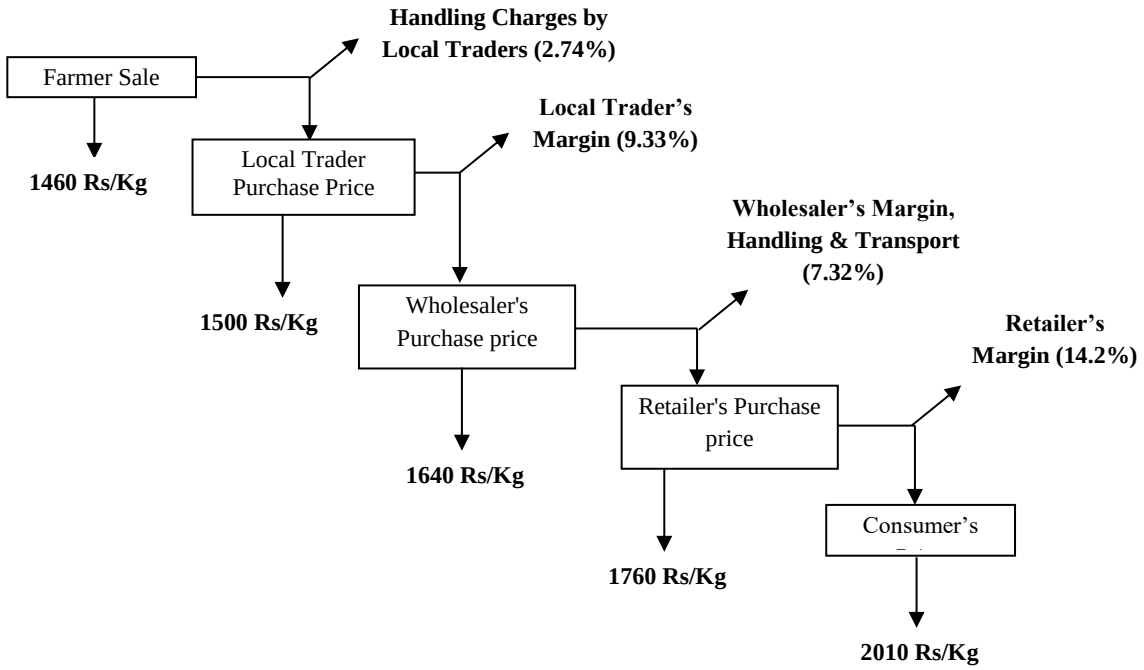
India is the largest producer of large cardamom with 54 per cent share in world production. With an estimated annual production of 4075 tons (2015-16) in Sikkim, large cardamom is the main cash crop of Sikkim which contributes upto 88-90 per cent of India's production. Large cardamom based agroforestry system generates Rs. 40-50 crores revenue to the state. A farmer can earn revenue of Rs. 25,000 to 30,000 from one hectare plantation.

In Sikkim, Singtam and Jorthang are main market for large cardamom. These market are dominated with large and small traders. Price of large cardamom which is paid to farmers varies from Rs. 1,400 to 1,600 per kg. Value of large cardamom depends on moisture content, colour and size of produce. Price to this value is on basis demand-supply status, and local trader sells the produce with a margin of 9 to 10 per cent which mean Rs. 1,500 to 1,800 per kg. Wholesaler price of large cardamom is 1,600 to 1,900 Rs/kg and retail price is around 2,000 Rs/kg.

Spices Board, regulates the cardamom market under the Cardamom (Licensing & Marketing) Rules, 1987. Spices Board opened an auction centre at Singtam and the auction is conducted fortnightly in the presence of growers. The auctioneers are required to submit monthly returns to the Board in prescribed format stating the source of purchase and sale with price and quantity details. The growers are allowed to withdraw any of their lot if they feel the highest bid is unsatisfactory. Only registered traders under Spice Board of Sikkim, Siliguri, Kolkata and Delhi can participate in auction of large cardamom. This intervention has helped in streamlining the price discovery mechanism and the auction price in turn is acting as the reference price at other markets.

[13] Marketing Strategies for Organic Produce, NIAM 2017

Figure 3.14 Price Spread of Large Cardamom



In order to capture greater value, there is need to clean and cure the produce. In addition, branding the organic produce will help. If storage is available, the selling can be staggered to take advantage of seasonal window in November and December. Major assembly markets of large cardamom are Gangtok & Singtam in Sikkim and Siliguri in West Bengal. Siliguri is a large aggregation market for and the product also comes from neighbouring Nepal & Bhutan. Due to larger size and colour, the quality of Large Cardamom produced in Sikkim is considered better than produce from Nepal & Bhutan. At the auction centre in Singtam, the North Eastern Regional Agricultural Marketing Corporation Limited. (NERAMAC) under Spice Board facilitated the auction by providing temporary storage facility, free of cost for the growers.

The average quantity of large cardamom sold is 1.5 metric tonne per auction. Spices Board also organized buyer-seller meet (BSM) to facilitate Sikkim famers to establish direct linkages with exporters. The joint efforts of Spices Board and NERAMAC, resulted in the auction handling at a minimum 50 per cent of the production in the State. Overall, this single platform has organised the marketing of large cardamom and enhanced quantity as well as price for farmers. The branding of this produce as organic by Sikkim Organic Mission is the next level to target to enhance higher value realisation.

3.3. Annotation

Any value chain system needs to have market demand at the core of its assessments. To be able to ascertain value to a product, the market is to be identified to work out the cost to deliver to

market. This will help the decision on what to produce and how much to produce. Optimisation of value chain activities, without an associated gain in value realisation is an exercise in futility.

Value chain optimisation means optimising the processes and activities of individual firms or commercial entities to make them more competitive against other firms indulging in the same trade. A value chain belongs to an organisation. A combination of value chains (organisations), functioning in an integrated manner on a product is the supply chain.

Supply chain optimisation means optimally managing and coordinating the chain of custody of the goods from supply to demand. The supply chain is defined by the product. The chain of custody in agricultural supply chains, is handled by a multiplicity of actors, each having their own value chain. This functional permutation of actors is the sectoral supply chain system.

A small farmer who uses own seed to produce small quantity and directly retails his output to a local consumer, owns his complete supply chain. Since the entire supply chain is under single ownership, it is synonymous with the farmer's value chain. The farmer-owner can optimise the involved operations to capture more value inside this limited supply chain model. However, when the farmer has to rely on other actors to produce and connect with the consumer, he does not own the supply chain and his value chain is only a component of the larger supply chain.

Large marketable surplus of a farmer will not get optimal value unless it is connected with end-consumer, usually remotely located from farms. This is done through intermediaries like the primary market, processor, trader, transporter, etc. Here, the farmer is only another actor in the larger sectoral supply chain. Such supply chain models extend the farmer's reach into larger markets.

Agri-supply chains are normally comprised of multiple firms under separate ownership, as functional segments in the chain of collaboration for the flow of goods. The forward flow of produce and the reverse flow of value defines the sector-wide agri-value system.

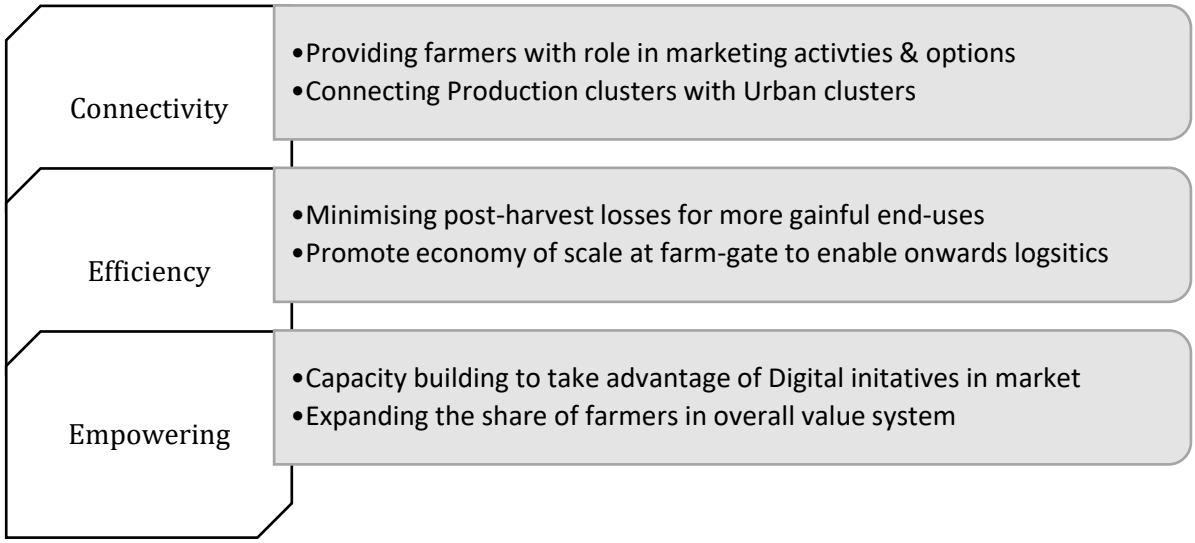
The sum total of all costs, to produce and deliver goods to market, should result in a higher value at destination. The value realised is a multiple of two key factors, the price at market and the total quantity or volume sold. The saleable quantities are rated by quality and demand at the point and time of monetisation.

Such models benefit from facilitation support and coordination between the individual actors who comprise the supply chain. Direct access to multiple market places, by empowering farm level aggregation units, is one such facilitation. Initiatives like alternate marketing can also result in expanding the range of farmers, to fulfil a wider market demand, provided it is met with physical delivery of the produce.

Rural level market centres need to be developed, not only to function as an exchange to transact local retail, but also to serve as aggregation platforms, that facilitate onwards connectivity to

other market centres of choice. Other interventions in the agri-value system, if they lead to expand the farmers' role in post-production operations, also add value to farmers. Farmers can be encouraged to capture greater value, by driving a combination of price and total saleable quantity across multiple markets. For this, farming groups need to take on next level activities in their marketing chain, such as aggregation, pre-conditioning, packaging, primary processing, and transportation. These services can be undertaken through employing village entrepreneurs, linked to farmer groups.

Market information on qualitative and quantitative demand needs to be communicated to farmers, well in advance, preferably from multiple markets. Price signals are post-facto information and are not sufficient. Demand projection will make the post-production supply chain and the overall value system more cost efficient.



The recent reforms effected by the Ministry of Agriculture & Farmers' Welfare to the agricultural marketing Act is a major step taken towards creating an enabling environment for income enhancements of the farmer. The Model APMC Act, 2003 which provided the States a template for adopting reforms have been replaced by the Model Agricultural Produce and Livestock Marketing (Promotion & Facilitation) Act, 2017. The States will need to take proactive steps to take full advantage of changed policy environs. As a first step the States will need to add and modernise the agricultural marketing infrastructure (logistics, storage, markets), immediately allow movement of agricultural commodities within and between states and enable e-trading across the state and country.

In addition, the States need to adopt market linked quality standards and invite participation of private players along with producer organisations, both for safeguarding value of fresh produce while linking with markets, and for processing of raw material into consumable food and non-food products.

At the policy level, Farmers need to be empowered with capacity to take up next level activities after harvest and not only push into the nearest outlet. Partaking in aggregation and market connectivity will organise farming and expand it into agri-business.

Key Extracts

- Higher value realisation does not merely mean getting higher price per unit of produce.
- Produce value is a factor of unit price and the total volume sold, besides produce quality and availability.
- The farmer's value chain needs to grow beyond mere cultivation, by promoting post-production aggregation in custody of farmers, and undertake transport from farm-gate.
- Interventions in the farmers' value chain must aim to capture value from every grain, ounce and drop produced.
- The agricultural value system comprises of many individual farmers and other types of actors, who integrate their indivual activities into the larger sector-wide supply chain.
- The supply chain is not under a single ownership and hence cannot be approached as a value chain.. Instead is is a value system, whose development calls for facilitating and optimising of the associated supply chain management systems.
- Ensuring that all produce finds gainful end-use will lead to better value realisation. Private sector involvement in the post-production supply chain needs more emphasis.
- Every market opportunity needs to get connected with, preferably with direct access to farmer groups, or as a service to farmers.
- Shortening the chain of custody, with more near-farm activities organised by farmers in collaboration, adds value in form of organisational capacity as well as income.
- Monetisation of all production brings gainful productivity; and aggregation is the first stage of value optimisation in the post-production supply chain.

Chapter 4
Strategy and Approach

A shift in strategic direction, from a production based push into markets, towards a demand based pull built on a 'fork-to-farm' approach is needed. The related development of interventions that suit the produce being handled are discussed.

4.1. Market Linked Strategy

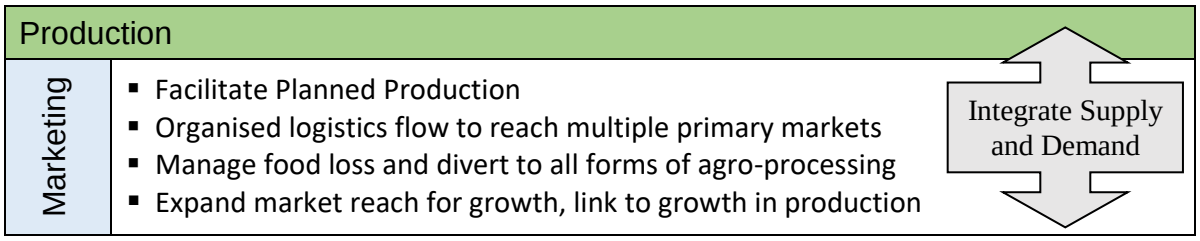
Agriculture economy of India is undergoing a natural progression of development, in terms of trade practices, business opportunities and availability of technologies, enabled by policy support. These dynamics offer opportunities and as well throw challenges for the agri-business systems and trade. A shift in food preference of the consumers, towards high nutritional value produce, characteristic of the rise in disposable income, is also resulting in a shift in trading preferences both in value and practices. To fully harness these opportunities, farmers today have the option to undertake crop diversification, vertically integrate as a value chain component of existing processors, horizontally integrate with market through appropriate aggregation of the produce and associated adoption of technology for the wider supply chain.

The required systemic and policy changes, however, need calibration to empower the farmers to convert these opportunities into income growth, ensuring an inclusive approach, as in the country there is a predominance of small and marginal farmers (>86 per cent). This calls for evolving an enabling environment and infrastructure that will endow the farmers with the tools to overcome the inherent constraints of the sector, for increasing their incomes from agriculture as well from activities allied thereto.

To double the famers' income by 2022-23, the strategies will need to bring key focus on production enhancement, cost reduction through smart nutrient management, low input farming system approach, non-farm income enhancement through diversification and skilling, stabilising of income and risk management. However, these components which are mostly production-centric need to be complemented with ease in market access with efficient post-production logistics, as the first step to market arbitrage. All efforts towards enhancing the production and productivity, along with diversification, require to be linked with market demand, with prime emphasis on ensuring that the complete quantity produced has physical access to all possible selling avenues and can get monetised. The priority has to be to increase the market reach of farmers to enhance their selling volumes, while all other incremental revisions to optimise upon the inputs would remain as ongoing interventions.

There are two key linkages that need to be strengthened between farmers and market in the post-production stage of farming. These are the physical logistics linkage with markets and information flow from markets, and this calls for significant attention on issues of access to infrastructure, technology, the institutional arrangements; and support services for capacity building, identification & development of markets.

The problem of access to market is more pronounced for the small and marginal farmers. These farmers suffer from inherent difficulties, stemming from the absence of economy of scale that restricts their ability to participate in markets a hundred kilometres away from the farm. These economies of scale are necessary for post-production activities and can be achieved through aggregation & pre-conditioning centres near farms.



There is added importance attached to linkage to market for the farmers in the context of new challenges and issues relating to market. There is a shift in demand and opportunities for a rapidly changing market environment brought about by trade liberalisation and globalisation. Rising incomes, population growth, urbanisation, changes in tastes and preferences, and increasing attention to health among a substantive section of the population have brought about changes in the consumption pattern. The consumers are increasingly aware about food safety and quality. Globalisation also offers incremental opportunities for agricultural exports.

The bane of Indian agriculture has been the fragmentation of farm holding into small land parcels[14]. At production level, this inhibits the ability to negotiate for inputs and has certain repercussion on the scope of optimising upon the input resources including mechanisation. However, the farms are effectively activity clusters around villages and some of these concerns are more notional and are solvable. The more critical impact of the fragmentation of farms has been on the post-production side as market linkage, has in turn, also become fragmented.

Farming is the primary exercise of cultivating, harvesting and monetising the production. The exercise of optimising on the input side is secondary to the concerns that yields are converted into loss, rather than generating income for farmers.

There is need to focus on strategies for development of an agricultural marketing system in the country with thrust on infrastructure creation, efficient flow of produce, access to market information and reduced food waste. Each aspect of strategy must aim to help farmers to organise the aggregation into viable loads, transport and sell more of what they produce, and thereby, leading to growth in income and in turn motivate further increase in production.

4.2. Inverse Approach, from Fork-to-Farm

The concept of seamless farm-to-fork connectivity is normally presented when relating to food supply systems. However, to function in agri-business mode, there is need to adapt to demand triggered supply chains. The farm-to-fork connectivity tends to infer, that farmers will directly interact with the consumer. The concept stems from a mind-set that promotes a push model

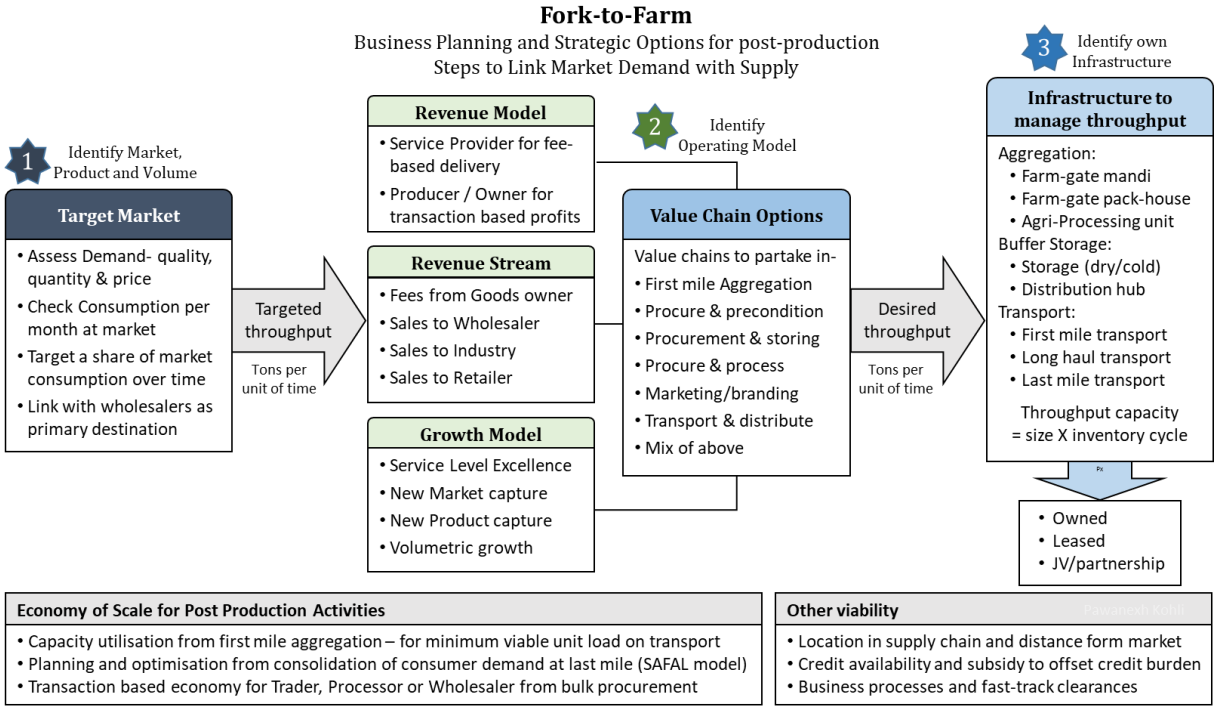
[14] See DFI -Vol 2, Chapter 1

from farms to market end, from a time when the market could absorb all that was supplied. However, the price and the quantities absorbed at markets are directly related, and require understanding market demand. All businesses dealing with consumer products follow a demand linked methodology when accessing market channels. While in case of certain crop types like fibres, potatoes for chips, grapes for wines, etc. the demand is consolidated in the hands of the agro-processing unit, in case of fresh consumables, such consolidation of demand is limited.

This has special import in case of India, which is the world's largest concentration of vegetarians, making the fresh market important. A reverse approach, to link demand with agriculture is needed for the crop types where farmers depend on income from marketing of fresh whole produce. Effectively, there is need to work backwards from demand, providing information that can intelligently direct the physical flow of foods to linked markets.

Adopting an inverse, **FORK-to-FARM strategy,** to guide future developments, is needed. A well designed strategy will look at capturing new markets so that subsequent ramping up of production will be monetised optimally. The immediate concern is to connect the produce with as many markets as possible and the business model requires linking the source with target markets, and planning a delivery or settlement mechanism after farm-gate procurement.

Figure 4.1 Options when planning an Agri-business



Source: DFI Committee

In the long run, information flow of demand, backwards to farms, is critical. Information Communications Technology (ICT) systems will play an important role in such market information flow, from fork-to-farm. However, the current demand is easy to map using data on per capita food consumption from surveys by the National Sample Survey Organisation (NSSO).

A region based matrix with tons consumed per month, categorised by crops, is a starting point to help direct relevant quantity of produce to regional wholesale markets (samples in annexures). Such demand assessment will also help improve cropping patterns and planning at farm level.

The fork-to-farm methodology should also observe that the country is one unified market, as too often, the farm-to-fork approach promotes limited efforts to push into nearby markets, within the boundaries of each state, or even within the circumference notified by the local APMC. It is understood that while cultivation is the core activity of farmers and bounded by the location of each farm and governed by the State, the farmers' market is the entire country, at national level. Hence, efforts for enhancing the agriculture marketing network and the physical flow of goods may need to be implemented at a national level. In fact, farmers' markets can also transcend the national boundary and enter the global markets, with necessary institutional and logistics support.

To fulfil existing demand, the access and logistics connectivity for greater market outreach is the immediate priority for gainful production activities.

4.3. Access and Tactic

To double farmers' income, the first priority is to ensure that the entire production off the farms finds a market to get monetised. To double income it is essential to double the selling volume of the farmers. This is critical when a large percentage of produce is lost after production, detracting from income, which results in the input costs being loaded on the remaining saleable volume. In the shorter term, value can be recovered by targeting sectors, where food loss incurred is high and demand goes unfulfilled.

The primary concern for India today, is to bring its immense farm-gate production to gainful and effective end use - to reach the hands of consumers, regularly and efficiently. Every kilogram wasted due to poor post-harvest handling & logistics capabilities is also a loss multiplied in terms of resource wasted and in greenhouse gas emissions. Any loss on the supply side has an immediate ramification on farmers' income and inflation.

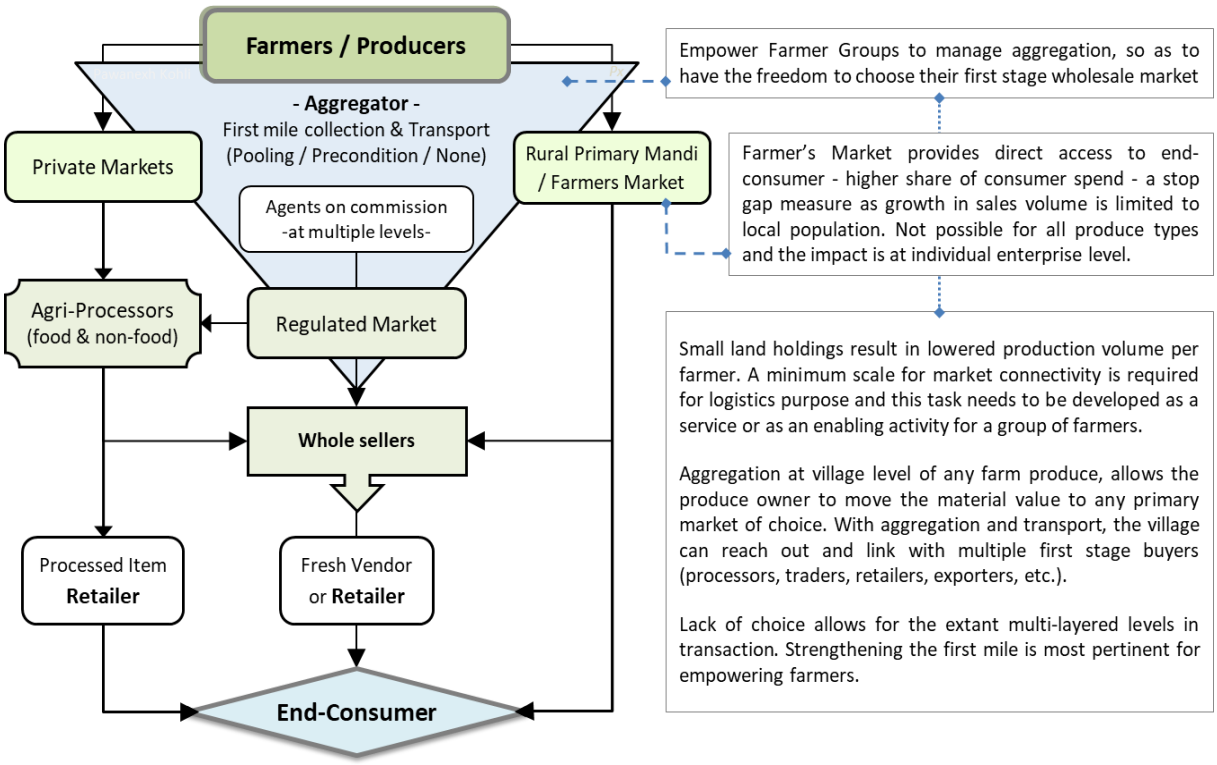
The ability to physically connect the material produced with markets is inhibited for individual farmers due to low handling quantity per farmer. This inhibiting factor is due to the generational fragmentation of land holding, leading to small lots of marketable surplus. All access to markets is made via some mode of transport and a critical mass or viable quantity is required for this purpose. Where the farmers are able to collectively pool their produce (milk is an example), onwards market linkage is easily undertaken to the benefit of the farmers. Except in case of milk and large plantation crops, there is little organised collection for onwards market linkage evident, though hundreds of market yards have been developed.

The market yards enforce a certain aggregation of produce, by dint of being the local nodal point, and some aggregation in paddy and wheat comes about due to collective buying by Food Corporation of India (FCI) & State procurement agencies. Some aggregation of pulses and oilseeds, as also potato and onions is seen to happen in recent years, largely on account of

procurement under government schemes. However, the scale is yet too small. The aggregation that occurs in today's scenario is acceptable for the purpose of crops that are suitable to handle at market yards and subsequent godowns and warehouses. However, perishables like freshly harvested fish, meats, milk, fruits, vegetables and flowers cannot survive the same methodology followed for cereals, pulses and grains. These produce categories need immediate attention after harvest, by way of pre-conditioning them, for further safe-keeping and market connectivity. **Without any organised and produce specific aggregation services, a major share of the perishables produced face high risk of food loss.**

Food loss results in less quantum of farmers produce left at last mile to generate value, and less of the value realised trickles down to farmers. Selling volumes by farmers can be enhanced, provided they are empowered with appropriate market connectivity services (logistics and information) and/or by bringing the primary produce buyers closer to farmers. However, a spread in markets is also required to avoid generating localised market surplus. Farming community is also to be promoted to take up the next set of activities in the supply chain, especially those like pooling and aggregation of produce, which can be managed at near farm locations and allow them to convey their harvested goods to markets of choice.

Figure 4.2 Next step interventions for farmer groups



Source: DFI Committee

Currently, the farmers do not have access to organised logistics services that can take custody of their produce, offering farmers a choice of market, to deliver to select wholesale points. The empowering effect of having such physical logistics, will build confidence in the cultivators and automatically induce and justify any additional efforts to increase their farm level productivity.

The recommended approach is to ensure that the maximum quantum of harvest:

i. is linked with multiple avenues of revenue as prime objective;

ii. is primarily connected with the markets, while the strategy of storing and biding time for a delayed transaction becomes a secondary objective;

iii. which becomes non-saleable or handling waste is diverted to food and non-food processing; and

iv. in case of specialised cultivars, produced for processing purposes only, the supply would bypass the direct market linkage which is used for table variety.

To enable post-harvest produce to access all possible avenues for revenue generation, a dedicated supply chain network is required.

Such a network will require at first instance, the establishment of first stage aggregation to create viable unit loads for connecting transportation. Such facilities do exist at the regulated market yards, but these have been mostly designed for the handling of foodgrains and cash crops as was their original focus, rather than for handling perishable agricultural produce. It is not a coincidence, that the milk trade is not handled through such market yards but through a network designed for suitable and hastened handling of the liquid harvest.

In case of government managed foodgrains procurement, the network can focus more on improved inventory management and with attempts to recover greater value from the stock.

The APMC market yards are designed more as premises where trade is transacted, rather than as logistics hubs where services of aggregation and transport can be resourced by the produce owner or farmer. The logistics activity that ensues at these yards, is an incidental development and after the farmer is relieved of the produce, post primary transaction. This mechanism, delinks the farmer from further market opportunity or choice of market, handing over this economic prospect to the intermediary buyer. This ongoing mechanism is probably expected to stay and relevant to the trade in cash crops and foodgrains, as the next level of consumption is at bulk handling enterprises in the form of processors (food and non-food outputs).

It is proposed, that in order to improve the farmers' revenue opportunity, separate facilitation of logistics services system be developed, with primary sorting, assaying, transport, storage and wholesale so that farmers can access markets further afield, remote from production areas and hence interlink with the National Agricultural Market (NAM). This will be most relevant in high value produce such as horticultural and livestock products. Except dairy, a specialised post-production supply chain system is missing in agricultural sectors. There is scope to build first stage of post-production logistics at the existing APMCs, which generally have vast parcels of land. The implication is that the farmers, both individually and in groups, can be facilitated to access market yards not only to sell produce but also for using the logistics infrastructure to access other markets. The Model APLM Act, 2017 needs to be amended to offer this opportunity.

This document is intended to provide broad guidelines to transform the way farmers' monetise their produce, and offer recommendations on improving the post-production handling of farm produce, so as to enhance the revenue streams for farmers. For the purpose of supply chain linkages, the farm produce is rationalised into categories that reflect their holding life.

4.4. Categorising Agri-produce by Holding Life

Strengthening of the country's agri-logistics for doubling the farmers' income and improving the post-production productivity is a necessary priority. Agriculture post-harvest logistics includes **a)** first stage aggregation; **b)** first mile transport; and depending on type of produce, **c)** transitory or long term storage; **d)** long haul or wholesale transportation (rail, road, water, air); **e)** distribution hub; **f)** last mile transport; and **g)** intermediary processing or manufacturing for certain produce types.

A modern supply chain needs to function within the holding life, or usable life of the produce. This is a primary factor when planning the post-production phase of logistical activities to cover the remaining life cycle of the farm harvest. Broad categories are long and short life cycles, as explained below. The holding life indicates the "time spread" in hand for sales.

4.4.1. Produce with long holding cycle

This category of produce include the ones that either have a natural long marketable life cycle, after harvest, or those that have an established pull by primary users and broadly includes –

a. Foodgrains such as rice, wheat, maize, millets and pulses
b. Field crops such as cotton, jute, sugarcane, and oilseeds
c. Plantation crops such as tea, coffee, tobacco, coconut and rubber
d. Other dry produce like nuts, spices, wood, silk, aromatics, etc.

This category of farm produce is distinct in two key aspects – that the commodities are capable of long term storage in warehouses and that these have an existing market linked user/processor network. Usually, the produce is purchased by an organised market network (FCI, millers, processors, manufacturers, commodity boards and commodity traders). Although all agricultural produce is eventually perishable, in these cases, with minimal post-production care, the inevitable is deferred by many months or even a few years. Therefore, having a long time-spread, the majority of such commodities are also readily brokered for purposes of hedging and arbitrage.

4.4.2. Produce with short holding cycle

This category of produce consists of those that quickly perish, possessing a short post-harvest holding life, having a short "time spread" in their selling cycle. This category includes –

a. Milk
b. Fruits, vegetables, certain roots and tuber crops
c. Floriculture and mushrooms
d. Meats (including fish and poultry)

This category of short lived farm produce loses its saleability very fast, from within hours to a few days, without technology aids to extend its marketable life. The harvest inherently does not last until the next harvest or supply cycle and perforce has to rely on quick logistics to bridge the disparity in demand and supply and thereby get a spatial spread in sales. Most of horticultural production fits in this category including the sensitive trio – tomato, onion, potato (Volume VIII).

The market linkage is a factor of time taken to cover market distance and the holding life of the produce and failure results in price fluctuation. In such produce, the main strategy of market will be selecting the place to sell.

This category uses cold-chain intervention to extend its marketable life. Through extending the holding life, the cold-chain connectivity also aids in increasing the marketing range of the producers. The extended holding life is better utilised to safely move the produce to consumption centres, rather than storing in-situ in cold stores. On account of poor holding capability of the produce, the average commodity trader avoids the nature of risks in perishable produce.

The short time spread can be countered by bringing a spread in place of sale, and form of produce being sold. Lack of concept clarity at policy level has also contributed to the absence of a comprehensive logistics and marketing network, resulting in creation of storage capacity alone.

4.5. Farm-gate Aggregation for Agri-logistics

Logistics connectivity between an origin and destination (OD pair) requires aggregation at primary location to accumulate initial capacity for logistics viability. At the point of origin, or farm-gate, the aggregation points must have the associated basic food handling facilities.

4.5.1. Long holding produce

The foodgrains, cash crops and other long holding produce have the existing market yards as the primary aggregation and care facility. The country is reported to have almost 6700 such markets (inclusive of principal and sub-market yards) regulated under the APMC ambit. These markets serve as the first node in the marketing of these crops, where farmers are able to monetise and generate revenue against their produce. The inability of the farmers to directly access these primary wholesale markets and the need for more decentralised aggregation platforms have been examined in DFI Volume IV. Approximately 22,000 rural periodic markets at village level should be upgraded into such centres, to allow village (*grameen*) level aggregation.

Subsequent to these markets, the produce is handled by traders and/or processors for onwards marketing against demand. Farmers also have the option to store their produce in warehouses for deferred transactions, in the hope of higher earnings from transactions at a future date.

Assuming no major change in price, the earning from such crops can only be enhanced with an accompanying increase in selling volumes. Therefore, the interlinking of agricultural markets at the national level will help to collate the country's demand and will streamline the trade in such crops. Within the country, spreading the silo and storage systems closer to high density

population centres will ease the distribution bottlenecks and allow for a more streamlined supply system and help minimise losses. The increase in demand for these crops can importantly lead and drive an increase in productivity at farm level. Since these crop types are normally processed before consumption, for the farmer, the change in demand mainly originates from food/non-food processors, traders and large retail organisations in the country. Future increase in demand under this category, is expected to be organic growth; incrementally linked to population growth and changing purchasing parity.

However, to enhance the farmers' income in this segment, there is need to explore and link the stored inventory with the demand outside of the country/region. This requires greater marketing effort for export of surpluses, with suitable support provided to processing industry (food and non-food) and marketers. The support would need to be directed towards increasing the global level competitiveness of the products and to making the final products more acceptable.

4.5.2. Short holding produce

The perishable produce has a shorter post-harvest holding life and this category requires pre-conditioning of the food item before it can be dispatched to distant markets. Pre-conditioning is defined as activities that prepare the produce for market, without changing its essential characteristics of the produce, i.e. it remains agricultural produce (whole food) and not a manufactured product. The activities of pre-conditioning involve trimming, cleaning, pre-cooling, waxing, retail packing, labelling of fruits and vegetables and ripening if needed. These preparatory procedures extend the marketable life of the produce, for subsequent travel to consumers, including short and long term storage to buffer the supply.

In case of milk, the pre-conditioning stage is the initial pooling, assaying and chilling of the milk in chiller tanks at village level collection points. In case of fresh meats (fish, poultry, pork, etc.), the preparatory activity after harvesting the animal includes rapid blast freezing at the abattoir or processing factory. As the fresh meat is pre-cut into smaller sizes (no longer whole), even if no additives or other preservation techniques are applied, the process is deemed under ambit of food processing. Once cut into marketable lots, the meat is rapidly cooled (to less than -18 °C or 0 °C) depending on the market requirements. If the meat is to be consumed shortly then freezing temperature suffices, but if the intended consumption is weeks or months after, the carcass is held at sub-zero (< -18 °C) temperatures.

In the case of milk, the success of this sector can be attributed to the fact that the raw milk supply chain was developed by prioritising on establishing the first level pooling systems, to function as the preliminary collection or aggregation centres. Individual farmers pool their milk at the aggregation or milk collection centres for onwards linkage, getting their share of the value ascertained at the milk receiving or processing facility – the value is not locally determined at the near-farm pooling point, but is evaluated on the basis of demand and supply at the remote processing unit. As such, the farmer is able to tap into value that is directly linked to the wider market demand.

A similar aggregation system for the larger basket of perishable fruits and vegetables is needed and is in deficit in the country. Modern pack-houses receive produce directly from farms, and are a vital first step in pooling and organising the post-production handling of perishable farm produce. These facilities have been developed in the country in case of grapes and bananas, and have boosted trade including exports, which in turn have been aiding greater and sustained productivity. In case of apples too, these pack-houses are increasingly seen to be assimilated into the near-farm cold storages, specially designed for apples.

It is recommended that pack-houses at village level be promoted as a priority infrastructure, to receive farm output. Pack-houses should be created with a small sized storage, only to stock about two (2) or three (3) days of harvested quantities, so that onwards market connectivity using transport is stimulated. If the transport arrival to a pack-house and dispatch to market is expected to be delayed, the pack-house in turn signals the farmer to defer that day's harvest, which mitigates post-harvest distress. Pack-house units therefore, can serve as signalling centres to decide the harvesting activities depending on market linkage. This signalling can be made robust by application based information messaging to the registered farmers.

At such facilities, the produce is assorted into market lots by quality, physically graded for packaging purposes to ease transportability, packed for onwards transport and eventually pre-cooled to extend the freshness. Thereafter, the produce is staged in suitable lots for onwards transport to wholesale markets. Since produce is initially assayed by quality, the pack-house is the gateway that decides which destination will generate the most viable returns.

Integrated pack-houses are created at village level also called farm-gate, and are a necessary requirement if the farmers are to extend their reach into markets. **A modern pack-house is actually the nerve centre of the fruit and vegetable supply chain.** This food segment shows faster growth in demand, fed by fast changing food preferences and growing affluence in country and shows scope to transform the economic situation of farmers.

Individual on-farm collection units are not to be confused with the modern pack-house. The latter is a logistics hub which service multiple farms, to communicate the produce forward to markets and manage the reverse flow of information to guide decision making for market linked harvesting. The pack-house allows to generate multiple revenue streams from the farm produce, applying metrics such as,

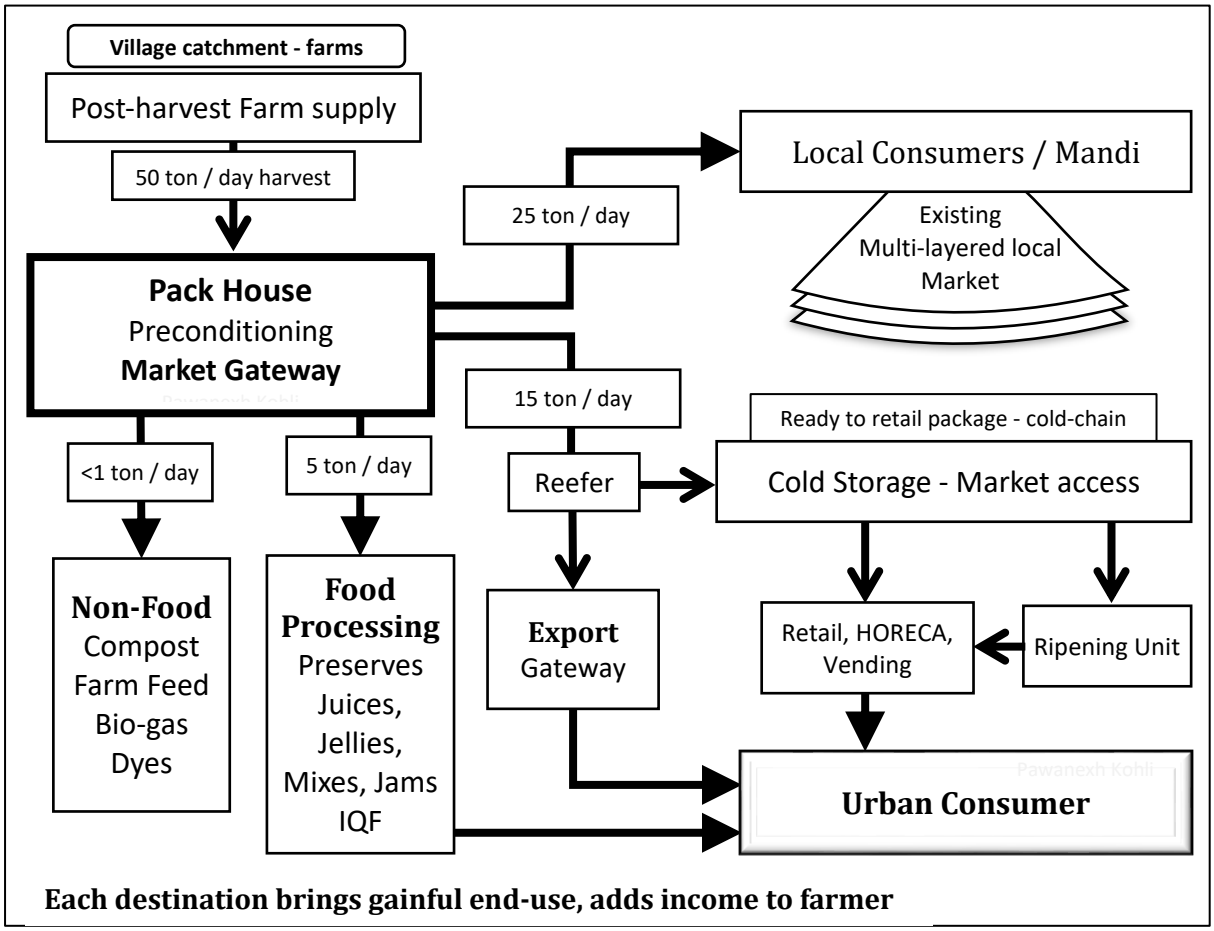
a) the late harvest that has shorter pending market life is pushed into the local regional market;

b) the produce suitable to withstand rigours of transport is prepared and dispatched to distant urban markets;

c) the produce that is unsuited for the fresh market is diverted into attached juicing, pickling or other processing units;

d) the poor quality or rejects is utilised in non-food processing such as cattle feed, dye making, compost, etc.

Figure 4.3 Concept of Modern Pack-house (assembly and village level nerve centre)



Source: Kohli, 2015: Report to Task Force for Cold-chain Projects

The organised flow of harvested produce from a pack-house ensures that economic value can be recovered from every phase of post-production handling of farm harvest. Produce can be managed into revenue streams from non-food and food processing, from local market, hotels, restaurants, caterers (HORECA), from distant markets including exports. **Modernising the farm-gate aggregation will have a direct and positive impact on farmers' income.**

Successful deployments of modern pack-houses have more than doubled farmer's income, and provided impetus to productivity (higher yields). Created at village level, they also bring near farm jobs. In India, common examples are seen with grapes, banana, apple and floriculture. Initially, pack-houses were used in case of exports, but increasingly domestic market is also showing preference for good quality fresh whole produce. The main enabler for growth in imported fruits and vegetables is that source farms abroad, have recourse to modern pack-houses, to prepare and initiate the produce for the long travel to the importing countries.

Unlike foodgrains, which have a simpler curing procedure at farm level, the perishable food items require more comprehensive pre-conditioning. Countering perishability has to be matched with equal logistics, to connect produce with markets well before it eventually perishes and slips into loss. Use of technology to extend holding life is not sufficient, as without a market, the goods will still perish and turn into loss. Market linked transport remains important.

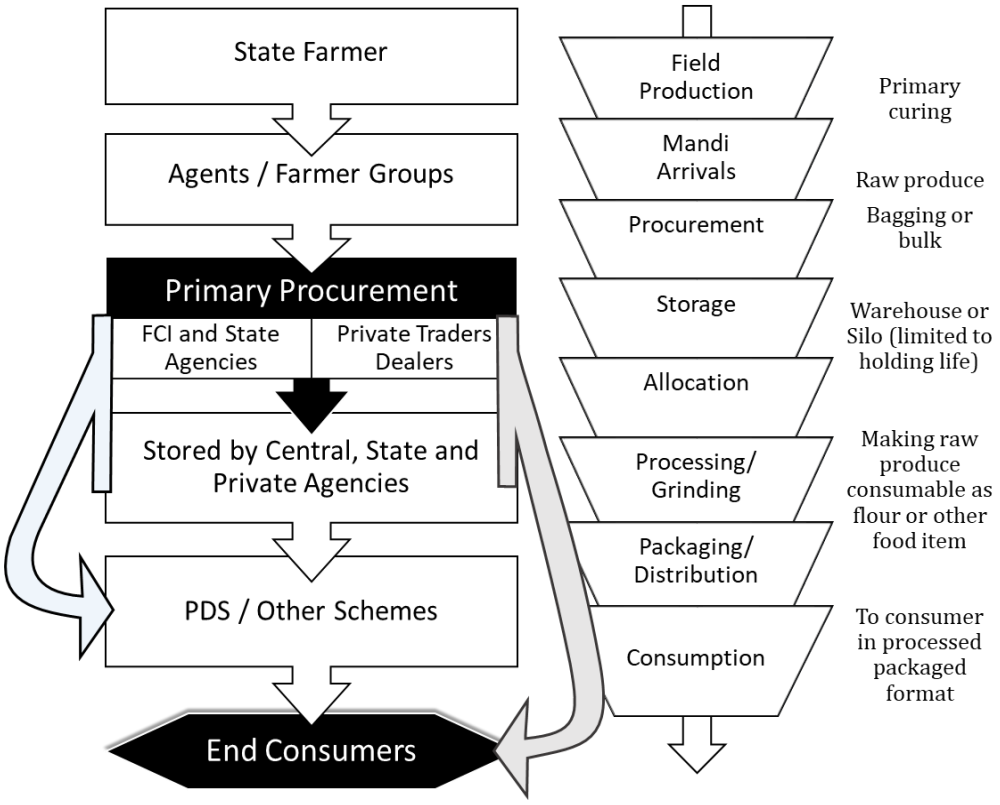
4.6. Transport and storage for Agri-logistics

Aggregation is the first stage requirement in agri-logistics. This is needed to build viable handling loads for forward transport connectivity, to link with the consumers. For the farmer, the consumer of the raw produce can be a processing unit, or the end-consumer. The end-consumer is accessed through the distribution & retailer channel. Retailers need localised access to the produce, usually through local mandis or wholesale terminal markets at urban centres. Transport and storage systems are used to reach the prepared produce to the consumers.

4.6.1. Long holding produce

In case of long holding produce (eg. cereals, foodgrains, etc.), the aggregation point itself can be co-located with the godown or warehouse. These dry produce types can catch onwards movement on ordinary trucks with or without any elaborate packaging. Any form of packaging or bagging is for the purpose of segregation and handling of inventory. The destination after the storage phase is normally another handler or processor where the produce is treated, extracted or milled into a final product before it undergoes retail level packaging. Modern movement of grain can also happen in conveyors or pipelines when loose bulk is handled.

Figure 4.4 Foodgrain procurement & distribution



In most such cases, the farmers would have completed their participation in the market chain by having off loaded their produce for revenue at the first stage, in the hands of a primary user. The linkage to the end consumer is managed by the processor, or marketing agency. Commodity traders also partake as the produce is easier to handle and hold in comparison to perishable crops.

Storage is intended to buffer an ongoing supply chain. Inventory as buffer is supposed to provide leeway to bridge supply side variations with constant consumer demand. Storage alone, bereft of agenda to link with market can result in idle value. Where and for how long the raw produce resides in the logistics chain, is defined by the vested supply chain. When the linkage with demand is well established through distribution channels, the produce can be forwarded in quantities that suit the processing capabilities and capacities, as well to suit dynamics of markets.

For long holding produce, the physical connectivity is accessible on existing transportation modes, unlike perishables. The railways already play a big role as can the container train operators or waterways where larger distance is to be covered. Ordinary trucks are commonly used for shorter distance and where otherwise suitable. In effect, the storage and transport technologies for long holding produce exist. Modernisation and scaling up is required. However, multi-modal transportation is an important missing link, presently.

4.6.2. Short holding produce

For short lived produce (milk, meats, horticulture, etc.) the dynamics in its trade is much hastened, compared to long holding produce. The effect of perishability reflects in the time remaining after harvest, to market the produce. If not for its perishable nature, the farmer could have had a broader spread in time and greater choice in marketing the produce. Perishable harvests also need to be assembled at first mile at specialised aggregation centres. Given the prevalent fragmentation and size of farms, the buyers need to ensure that viable transportable loads are available. The buyer could be a first user if a food processor, a wholesale buyer, or even the organised retailer or end-consumer.

i) Milk

Milk does not reside as inventory for long and is almost always on the move. The raw liquid milk produced by the farmers is first pooled at village level. This common aggregation is possible due to the homogenous nature of the harvested liquid. From the pooling centre, the milk is transported in cans to the local bulk milk chiller or milk chilling plant. The milk chiller can range from 200 to 1000 litres onwards, to very large capacities at processing plants.

The first mile pooling point can also incorporate a milk chiller unit, in which case the collection tankers can directly lift the milk from the first point collection/milk-chilling unit.

For farmers, the most significant step is the collection or pooling points. Milk starts to deteriorate within hours, and without these points to aggregate the produce for the organised supply chain, the farmers can either consume themselves, or sell the milk only within a limited radius. In this case, when the local production is beyond local consumption demand, the scope for monetisation gets curtailed and further production would lead to waste.

The collection points link to processing units and other marketing channels, and hence are the first and critical stage of linking the larger market with the local milk farmer.

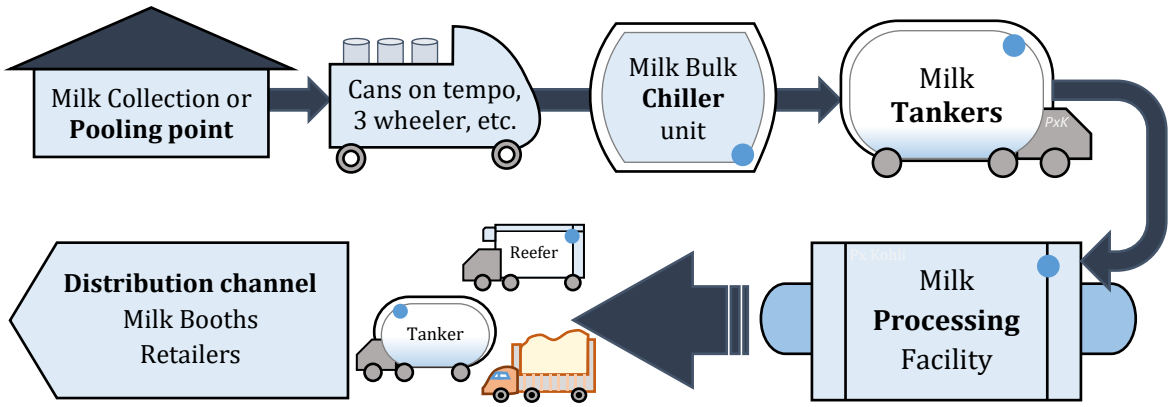


Figure 4.5 Typical Milk Supply chain

In such a supply chain system, the farmers do not directly access the end-consumer and the market demand is communicated from the distribution channel, backwards to village level. The milk pooling points become a medium to access this demand from the end-consumers. Being a homogenous produce, any minor variation detected in the quality of milk collected, is easily rectified to meet the minimum standardised quality norms.

Another revenue channel for farmers is the informal market, where the farmer directly sells the raw milk to small processers (*halwais*), nearby vendors, consumers and milk traders. Though this market channel is also an important source of demand, the modern networks with systemic procurement is proving to be a more transparent and assured mode of income for farmers.

As per estimates, milk procured is largely sold in its liquid fresh format (about 45 to 50 per cent). Another 25 to 30 per cent is sold as ghee (clarified fat), and less than 15 per cent of the quantity is sold as butter and curd. Remaining 5 to 10 per cent surplus serves the demand for milk powders, milk whitener, ice creams, cheese, sweets, etc.

The milk pooling points are logistics enablers; the milk chillers and transport connect to the distribution channel via the milk processors. Due to liquid characteristics of milk, once chilled to the right temperature, it retains the cooling longer and insulated (non-refrigerated) tanks can suffice for transporting. When milk is converted into other formats, the technology needed will vary depending on the manufactured product. Milk is easily unitised for safe handling.

Fresh dairy products such as pouch milk, *paneer* (cottage cheese), curd, butter are normally maintained in temperature range of 2 to 4°C, in the distribution chain and at consumer. This can also be done using insulated vans to cover short distribution ranges. In most cases, the selling and consumption cycle is faster and daily stock replenishment is carried out. Butter is also kept for longer duration between 0 to -10°C. In case of ice cream and frozen products, the distribution channel keeps them at temperatures below -18°C (frozen) using active refrigeration; in reefer transport, cold stores as distribution hubs and in merchandising cabinets.

A large quantity is sold as ghee, powder or as aseptically packed (tetra packed) milk does not require refrigeration and can be moved to market in the ambient.

The organised milk business is quite efficient with minimal losses in the system. The value optimisation targets of the milk business is more focused on logistics costs, expanding the network of first mile collection centres, enhancing the quality of milk procured and avoiding adulteration. For farmers' benefit, the strengthening and expansion of the village level collection or procurement network is preferred, as demand for good quality milk and dairy products is growing in the country, and organised marketing channels help expand into new regions.

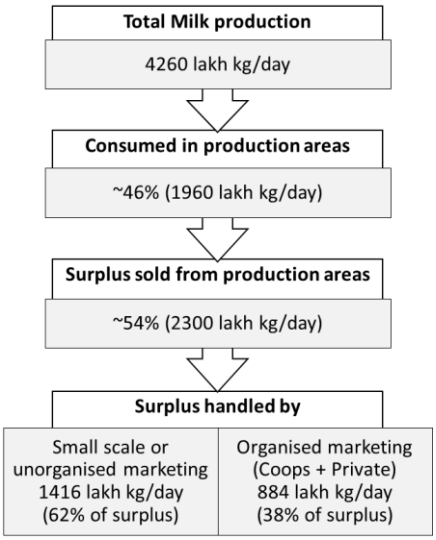


Figure 4.6 Estimated share of milk in organised & unorganised marketing

The trade in perishable horticultural produce requires a different format of Agri-logistics.

ii) Horticulture

Though less sensitive than milk, and with a comparatively longer holding life that extends to a few days or weeks, horticultural produce has its own differing and specific requirements for its post-production handling. Horticulture is a broad sector that covers high perishable crops like most flowers, fruits & vegetables; low perishable crops like cardamom & nuts; and partially sensitive crops like potato and onion. However, the common thread across horticulture is that the produce continues to live and breathe, and thereby, itself generate heat through continued metabolic activity, throughout its saleable life cycle. The produce can also be sensitive to rough handling, and suffer damage and become more susceptible to disease. Once the produce is damaged or naturally perishes, its tissue structure degenerates and it is no longer marketable. This non marketable quantity adds to food losses.

For the farmer, the produce fetches its highest economic value in its fresh form. The freshness of the produce is directly linked to post-harvest ageing, a physiological timeline that limits the time remaining for the farmer to monetise the produce. This aspect, if not attended to, causes farmers to push their sales or resort to distress selling. Once the produce perishes, the produce succumbs to natural forces of decomposition and physically rots away, but can used for composting, etc.

The metabolism or physiological activities of the living produce can be slowed down by cooling it rapidly to its optimal holding temperature. The procedure does not involve freezing the crop as that would kill it and make it non-saleable in fresh format. The cooling is, therefore, in the positive temperature range (chilled), with each crop type having its own predetermined temperature set point (ranging from about 0°C upto 15°C).

The ageing process is also dependent on moisture content of the produce; temperature control alone does not fully extend the holding life. Therefore, horticultural produce also needs to be

maintained at high humidity levels to remain fresh. With the right combination of temperature and humidity, the saleable life cycle of horticultural produce can be suitably extended, and this allows the producer a longer time to plan their sales and to reach far-away markets.

The use of a modern pack-house, integrated with pre-cooling, is necessary to retard the ageing process, and to keep the produce fresh for a longer time. Once so pre-conditioned, the readied quantity is staged and dispatched to market using temperature controlled transport units (reefer trucks or reefer containers). In long run, a shift to palletisation and containerisation is needed.

The time at hand before taking the transport depends on the crop holding life, the time to market and the desired time to keep on shelf pending sales. Fresh horticultural produce normally has a fast selling cycle, and a couple days of shelf life (shelf presence) can suffice. Working backwards from this shelf life, the supply chain assesses the total holding life and the time expended in travel, to plan the dispatch to end consumer.

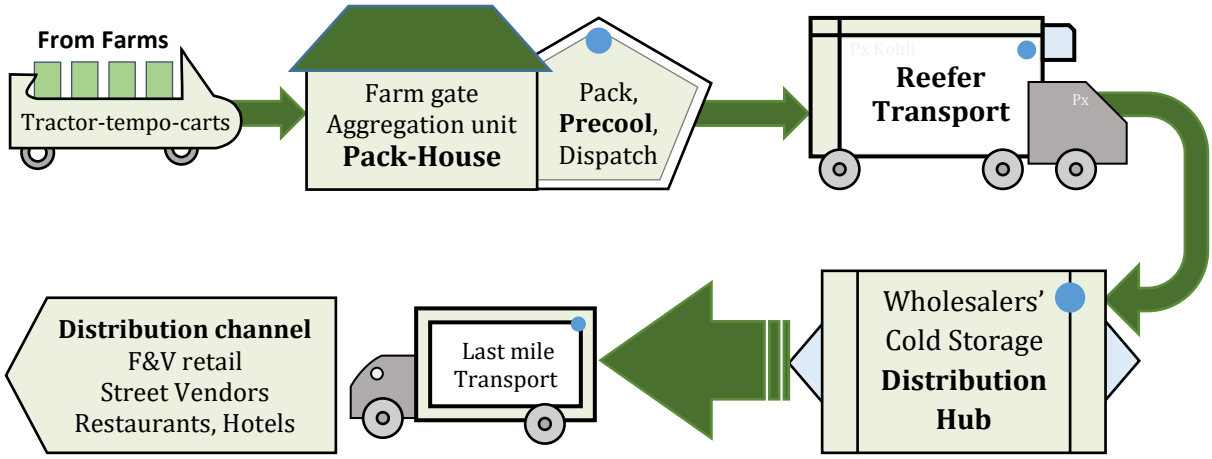


Figure 4.7 Desired supply chain for table variety produce

After leaving the pack-house, the produce is optimally kept in temperature and humidity controlled environs, in reefer units and cold storage hubs, during the delivery cycle to the last mile seller. In Indian market, the consumer habit of daily purchase or frequent fresh stock, allows for less last mile storage and eases the front end merchandising requirements. Even produce maintained and transiting in the cold-chain can be safely sold off the street vending carts to consumers with daily consumption cycles.

The flow of produce in all supply chains is always directed towards the end consumer with necessary stakeholders playing an intermediary role in the chain. But without the appropriate infrastructure tools, the logistics chain fails to aggregate viable volumes at the various stages. This brings in a larger number of intermediaries, who add an incremental yet small value-add to market connectivity; however, the profit mark-ups remain comparable. Large number of stakeholders can result in multiple handling of the produce, leading to inefficiencies and larger losses in the market logistics.

For the majority of horticultural food items and floriculture, the modern distribution and marketing platform requires village level pack-houses with only a small buffer cold store, reefer transport units and cold stores as distribution hubs at the front end. Globally, chilled horticulture movement occupies 50 to 70 per cent of the cold-chain, whereas in India more than 90 per cent of the integrated cold-chain is for frozen goods. For enabling greater market access and connect for famers, the cold-chain for fresh farm produce needs to be developed as a priority. In contrast, the milk chain has 1.7 lakh cooperatives linked through large number of pooling centres.

Though pack-houses could be another node for farmers to monetise their produce, more importantly they strengthen the supply chain systems and facilitate in market demand being communicated down till village level. The organisation that ensues, will also allow for more of the farm produce to be evacuated to consumers and reduce the food loss at farm level. Cold-chain logistics will also allow for faster selling cycles and quicker cash flow cycles to farmers, as majority of the produce will be able to reach markets within days or weeks of their harvest.

Certain fresh produce have longer holding life, such as potatoes, apples, dried chillies (about 8 months) and in such cases long term holding in cold storages is developed, basis market opportunity. A very large network of cold stores dedicated for potatoes and dried chillies exists. These bulk cold stores help to streamline episodic supply with market demand in these crop types. There is also need to develop cold-chains that facilitate more than storage alone, so as to fast-track the access to markets for the wider basket of produce with a low holding life.

iii) Meats

Meat production, unlike horticulture, is not episodic as its harvest can be more easily adjusted to suit demand. Yet, meat cannot remain fit for consumption, as after demise, decomposition from enzymatic and bacterial activity sets in quickly. Therefore, unless the animal is harvested shortly before consumption, the meat needs to be kept in refrigerated condition until consumed. Fish harvest cycles are a little more varied than those applicable for poultry or livestock meat.

Modern day supply chain for meats includes collection of the live animal at abattoir units, processing the meat and blast freezing the carcass before maintaining it at less than -18°C (frozen) temperatures. Meat processed in this method can last for many months. However, where domestic demand manifests in a more frequent buying cycle, the meat can also be kept fresh for a short duration at zero °C. Abattoirs and poultry processing units are primary consumers of the produce from the farmers.

The growth in this sector is linked to changing food preferences of Indian consumers, which can be faster than the organic growth in demand from increase in population. The modern temperature controlled supply chain for meats has already aided in opening foreign markets, and the export of buffalo meat (carabeef) from India has already touched record levels. In case of fish meat, the country is considered among the top 10 exporters in the world. The combined production of meats (including fish and poultry) was less than 18 million tons in 2015-16.

The agri-logistics for market connectivity in this sector is a shared infrastructure resource among other perishable food items. The reefer transport units are able to handle frozen to chill temperature ranges (-25°C to +25°C) and cold storages at last mile are compartmentalised to handle frozen goods. The merchandising units at retail side are also readily available technology, though the modernising of retail shops is important keep the product safe. The back-end infrastructure in form of slicing, cutting, blast freezing, etc. is covered under ambit of the processing industry.

Besides the edible meat, the organised meat business also services the demand from the leather industry, and provides raw material as inputs for other processes for commercial products.

4.7. Role of Agro-processing

The agro-processer is an intermediary in the farm-to-consumer supply system and communicates demand from end consumers to farms, and constitutes another mode of revenue for the farmer. In case of non-food crops, processors are the oldest example of agriculture allied business enterprises, **which converted farm produce into usable consumer goods**. Agro-industries like textile, leather and medicine are apt examples and have been a driving force for agriculture worldwide. Modern technology allows even the traditionally unwanted by-product from food produce, to be brought into commercial use as raw material for use in building materials, polymers, cosmetics, adhesives, dyes, fuels, detergents, bio-energy, etc.

Agro-processing activity is an important source of income for farmers as it converts the primary agricultural produce into usable items for food, feed, leather, fibre, fuel or industrial raw material. Regular developments in agro-processing technologies have led to the progress of agro-allied industrialists and they have become a primary market for the farmer. Of these, food processing specifically deals with manufacture of food products and given industry status in the country.

Globally, there are varying interpretations of food processing and some countries include the activities that only prepare and package the fresh produce for marketing purpose. However, these activities do not convert the farm produce into another product, but only precondition the fresh produce for travel to market.

In India, the overriding definition of "Agriculture Produce" means any produce of agriculture on which either no further processing is done or such processing is done as is usually done by a cultivator or producer which does not alter its essential characteristics but makes it marketable for primary market[15]. Correspondingly, the activities by way of pre-conditioning, pre-cooling, ripening, waxing, retail packing, labelling of fruits and vegetables which do not change or alter the essential characteristics of the said fruits or vegetables, are not considered to output processed foods. Various fiscal and financial implications are associated with this understanding, to favour the marketing of agricultural produce, including under the Goods and Service Tax rules.

[15] Agricultural produce as defined in the Finance Act, Section 65B(5)

Food processing is undertaken when the raw farm produce undergoes a transformative treatment that changes or alters its essential characteristics. The transformative processes may involve liquefaction, emulsification, cooking (such as boiling, broiling, frying, baking or grilling), mincing or macerating, dicing or slicing, pickling or preservation, canning or jarring, freezing or drying, refining, grinding, additives, etc. – that is, the natural attributes are altered, or ingredients added where the produce is transformed from its natural physical or chemical form into a new product - e.g. confection, beverages, sauce, canned vegetables, juices, jam, pickles, deep frozen goods, flakes, powder, etc. The output is no longer construed as agricultural produce, but a finished product. For the consumer, the food product manufacturer is the producer and not the farmer. For the farmer, the processor is a consumer and another point of demand.

Food processing plays an important role in the post-harvest food supply chain as the industry is a market, for all intents, for the farmers. The industry is in a favourable position as it is intrinsic for making produce like oil seeds, foodgrains and cereals fit for consumption. In the past, the industry developed as a localised service for the end-consumers, who would normally procure whole grain and convert it to flour (*atta*) at a nearby flour mill (*chakki*) service. Milk was usually procured raw and boiled at homes, and meats were harvested locally as per demand. Urbanisation has brought about concentrated demand and scale to such services which have developed into product manufacturers as food processors.

Agro and food processors source raw agri-produce and the processing line capacities are fulfilled by staggering the inventory held by aggregators, traders and contracted farmers. This system helps develop a steady state demand of certain crops, and is an effective mechanism to translate consumer demand for certain products into demand for farmers' whole produce.

However, there is a growing preference among discerning consumers for fruits and vegetables in its fresh format. It is expected that as the country becomes more affluent, the demand for fresh fruits and vegetable will increase, and even lead to increase in demand for fresh organic produce. Fruits, vegetables and even flowers, fetch highest value in their fresh form, if of suitable quality.

Nonetheless, perishable crop types are prone to damage in handling and frequently such material is culled from the logistics chain. This culled material, if captured at first mile, at the pack-house level, can be safely diverted into small food processing units to recover value. In case of certain crops, non-table variety cultivars are specially grown for food processing purpose. Potato, grapes and tomato are examples; the table variety and processing variety have segregated uses.

Agro-processing has three roles in the overall supply chain: **a)** primary processing without value addition where primary agricultural commodity is converted into a consumer ready format; **b)** value added processing where the primary produce is converted into new products (food or non-food); and **c)** value recovery where culled non-saleable produce is converted into other usable items, akin to b). The first two are primary avenues of monetisation for farmers, and the last allows the supply chain to recover value from produce that would otherwise have been discarded as non-marketable.

In case of value added processing, industrial level processing is the mainstream business activity. Primary processing can also happen in the hand of farmers or at cottage industry scale as part of secondary agriculture (discussed further in Volume IX of this Report). Where culled produce is retrieved for processing, the business is a sub-set of the agricultural supply chain and value addition is done on the non-saleable produce, which is a by-product of handling inefficiencies. This latter also helps to optimise on total value recovery to the farmers, while their mainstream business is the marketing of fresh produce.

In the horticultural supply chain, barring a few processing variety cultivars, this third intervention helps to mitigates possible food loss. Such processing units could be small or medium in scale and appended to aggregation centres at the back-end, where the primary segregation takes place. Though the prime motivation remains to market the fresh produce for highest market value, the remaining quantity can be utilised for processing into other consumable products and uses. Integrating processing with the agri-supply chain allows the system to add value to the farmer, by ensuring all of his/her production finds gainful end-use.

4.8. Modernising Infrastructure for Agri-logistics

With rapid technological developments, there is need to modernise our basic post-production infrastructure, especially those infrastructure components that help safeguard value (warehouses and cold-chain) and provide an opportunity to spread the supply to suit the demand. The same would also apply to infrastructure that helps to recover value from the non-saleable produce or that makes the produce fit for consumption (processing units). Unit load handling (palletisation and containerisation) is well established for exports, yet this modern handling methodology is not appropriately developed in the domestic agri-logistics sector and needs to be encouraged.

Storage is intended as a buffer in an ongoing supply chain. Inventory as buffer is supposed to provide leeway to bridge supply variations with constant consumer demand. This opportunity is easily applied in the case of long holding produce. There is need to modernise storage and movement of grains, by moving towards modern silos and containerisation[16]. Modernising the storage and handling can double the usable life of the inventory, though the eventual liquidation to market and PDS/OWS, etc. will still be needed.

There is also frequent debate on use of alternate and renewable energy as captive sources to offset the energy needs of warehouses and cold storage systems. This has normally been interpreted as the use of solar photo-voltaic based electricity generation systems. Since dry warehouses and godowns have limited energy requirements in terms of lighting and low power utilities, the installation of solar power is seen to be practical.

Conversely, refrigerated warehouses are energy intensive and have very high load, in use 24 x 7 for their operations. The use of captive solar power in such cases, from installations on available rooftop area, does not generate sufficient power for the requirements. Further, the need to use

[16] Report of High Level Committee on Reorienting the Role and Restructuring of FCI.

larger number of batteries to cover the night-time operations, adds to the costs and makes such applications somewhat impracticable. The need for hybrid systems that share the load with the grid, as well with other renewable energy sources are required. For large cold stores, the optimal option is to design for use with clean grid energy, to maintain improved viability in operations.

In the milk chiller installations, a large number of units have also innovated with *gobar-gas* (bio gas) based electricity generators. Other possible technologies to generate cooling are solar thermal solutions, vapour absorption based systems and hybrids of electricity source inputs. Successful developments include creating refrigeration using cow dung as fuel, where the heat generated is seamlessly converted into cold without use of compressors or other machines. Thermal storage (PCM- Phase Change Materials) also help reduce the energy risk in bulk milk chillers. Thermal banks also help store solar heat and are useful where crops need to be dried. The use of phase change material or eutectics for portable cooling is common, including in transport and vending platforms.

The use of program logic control (PLC) based systems has an immediate impact on energy used and is easily implementable. Similarly, upgrading the insulation of temperature controlled spaces has high energy saving impact. The ensuing automation of energy intensive applications can reduce operating costs upto 20-25 per cent in old cold storage units.

It is important to note, that a large part of the energy load for marketing food is from the transport segment. This is further intensified when using refrigerated transport since the cooling system adds to the fuel required. Food mile is a measure of assessing the energy that goes into the delivery of a unit load of food. In the overall product life cycle, a short holding food item will typically spend the maximum time on transport modes, on the way to market and this accounts for the highest energy usage per ton.

Except for rail mode of transport, all other modes cannot be connected to the electricity grid; and the transport on road, ship and air are reliant on availability of fossil fuel. **Therefore, technologies that can reduce the energy load in transport are equally, if not more important to the overall food chain.**

Modernising of the food handling infrastructure will also aid compliance with the country's food safety regulations and will help ensure competiveness at a global level. In addition it promotes efficiency, integrity and safety of the individual operations at enterprise level. In relation to farmers' income, the availability of appropriate infrastructure, as the medium to connect with markets is important and a matter of precedence.

4.9. Role of Railways in Agri-logistics

Once agricultural produce has been aggregated and prepared for onwards transit, the next step is to evacuate the pre-conditioned produce to distant markets, thereby bridging the supply side with demand, through the provision of transport over multi-modes, i.e. roadways, railways, waterways and/or airways. The aspect of sub-continental distances to consumption centres, indicate that Railways can play an important role in triggering an agricultural marketing revolution, wherein

railheads can co-locate or be linked to the modern produce collection centres, encourage a number of floating stock of containers (refrigerated) dedicated for food cargo, and be the transport backbone to the National Agricultural Market.

Railways not only speed up the logistics connectivity, which is important in case of perishables, but also can cover longer distances, which is key to achieving improved value realisation for farmers. As such, railways will play an important role in the marketing and delivery mechanism.

4.9.1. Rail-based Intervention

The movement of foodgrains has regularly used railways wagons and is an ongoing intervention on freight trains. Since majority of the shipments are undertaken by FCI, bulk handling is possible. To compete with roadways and to bring more idle rolling stock into use, railways have also been offering discounts and incentives for carriage of foodgrains. Railways also have an Automatic Freight Rebate Scheme to elicit freight in the traditional empty-flow direction. **Yet, for perishables there is no evidence of similar positive focus. Now this requires due attention.**

The agricultural trade, especially in case of perishable commodities, faces a perpetual shortage of time, once the produce is harvested. The agri-logistics of such produce has to resort to technologies such as pre-cooling and cold-chain to enhance the marketable or holding life of the perishable goods, because of inability to access markets within the normal lifespan of the produce. On the other hand, assured connectivity to market centres is not possible until a certain economy of scale is generated from a single commercial entity.

However, on the demand side, the volumetric consumption is well ascertained from various surveys, including through multiple NSSO rounds. For example, on a monthly basis Delhi consumes 11,600 tonnes of banana, 18,600 tonnes of tomato, 23,500 tonnes of onion and 54,000 tonnes of potato. None of these is produced in Delhi and they are transported from neighbouring and/or distant regions. The example is similar for all major metropolis and their fresh food intake is routed from multiple sources and states.

All major city centres also have modern rail terminals and freight handling yards. These cities are easily identified as the destination points of agri-produce freight. The points of origin are also fixed for certain crop types that are produced perennially, or have a short harvest window with longer holding life – e.g. banana, apple, potato, carrot, kiwi, peas, etc. In such cases, the supply side or origin can be said to have a comparatively steady throughput outflow.

In some other cases, the supply volumes will shift depending on seasonal variations or because of shorter production cycles and a shorter holding life (more perishable) – eg. tomato, lettuce, mango, brinjal, okra, papaya, strawberry, pineapple, etc.

In both examples above, recent reports showcase that the surplus crops had to be discarded on the wayside, while unsated demand in faraway cities resulted in price inflation. This clearly indicates that effective logistic-bridges were the critical missing links between the points of surplus and demand.

A scheduled fixed route service will inspire and spearhead the development of large volumes along identified freight lanes. Railways can provide the opportunity to service consumption centres at long distance from farms, especially where time and product care are critical to the saleability of the product.

4.9.2. Operational Requirements

This vision of affecting the food supply chain has following key aspects to consider:

i. Aggregation facilities with efficient transport linkage. The link provides a network as to bring the market within reach of the producer.

ii. The logistics has to cater to the requirement of a rapid and trustworthy transport mode, and where required to provide ambient conditioning.

iii. With most fresh perishables, the primary need is provision of transport, with storage at receiving front-end. Fresh perishables must not be stored at production centre, but moved to demand side while still young and firm to withstand rigours of transport.

Indian Railways with its pan-India network is the optimal and preferred choice for horti-produce movement. Yet, this burgeoning demand is not fully tapped and deserves to be planned for in full and on priority.

Most of the proposed agri-hubs are remote from onwards railways linkage. Currently, the railways itself has very few options for servicing the thermally managed movement of fresh and frozen produce. Lack of rail side facilities to safely handle perishable cargoes leaves that growing service need to be met mainly by the road transport segment.

For Railways to tap into this growing transport demand from agri-logistics -

i. Upgrade logistics to facilitate the supply chain of fresh produce - agri-hubs or handling facility adjoining railway sidings for loading unloading.

ii. Provide the use of railways communication network to aid price transparency to farmers & markets.

iii. Create Receiving hubs from where local secondary or tertiary distribution can be handed over to road transport.

iv. Provide Links to export hubs, including to alleviate export delays. This can be done in liaison with APEDA and MPEDA and other export promoting bodies.

Primary Advantages to Indian Railways-

i. Assured income from logistics service from agri-hubs. Any producer with efficient and easy access to rail transport will rarely opt for long haul road transportation.

ii. Income from railway land on which agri-hubs can be established. Land with railway sidings can be leased to proposed users under PPP mode or through outright sale.

iii. Service to the nation- with temperature controlled transport, railways will have developed an enhanced ability to provide emergency services at times of disaster by having capacity to supply fresh food including perishable medical supplies.

iv. Upgradation of railways equipment and work-force. This will add value and fresh skills to both people and the railways service.

Following table provides a broad view of Rail linked infrastructure, with Indian Railways:

SN	Description	Nos	Remarks
1	Integrated Pack-houses	Zero	Used for aggregation or collecting of produce from farms. Produce is pre-conditioned for travel by sort and packaging before precooling. These can be outsourced to off-site locations or established at railways land adjoining railheads.
2	Reefer transport	Zero	Used to link pack-houses with next chain of distribution. Can be outsourced to transporters. For certain produce like potato, ordinary trucking will suffice.
3	Distribution Hub (Cold warehousing)	1	Used for transient warehousing for produce while waiting rail connectivity. Can be used for stuffing containers in advance for container trains and destuffing service created in Bengal near Singur railway stn.
4	Containers	98	Insulated (but non-refrigerated) containers with CONCOR and earlier in use for onion and banana. Procured with funds provided from National Horticulture Board (NHB). Currently not used for any movement.
5	Reefer Containers	Zero	No refrigerated containers are available for domestic users – hence multi-modal refrigerated transport is not possible.
6	Refrig. Parcel Vans (VPN)	10	These are reported in partial use (2016).

The Private Container Train Operators (PCTO) also do not operate reefer container movement to service the domestic cold-chain. CONCOR (Container Corporation of India) formed a subsidiary company with business of trading in fresh produce and may need to review employee norms in relation to bring professional management with specialised expertise suited to the business, as well provide logistics support to that business.

All aspects of technology aided agri-logistics are supported under schemes of the Ministry of Agriculture & Farmers' Welfare as well as Ministry of Food Processing Industries. These include reefer containers besides pack-houses with staging cold rooms, reefer vehicles, refrigerated warehousing, material handling systems, storage and racking systems, etc. This provides railways and/or partner organisations the opportunity of **'build-to-suit'** facilities which can be specifically designed as per need and avoid capacity and cost over-runs.

4.9.3. Operating Models

Broadly two methodologies can be considered for establishing pan-India rail-based network for fresh produce supply chains. **In one**, the existing infrastructure can be utilised – first mile truck to rail-side → load onto wagons → long haul on rail → off load at destination → short haul to buffer storage by truck. This can be used for non-specialised movement of bagged and hardy vegetables such as onion and potato.

In the other, for perishable produce, where delivery can be managed within 24 hours, enclosed carriage on VPNs can also be carried out. For goods requiring temperature controlled carriage and storage, refrigerated containers are needed. Since such movement will be on container trains, additional handling facilities will be required at loading and offloading rail-siding at Container Rail Terminals (CRTs).

It is proposed that a predetermined schedule be run to induce volumetric throughput from users/buyers. A special consideration may be given to traders who are registered on eNAM platform and are intending to move the produce over more than 800 kms. A detailed study is recommended for long term planning purposes. However, with a purpose to spearhead the initial freight the following observations are to be considered-

- A north to south perennial flow of apple and potato is already in play. Similarly, there is south to north perennial movement of bananas, chicken, lettuce, etc. Majority of this occurs over trucks and reefer trucks and there is opportunity to convert this into rail-based containers. On West to East direction there is large movement of Amul products via trucks and return loads are not fully established. However, opening a fixed schedule of one or two containers will facilitate market linkage from North Eastern region.
- It is important to realise that unlike most of the bulk freight on railways, in case of fruits and vegetables large volume shipments impact market price as receiving ends cannot absorb large supply. Hence, for the purpose of conceptualising horti-produce rail links, it may be necessary to consider piecemeal or partial rake loads. Therefore, this requires having floating stock of containers, attached to existing rakes.
- To assist the development of such trade, the ongoing scheme for fresh produce handling infrastructure will be availed by freight forwarders who wish to scale up shipments through railways. As such, a system based approach would be advanced.

Two options can be considered for a predetermined time period:

i) Use covered rail wagons or VPNs ii) Promote container movement

Containerisation is a preferred final option. A time table of available capacity can be published and publicised for freight forwarders and other stake holders to take advantage of. Once cargo volume is scaled up, other associated infrastructure development can be undertaken.
The ability to use railways to cover longer distances in shorter times, empowers farmers by allowing them to expand their market reach. This is more important for perishable crops. While existing trade into local markets will continue, the amount that is surplus to the localised

demand can be safely connected to consumers farther away, thereby mitigating loss and increasing recovery from surplus. Otherwise the surplus produced is incurred as total waste.

4.9.4. Previous Reports

A report of the National Transport Development Policy Committee (Planning Commission - 2014) had stated that most of the thinking on transport in India had been project-centric, done in single-mode solitary fashion. The recommendation is to have a system based approach, cutting across modes of transport and geographies.

The Planning Commission's "Total Transport System Study on Traffic Flows and Modal Costs" by RITES, published in March 2008, highlights certain key aspects such as average lead time and share of various products on railways and road.

Table 4.1 Top 21 commodities share of volume moved by rail and road

SN	COMMODITY NAME	Total both modes	MODAL SHARE			
			RAIL		ROAD	
		Million tonnes	Million tonnes	% OF TOTAL	Million tonnes	% OF TOTAL
1	Coal	415.37	331.77	79.87	68.35	16.46
2	Iron ore	154.69	121.80	78.74	23.30	15.06
3	Limestone & dolomite	19.85	13.69	69.00	6.15	31.00
4	Chemical manures & fertilizers	54.57	36.38	66.67	18.19	33.33
5	Cement & cement structures	157.86	78.83	49.94	75.98	48.13
6	Salt	11.06	4.62	41.77	6.44	58.23
7	Ores other than iron	14.68	5.49	37.40	9.19	62.60
8	**Rice (all types)**	**69.54**	**22.43**	**32.25**	**47.12**	**67.75**
9	Containers (loaded & empty)	85.44	27.10	31.71	56.60	66.25
10	**Wheat and wheat flour**	**41.67**	**12.31**	**29.54**	**29.36**	**70.46**
11	**Sugar and khandsari**	**24.84**	**5.98**	**24.08**	**18.86**	**75.92**
12	Granite, marbles & other stones	31.97	6.79	21.24	25.18	78.76
13	Iron & steel (all types)	134.49	27.31	20.31	107.18	79.69
14	POL products (liquid)	189.56	35.13	18.53	128.14	67.60
15	**Other food grains**	**15.29**	**2.29**	**14.98**	**13.00**	**85.02**
16	Parcels, miscellaneous & others	227.17	22.29	9.81	201.50	88.70
17	Building materials	121.13	5.05	4.17	116.08	95.83
18	Edible oils	26.36	1.09	4.14	25.26	95.83
19	Wood, timber, plywood, etc.	33.91	1.14	3.36	32.77	96.64
20	Chemicals (Powder & liquid)	34.90	1.11	3.18	33.79	96.82
21	**Fruits and vegetables**	**71.81**	**1.89**	**2.63**	**69.93**	**97.38**
TOTAL ALL COMMODITIES		2386.97		32.03		46.60

Planning Commission Total Transport System Study

In case of fruits and vegetables, 97.4 per cent of volume ships on roadways. It is to be noted that among the top 21 commodities, fruits and vegetables have the lowest share with railways. It is felt that sector-wise, there is a relative transport isolation in the perishable horticulture

sector, reflected in its average distance or lead in travel being correlated to the range of roadways. Integration between railways and roadways modes for perishable goods is conceivable in the short term, as a conscious move to total multi-modal transport system.

Table 4.2 Mode-wise average leads of 52 commodities

SN	COMMODITY	MODEWISE AVG. LEAD (KMs)				AVG - ALL MODES (KMs)
		RAIL	ROAD	COASTAL SHIPPING	AIRWAYS	
1	**Jute and Coir (Raw & Mfd)**	**1585**	**697**			**758**
2	**Tea and Coffee**	**478**	**750**			**750**
3	**Wheat and Wheat Flour**	**1375**	**437**			**714**
4	**Tobacco & Products**	**250**	**645**			**645**
5	**Rice (All Types)**	**1294**	**327**			**639**
6	**Grams & Pulses**	**1261**	**607**			**619**
7	**Cloths Raw & Manufactured**	**1629**	**601**			**601**
8	**Fish/Egg/Meat**	**476**	**600**			**600**
9	**Oil Seeds (All Types)**	**1155**	**576**			**598**
10	**Sugar and Khandsari**	**997**	**462**			**591**
11	**Cotton (Raw & Mfd)**	**1633**	**576**			**583**
12	**Rubber (Raw & Products)**	**1888**	**574**			**574**
13	**Fruits and Vegetables**	**1653**	**522**			**552**
14	**Leather & Goods (Incl. Bones)**	**564**	**545**			**545**
15	**Fodder**	**1742**	**415**			**452**
16	**Other Food grains**	**895**	**370**			**448**
17	**Livestock**	**1529**	**215**			**234**
18	**Milk & Products**	**2223**	**160**			**165**
19	**Sugar Cane**	**88**	**136**			**133**
20	Salt	1452	480			886
21	Car, Vans, etc.	2025	810			868
22	Chemical Manures & Fertilizers	834	373			680
23	Tyre and Tubes	2489	673			673
24	Parcels, Misc, Others, etc.	720	628	1408	1027	648
25	Paints & Dyes	758	627			627
26	Chemicals (All Types)	943	611			622
27	Electricals (Incl. Wires)	810	614			614
28	Containers (Loaded & Empty)	1250	306	664		613
29	Plastic & Plastic Goods	2070	611			612
30	Iron & Steel (All Types)	936	525			609
31	Limestone & Dolomite	676	438			602
32	Heavy Machinery (Agr. Equp.)	1345	595			596
33	Coal	581	463	1271		587
34	Edible Oils	1519	538			579
35	Iron Ore	437	304	2965		574
36	Paper & Paper Products	2044	545			571
37	Spare Parts (All Types)	1763	568			569
38	Provisions & Household Goods	2095	535			539
39	Coal tar and Bitumen	1204	399			521
40	Granite, Marbles & other stones	331	551			504
41	Metals other than Iron & Steel	575	477			479

SN	COMMODITY	MODEWISE AVG. LEAD (KMs)				AVG - ALL MODES (KMs)
		RAIL	ROAD	COASTAL SHIPPING	AIRWAYS	
42	POL Products (Liquid)	658	272	1163		467
43	Scrap (All Metals)	1188	455			465
44	Cement and Structures	557	358	552		461
45	Wood, Timber, Plywood, etc.	737	450			460
46	Ores other than Iron	478	350			398
47	Empty Tins, Bottes, Drums, etc.	311	374			374
48	Building materials	327	153			160
49	Gas Cylinder - All Types		151			151
50	Three Wheelers		739			739
51	Cycle & Cycle Parts		729			729
52	Two Wheelers		728			728
AVERAGE OF ALL MODES		661	453	1450	1027	545

Planning Commission Total Transport System Study

Among the top 52 commodities, the average lead (or distance travelled) is about 500 kms, mostly (97 per cent) on road. It is reiterated that long haul movement can be facilitated by scaling up rail based movement of fruits and vegetables, to help farmers capture more markets, and therefore become more productive in gainful terms. Though the above data is of 2007-08, its status is probably similar in 2017. It is, therefore, inferred that perishable crops, which can benefit greatly from reduced transit time to market and better travel conditions on rail modes, are not able to take advantage of current rail system. The reason can be a lack of suitable handling facilities, but mostly from lack of special focus to capture such freight.

- Currently majority of foodgrains and certain quantum of tea, potato and onion moves on railways wagons. Wagons are not designed for sensitive or temperature controlled transport.
- Very small quantum of fruits & vegetables avails rail transport, as the past approach has been to evaluate full train loads, instead of breaking down into smaller unit loads.
- Container trains allow the opportunity to consider a smaller unit load of container, instead of full train loads only – a container train can load multiple commodity types and stuffing can happen in advance to train arrival.
- A floating stock of containers, for on demand use can be located across terminals and carried on empty slots of existing routes. Individual containers can be used for multiple loads, interchangeable along a series of freight lanes, promoting multi-modal format for agri-logistics.
- Two types of freight systems are expected – i) for hardy produce such as potato, tea, ginger, spices, etc. where long distance connectivity is more of essence. In such cases the offloading end is not expected to be specialised; and ii) for more perishable produce such as mangos, bananas, pineapple, brinjal, tomato, etc. where time is of essence and needs temperature controlled handling facilities to stuff and destuff the containers.
- In the first, railways system would only be used to freight the aggregated crops for an offsite wholesale yard or receiving facility. Railways wagons (covered type) could also be used.

- In the second case, refrigerated containers would be the unit load for transport and the receiving facility may require refrigerated cross-dock or storage options – offsite or at railhead.
- To spearhead use of railways for movement of horticultural produce, partial or piecemeal movement will have to be started. This may manifest, preferably, in form of reserved parcel van freight or single container freight on existing lanes. The pre-reserved option can be opened on select routes for a fixed time window of two years.
- As a full unit load is achieved, with reverse logistics, the opportunity can be passed on to other service providers such as PCTOs (Private Container Train Operators).
- Fixed lanes between North to/fro South and West to/fro East are possible. It is envisaged that a fixed freight service will promote the use of rail mode for perishables' transport and develop the appropriate eco-system of freight forwards/ aggregators.

4.10. Annotation

Farm produce needs more efficient and effective post-production logistics to establish physical connectivity with market. The market for the farmer is normally a first stage buyer – the aggregator, processor, trader – depending on type of produce being handled. In some cases, with hardy crop types such as foodgrains, farmers can also store inventory for a delayed sale.

Effective post-production logistics chains, result in organising the management of the production, leads to less food loss, expands market reach, and motivates efforts to generate higher yields. While it is important that a 'farm-to-fork' flow of food produce is established, the approach taken should be **FORK-to-FARM**. Such an **inverse approach in integrating the supply chain will ensure linking of demand from consumers with farmers**.

Post-harvest supply chain systems allow for streamlining and balancing of supply and demand, and provides farmers the opportunity to integrate horizontally with many markets. Post-harvest logistics and connectivity are a critical enabler for farmers, as it allows evacuation of produce to markets. Long-term stability can best be achieved through developing dynamic logistics chains, designed to link the rural farmscape with high density population centres.

There is a general increase in the ratio between the output-marketed to output-produced, over the years. However, the marketed surplus may not be finding optimal value because it is monetised at the first available instance, at nearby markets. These markets may not necessarily have sufficient demand from its consumer catchment, to absorb the entire supply. Therefore, the value gets pushed down in the local market's price discovery process. It is important that besides marketed surplus, the market surplus is also monitored. Farmers should have ability to direct their supply to markets that are optimal – i.e. have sufficient demand in their catchment, or have ready links to other consumption centres. When optimal value is not realised, motivation to grow production fades.

Measure of productivity should not be merely in terms of yield per acreage but be correlated with quantity of production monetised. Farm productivity measures must relate to sales or

farmers' income and assess net productivity gains. Yield gap assessments must be benchmarked against the associated delivery & distribution mechanism and not merely against foreign yardsticks to avoid producing surplus as loss.

The majority of farm produce undergoes value added processing (food and non-food) except in the case of horticulture, where food processing has a different role to play. Food processing units are natural when handling oilseeds, foodgrains, milk and meats. In case of horticulture, barring a few special cultivars, the majority is sold fresh. India is the largest population density of vegetarians and consumer demand for fresh fruits and vegetables is growing. Organised logistics chain for horticulture segment is lacking and development will also add impetus to build small and medium processing units to recover value from non-saleable or culled produce.

Farmers are typically delinked from activities where the value is added to raw produce through additives, preservatives and other processing. **Development must stem from agenda to empower and add value to farmers; this includes integrating horizontally with multiple markets, i.e. food processors, non-food processors, as well as the fresh market.**

There is a deficient status in transport agri-logistics, especially in cold-chain. This results in business models that focus on tradeable commodities with long term storage, leaving the more difficult business in fresh perishables under-serviced. This causes the growing demand to lead to inflation, with surplus being discarded roadside. A case of double jeopardy to the country.

Agri-logistics infrastructure is a necessary tool-of-trade for agricultural produce and greater development impetus is indicated. The post-harvest supply chain commences at farm gate in the form of aggregation centres and transport, which enables the farmers to access more distant markets and partake in transactions higher up the value system.

Key Extracts

- Post-production activities have to suit the type of produce being handled. Development needs to factor the marketable life span of agri-produce.
- To take agriculture from only cultivation targets to agri-business mode, adopting a Fork-to-Farm or demand linked strategy is needed.
- Produce specific aggregation at farm-gate has to be linked to evacuation modes, and not merely for storage. High value agriculture requires faster evacuation.
- Modernise logistics into multi-modal handling - palletisation and containerisation.
- Inverse relation between production and income can be broken by logistics networks.
- Create a national policy to streamline logiscs with priority on agri-logistics for farmers.

Chapter 5
Potential and Challenges

Ongoing urbanisation, changing consumer preferences and government support mechanisms provide definitive potential to the agri-business sector. The challenges are largely in managing the implementation and addressing the need to maximise the delivery of produce to multiple market channels.

Farmers' see agricultural markets as an important avenue to monetise their produce. Essentially, for the farmers, the possible ways to monetise their produce are the local mandi, the wholesaler, agro-industry and local consumers. Any inability to do so, leaves the farmers to sell off their produce to agents or intermediaries between these points of sales, which comes at a cost. The future growth of farmers, is therefore, limited to the growth of such intermediaries, rather than their own capability to connect with larger markets. From the farmers' perspective, the ability to easily connect with buyers and safely execute an exchange with market players, is a priority.

Without expanding the market range of farmers, their income growth is directly linked to growth of local buyers (growth in population plus shift in consumption patterns). To capture a larger share of consumption, the frontiers of their market need to expand into the national market and further into exports. For this, agri-logistics capabilities of both farmers, as well as aggregators and facilitators, have to be suitably developed. Agri-logistics plays an enabling role, by aiding direct connectivity with the larger market, backwards to the farmers.

There has been much focus on creating farmer markets, as an opportunity for farmers to directly sell to local consumers. Farmers' markets are operating in different States in the name of *Apnamandis* in Punjab & Haryana; *Rythu Bazaars* in Andhra Pradesh and Telangana; *Uzhavar Sandhai* in Tamil Nadu, *Shetkari Bazaars* in Maharashtra; and *Raitha Santhe* in Karnataka. These are typically located at the rural-urban fringe and benefit both farmers and local consumers.

These farmer bazaars can be compared with the local dairy shed, where consumers could visit the milking shed and buy their daily needs directly from the milk producer. Being limited in their geography, these bazaars do not change the selling radius of a farmer. As a result, the customer footfall remains limited to local consumers, and the capacity of local population to absorb higher production is constrained. Like the local *doodh-wala*, farmers' bazaars are essentially a stop gap measure, to provide individual enterprising farmers an independent and nearby avenue to monetise their produce. They do get a higher share of the consumers' spend, but any agenda to tap into other markets is not fulfilled.

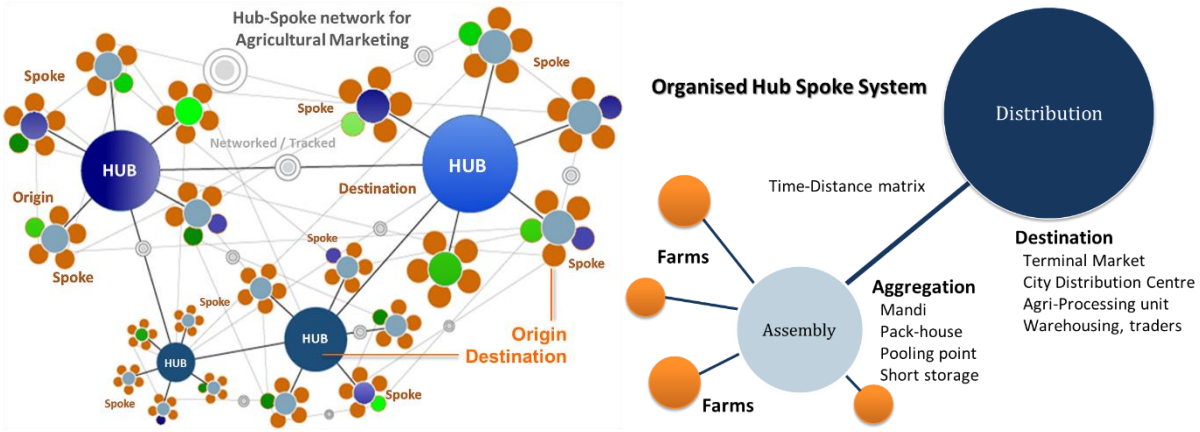
Such markets have limited scope to effect a transforming impact on the overall future growth in production. Near-farm direct markets will only be able to tap into the existing local demand and do not expand the overall selling reach of the farmer, and are more suited as city proximate locations. The real potential lies in capturing larger volumes, by bridging the distance between urban consumers across States, and leveraging the country as a unified market. This will transform the situation to have a larger impact, will drive high growth targets in farmer's revenue, and allow for further and viable increase in farm productivity.

Direct marketing can be in various formats such as roadside vending stands, clustered stalls within designated farmers' market, direct sales to local HoReCa (Hotels, Restaurants & Caterers) and even direct procurement by large retailers, supermarkets and processing units. The latter examples are more relevant to farmers' growth and policy initiatives need to strategically target direct purchase from organised demand. Easing of marketing regulations to allow direct purchase from farmers from large users is a preferred approach to adopt. Similarly, the village level aggregator and/or the farmer group or FPO, needs to be empowered with the tools to access markets beyond their immediate range.

To access markets beyond the immediate range of farmers, transport connectivity is the primary market tool. The transport needs to have a loading point, which in effect raises concerns on availability of the near-farm aggregation points. Each such aggregation and dispatch point, needs to have ability to prepare the produce for safe transportation to markets.

The bulk of the private sector has mainly organised itself to participate in easily handled cereals and other long holding commodities. Besides wholesalers and traders of raw produce, they also partake in industry based activities whence produce is converted into other products. These industries are an end-destination of the farmers' produce, and further development in agro-processing will create demand for produce. The industry is comparatively better organised and any constraint is already linked to market demand. Nevertheless, domestic demand shows steady growth in the dairy, meats, fresh fruit & vegetable sectors with growing business potential. The lack of suitable logistics is the only bottleneck to growth.

These important aggregation units are seen in form of assembly markets, milk collection centres, modern pack-houses, rural godowns and warehouses. These components of the logistics chain work to consolidate the fragmented production into larger and more viable handling loads. Inventory so collated, is managed for the purpose of meeting demand, current and future, depending on the longevity of the inventory stored.



The subsequent consolidation into inventories is thereafter deconsolidated and distributed to multiple consumers at the front end – the hub-spoke system is reversed at the front end of the supply chain. Therefore, a hub and spoke system works at both the back-end and the front-end.

The supply chain for non-perishable agricultural produce has the opportunity of a large storage capacity and associated transport linkages, coupled with longer holding life of the produce. Given the surpluses in stock and trends in consumption, gross level growth in this segment is intrinsically linked to population growth and with efficiency and optimisation of the existing supply chain. Another option is to foster links with international demand, for which support from industry and exporters must be garnered. However, developing exports requires long term changes to cultivation and handling practices to meet the quality norms of export markets. These interventions are ongoing and will continue to over the longer term.

To bring about the targeted doubling of the farmers' income, the identification and connectivity with domestic consumers needs to be prioritised. The consumer's preference for fresh fruits and vegetables is a decisive factor for further prioritising efforts to develop infrastructure for such connectivity. Consumption trends will indicate the sectors that show potential for immediate growth (Fruits, Vegetables, Floriculture, Dairy, Fish and Meats).

Reinforcing, to commence any logistics chain, at first instance there is need to build a viable load for the carrier or transport. Therefore, aggregation centres are imperative to serve as loading and dispatch facilities at village or block level. It is visible in case of foodgrains and other cash crops, where the handling yards or warehouses have become logistics hubs for onwards delivery to users. The dry goods storage system for long term holding crops, can benefit most from modernisation of existing infrastructure and improved inventory management.

However, for perishables, the modern pack-house units that concentrate the harvest into market linked loads are in shortage and warrant new creation of such infrastructure. Lack of such units, allows fragmented players and traders to step in, causing multiple handling and aggravates the risks. The post-production supply chain for milk commences, at first instance, with aggregation at village level and this model can be suitably emulated and adapted for other produce types.

It is important that besides the ongoing efforts in developing of warehousing and food processing facilities, a high priority initiative be undertaken to develop the modern pack-houses and other associated components in cold-chain. Horticultural production alone, is estimated at >295 million tons in 2016-17, and only about 300-350 modern pack-houses are developed as of now to handle such produce. This is far short of the estimated numbers required to handle the current consumer demand in a scientific manner. This is a potential area for future investments.

5.1. Near-farm jobs

Pack-houses provide a permanent near-farm facility to initiate an organised flow of produce to markets, for the post-production supply chain. Pack-houses require transport connectivity to feed the terminal markets which in turn distribute the food to consumers. Pack-houses, in effect function as small scale logistics centres at village level, connecting agriculture with urban centres. They are opportunities for growth and job creation.

Table 5.1 Estimation of the near-farm employment and others possible through new infrastructure for cold-chain logistics -

Infrastructure Item	All India Required	Manpower per unit (est)	Total Manpower	Remarks
Modern Pack-houses	70,000	40	28,00,000	In operation, functioning of pack-houses requires workers for sorting, grading, washing, packaging and material handling. Additionally, will have a technical hand to operate and maintain machines. Depending on produce handled, the total team size can range from 25 to 60 persons.
Reefer Trucks	62,000	3	1,86,000	Each reefer vehicle on long-haul mode operates with 2 drivers and 1 helper. There will also be need to maintain the vehicle prime mover and the reefer unit, which is expected to be covered by the technician at the integrated pack-house and at service stations.
Cold Store (Bulk)	650	6	3,900	Cold store (Bulk) typically operates with a warehouse manager, records keeper, technicians and security. During loading period, temporary handlers are used on contractual basis, also provided by farmers. Over the long holding period, less workers are needed.
Cold Store (Hub)	360	50	18,000	Cold store (Hub) has daily material handling and needs staff to manage inventory and equipment, maintain records, handlers, fork lift operators, etc. For heavy handling periods, logistics operators use outsourced handlers.
Ripening Units	8,000	5	40,000	A ripening unit has daily material handling and bulk of workers is for loading and offloading from transport and chambers. A technical operator and records keeper is also employed.
Last-mile distribution	-	-	-	Small vehicles for last-mile delivery, retail shops and street carts form this segment. An estimation of numbers not made. However, approx. 2 million food and retail outlets exist and an average of 2 persons per outlet may be estimated.
			30,47,900	

Source: NCCD

Note: This table does not cover secondary jobs and the need for informal daily workers.

Pack-houses fill the job creation gap in an under-penetrated sector. New income options are generated at pack-houses, providing near-farm jobs, across genders. Again, similarity can be drawn with the 4 million women who are part of the large number of dairy cooperatives. Women empowerment is accordingly serviced by providing jobs, close to farm households.

Analogous to the example shown in the milk chain, the village level aggregation units help to foster organised supply chain systems. Estimates by National Centre for Cold-chain Development (NCCD) show, that about 70,000 pack-house units (assessed at a standard size) is

required in the country to better handle the existing production of perishable crops. The actual size and throughput will depend on individual project and the overall numbers would adjust accordingly. Similarities can be drawn with the 171,000 dairy cooperatives that currently function through the milk pooling or collecting facilities across the country.

The activities at a pack-house are complementary to farming and dedicated to organising the marketing of the farmers' produce. The jobs at the modern pack-houses will provide a new earning mode for the farmers' communities, while the involved in functions will continue to promote and empower their core activity of cultivation. A modern pack-house is a small sized unit occupying half an acre to 1 acre of land depending on size of pack-house. These become a collecting centre for locally produced fruits and vegetables from small farms. As explained in chapter 3, a pack-house will route the produce to consumers of the raw produce being handled. Each pack-house should be attached a minimum number of trucks, to suitably transport the pre-conditioned produce to their end destination.

Currently, this sector is more in need of substantive entrepreneur and capacity development, as the shortfall of infrastructure is acute. As the infrastructure gets created, there will be associated demand for skilled workers when suitable skill development can also be undertaken.

The jobs created at grain storage facilities would be similar to those estimated for bulk cold stores. Average job creation within the agro-processing units can be considered similar to those at a cold distribution hub or a factory facility. The recent Krishi SAMPADA Yojna by the Ministry of Food Processing Industries (MoFPI) is expected to create avenues for about 5,30,500 direct and indirect employment.

Future development of the food processing units will bring an associated demand for skills and the industry is currently more focused on building competitiveness and compliance with food safety norms. Consumers have shown increasing preference for food items, which have lesser additives / preservatives / sugar, cold pressed, and similar. These variations in consumer mind set, is also seen in textiles, with biodegradable and natural fibres rebounding. However, consumers may not always make decisions on basis of comprehensive information but are fickle and sway depending on generic media reports. Private sector inputs indicate that this industry may be getting saturated and undergoing a plateau stage in some areas, and is in greater need of support for upgrading of processing technology and to build global level competiveness. From the farmers' angle, the linkage with processors allows them yet another option to directly sell their produce to primary users. In accordance, promoting food processors to grow their backwards linkage for direct sourcing from farmers and to partner for quality assurance is preferred.

5.2. Increase in selling volumes

Higher selling volumes mean higher income and impetus for greater productivity on farm. Logistics connectivity allows more produce to securely reach more markets. The idea behind scientific post-harvest management is to enhance post-production monetisation of the produce.

The obvious corollary is that after primary post-harvest care, the value must be transported to end-destination. Increase in production quantity has to be met with expansion of the market frontiers, so that all that is produced has a chance to get monetised.

Agri-logistics when limited to warehousing or storage alone, only builds buffers to buy time for a delayed transaction. This may be suitable for foodgrains and allied goods, as the commodity has long holding life and can be actively traded in futures linked to demand from the processing industry or end consumers. However, the organised users who take final delivery, stay limited and volumetric throughputs can remain more or less flat.

In case of perishables, the time gained in holding life by using cold chain, is better used for covering distances and capture a larger market footprint. Expanding the geographical reach of producer from growing area across the unified market, will help to bridge the demand supply gap and increase the selling volume. Improved post-production logistics will also transform the dynamics of the unified National Agricultural Market network.

In all cases, post-production activities that lend towards expanding the market reach of the farmers, will increase the selling footprint of the produce and bring greater organisation to the flow of produce from farms to markets. Keeping in mind food loss reports and other inputs, effective market linkage provides opportunity to reduce produce loss and convert that share into revenue. Besides converting food loss into earnings, an increase in selling volume is also expected to build confidence in the farmer to accordingly produce more and adopt more productive practices for cultivation.

5.3. Financial assistance provided by Government

The Government has various subsidy based schemes for strengthening marketing, cold-chain, warehousing and processing infrastructure facilities in the country. The broad outline of some of the major schemes that subsidise the creation of post-production infrastructure are:

i. Schemes of Ministry of Food Processing Industries (MoFPI)
ii. Schemes of Department of Animal Husbandry, Dairying & Fisheries (DAHDF)
iii. Mission for Integrated Development of Horticulture (MIDH – DAC&FW)
iv. Rashtriya Krishi Vikas Yojna (RKVY – DAC&FW)
v. Integrated Scheme for Agriculture Marketing (ISAM – DAC&FW)
vi. Programmes supported by Food Corporation of India (FCI – DFPD)
vii. Agricultural and Processed Food Products Export Development Authority (APEDA - MoCI)
viii. National Cooperative Development Corporation (NCDC – DAC&FW)

(i) **Ministry of Food Processing Industries** (**MoFPI**): had been implementing a Central Sector Scheme to support Mega Food Parks, Modernisation of Abattoirs, etc. as well as a scheme on Cold-chain, Value Addition and Preservation Infrastructure since 2008-09.

The Ministry has re-structured its schemes under a new Central Sector Scheme called "Kisan SAMPADA Yojna" (KSY) as of May 2017. KSY is designed as a comprehensive package to give renewed thrust to agro-marine processing and the development of agro-processing clusters in the country. As an umbrella scheme for processing industries, KSY incorporates some ongoing schemes of MoFPI with three (3) new ones. The following component schemes are implemented under KSY:

a. Mega Food Parks (on going) – grant-in-aid of 50 per cent of eligible project cost in general areas and 75 per cent in NE region and difficult areas, maximum Rs. 50 crore.

b. Integrated Cold Chain and Value Addition Infrastructure (on going) – grant-in-aid for projects integrated with processing, maximum Rs 10 crore. For project's storage infrastructure including pack-house, precooling, transport, etc., the assistance is capped at 35 per cent of eligible project cost in general areas and 50 per cent in NE & Himalayan States, ITDP & Island areas. For value-addition and processing infrastructure (including frozen storage/deep freezers and irradiation facilities) the assistance is similarly patterned by region at 50 per cent and 75 per cent.

c. Creation / Expansion of Food Processing & Preservation Capacities (new) – grant-in-aid of 35 per cent of eligible project cost in general areas and 50 per cent in NE States and difficult areas, maximum Rs. 5 crore.

d. Infrastructure for Agro-processing Clusters (new) – grant-in-aid of 35 per cent of eligible project cost in general areas and 50 per cent in NE States and difficult areas, maximum Rs. 10 crore.

e. Creation of Backward and Forward Linkages (new) – grant-in-aid of 35 per cent of eligible project cost in general areas and 50 per cent in NE States and difficult areas, maximum Rs. 5 crore.

f. Food Safety and Quality Assurance Infrastructure (on going) – for quality control and food testing laboratories under Central/State Government organisations and universities (including deemed universities), grant-in-aid at 100 per cent of cost of equipment and for others agencies, including private sector organisations/universities at 50 per cent in general areas and 70 per cent in NE States and difficult areas. To promote adoption of food safety and quality assurance mechanisms, grant-in-aid to reimburse expenditure at 50 per cent in general areas and 75 per cent in NE States and difficult areas of eligible project cost subject to maximum Rs.17 lakh and 22 lakh respectively.

g. Human Resources and Institutions (on going) – grant-in-aid for R&D in processing and allied technologies at 100 per cent of all eligible costs to Government organisation/universities/institutions and for private organisation/universities /institutions at 50 per cent of equipment cost only in

general areas and 70 per cent in NE States and difficult areas. In addition, this also has sub-schemes to support promotional activities (including publicity, studies and surveys), skill development and strengthening of institutions.

The grant-in-aid is credit linked but not back-ended and serves as a bridge fund to approved projects. The pattern of assistance varies for each component scheme as listed above. The beneficiaries can include individuals, group of entrepreneurs, cooperative societies, Self Help Groups (SHGs), Farmer Producer's Organizations (FPOs), NGOs, Central/State PSUs, etc., subject to fulfilment of scheme guidelines.

(ii) **Department of Animal Husbandry, Dairying & Fisheries** (**DAHDF**): Central Sector Schemes and Centrally Sponsored Schemes are operated by the department to provide support to the sectors. The support to post-production activities is as follows-

a. Establishment/ modernization of Rural Slaughter Houses by Panchayats/ Local Bodies/State Governments is supported with 75 per cent subsidy.

b. Under the component of 'Entrepreneurship Development and Employment Generation' the sub-component - Poultry Venture Capital Fund provides 25 per cent subsidy for Transport vehicles (open cage or refrigerated), mobile marketing units and cold storage units for poultry products. The subsidy ceiling for these items ranges from Rs 2.5 lakhs to Rs 5 lakhs. Subsidy at 25 per cent is also provided to poultry processing units (subsidy ceiling of Rs 250 lakhs) and for emu processing and feather processing units (ceiling of Rs 125 lakhs).

c. The sub component for Pig Development includes subsidy at 25 per cent for Retail Outlets with chilling facility with a subsidy ceiling of Rs 2 lakhs.

d. Centrally sponsored capital assistance for development of fish processing, preservation and storage infrastructure, with 100 per cent grant to Govt undertakings; 75 per cent grant-in-aid to Cooperatives/NGOs/SHGs in NE region, Hilly/Tribal areas, Women SHGs, Fisher SHG/Cooperative, SHGs of SC/ST in all areas; and 50 per cent to NGO/Cooperatives other than above and Private organisations owned by SC/STs and fishermen in all areas. Same pattern of assistance is also provided for refrigerated truck and non-refrigerated insulated truck ranging in capacity form 3 tonne to 6 tonne and for auto-rickshaw, motor cycle or cycles fitted with ice box. Each component has a ceiling on admissible unit cost.

e. Establishment of Fishing Harbours and Fish Landing Centres is also supported under centrally sponsored schemes, i.e.,

    i. 75 per cent assistance to Coastal States, Port Trusts, Fishermen Cooperative Societies/Organisations/Associations, and 100 per cent to UTs for new construction and upgradation/expansion/repair/renovation of minor fishing harbours & fish landing centres.

ii. 100 per cent assistance to States, UTs & Port Trusts and Fishermen Cooperative Societies/Organisations/Associations for construction and expansion/ modernisation of existing major fishing harbours.

iii. For private entrepreneurs, 50 per cent assistance for construction of major/ minor fishing harbours & fish landing centres on BOT basis.

f. Capital assistance is provided for development of central fish markets in Metros & big cities as 50 per cent grant-in-aid (unit cost capped at Rs 2.0 crore) to Municipal Corporations/State Marketing Board/Local bodies.

g. The National Fisheries Development Board (NFDB) provides central financial assistance for establishment of fishing harbours and fish landing centres, including upgradation/expansion and repairs. The assistance provided is at 50 per cent of approved project cost to State Governments/State agencies and 100 per cent to UTs & Central Government agencies.

h. Central Sector Scheme under NFDB also supports Ice Plants, Cold storages (or combination thereof), Retail fish markets, Fish Kiosks, Refrigerated Truck/Container (>10 tonne), Insulated truck (> 6 tonne), and auto-rickshaw, motor cycle or cycle with ice boxes. The pattern of assistance is applied on admissible project cost at 50 per cent in General areas, 80 per cent in NE/Himalayan States, 100 per cent for projects owned by Central Government organisations and UTs under individual ceiling for each item.

i. Scheme under National Program for Dairy Development supports post-production activities by assisting the creation and strengthening of related cold-chain infrastructure linking farmer to consumer and infrastructure for procurement, processing and marketing of milk and milk products. A differentiated pattern of assistance is practiced ranging from 50 to 90 per cent based on location and profitability of existing enterprise. The post-production component items are milk coolers and milk chilling centres, milk processing/ powder/processing plants, transport tankers (insulated and/or refrigerated), cold storage, marketing infrastructure, (visi coolers, refrigerators, etc.), and transport subsidy for milk transport.

j. The Department also implemented the Dairy Entrepreneurship Development Scheme under which financial support for post-production activities is provided. The items supported are milk cooling units, processing units, dairy transport and cold-chain, cold storage for milk & milk products, and dairy marketing outlet/parlour. The assistance can be availed by farmers, entrepreneurs and groups including milk federations and Panchayati Raj Institutions. The capital subsidy is purely credit linked and at 25 per cent of project cost for general category and at 33.33 per cent for SC/ST farmers, with individual ceiling to each component item.

k. Dairy Infrastructure Development Fund (**DIDF**) of. more than Rs. 11,000 crore over next 3 years is set up following the 2017 budget announcement for modernisation of obsolete infrastructure with the cooperatives, as a corpus fund under by NABARD with support from the Department.

(iii) **Mission for Integrated Development of Horticulture** (**MIDH**): Department of Agriculture Cooperation & Farmers Welfare is implementing MIDH which has come to subsume the schemes of NHM, HMNEH, NHB, CDB, NBM, CIH, under which financial assistance is provided for various activities for horticultural development encompassing post-harvest management including establishment of cold storage infrastructure. The assistance is available primarily for handling of horticultural crops in the form of subsidy @ 35 per cent (for general areas) and 50 per cent (for hilly and scheduled areas) of the capital cost of admissible project components for both public and private sector enterprises. The assistance is demand/entrepreneur driven and the financial assistance is typically credit linked and back-ended, such that the subsidy serves to partially offset the interest burden of a fully financed commercial project.

Table 5.2 Snapshot of MIDH scheme

Post-Harvest Management (Normal Storage and Cold-chain Components)		
SN	**Description**	**Cost Norms for MIDH (admissible cost)**
1	*Functional* on-Farm handling unit	Rs.4.0 lakhs/unit with size of 9m x 6m.
2	Integrated (*modern*) Pack houses	Rs.50.0 lakhs/unit with throughput capacity of 16 MT/day, with facilities for conveyor belt sorting, grading, washing, drying & weighing.
3	Precooling Unit	Rs.25.0 lakhs/unit with batch capacity of 6 MT.
4	Cold Room (staging)	Rs.15.0 lakhs/unit of 30 MT storage capacity
5	Mobile Precooling Unit	Rs.25 lakhs per Unit.
6	Cold Storage Type 1 : basic mezzanine structure with large chamber(> 250MT) type with Single temperature Zone	Rs.8000/MT upto 5000 MT capacity, Rs.7600/MT for capacity between 5001 to 6500 MT, Rs.7200/MT for capacity between 6501 to 8000 MT, Rs.6800/MT for capacity between 8001 to 10000 MT
7	Cold Storage Type 2: PEB structure for Multi-temperature and product use, more than 6 chambers (<250MT) and basic material handling equipment.	Rs.10000/MT upto 5000 MT capacity, Rs.9500/MT for capacity between 5001 to 6500 MT, Rs.9000/MT for capacity between 6501 to 8000 MT, Rs.8500/MT for capacity between 8001 to 10000 MT
8	Refrigerated Transport Vehicles	Rs.26 lakhs for 9 MT, pro-rata but not below 4 MT, Rs.30.00 lakh for 15 MT, pro-rata between 9 to 15 MT.
9	Ripening Chamber	Rs.1.0 lakh/MT, ceiling of 300MT
10	Evaporative / Low Energy cool chamber	Rs.5.00 lakhs/unit for 8 MT capacity
11	Low cost onion storage	Rs.1.75 lakhs/unit of 25MT
12	Pusa Zero energy cool chamber	Rs.4000 / unit of 100 kg
13	Integrated Cold-chain supply system	Rs.600 lakhs/project integrating two or more of above components
14	Integrated Post-harvest Management Projects eg. Packhouses, Ripening unit,	Rs.145 lakhs per project. Components of postharvest management can be taken up as

Post-Harvest Management (Normal Storage and Cold-chain Components)		
SN	**Description**	**Cost Norms for MIDH (admissible cost)**
	Reefer vans, Retail Outlets, Precooling, Primary processing, etc.	individual stand-alone projects as guided by norms listed above
Add-on Components for cold-chain including modernisation		
15	Nitrogen Generator	Rs.125 lakhs Per Unit, maximum of 2 units
16	Specialised CA doors	Rs.2.50 lakhs per door, maximum 20 doors.
17	CA Tents	As per original invoice, maximum 5 enclosures
18	Programmable Logic Controller	50% of cost of original invoice, Max Rs.10 lakhs
19	Dock Leveller System	Maximum Rs.7 lakhs per Unit, max 5 units
20	WRDA System	100 % cost of original invoice, max Rs.2 lakhs
21	Specialised Packaging lines	100 % cost as per invoice, max Rs.15 lakhs per project
22	High Reach handling equipment	Rs.17 lakhs per unit, for max 2 units
23	Modernisation of refrigeration	50% of cost, max Rs.100 lakhs @ Rs.2500/MT capacity
24	Modernisation of insulation	50% of cost, max Rs.100 lakhs @ Rs.1500/MT capacity
25	Reefer Container	Maximum Rs.6 lakhs per 9 MT (20 ft. reefer container)
26	Advanced Grader	100% of invoice cost, max Rs.75 lakhs per line
27	Stacking System	100% of invoice cost, maximum Rs.2000/MT
28	Retail Shelf/Equipment	Maximum Rs.10 lakhs per establishment
29	Alternate technology (Vapour absorption, Solar, hybrids, etc.)	100% of invoice cost, maximum Rs.35 lakhs per project

- Items 1, 10, 11, 12: subsidy at 50% of total admissible cost.
- Others: credit linked back-ended subsidy at 35% in General areas / 50% in Hilly & Scheduled areas.
- Applicants can select multiple components with purpose to develop activity integration with any existing facilities.
- Credit linked projects must be fully financed by project promoter & bank, and subsidy amount is capped to the total credit availed and is back-ended. Guidelines and minimum system standards need to be followed.

(iv) **Integrated Scheme for Agriculture Marketing** (**ISAM**): is implemented through the Directorate of Marketing & Inspection (DMI) under DAC&AFW, and is an umbrella scheme having following five sub-schemes-

a. Agricultural Marketing Infrastructure (AMI);

b. Marketing Research and Information Network (MRIN);

c. Strengthening of Agmark Grading Facilities (SAGF);

d. Agri-Business Development (ABD) through Venture Capital Assistance (VCA) and Project Development Facility (PDF); and

e. Choudhary Charan Singh National Institute of Agriculture Marketing (NIAM).

Through its sub-schemes, ISAM promotes the creation of agricultural marketing infrastructure, scientific storage capacity, pledge financing and integrated value chains

(vertical integration of farmers with primary processor). ISAM also supports the use of ICT for extension work, framing of grade standards and quality certification and establishing of nation-wide information network system of market information. To further catalyse private sector investment in agri-business projects, training, research, education, extension and consultancy in the agri marketing sector is also an objective under ISAM. Each sub-scheme has its implementing parameter detailed in the ISAM operational guidelines.

The financial assistance under ISAM is credit-linked subsidy @ 25 per cent of the capital cost for general category beneficiaries and @ 33.33 per cent for special category beneficiaries for construction/creation of scientific godowns, their renovation and other infrastructure in the field of agricultural marketing. The assistance for renovation is however restricted to storage infrastructure projects by cooperatives only. Cold storage as a part of a permissible integrated value chain project is eligible for subsidy provided the cold storage component is not more than 75 per cent of total financial outlay. If it is more than 75 per cent, subsidy is restricted and calculated on the basis of capacity calculation and cost norms of MIDH. The cap on subsidy varies for each component as enumerated in the operational guidelines of ISAM.

(v) **Rashtriya Krishi Vikas Yojna** (**RKVY**): is a scheme to incentivise states to draw up plans for their agriculture sector more comprehensively, taking agro-climatic conditions, natural resource issues and technology into account, and integrating livestock, poultry and fisheries. RKVY is administered by the MoAFW over and above its existing Centrally Sponsored schemes, to supplement the State-specific strategies. The scheme was recently modified to allocate 50 per cent of the annual outlay for infrastructure and assets, split in a ratio of 60:40 for post-production and production related infrastructure. The subsidy for infrastructure projects is capped at 50 per cent for private individuals/NGOs, etc. As a number of infrastructure items are covered under Rural Infrastructure Development Fund (RIDF) and Viability Gap Funding (VGF), etc., RKVY is intended to supplement these other sources and not replace them.

(vi) **Food Corporation of India** (**FCI**): provides guaranteed hiring for covered storage capacity created by private parties, CWC, SWCs and other State Agencies, under the Private Entrepreneurs Guarantee (PEG) Scheme of the Department of Food & Public Distribution. FCI hires the storage capacity for a guaranteed period of 10 years from private parties and for 9 years in case of Public Sector agencies. In addition creation of modern silos under VGF and non-VGF mode is also promoted. The Department also implements a plan scheme for augmenting storage capacity, with special focus on NE region.

(vii) **Agricultural & Processed Food Products Export Development Authority** (**APEDA**): the Ministry of Commerce & Industry, through APEDA provides 90 per cent grant-in-aid to State Government agencies for setting up of common infrastructure including cold storage facilities for export oriented units. Assistance to private exporters is also available upto 40 per cent as subsidy with a ceiling of Rs.7.50 lakh to

Rs.75.00 lakh for different post-harvest components including cold storages. APEDA is in process of revising the scheme.

Table 5.3 Snapshot of APEDA scheme

PART I	
A) Establishment of common infrastructure facilities by APEDA or any other Government or Public Sector agency.	90% grant-in-aid by APEDA and 10% from other government or public sector agency other than land.
B) For establishment of common infrastructure facility in PPP mode	Operating Guidelines under preparation.
PART II	
A) Assistance for purchase of specialised transport units for animal products, horticulture and floriculture sector.	40% of the cost subject to a ceiling of Rs. 7.5 lakh per beneficiary.
B) Assistance for all APEDA scheduled products (max Rs 75 lakhs per beneficiary unit):	
1. Setting up of sheds for intermediate storage and grading / storage / cleaning operation of produce.	40% of the cost of equipment subject to a ceiling of Rs. 10.00 lakh per beneficiary
2.(a) Setting up of mechanized handling facilities such as sorting, grading, washing, waxing, ripening, packaging & palletisation, etc.	40% of the cost of equipment subject to a ceiling of Rs. 25.00 lakh per beneficiary
2.(b) Setting up of both pre cooling facilities with proper handling system as well as cold storage for storing	40% of the cost of equipment subject to a ceiling of Rs. 25.00 lakh per beneficiary
2.(c) Providing facilities for treatment such as fumigation, X-ray screening and other screening/detection equipments, hot water dip treatment, Water softening Plant	40% of the cost of equipment subject to a ceiling of Rs. 25.00 lakh per beneficiary
2.(d) Setting up of integrated post-harvest handling system (pack houses with any two or more of the above facilities (see 2(a) to 2(c)	40% of the cost subject to a ceiling of Rs. 75.00 lakh per beneficiary
3. Setting up of cable cars (covering minimum of 50 ha of plantation) for banana and other crops (as decided by APEDA)	40% of the cost subject to a ceiling of Rs. 75.00 lakh per beneficiary
4. Setting up of vapour heat treatment, electronic beam processing or irradiation facilities	40% of the cost subject to a ceiling of Rs. 50 lakh per beneficiary
5. Assistance for setting up of environment control e.g. pollution control, effluent treatment etc.	40% of the cost subject to a ceiling of Rs. 35 lakh per beneficiary
PART III	
Assistance for fresh & processed horticultural produce for Setting up of specialized storage facilities such as high humidity (Relative humidity more than 95%) cold storage deep freezers or cold storage etc.	40% of the cost subject to a ceiling of Rs. 25 lakh per beneficiary

(viii) **National Cooperative Development Corporation** (**NCDC**): provides loan as financial assistance for setting up of cold storages to the cooperative sector. NCDC has dovetailed its lending program with the Capital Investment Subsidy Scheme of MIDH.

The operational guidelines of each of the schemes enumerates the objectives and may be referred to for more specific details regarding the respective scheme. There are various sub-schemes and Boards to promote post-harvest market linkages. In addition, the government has

also designed Viability Gap Funding (VGF) models as a method of financing projects under Public Private Partnership. Viability gap finance means a grant to support projects that are economically justified but, their financially viability is not attractive.

There may be operational bottlenecks to development of extended value chains, which will not always be alleviated by applying additional funds to individual projects. A number of stakeholders link the supply chain, from first mile to last mile, and each individually have impact upon the service results – few would have capacity to take up the full chain - the value system requires an extended chain of custody, collaboration, best practices at farm end, assured or contractual demand for the service and has a cross regional /cross border footprint.

Schemes need to address projects with a cross regional spread of multiple aggregation centres such as modern pack-houses at farm-gate with transport connectivity. To fulfil VGF norms, these facilities could be required to operate as a service for local farmers, with viability of predetermined service fees and from seasonal utilisation assessed for gap funding. At the end of the concession period, the assets of the facility may be transferred to the relevant farm-gate ownership. In the duration, the concessionaire would have spearheaded supply chain practises and market linkage, with associated capacity building at near-farm establishments.

There may be an option to assess the viability gap in freight to initially expand market frontiers, and the same can be supported to promote and spearhead rail/road/multi-modal transport connections. Currently, uncertainty of market access, with the associated risk to producers, disallows the initial small volume movement to first breach a market. Moderating this gap in transport through a VGF model for long haul rail/road/water movement may be considered.

5.4. Fiscal and Other support by Government

The union government also provides fiscal incentives to post-production activities, including exemptions under GST.

i. As per the revised RBI Guidelines issued on 23/04/2015, post-harvest activities and cold-chain have been classified under Agriculture for Priority Sector Lending (PSL) and the distinction between direct and indirect agriculture is dispensed with. Farm credit can include loans to farmers/cooperatives of farmers/FPOs for post-harvest activities, viz., sorting, grading and transporting of their own produce. Under Agriculture Infrastructure, PSL includes loans for construction of storage facilities (warehouses, market yards, godowns, silos), including cold storage/cold-chain designed to store agriculture produce/products irrespective of location.

ii. In regards to agricultural production and post-production linked activities, the following services continue to be exempted under GST:

    a. Services relating to cultivation of plants and rearing of all life forms of animals, except the rearing of horses, for food, fibre, fuel, raw material or other similar products or agricultural produce by way of –

(i) Agricultural operations directly related to production of any agricultural produce including cultivation, harvesting, threshing, plant protection or testing;

(ii) Supply of farm labour;

(iii) processes carried out at an agricultural farm including tending, pruning, cutting, harvesting, drying, cleaning, trimming, sun drying, fumigating, curing, sorting, grading, cooling or bulk packaging and such like operations which do not alter the essential characteristics of agricultural produce but make it only marketable for the primary market;

(iv) Renting or leasing of agro machinery or vacant land with or without a structure incidental to its use;

(v) Loading, unloading, packing, storage or warehousing of agricultural produce;

(vi) Agricultural extension services;

(vii) Services by any Agricultural Produce Marketing Committee or Board or services provided by a commission agent for sale or purchase of agricultural produce.

b. Services by way of slaughtering of animals

c. Services by way of pre-conditioning, pre-cooling, ripening, waxing, retail packing, labelling of fruits and vegetables which do not change or alter the essential characteristics of the said fruits and vegetables

d. Services provided by National Centre for Cold-chain Development (NCCD) by way of cold chain knowledge dissemination

e. Services by way of transportation by rail or vessel from one place in India to another of the following goods - agricultural produce; milk, salt and foodgrain including flours, pulses and rice; organic manure

f. Services provided by a goods transport agency by way of transport in a goods carriage of - agricultural produce; milk, salt and foodgrain including flours, pulses and rice; organic manure

g. Services by way of loading, unloading, packing, storage or warehousing of rice.

iii. Certain erstwhile exemptions have been done away with and are subject to GST –

a. Services by way of construction, erection, commissioning or installation of original works pertaining to postharvest storage infrastructure for agricultural produce including cold storages for such purposes; mechanised foodgrain handling system, machinery or equipment for units processing agricultural produce as food stuff, excluding alcoholic beverages.

b. Services by way of loading, unloading, packing, storage or warehousing of cotton ginned or baled.

c. Certain goods intended to be used for the installation of a cold storage, cold room or refrigerated vehicle, for the preservation, storage, transport or processing of agricultural, apiary, horticultural, dairy, poultry, aquatic and marine produce and meat (earlier notified exempt of excise by CEBC). The list includes- (1) Gas compressor, all types (2) Flywheel and pulley (3) Truck refrigeration unit (4) Walk-in-coolers/walk-in-freezer (5) Condensing unit (6) Evaporator (7) Oil separator (8) Receiver (9) Purger (10) Air cooling unit/air handling unit, all types (11) Evaporator coil, all types (12) Plate freezer (13) Blast freezer (14) IQF freezer (15) Cooling tower (16) Condenser-atmospheric/shell and tube/evaporative (17) Valve and fittings (18) Mobile pre-cooling equipment (19) Stationery pre-cooling equipment (20) Control equipment for control atmosphere/modified atmosphere cold storage (21) Refrigeration equipment (including compressor, condensing units and evaporator) having capacity of 2 tonne Refrigeration and power rating 5 KW and above (22) air conditioning equipment and panels having capacity of 3 tonne air-conditioning and above.

There is a continued need to create additional capacity and to modernise the agricultural supply chain. Logistics assets are a priority for enabling access to a wider one-nation market. Such infrastructure and business development is largely attracted through incentives to target capital investment from the private sector who are also expected to bring in the desired operational efficiencies. As such, to maintain the momentum in creating relevant infrastructure, maintaining the earlier status quo, especially the exemption to equipment needed for creating scientific storage and transport systems and their construction, may need to be also considered under GST.

iv. In regards to output of agri-goods / food items marketed, the following are exempted from GST –

a. Meat and edible meat offal – fresh or chilled, other than in frozen state and put in unit container.

b. Fish – fresh or chilled, other than processed cured and in frozen state

c. Fresh milk and pasteurized milk, including separated milk, milk and cream, not concentrated nor containing added sugar or other sweetening matter, excluding Ultra High Temperature (UHT) milk

d. Eggs in shell, fresh, preserved or cooked

a. Curd, Lassi, butter milk

b. Chena or paneer, other than put up in unit containers and bearing a registered brand name.

c. Natural Honey, other than put up in unit containers and bearing a registered brand name.

d. Fresh vegetables, roots and tubers other than those in frozen or preserved state

e. Fresh fruits, roots and tubers other than in frozen or preserved state

f. Coffee beans not roasted, unprocessed green tea leaves, fresh ginger and fresh turmeric other than in processed form.

g. Cereals – all goods (other than those put up in unit containers and bearing a registered brand name).

h. Flour, Atta, Maida, Besan etc. (other than those put up in unit containers and bearing a registered brand name).

i. Wheat or meslin flour, other cereal flours (maize, rye, etc.), flour of potato dried vegetables, pulses, roots, etc.

j. Lac and shellac

k. Betel leaves

l. Cane jaggery (gur)

m. Puffed rice (muri), flattened rice (chira), parched rice (khoi), parched paddy or rice coated with gur. Pappad (except when served for consumption), Bread branded or otherwise (except when served for consumption and pizza bread).

n. Prasadam supplied by religious places.

o. Non-alcoholic toddy, Neera and Tender coconut water (other than put in unit container and bearing a registered brand name)

p. Residues and waste from the food industries; prepared animal fodder to feed aquatic, poultry and cattle.

The above list is indicative only and GST being a recent introduction (July 2017) is undergoing review. Many goods previously exempted from VAT/Central Excise are been included under GST and differentiated rates are applicable. In some cases, capital investment may get negatively impacted where the services off the infrastructure are exempt from GST, and hence cannot avail credit input. For details, refer to published GST rates that are being updated.

v. Under the Income Tax Act, concessions are available, some are mentioned below-

a. Under Section 80(IB)-(11A) of the Income Tax Act, 1961, 100 per cent tax exemption is available on profits derived for the first five years of operation and after that, at the rate of 25 per cent (30 per cent in case of a company) for next five years, from the business of processing, preservation and packaging of fruits or vegetables, meat and meat products, poultry, marine or dairy products or from the integrated business of handling, storage and transportation of foodgrains.

b. Under Section 35-AD of the Income tax Act 1961, deduction to the extent of 100 per cent is allowed for capital expenditure incurred on investment for (i) setting up and operating a cold chain facility; (ii) setting up and operating warehousing facility for storage of agricultural produce and for storage of sugar; and (iii) bee-keeping and production of honey and beeswax.

c. Under 35CCC of the IT Act, an assessee that undertakes agricultural extension project notified by the Board, shall be allowed a deduction equal to the expenses incurred. The list of agriculture extension activities by MoAFW includes supply chain training on shelf-life increase and better on-farm storage, supply chain management and any other activity related to farm production or agricultural value addition.

d. 100% per cent FDI in marketing of food products produced and manufactured in India.

e. 100 per cent FDI is also available through automatic approval route for cold chain undertakings as well as for food processing business.

f. External Commercial Borrowings (ECB) can be availed for post-harvest storage infrastructure for agriculture and horticultural produce including cold storage and cold chain (includes cold room facility for farm level pre-cooling, for preservation or storage or agriculture and allied produce, marine products and meat).

Minimum system standards have been formulated for cold chain infrastructure, which is mandatory, for projects supported under schemes implemented by agencies under the Department of Agriculture, Cooperation and Farmers Welfare.

It is evident that Government of India provides various concessions to the advantage of stakeholders of the agriculture supply chain and marketing. States have also been advised to allocate 35 to 40 per cent of budget from the resources out of MIDH funds for creation of post-harvest infrastructure including cold-chain.

However, the active involvement of the private sector in the development of the physical infrastructure was largely limited to creation of warehousing, cold storage and processing capacities alone. There is need to provide higher impetus in the links that empower the farm-gate through opening connectivity to cross regional market; i.e., aggregation hubs, modern pack-houses and integrated transport options.

5.5. Capital flow to post-production infrastructure

Developing infrastructure for post-production activities, adds to Gross Capital Formation (GCF) in agriculture linked activities. The capital investment has a direct impact on the development of agriculture sector. Furthermore, in the course of creating and maintaining such infrastructure, at rural level, additional allied jobs will be generated for short and long term.

The capital investment to fill the shortfall in post-harvest infrastructure, to enable the relevant post-production activities, can be ascertained for the major components at national level. Each enterprise will have inherent needs, for the business model used. In case of warehousing and grain silos, the infrastructure is being created under PPP mode and rental guarantees by FCI. The development is therefore demand linked and an assessment of real demand is important.

There will be also be need for market infrastructure, especially at rural level, in the form of primary assembly centres cum local retail markets. The evaluation of such market requirements is discussed subsequently in DFI Volume IV.

Excluding these infrastructure items, the specialised infrastructure needed to complete the integration of cold-chains was assessed by NCCD in 2015.

Table 5.4 Infrstructure investments for developing integrated cold-chains

Infrastructure Component	**Shortfall** ***All India***	**Unit Cost** ***Rs Lakh***	**Investment** ***Rs Crore***	**Remarks**
Integrated Pack-houses (units)	70,000	95	66,339	For pre-conditioning 16 tons a day for cold-chain transit. Includes a pre-cooler and staging cold room with dispatch area for trucks. Facility will handle a larger volume of incoming to segregate for local market also.
Reefer Transport (units)	62,000	30	15,848	Cost considered for 30 foot vehicles. Vehicle is insulated and refrigerated, capable of full range of temperature (-25 to +15 °C). Each vehicle to have a GPS and temperature/humidity data logging. Smaller vehicles will have lower costs.
Cold Store (Bulk) (units)	650	400	2,600	Cold store (Bulk) with large chambers for long term storing of certain produce, for periodic sale to markets over months. Average size of 5000 tons is considered.
Cold Store (Hub) (units)	360	350	1,260	Cold store (Hub) with chambers of less than 250 tons each with multiple docks and doors, racking and fork lift systems. Average size of 2500 tons is considered.
Ripening Chambers (units)	8,000	40	3,328	Ripening units with daily handling of 10 tons after a 4 day ripening cycle.
Infrastructure Investment required			**89,375**	**Rs Crore**

Source: Kohli.2016, NCCD

Under ISAM sub-schemes on marketing infrastructure development, for storage infrastructure, a total of Rs 3149.57 crore has been sanctioned as of 31 March 2017. This covers a total number of 37,992 projects for a capacity of 65.19 million tons of which 57.75 million tons is created.

In case of marketing infrastructure, other than storage, under ISAM a total of 18,393 projects have been with subsidy of Rs. 1,975.22 crore has been sanctioned of which subsidy of Rs. 1,633.61 crore has been released.

The MoFPI has projected the development of processing linked infrastructure, to leverage investment of Rs. 31,400 crore. To suit the needs of the food processing industries, this includes components of cold-chain, value-added processing and modernisation of the existing infrastructure.

Similarly, other centrally sponsored and supported schemes have large budgetary allocations for developing and strengthening post-harvest infrastructure in sectors of dairy, fisheries, piggeries, etc. The primary objectives of the fiscal and financial support is to incentivise the private sector to establish and operate facilities that will streamline the post-production care and market linkages for the farmers.

Table 5.5 Gross Capital Formation (GCF) in Agriculture and Allied sector (Relative to Gross Value Added (GVA) at 2011-12 basic prices)

Period	GCF in Agriculture & Allied Sectors			GVA in Agriculture & Allied Sectors	GCF as percentage of GVA		
	Public	Private	Total		Public	Private	Total
2011-12	35,715	238,717	274,432	1,501,816	2.4	15.9	18.3
2012-13	36,078	217,230	253,308	1,524,398	2.4	14.3	16.6
2013-14	32,472	244,694	277,165	1,588,237	2.0	15.4	17.5
2014-15*	36,061	220,434	256,495	1,584,293	2.3	13.9	16.2

(Rs. in crore)

Source: Central Statistics Office, MOSPI

*As per Advance Estimates for 2015-16 (latest available) released on *8.2.2016*

The larger share of private sector participation in GCF is also a result of policies and support schemes that encourage their participation. To take agriculture into agri-business mode, more private sector participation in areas that require market linked operations would be a preferred path. Understanding consumption trends, both local and global, is a form of market intelligence that the private sector will regularly assess.

5.6. Consumption Trends

The potential for an agri-business stakeholder lies in understanding market demand, the ability to access the market demand and on quality of the produce or product being sold. The consumption trends observed in recent years is touched upon in this section.

Consumption patterns will normally reflect **i)** growth in demand through organic growth in population; **ii)** changes in demand due to changes in purchasing prowess; **iii)** change in demand due to change in access and affordability of food; and **iv)** others - such as cultural changes in food ethics, demographic shifts in a region, etc.

Indian consumers are undergoing a "food to nutrition transition", evidenced by changed preferences in food items, connected to growth in per capita income. This transition passes through an initial preference for high calorie or high energy foods, which results in increased consumption of sugars, oils, fats and processed food products.

With greater affluence, the average consumer then transitions towards high nutrition foods, inducing greater demand for fresh whole food formats. This eventually feeds consumption of agricultural produce types that are perceived with higher nutrition value, such as fresh milk,

fruits & vegetables and fresh meats, fish and poultry items, including organic food items.

The recent trends in consumption and projections for the next ten years are presented to aid the assessment of market potential in various agriculture sectors. Such assessment will also indicate the focus areas for post-production interventions, so that efforts to double farmers' income is market linked and aligned to current demand patterns.

5.6.1. Cereals

In India, the per capita consumption of cereals (rice, wheat and coarse grains) is showing a falling trend. Consumption of wheat and rice are likely to plateau out. Coarse grains are henceforth referred to as nutri-cereals, to reflect the inherent high nutritional contents.

Figure 5.1 Trend in Rural consumption of Cereals – (per capita Kgs/year)

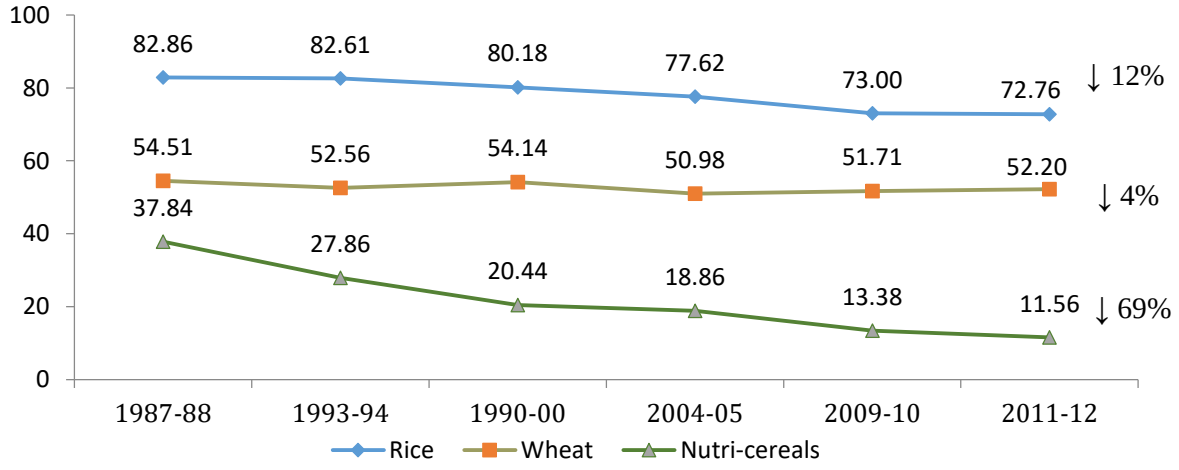
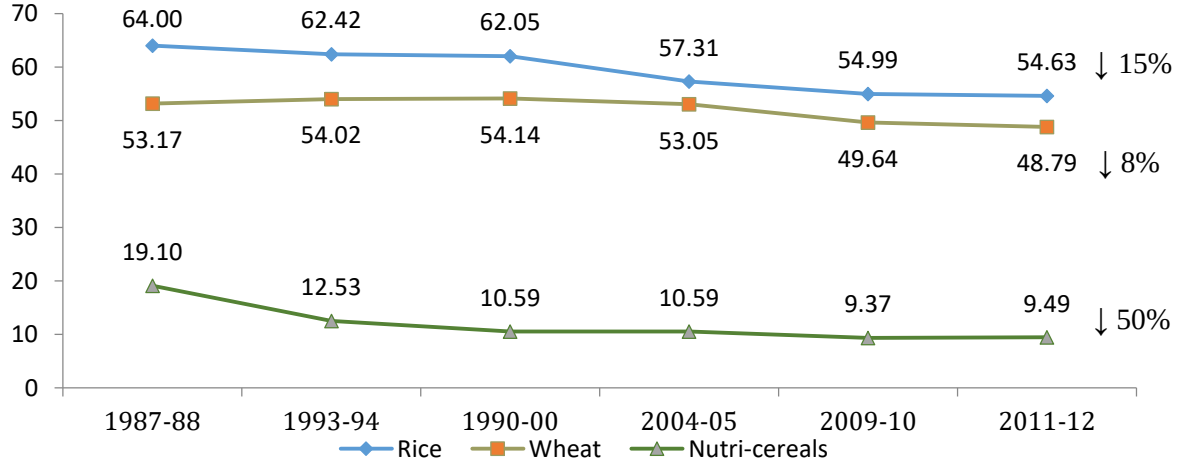


Figure 5.2 Trend in Urban consumption of Cereals – (per capita Kgs/year)



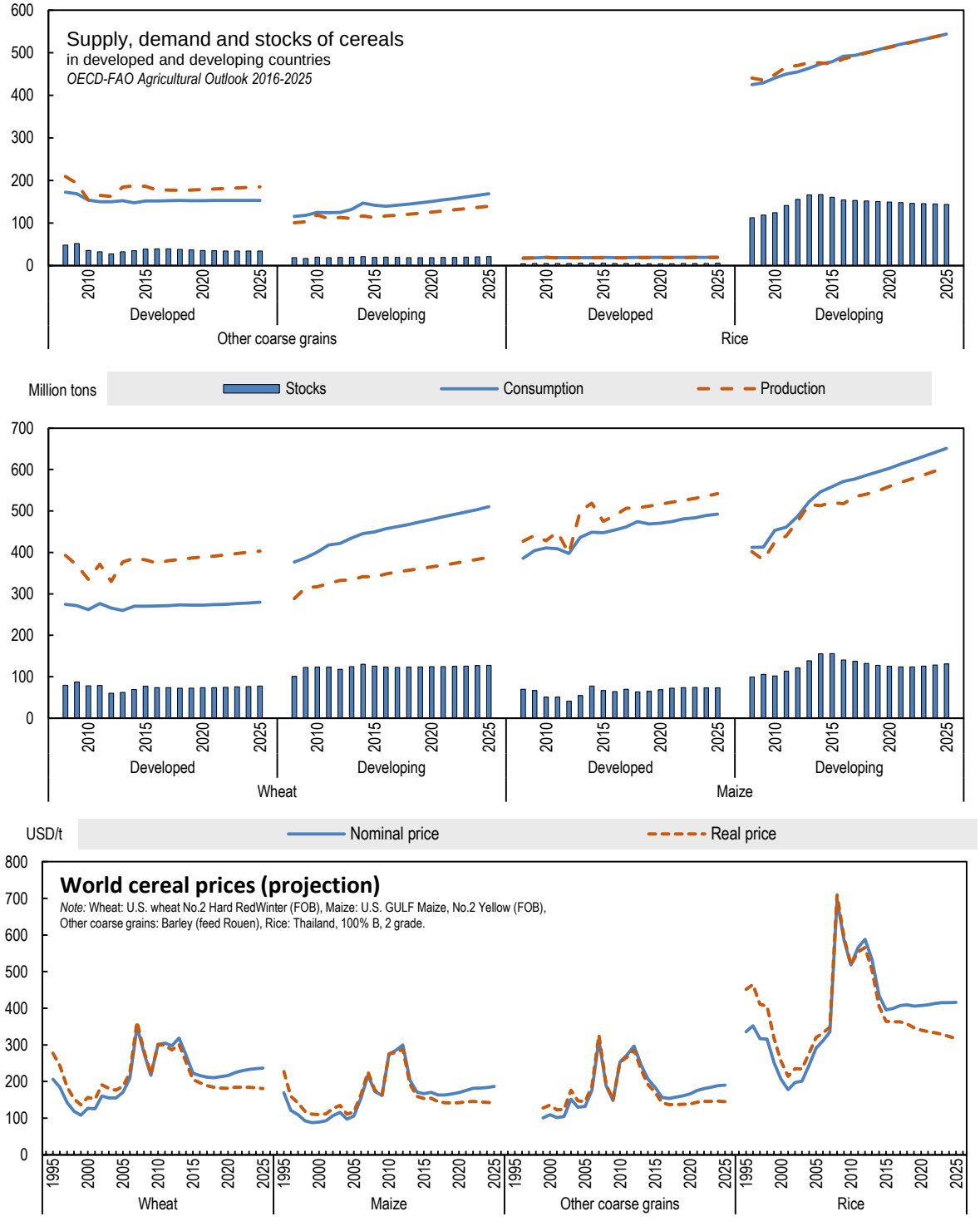
Source: NIAP, Various NSS Rounds

A ten year Agriculture Outlook published by OECD/FAO[17], estimates that though, cereals will remain the main ingredient in diets across the world, and it will have decreased importance

[17] OECD/FAO (2016), *OECD-FAO Agricultural Outlook 2016-2025*

especially in the developed world.

Figure 5.3 Global trend & projections - Cereals



Source: OECD/FAO (2016), "OECD-FAO Agricultural Outlook 2016-2025"

The outlook projects slight growth in demand in the developing world except in case of Sub Saharan Africa. The report indicates that weaker demand and larger inventories in 2016 will lead to relatively low prices globally. Improved cultivation and handling practices in other

producing countries, such as for rice in Cambodia and Myanmar, will also disrupt the availability and price for cereals.

India's demand for cereals is stagnating or falling, and this needs to be kept in mind, against the backdrop of ongoing focus to increase cereal production through productivity gains. The CIPHET 2015 study on post-harvest losses had reported only 4.6-5.99 per cent loss in case of cereals. It is obvious that improved post-harvest inventory management would ease the need to produce more of the crops that show falling consumption patterns. There is greater advantage to increase farm level productivity (per acre yield), while maintaining the same quantity of production, so as to free up the land for other higher income uses. These higher income opportunities can be in case of poultry, fruits and vegetables, mushrooms, etc.

The reconciliation in area under cultivation between cereals and high value crops will however, have to take into account the growing population and associated assessment of the country's food security needs.

Cereals need to undergo processing before considered fit for marketing to consumers. The bulk of all foodgrain production moves through processing factories where they are polished, ground into flour or converted into ready to eat food items before being accessed by consumers.

Along with the falling per capita demand for cereals, the large government procurement contributes to surplus stock in storage and can cause further fall in market prices. Modernising our inventory handling facilities as well as scheduled and compulsory rotation of foodgrain inventory into markets is recommended. This is an immediate intervention that can help ease pressure on exchequer and add to value realisation from the inventory.

5.6.2. Milk

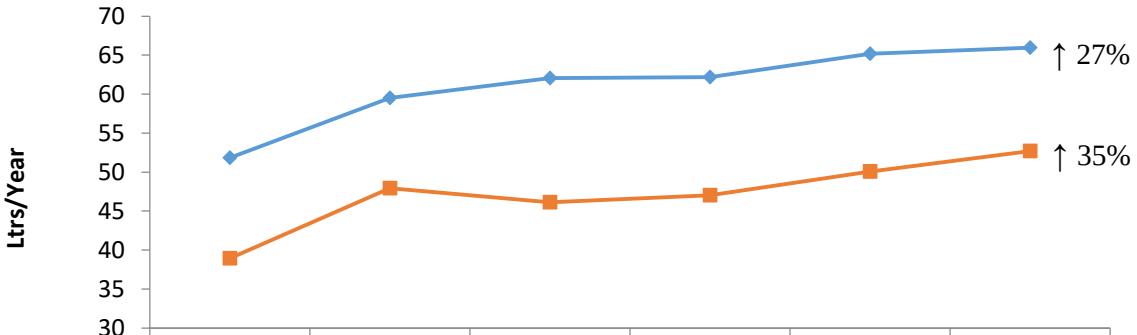
India's estimated milk production in 2015-16 was 155.5 million tonnes and the average annual incremental milk production in last five years was over 6 million tonnes[18] (2016-17 estimates indicate 164 million tonnes). Equally, milk consumption in India is progressively growing.

The average per capita global milk consumption is estimated at about 100 kg of milk/year, with substantial variances between countries/regions. Per capita consumption in Western Europe is in excess of 300 kg of milk/year compared with less than 30 kg in some African and Asian countries.

The demand for milk is not directly linked with population growth alone, but is more a function of increase in income levels and purchasing parity. In the fast developing India, the demand for milk and milk products can be expected to show upwards trend.
The per capita consumption of milk in the country shows continued upwards trend, evidenced through NSSO consumption surveys of households. Rural per capita consumption has grown faster, touching 35 per cent increase in last three decades.

[18] National Dairy Development Board - NDDB Annual Report 2015-16

Figure 5.4 Trends in Milk Consumption (per capita annual)

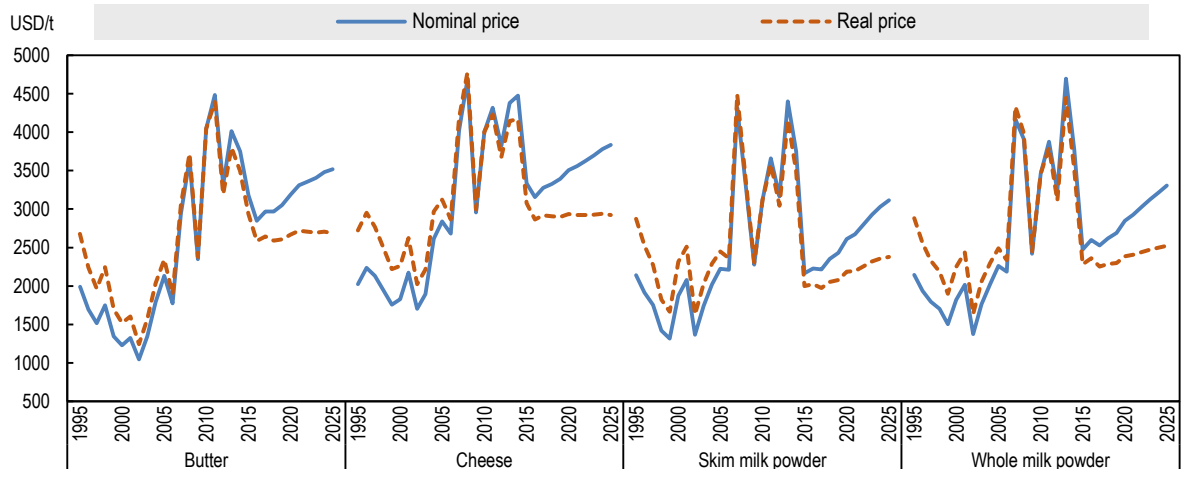


	1987-88	1993-94	1990-00	2004-05	2009-10	2011-12
Urban	51.83	59.50	62.05	62.17	65.19	65.97
Rural	38.93	47.94	46.11	47.04	50.09	52.72

Source: NIAP, Various NSS Rounds

As per Annual Report of the National Dairy Development Board (NDDB), recent decline in domestic and international prices resulted in significant increase in accumulation of stock in processed / preserved formats This surplus in conserved commodities also is reflected in price of Skim Milk Powder (SMP) falling from Rs 206/kg in April 2015 to Rs 182/kg in March 2016[19]. International farm-gate prices for fresh milk fell almost 50 per cent in some countries[20], though strong domestic demand prevented a similar scale of price drop in India.

Figure 5.5 Global trend & projections - Milk



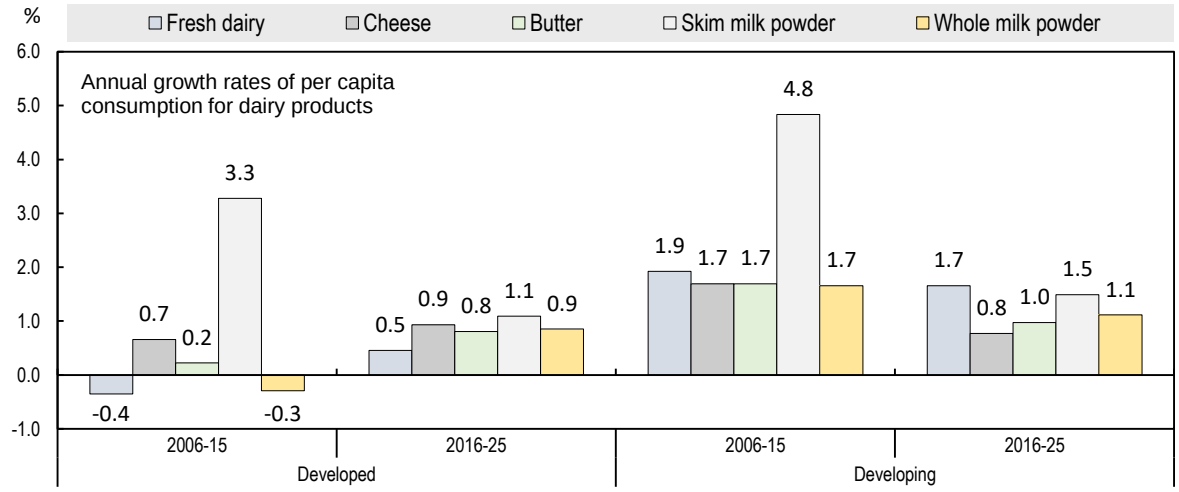
Note: Butter, Skim Milk Powder, F.o.b. export price, non-fat dry milk, 1.25% butterfat, Oceania; Whole Milk Powder, F.o.b. export price, 26% butterfat, Oceania; Cheese, , F.o.b. export price, cheddar cheese, 39% moisture, Oceania. Real prices are nominal world prices deflated by the US GDP deflator (2010=1).
Source*: OECD/FAO (2016), "OECD-FAO Agricultural Outlook 2016-2025"*

International prices of all dairy products declined globally, more sharply for skim milk powder (SMP) and whole milk powder (WMP). However, a recovery and increase in nominal price is expected in mid-term in the coming decade, including real prices.

[19] NDDB Annual Report 2015-16
[20] International Dairy Scene, NDDB Annual Report 2015-16

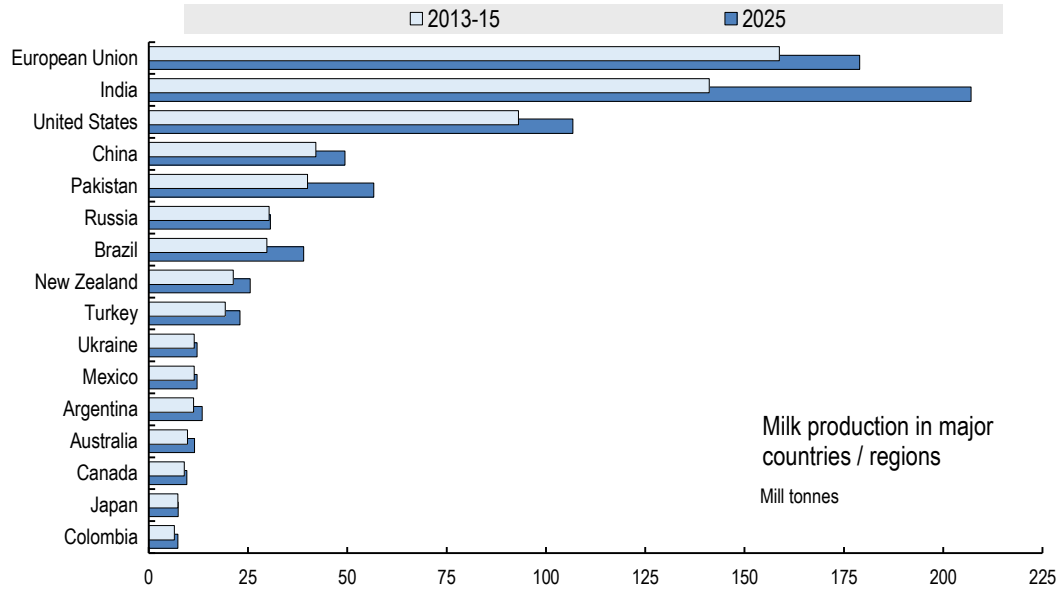
The projections by OECD-FAO, indicate that the per capita demand for dairy products is expected to grow consistently in developing countries (demand growing from 0.8 to 1.7 per cent per annum) over the next ten years. Even in the developed world, per capita consumption for fresh dairy products is expected to grow 0.5 per cent per annum and at 1.1 per cent for skimmed milk products.

Figure 5.6 Global Annual growth rates - Dairy



Source: OECD/FAO (2016), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database).

Figure 5.7 Milk Production – Global projection



Source: OECD/FAO (2016), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics

World milk production is expected to increase by 177 mill tons by 2025, in relation to base year (annual average of 2013-2015). The increase in production is projected to be in fresh dairy products and the bulk of this increase is anticipated from India, Pakistan and Brazil.

India holds mantle as the world's largest producer of milk, and projections indicate that by 2025 the production of milk in India will cross 200 million tons per annum, implying a growth

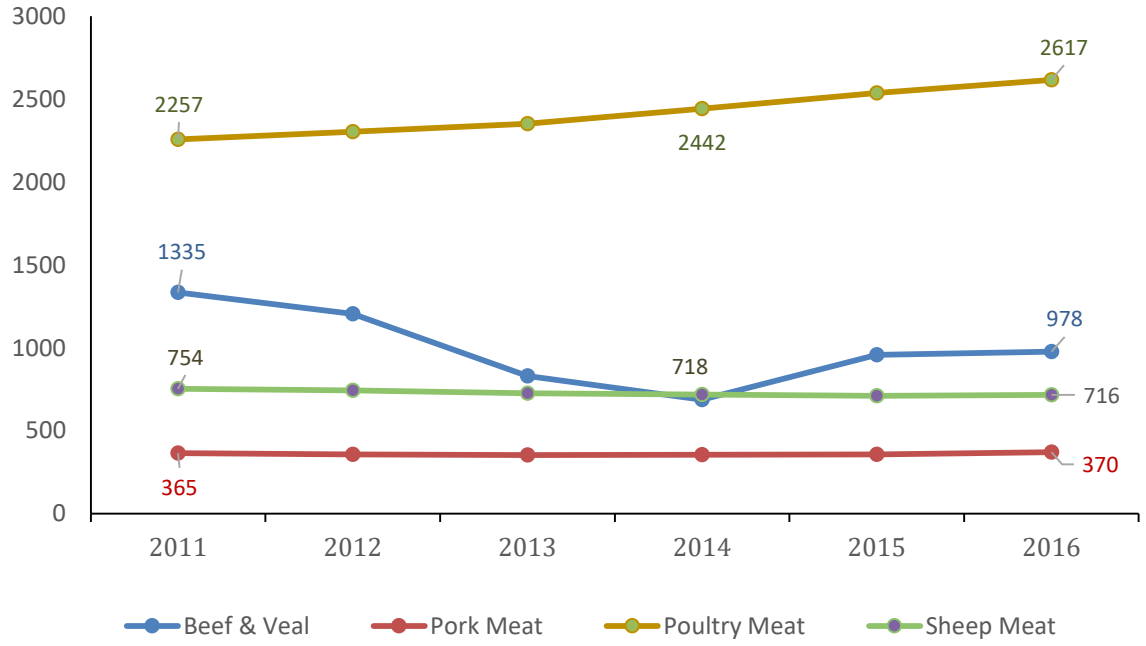
of over 30 per cent over the average of annual production in 2013-2015. All other countries are expected to enhance their milk production by 2025, with growth ranging from 1 to 29 per cent (average growth of 13 per cent) over their 2013-2015 production average.

As there continues demand for milk and dairy products from consumers, the sector will benefit most from productivity increase by expanding its network of milk collection centres.

5.6.3. Meats, Egg and Fish

Domestic consumption of meats shows a differentiated trend in demand between meat types in recent years. Graphic below shows total consumption from 2011 to 2016.

Figure 5.8 India Meat Consumption ('000 tonnes)



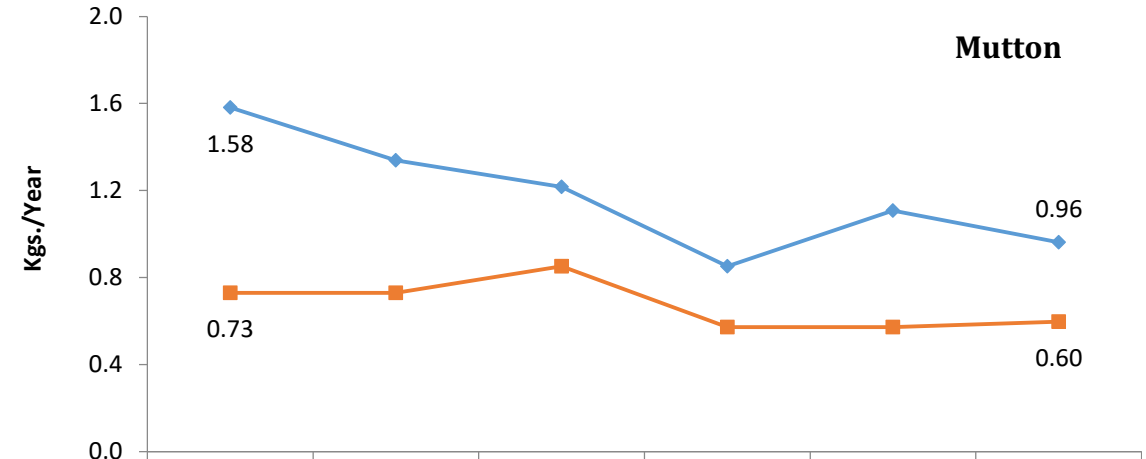
Source: OECD/FAO (2016)

Poultry has fetched significant consumer preference over other meat types in recent years. Pork meat consumption has grown 1.4 per cent in the last five years, not even keeping par with population growth rates. Beef consumption has shown overall 25 per cent decline in consumption since 2011. Meanwhile, poultry consumption at 26 lakh tons is more than sum total of the red meats in figure above, a growth of 16 per cent in five years.

In comparing the per capita consumption data from multiple NSSO rounds, domestic demand for red meat shows an overall declining trend whereas protein intake in the form of poultry, fish and eggs shows consistent increase.

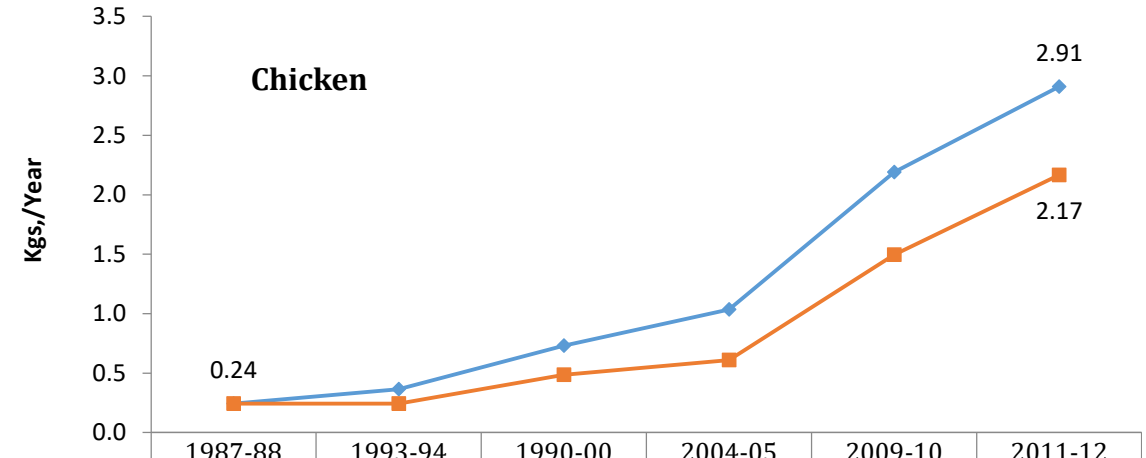
Nevertheless, the per capita consumption in poultry is only in the range of 1.5-2 kgs per annum. India is the world's largest concentration of vegetarians; a person having only once-a-week meat dish would be categorised as non-veg, while the bulk of food consumed is vegetables.

Figure 5.9 Trends in Mutton & Chicken Consumption (per capita annual)



	1987-88	1993-94	1990-00	2004-05	2009-10	2011-12
Urban	1.58	1.34	1.22	0.85	1.11	0.96
Rural	0.73	0.73	0.85	0.57	0.57	0.60

Source: Various NSS Rounds

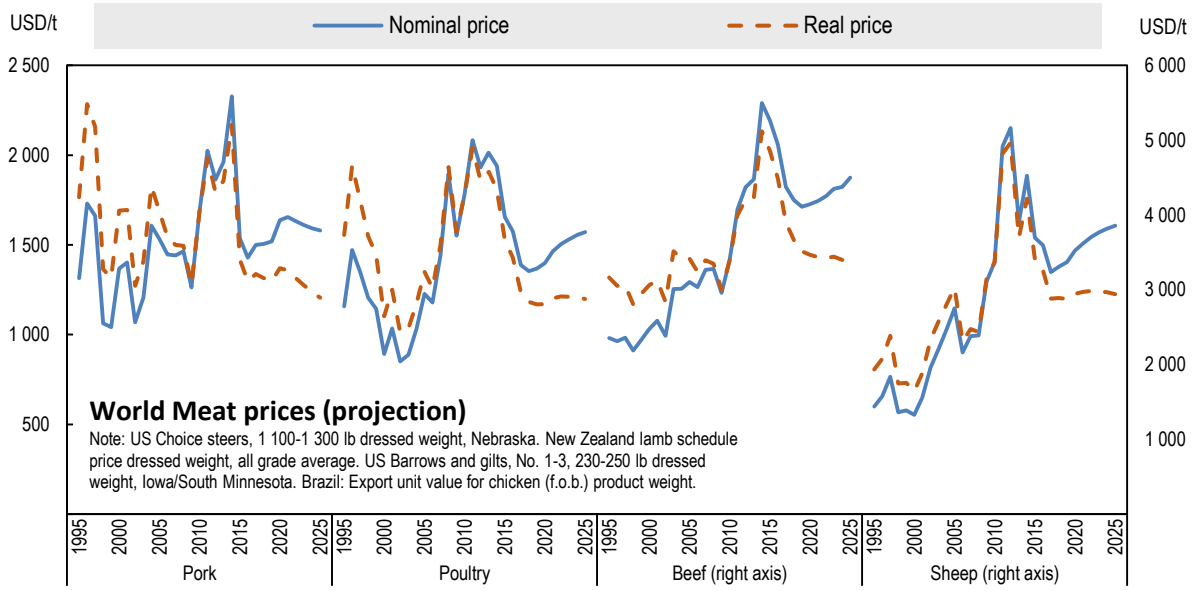


	1987-88	1993-94	1990-00	2004-05	2009-10	2011-12
Urban	0.24	0.37	0.73	1.03	2.19	2.91
Rural	0.24	0.24	0.49	0.61	1.50	2.17

Globally, per capita annual meat consumption is expected to increase by 1.3 kg by 2025. Disease outbreaks and trade policies are main factors influencing this sector. In 2015, the International Agency for Research on Cancer announced that processed meat is carcinogenic. Such concerns can also effect projected consumption in high per capita meat eating regions.

According to FAO Meat Price Index, meat prices in 2015 fell to 2010 levels, and indicated weaker demand for meats from emerging economies and Middle East. However, the ten year outlook is reported as strong with some stability expected from feed grain prices staying low. In the coming decade, at international level, the market price of meat is expected to grow in nominal terms but the real price could decline.

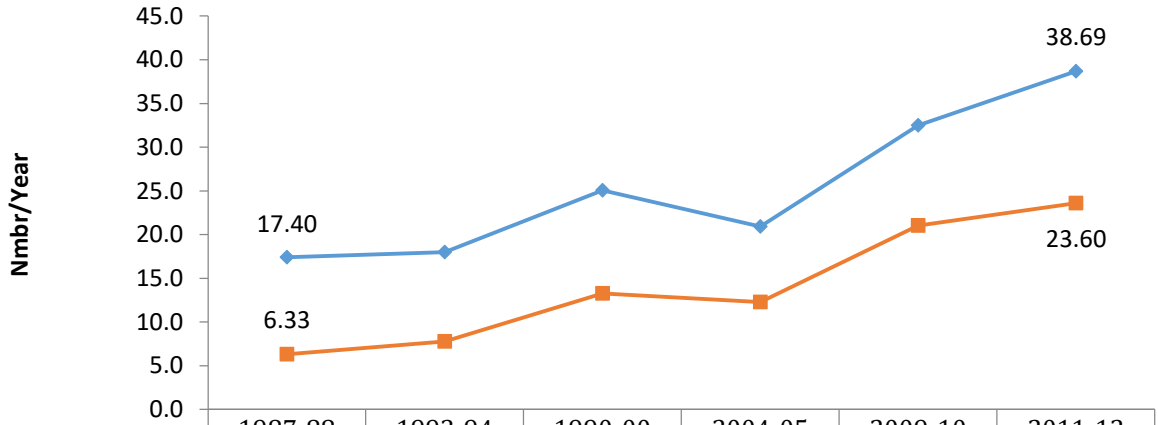
Figure 5.10 Global trend in Meat prices



Source: OECD/FAO (2016)

The meats sector relies on specialised post-production activities, include harvesting units or abattoirs, processing units to cut and blast freeze, storage and transport to retail units. Meats can be harvested on demand to suit the supply chain, and short term holding in storage suffices.

Figure 5.11 Trends in Egg Consumption (per capita annual)

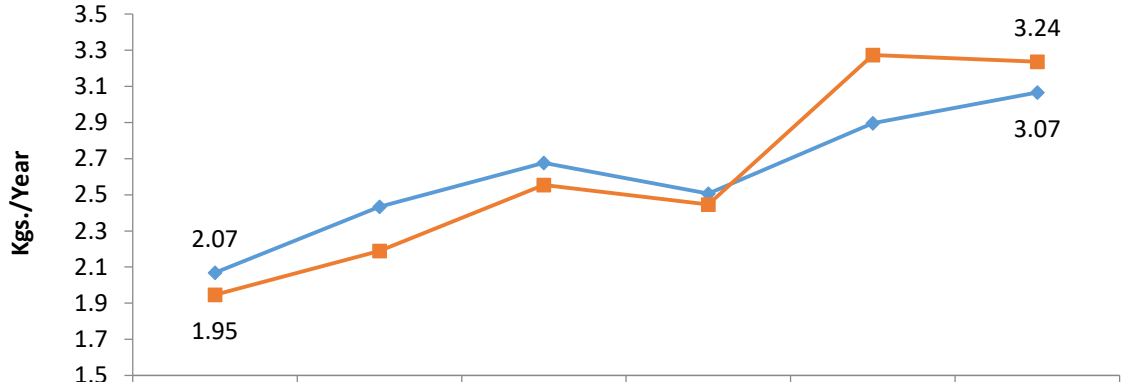


	1987-88	1993-94	1990-00	2004-05	2009-10	2011-12
Urban (nos)	17.40	18.01	25.06	20.93	32.49	38.69
Rural (nos)	6.33	7.79	13.26	12.29	21.05	23.60

Source: Various NSS Rounds

Consumption of eggs shows constant growth, having doubled in the past decade. This coincides with consumption growth in chicken meat. Poultry produce as a source of income can be expected to be a favoured sector.

Figure 5.12 Trends in Fish Consumption (per capita annual)



	1987-88	1993-94	1990-00	2004-05	2009-10	2011-12
Urban	2.07	2.43	2.68	2.51	2.90	3.07
Rural	1.95	2.19	2.56	2.45	3.27	3.24

Source: Various NSS Rounds

With increasingly health conscious consumers, demand for white meat is expected to grow. In this meat segment, fish market in the northern parts of the country has remained untapped. Appropriate fish handling and cold-chain connectivity will be required to deliver fish to the northern markets of the country. Private sector entrepreneurs are recognising opportunity from this unserved demand and realise, that regular and efficient supply to these untapped markets will make fish more affordable and in turn further drive consumption volumes upwards.

Internationally, the fish market underwent a slowdown, due to multiple factors including market contractions and exchange rate fluctuations. Fish is highly perishable and its export have to rely on the intervening food processing industries. The overall projection for the fish sector is largely positive and world fish production is expected to grow 1.5 per cent per annum over next ten years[21].

Worldwide, the overall outlook is that global fish production will increase by 39 million tonnes by 2025. World production of fishmeal is also expected to increase by 15 per cent in 2025 relative to the average 2013-15 level to reach 5.1 mill tonnes. The capture fishery sector depends on the ecosystem's natural productivity and subject to weather uncertainties.

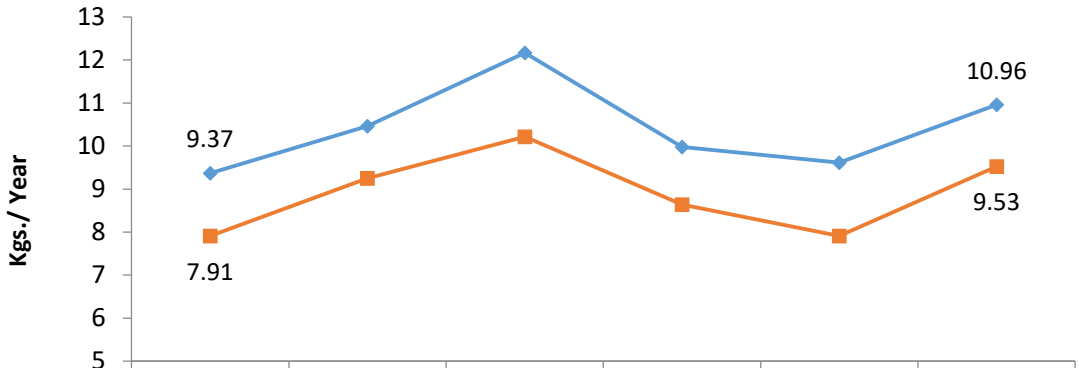
5.6.4. Pulses and Oilseeds

NSSO round of surveys indicate, that the per capita pulse consumption has generally shown a declining trend after an upward trend evident from 1987-88 through to 1999-2000.

Since then, the per capita consumption fell in urban households from 12 kgs to 9.6 kgs in 2009-10 and from 10 kgs to 8 kgs in rural households. Conversely, the consumption of edible oils has shown a steady rise in consumption.

[21] OECD/FAO 2016, *OECD-FAO Agricultural Outlook 2016-2025*

Figure 5.13 Trends in Pulses Consumption (per capita annual)



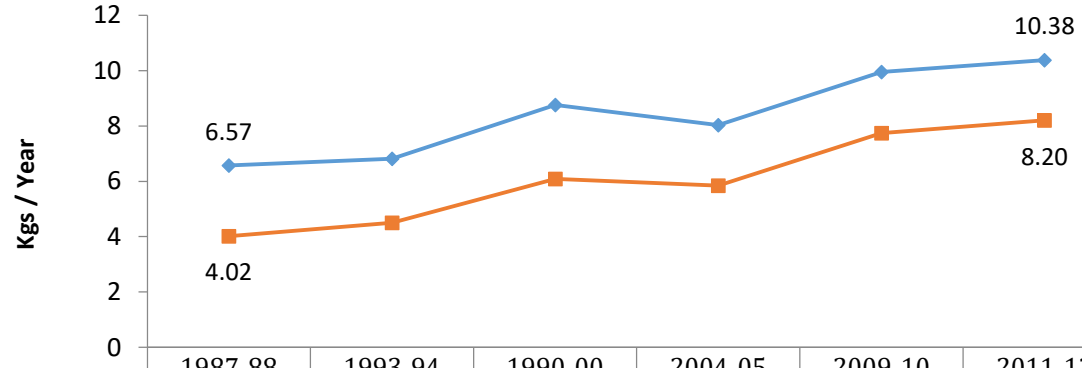
	1987-88	1993-94	1990-00	2004-05	2009-10	2011-12
Urban	9.37	10.46	12.17	9.98	9.61	10.96
Rural	7.91	9.25	10.22	8.64	7.91	9.53

Source: Various NSS Rounds

Over the last decade, consumption of pulses seems to have reverted back to those from about three decades ago. These could be a reflection of consumer perception of their affordability, though expected is indication is a plateauing out into a steady state of demand.

Edible oil consumption has shown a steady upward trend both in rural and urban households with per capita consumption increasing from 4 kgs to 7.7 kgs per annum in rural areas and from 6.6 kgs to 10 kgs in urban households during 1987-88 to 2009-10.

Figure 5.14 Trends in Edible Oil Consumption (per capita annual)

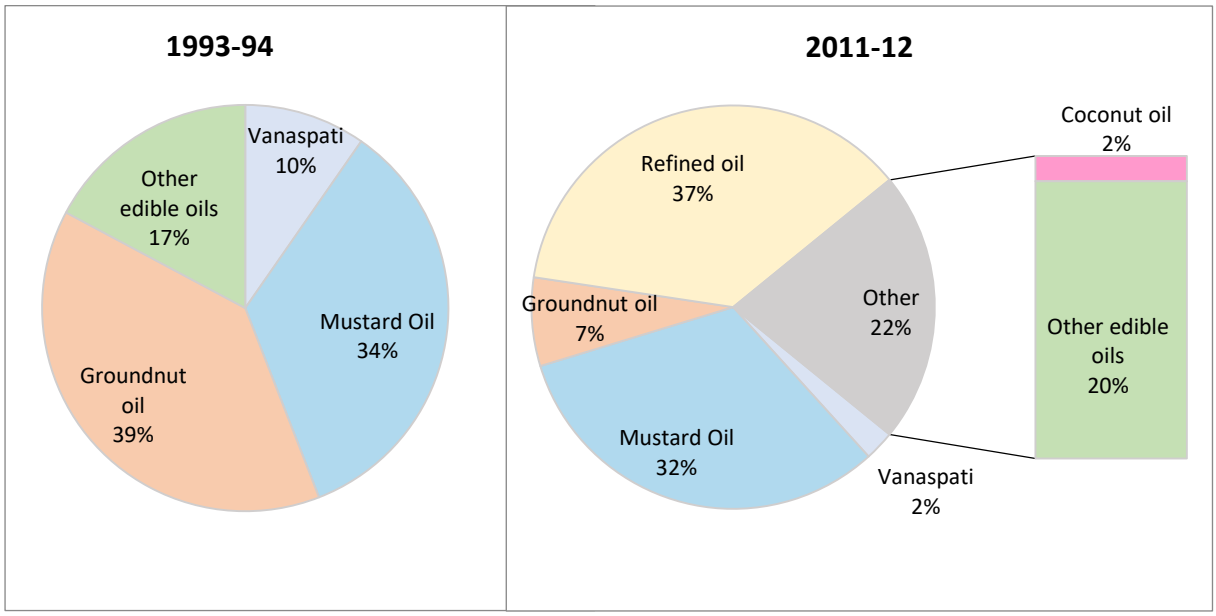


	1987-88	1993-94	1990-00	2004-05	2009-10	2011-12
Urban	6.57	6.81	8.76	8.03	9.95	10.38
Rural	4.02	4.50	6.08	5.84	7.74	8.20

Source: Various NSS Rounds

The composition of oils in the consumption basket has changed over the past two decades with groundnut oil consumption halving and palm oil and soybean oil emerging as the major oils consumed due to larger imports influenced by lower international prices. Nevertheless, mustard oil continued to retain the highest share among vegetable oils consumed in India. In 1993-94, mustard and groundnut oil had more than 70 per cent share in oil consumed. By 2011-12 mustard oil and refined oil forms the bulk of consumption, with *vanaspati* and ground nut oil below 10 per cent.

Figure 5.15 Consumption share among Edible Oils



Source: Various NSS Rounds

Wherever consumers demand is sustaining, the selected produce and product types will find a ready market. Normally, pulses and all oilseeds are dependent on processing units for the necessary intermediary activity in the farm to market value system. These processing unit capacities are closely linked to their marketing capabilities and they are a primary user of these crop types.

5.6.5. Sugar and Biofuels

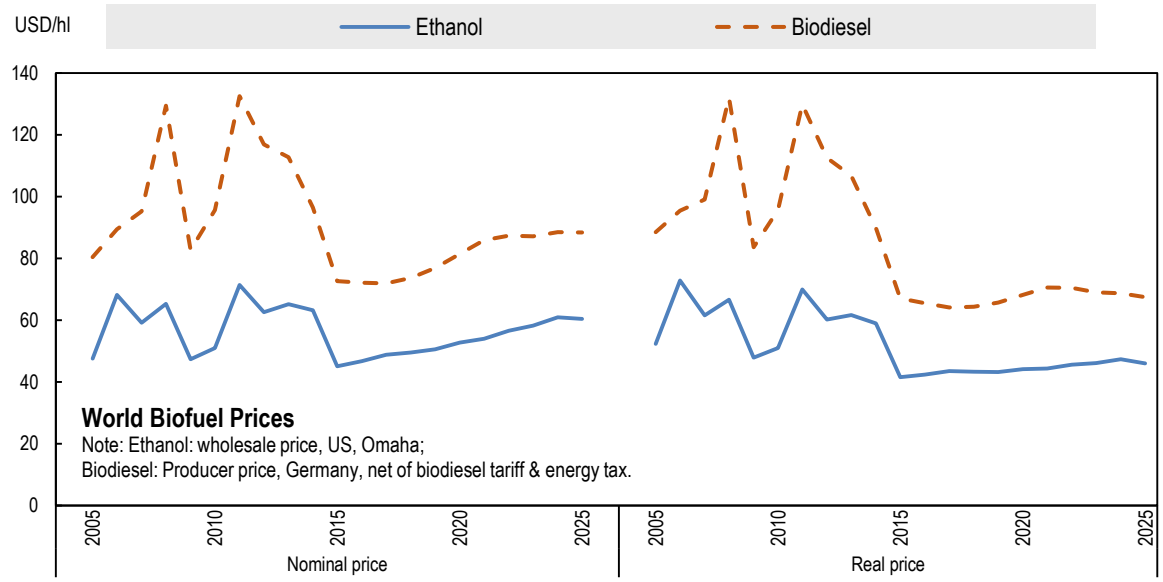
Sugar price is sensitive to global dynamics, and in 2014 the international prices fell by more than 30 per cent. Being a long term storable commodity, large stocks have been built and until the inventory-to-use ratio declines, the global price of sugar is unlikely to regain substantially in the short term. Any future increase in demand for sugar can be readily met with increased production, and price fluctuations are expected to be temporal. Is India, sugarcane production is expected to increase in 2017-18 after the dip in previous year.

The use of sugarcane for producing ethanol is also expected to rise and the share of sugarcane devoted for this purpose is expected to increase from 20.7 to 22.3 per cent until 2025[22]. It is expected that maize based ethanol production will also show an increase.

The use of ethanol and biodiesel, if promoted, will provide yet another opportunity, from the agro-processors, to farmers of crops that can alternate or supplement fossil fuel. The global price projections from OECD/FAO indicate steady though slow growth in demand for of ethanol and biodiesel, in the coming years.

[22] OECD/FAO 2016

Figure 5.16 Global Biofuel price, trend and projections

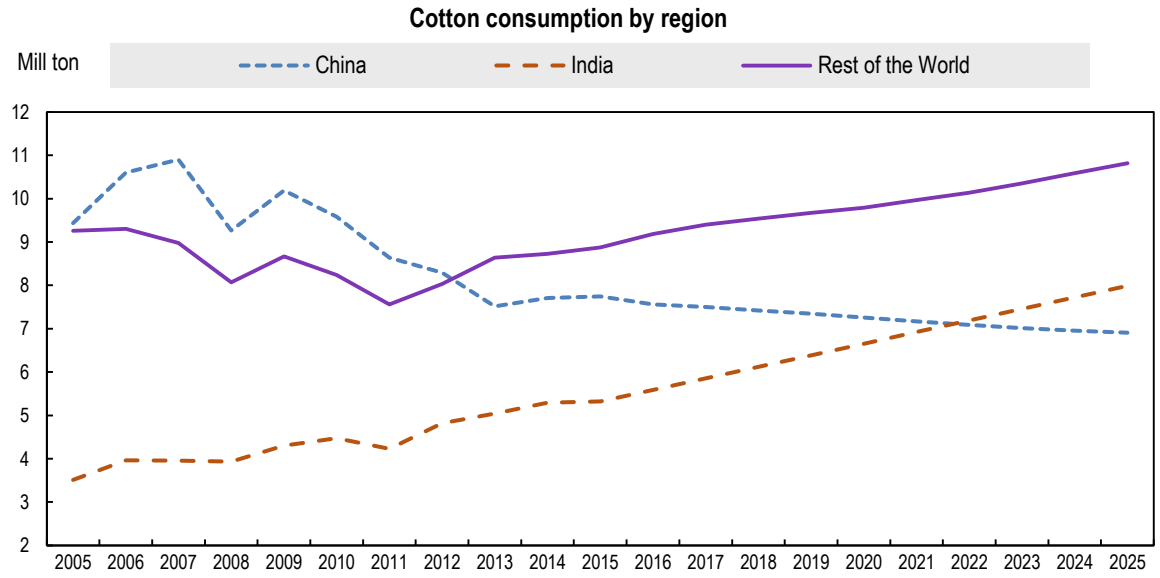


Source: OECD/FAO (2016)

5.6.6. Cotton and others

Worldwide, cotton production faced an acute decline in 2015, and led to release of stocks. However, global stocks remained high from accumulations in the 2010-14 period, but the balance against growing demand is expected in coming years. Cotton faces heavy competition from synthetic fibres, and world production is expected to grow at a slower pace, closely linked with market demand.

Figure 5.17 Cotton Consumption, trend & projection



Source: OECD/FAO (2016)

India is expected to become the world's largest country for cotton mill consumption (8 mill tons) by 2025, overtaking China around 2022. A shift to trading in cotton yarn and fabrics from raw cotton is observed in recent years.

Among the oldest traded commodity in modern era, demand for raw cotton is closely integrated with capability and capacity of processing units - the textile factories. This is similar in case of other commodity crops like coffee, tea, etc. With established demand from the primary buyers, i.e. cotton ginning and textile units, the farmers will benefit from greater productivity measures; and post-production activities for market connectivity are well established.

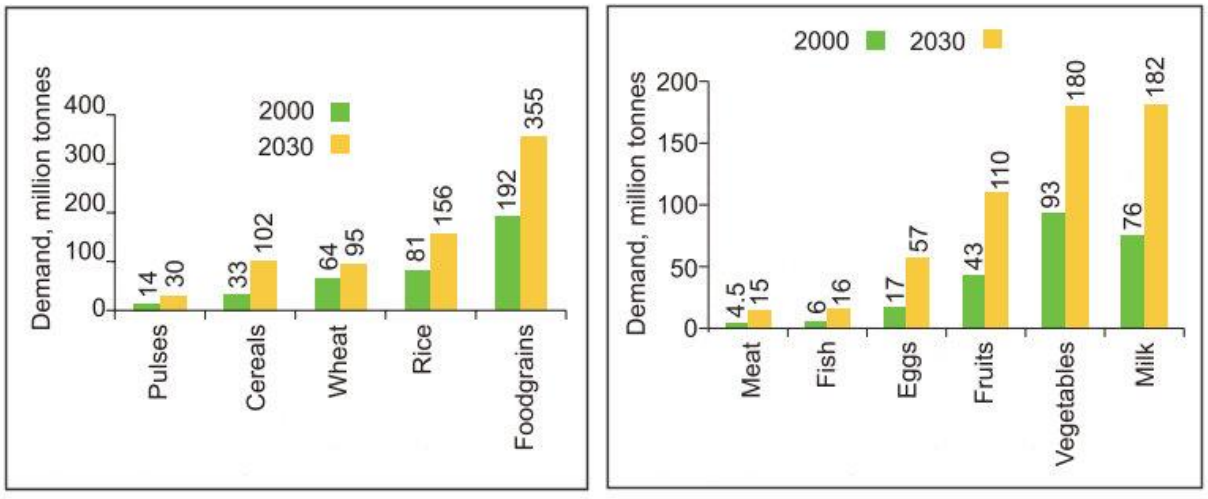
As per the OECD-FAO World Outlook, the stock-to-use ratio is expected to be over 40 per cent in 2025, which though high, will be well below the historical high of 87 per cent in 2014. The unprecedented high stock level is a key driver of the world cotton price.

World cotton area is projected to grow from 2020 onwards. Cotton farmers would benefit from technology driven productivity processes, adopting bio-tech cotton, pollination efforts, etc., and by freeing arable area for other high value crops.

5.6.7. Other consumption patterns

The Vision 2030 document by Indian Council of Agricultural Research (ICAR), reports that the demand for high-value commodities (such as horticulture, dairy, livestock and fish) is increasing faster than foodgrains - for most of the high-value food commodities demand is expected to increase by more than 100 per cent from 2000 to 2030. These are all perishable produce and require specialised infrastructure for handling and marketing, while the erstwhile marketing system is more tuned to handling foodgrains and fibre crops.

Figure 5.18 Demand for horticulture, dairy, livestock & fish is increasing faster than for foodgrains



Source: ICAR – Vision 2030

The format in which the produce is consumed is also linked to consumer preferences. A review of various studies and trends can indicate a distinct leaning of the Indian consumer for certain preferred forms of food consumption. These preference will go through dynamic changes on the basis of convenience, affordability, and health based perceptions. Currently, all indicators show that there is a more ready market for the fresh format of foods, especially in dairy, meats

and fruits & vegetables. Floriculture too finds demand in the fresh format. The fact is that almost 70 per cent of milk is demanded in liquid form, more than 97 per cent of meat, pork & chicken is consumed in fresh cut form, and similar fresh form is the preference in case of fruits and vegetables. Low food processing levels indicate that India is largely a wet market. This fact has to be seen as an immediate and more advantageous opportunity for the purpose of doubling farmers' income. While consumers could be expected to shift their preference in some future decade, the low level of food processing is an opportunity that will only fructify, as and when consumers shift preference to cut or processed foods. However, post-production activities that maximise gains to farmers, by supplying the consumer with what they prefer, has to be the short term objective.

It is notable that the imports of fresh fruits has grown multi-fold in the last 15 years, and these trends are an indicator that domestic market has growing capacity to pay prices at par with international levels for quality produce. The imports, arrive using shipping line (EXIM) refrigerated containers at inland container depots. From there, local cold storages hubs are the platforms to access the Indian consumer. Though the domestic consumer demonstrates ability to absorb the supply, yet the very same produce from farms within India are unable to connect to this internal demand. This stems from the fact that domestic farms lack modern pack-houses to precondition, and the refrigerated containers or transport to connect with the city cold store hubs. Hence, domestic traffic of quality produce is not facilitated, and the market growth for farmers within India is limited. This deficiency in marketing, in turn, dissuades producers from making other interventions to improve their productivity.

Agricultural produce of farmers has a large basket of crop types; including aromatics, tea, coffee, other plantation crops, bamboo, floriculture, etc.; and, these are also directly linked with demand from processor and/or consumer. Those that can be stocked over extended periods, have their demand subject to the inventory-turn ratios which in turn effects future growth and determined market value. The growth, in the more perishable segment, is more closely linked to the efficiency and reach of the distribution and marketing system.

5.7. Challenges to Post-production Activities

In the agriculture allied domain, the infrastructure development efforts were focussed largely on building storage capacity, basis a favoured hypothesis of cross seasonal carry through of produce. This has resulted in the development of single commodity bulk storage and warehousing (both ambient storage and cold storage).

All infrastructure need assessments were done with the harvest quantity as the starting point, assigning a predetermined percentage of the production as surplus for storing. The assessment presumed that all agricultural commodities can be stored endlessly, for trading or against collateral based credit, like other hardy commodities. However, the large basket of agricultural produce, requires a highly differentiated approach to the infrastructure development, keeping market access, storable life and the marketable life cycle of the produce in context.

A mind-set change is required to move away from mere storage of excess production, and adoption of a system-wide value chain approach, to ensure that all inventory can be brought to final consumption, in quality and in time. For the immediate benefit of farmers, the priority is to connect with demand, and not delaying or deferring the consumer as a preferred option, where practicable. Agriculture is not fully served by procuring and storage of produce, but by directing the harvest to consumption. A holistic approach to logistics requirements is needed.

The infrastructure system – the aggregation, transportation, storage and distribution – requires to integrate their operational capacities so as to serve as a conduit to the market and not function in isolation. This also necessitates that the capacities and number of infrastructure created, complement the overall volume being handled. For e.g., having a large capacity in warehouses, without access to an equivalent handling capacity in transportation, only results in a self-inflicted bottleneck to the desired market connectivity. This delayed or failed linkage is the cause of unnecessary inefficiencies, including price instability for consumer. Many a time lack of collaboration and market linkage has let good inventory to turn into wasteful discard.

Strengthening agricultural marketing will directly impact doubling farmers' income. In a study "Liberalizing Agricultural Markets in India" in May 2016 by CII's Food & Agriculture Centre for Excellence (CII-FACE), the report stated the following drivers for reforming agricultural marketing regulations:

- Widening gap between farmer and consumer price
- Overload of agriculture marketing charges and fees
- Practices that promote speculation and hoarding
- Overcrowding of commission agents and market intermediaries
- Complex market licensing system
- Inadequate infrastructure resulting in wastage (estimated 30-50 per cent wastage in fruits and vegetables). Whenever the handling loss in the activity chain is not diverted efficiently, it limits the total scope of value recovery through other value addition processes.

Currently, except for the significant procurement of grain by public sector, 75 per cent of value of agriculture output is routed through agricultural markets. Irrespective of public or private control, there is need to make market practices more efficient and driven by competition.

Some of the following findings validate as to why the farmers are unable to benefit in the current marketing regime in terms of managing transactions at higher prices:

- Typically the larger markets are dominated by commission agents and traders who have been in business for several decades as observed in Azadpur market as against fairly new entrants in the *mandis* surveyed in Punjab.
- Cash remains the most common mode of payment, although other modes such as bank transfer and cheque payments are increasingly becoming common use. In Azadpur,

there are a significant number of commission agents and traders who make and receive payments in cheque and bank transfers. Given the increasing penetration of technology and access to formal banking, a large number of market functionaries are moving towards handling less cash. In Punjab on the other hand, more than 90 per cent of the payments are made in cash, while a fairly small proportion are made and received via cheque or bank transfers.

- Time taken to settle payments is fairly quick, particularly those made by the commission agents to the traders and farmers who come to sell their produce in the *mandi*. Farmers are usually paid on the same day except in cases where farmers have taken advances from the commission agents.
- In the *mandis* of both Azadpur and State of Punjab, the main factor determining payments is the type and quality of produce. Other factors such as loan amount payable, mutual relationship (built over the years), and availability of cash also influence payment decisions in Azadpur. On the other hand, in Punjab, the value/quantity of transaction plays a much larger role than mutual relationship given that neither commission agents nor traders/farmers have a stronghold in the markets surveyed.

This CII-FACE study reported that there was unanimous opinion among farmers/traders that commission agents form an integral part of the *mandi* system and are a lifeline for them, because they provide cash advance, guarantee purchase and make payments on time. In Punjab, while most farmers considered commission agents integral to the system, only around 15 per cent felt that they were not required. Also, while many respondents declined to give their opinion on commission fees, around 13 per cent responded that buyers are reluctant to pay fees and that they are often unaware of the fees being charged to them.

While farmers as sellers will require better access to information from markets that helps them take control of negotiations and drive more favorable bargains, this will merely result in short term benefits and will still require that information flow is met with physical flow of produce. As immediate priority, there is need to first focus on flow of produce from farms to markets.

For purpose of doubling farmer's income, logistics to make markets physically accessible is a first step in the post-production value chain. Without such physical connectivity, the farmer has to resort to sale in the local market environment, where pricing is in relation to the regional consumer demand. To make markets available, a hub and spoke model of operations need to be is deployed. India has high fragmentation of farm holding, and hence small lot outputs, for which the aggregation centres are necessary as starting points of the hub-spoke supply model. Similarly, the front end is fragmented, needing a shared distribution system for the last mile.

Markets afar, are made accessible through a forward hub and spoke model, where the *mandis* can play an important role, making the last mile accessible. However, there are other multiple handovers between the destination terminal markets and the farmers' *mandi*, which can be streamlined through modern supply chain systems. Normally, a producing region should have capacity to aggregate sufficient quantity to directly move the produce to the destination

wholesale market within practical limitations. For logistics purposes, the foremost challenge is to aggregate viable loads for transport to markets. Hence, first level aggregation of crops under collaborative farms or a group of farmers in a village, will justify the village level aggregation infrastructure and the vehicles to connect directly with wholesalers further up the supply chain.

The empowerment from farm-gate aggregation and transport linkage is not only expected to work alongside the existing multi-layered marketing mechanism, but also give impetus to more direct links with other city located market terminals.

Government enablement through subsidy schemes allowed for non-structured development of cold storages in isolation. Further, cold storages developed in clusters, irrespective of business model validation, or of impact on demand gap or the viability of location. Example, excess storage capacity developed in some regions for potato has resulted in non-viable cold storages. Similar capacity overruns in regions are reported from dry warehousing.

The shortfall in post-production market connectivity is largely the shortfall of the tools that enable such connectivity, namely, the logistics infrastructure. To ensure that any such infrastructure achieves viable capacity utilisation, the collaborative cultivation or shared farming of FPOs is important. There are some other challenges too, such as permits, access to a unified national market and bank credit. A list of challenges is bought out hereunder:

- **Lack of collaboration among farmers to cultivate a common crop for economy of scale in the post-production logistics utilisation** – FPOs have been created as a mode to mobilise individual farmers into companies, as a first stage development. There is now a need to promote the clubbing of contiguous or adjoining farms. Having met success in general mobilisation of farmers, now FPOs need to advance to the next stage where farmers are able to undertake collaborative, crop-specific farming on contiguous stretches of land. More important than a group of farmers under a common banner, is having a collection of adjoining farmland having common cultivation patterns, besides other activities. An entire village producing a common crop can be envisages, for still higher level of operational efficiency.
- **Lack of suitable clusters of operations to support farm-to-consumer links** – Government interventions have helped in creating physically demarcated zones, such as food parks of mega scale. Subsequent to their creation, the parks seek post-facto functional occupants. Alternately, the existing cluster of farming activities in a region can be facilitated through appropriate sized logistics hubs, co-located with the aggregation centres, so as to expedite the movement of raw produce to industrial users and wholesale for consumers. Rather than consumers needing to move to farms, it is the produce that needs to travel wherever it can find gainful use.
- **Delays in permits and Change of Land Use (CLU) for developing agri-infrastructure** – It is understood that infrastructure for industrial uses must be regulated and a CLU is necessary. However, the small scale infrastructure, such as pack-houses, that are used only

to prepare the agricultural produce for marketing, could be waived from CLU laws. Other permits for handling water run-off and managing agricultural waste can be fast tracked.

- **Poor availability of bank credit for infrastructure creation** – The banking system has not created product lines, akin to those created for other high value products (cars, consumer durables, etc.) for many infrastructure items needed in the agriculture sector. The success of tractors can be attributed to financial sector having ready forms that ease credit procedure for farmers to buy tractors. Similar types of packages to access credit for farm-gate infrastructure can be created.
- **Availability of logistics support in perishable sector** – The shortfall of reefer transport capacity is not coincidental, but linked to the shortfall in the loading platforms. Without the development of pre-conditioning and staging facilities, the associated transport segment has not found demand to justify further development.
- **Policy interventions promoted the storage of produce for main purpose to defer the sales** – This did not encourage a chain approach for developing post-production activities to connect with the wider market. Future development assistance needs to be directed so as to nurture horizontal market integrations, so that farmers can connect and avail of all the possible market avenues.
- **Tendency to focus on post-production value chain systems that are local to the producing area** – Inter-State supply chains are not actively promoted and States tend to aim for self-sufficiency in every food item. However, supply chains are intended to build cross-geographical value chain systems, to spread the market breadth and interlink demand and supply at the national level. Too often States speak in terms of importing produce from another state and view it as a weakness instead of as an opportunity to use the logistics in reverse as a supply chain link. The country needs to be accessible as one market and not as isolate from this advantage.
- **Changes in taxation environment** – the business environment changes when rules, regulations and laws are amended. While such changes are intended to bring about an improved environment, in the initial phases, a disruption of the working environment can be expected. The general reaction is one of resistance to change in working practices. GST is one such recent example and greater awareness and dissemination of the benefits and methods to comply will benefit.

5.8. Annotation

The existing practice of procurement and storing inventory in the Central Pool is designed to compensate a minimum price to farmers and to promote higher production of the items with assured centrally sponsored procurement. Having proved successful, farmers have responded with large production, leading to larger surpluses.

There is need to rationalise the central pool procurement by correlating it to gainful end-use. Gainful end-use can be categorised into food security stocks, domestic annualised demand and foreign markets. The inventory maintained under central pool, be actively rotated into markets

at regular schedules all through the year. The food distribution system can incorporate links with other value chain systems to ensure, that the concept of "first-expire first-out" is practiced and monitored for foodgrain stocks.

Plantation and cash crops are primarily linked to existing demand through intermediary businesses and can be transformed only through increased market capture. Global market dynamics need to be addressed in case of textiles, tea, coffee, rubber, etc. The demand for raw produce from the large food and non-food processing sector is important information for those farmers, who are vertically integrated with these processing units. The requirements of these units are normally communicated to align production, along with quality requirements. Concerns regarding raw produce availability by some of these industries (especially food processors) highlight two aspects:

a) specific cultivars suited for processing are not produced locally; and

b) product quality and food safety norms are impacted due to unsafe chemical residues on the raw material produced.

The state governments could also facilitate such demand mapping and share the quality and volume needs to local farms. Accordingly, the industries can become more competitive by shortening their input supply chain, by supporting appropriate variety and farm inputs for the raw produce within their catchment region. Where table variety cultivars are not finding evacuation modes to supply the national markets, cultivation of processing variety to suit processing available capacities is indicated. Progressive collaboration between farmers and processors will be needed.

Economic development in India has resulted in growing affluence among urban consumers. This affluence has brought a shift in consumer preferences and is visible with an increasing demand for fresh whole food. Besides high growth in demand for fresh fruits and vegetables, some shift in consumption is also visible in other high nutrition foods like milk, dairy products, fish, eggs and meats. All these food items, besides assuring nutritional security, are dependent on efficient time bound logistics in the form of cold-chain.

In the perishable produce segment, the fruit and vegetable sector is the one with the weakest market connectivity and in consequence suffers the highest food loss. These cultivators are also small and marginal and would benefit the most from future development of market linked aggregation and logistics. All of this indicates a greater potential for developing the cold-chain as a market enabling service for the perishable food sector.

Future development, at first instance, needs to focus on promoting the pack-house and transport segments. Such farm gate aggregation units are expected to transform the ability of farmers to access markets, encourage greater collaboration among farmers and generate greater economic growth. This sector uses technologies and scientific practices that can be easily implemented.

Holistically developed post-production market linkage provides immediate opportunity to connect with distance markets and empowers farmers by expanding their radius of sales. This form of agri-logistics does not tamper with the farmer's harvested value, but only safeguards the produce and makes it more marketable, thereby allowing control of the business to remain in the hands of the producer or fam-level aggregator/owner.

The supply of produce from farm to fork, operates when multiple enterprises work together to integrate their value chains and physically connect the farm produce with markets. This chain is made efficient when it is market linked, i.e. guided by flow of value and information in reverse, from 'fork-to-farm'.

Post-production activities are the key enabler for agri-business, providing option to sell across place, time and form – by connecting across geographies, buying time to reach a sale or by converting the produce into a new format of food or consumer item.

Key Extracts

- Large network of market yards can be linked as part of a larger hub-spoke network. Inclusion of existing warehouses under the APLM Act, 2017 is a forward move.
- Policy interventions must look to expand the farmer's horizon and not only to leverage on farm or city-proximate markets. Holistic development will require greater and easy access to a one India market.
- Logistics is hampered by non-viable aggregation can be improved by having more near farm aggregation centres, with onwards transport connectivity.
- Promote Village level economy of scale for production and marketing gains.
- Increase in production quantities must match with equal attention to increase the selling volumes through expanding the marketing frontiers.
- Near farm post-production infrastructure supports new job creation, while strengthening the core activity of cultivation.
- Handling practices of the Central Pool of foodgrains can be optimised and private sector involvement in areas other than warehousing can be assessed.
- Govt. provides fiscal and financial support as an opportunity driver to private sector.
- Current consumption patterns and future trends across agricultural produce types, help identify potential and opportunities.

Chapter 6
Targeting the Outcome

Agriculture linked activities need to adopt a system wide approach to result in the desired outcome. The prime outcome to double farmers' income stems from maximising the delivery of farm-output to consumers. Target placement for development agencies needs to include establishing the physical flow of goods, as value under care, from farms to points of value realisation where produce gets monetised.

To enhance farm incomes, an important component of farmers' income, there is the related need to enhance the selling volume of the farmers, and not merely the growth in farm output. This desired increase in selling volume can be achieved by enabling that a large part of the currently high percentage of the losses, especially in high value produce, reaches markets and is monetised; besides opening up the country as one market with eased access.

Metrics for evaluating impact of development efforts need to be rationalised and made outcome oriented. The annual reports by development agencies normally list the financial and physical numbers to demonstrate achievements. There is need to observe outcome and output measures to adopt result oriented targets. These measures would typically be the throughput achieved vs capacity created; food loss vs production; revenue vs inputs costs; and new market capture.

6.1. Throughput achievement

Agri-logistics infrastructure is created in case of agri-allied activities for post-production market linkage. The physical target of implementing agencies should include the volumetric throughput of farm produce, at least for first 3 years of operation. Throughput measure is a multiple of two factors - the holding capacity created, and the number of rotations or cycles achieved on this capacity in a year. Using this measure as a target, will ensure that the development activities do not cease at just creation of infrastructure, but also encompass monitoring and support in the initial years of operation, making the development more outcome based.

As an example, the throughput capacity for components under cold-chain infrastructure, supported by the Mission for Integrated Development of Horticulture are:

Table 6.1 Estimated throughput capacity of cold-chain infrastructure items

Description	Unit Size MT	Annual Operating Cycle	Annual Handling Capacity MT	Remarks
Modern Pack-house	16	90 to 120	1,440 to 1,920	Operating cycle can be 300 days in case of bananas or if used for multi-crops
Reefer Transport unit	10	52	520	Trucks or containers, can vary in size and turn-around-times (weekly cycles)
Cold Store (Bulk)	5000	1	5000	Assessed for single annual harvest crops
Cold Store (Hub)	2500	42	105,000	City distribution or delivery hubs
Ripening Unit	40	300	3000	For fruits that need ripening

Assessments Kohli.2016 NCCD

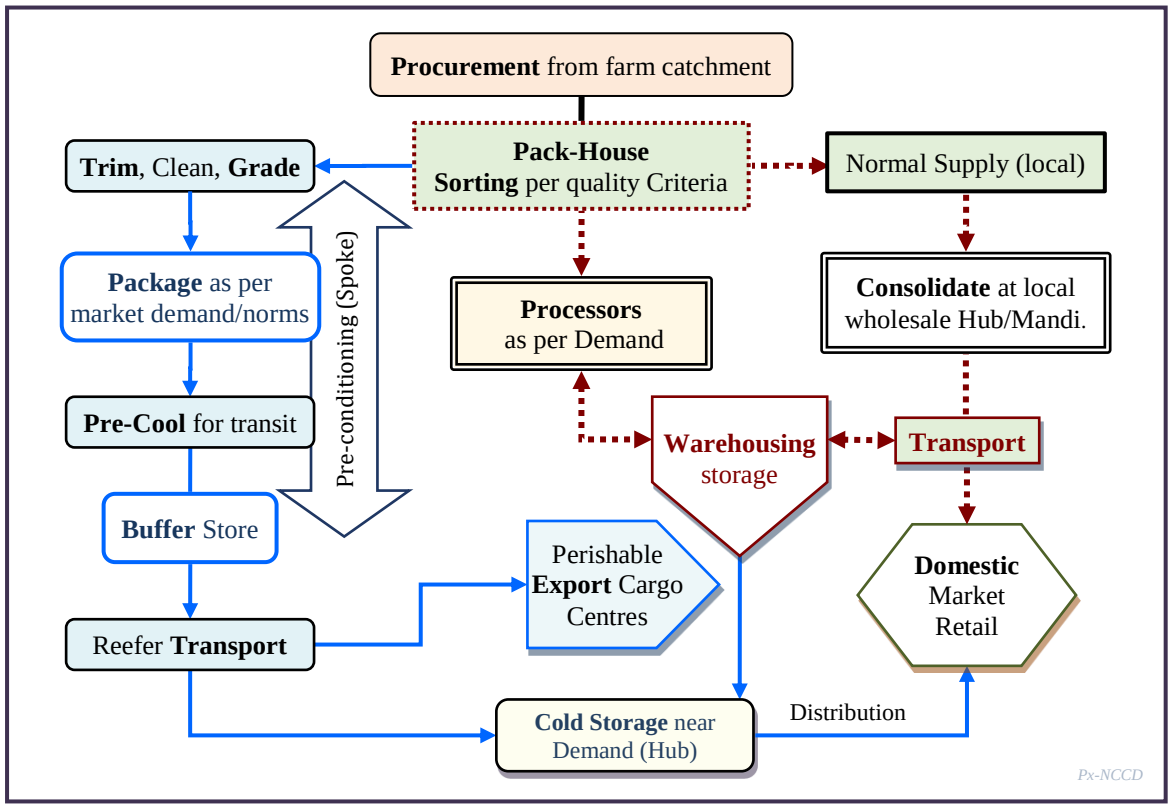
NB *-Modern Pack-house of average throughput 16 tons per day for 90 days*
-Reefer transport unit with weekly turn-around cycle of 10 tons

-Cold store (Bulk) assessed with average holding period of 1 year of size of 5000 tons
-Cold store (hub) assessed with average holding period of 9 days of size 2500 tons
-Ripening Units of 4 chambers of 10 tons, supply from each chamber every fourth day
-Throughput capacity installed and used is more important than the unit numbers

For instance, each modern pack-house (of 16 ton throughput size) should generate 1000 tons to 2000 tons of supply to market. Similarly a bulk store holding potato will manage one inventory cycle per annum, but a ripening unit rotates its holding capacity every 4 days.

Similarly, the targets for other agri-allied infrastructure could be linked to capacity utilisation and monitored accordingly. Implementing agencies may decide on three year target periods to bring each project to 50-70 per cent capacity utilisation. Such outcome targets will rationalise the support and financial support will be viewed as an incentive to achieve desired outcomes.

Figure 6.1 Illustrative flow of produce & activities



End-use must ideally match, from first aggregation to consumption

The advantage of holding inventory for trading or as a hedge against demand and/or supply variances in the future, is that it helps with price discovery and in sharing the risks across multiple traders/players. However, trading when improperly managed, may lead to larger than needed inventories or give signals bereft of immediate demand from end-user.

To ensure that agri-business at the grass root remains more closely linked to demand from markets or consumers, it is recommended that the quantum of inventory in storage be matched

with physical deliveries at least once in the year. A settlement cycle that balances physical delivery with inventory held in storage could minimise speculation based price fluctuations.

6.2. Food Loss reduction

Normally, production statistics are put forth during and after harvest season. These production numbers undergo a series of iterations, until the final production by district or state is declared. The declared production figures are used to assess the GDP/GVA contribution of farmers. The quantum of production that cannot be monetised, due to lack of post-harvest market linkage, is a loss that must be considered as recoverable value to farmers and the country.

An independent and regular sampling survey schedule to assess physical loss of food produced along various activity stages should be put in place. The key stages in post-production would be the quantum aggregated and rejected at farm-gate (local market yard, pack-house, or private aggregator); quantity discarded at wholesale market (processor, warehouse and wholesale *mandi*); and quantum lost in fields. Reducing such physical loss will permit more saleable volumes in the value chain system, allowing for greater monetisation of the produce.

6.3. Revenue generated

There has been no comprehensive and regionally differentiated assessment of the revenue generated by farmer from various available avenues. An ongoing third party assessment of the revenue by farmer from sale of own cultivation (to wholesaler, processor, trader/aggregator), from near-farm jobs, from non-farm jobs, from migratory jobs may be initiated. The development activities can accordingly be adjusted and relevant course corrections initiated to achieve the overall strategy of doubling farmers' income.

6.4. Market expansion and access

In order to give the farmers better access to markets, a number of reform measures have been undertaken by Government of India in recent years. Government of India has formulated the Model Agricultural Produce and Livestock Marketing (Promotion & Facilitation) Act, 2017, and States should adopt its provisions to evolve a common market for the marketing of agricultural produce across the state and country. A central Agricultural Trade Act is also being contemplated, which will more pronouncedly provide a legal footing to create a barrier free access for trade across the country and enable all the pre-requisites for a truly unified national agricultural market. The constitutionality of such a central Act will however need to be evaluated.

The focus needs to be on integrating the small holders, constituting 85 per cent of Indian agriculture, into an organised mechanism that will facilitate national level access and increase the selling range of the farmers. An effective linkage, however, is also stymied by small lots of marketable surplus, dispersed & disjointed centres of production, resource constraints, high price risk, etc.

The quantity of produce that is sold outside of the boundaries of a State will help expand the

value chain system, while promoting the concept of a unified national market for agricultural commodities. Consumption trends by quantity for each produce are easily assessed. Therefore, targeting the volumetric flow of produce to markets, within and outside the producing region or State, is recommended. This is most applicable where agriculture allied infrastructure is being developed at great cost. Placing and monitoring such a target will also help to ensure that relevant capabilities to link with external markets, including exports, will be suitably promoted and developed.

6.5. Infrastructure Development Targets

Creating infrastructure is not a sufficient condition; the creation must be outcome oriented and they must come into productive use. Besides the existing methodology of monitoring annual physical and financial achievements, the following 'outcome matrix' is recommended for use by various development agencies and departments.

Table 6.2 Sample Outcome based Targets to develop

Measure	Target	Weightage for Achievement	Remarks
Tons per annum handled	70% of design capacity	40%	Can apply to mandi/markets, warehouses, cold-chain and retail infrastructure components
Tons marketed in local region	Share of total capacity handled	5%	Can be within State or within 300 kms of production area.
Tons marketed to other States/region	Share of total capacity handled	10%	Can be outside State or beyond 300 kms of production area.
Tons of food lost in the supply chain	Physical loss in tons	5%	Physical shrinkage or discards due to non-saleable status
Total revenue generated	Total marketed revenue	40%	Can be differentiated by crop and production area

In case of long holding commodities, the throughput could also refer to the unit's inventory-turn-ratio. Generally, having larger stocks over extended periods would reflect as a signal about demand variation, and be used as an indicator for the next cropping cycle.

Lowered throughput achievement in relation to the size created would be used as a signal to rationalise the expenditure on infrastructure creation and divert efforts to the missing links.

To double farmers' income, changes need to be implemented to measure and monitor the outcome from developmental efforts. The target setting should primarily be to affirm that more of the farm production reaches all possible market avenues and gets monetised. Besides having a direct impact on increasing the earnings, this will also lend impetus to become more productive of the land, which will further add to farmers' incomes.

Development interventions must keep their focus on making sure that **every grain, every ounce and every drop of produce finds opportunity to realise value, and not limited in markets by place, time and form.**

6.6. Some Successful Outcomes

Examples of effective use of investment and government spend on infrastructure for marketing are highlighted in this section. In most cases, the enabler for success was in understanding the concept and utility of the available logistics chain, and in establishing a throughput of produce from producing areas to consumption centres. The measures are in terms of volumetric flow of produce, the value extracted and other benefits as outcome based targets.

6.6.1. Grapes

Grape Marketing Cooperatives in Maharashtra (MAHAGRAPES) exemplify the ideal achievements from farm-gate aggregation. Mahagrapes is a partnership firm of sixteen grape growers' cooperatives from the areas of Sangli, Solapur, Pune & Nasik regions, having a membership of almost 2,500 farmers. Mahagrapes acts as facilitator, quality controller, input supplier as well as service provider to its member societies.

Since reaching individual farmers was a difficult task, formation of co-operative societies afforded the solution. MSAMB provides societies with day-to-day international market price and supplies them with the packaging materials required for exports.

Each co-operative society is equipped with a pre-conditioning facility i.e., pre-cooling pack-house attached to a cold store; the technology has enabled the farmers to immediately sort the produce by market-desired quality, package and remove the field heat and dispatch to various markets. The produce is prepared in packaged form and dispatched in palletised loads in containers to safely travel to global consumers.

The use of modern pack-houses has been a game changer in case of grapes, as it has effectively empowered the cooperatives with the ability to extend the market range and connect with consumers across the world. The market for table grapes in Europe was opened and quality benefits are evident from low rate of rejection at the markets. The technology has proved to be an essential tool to allow access to export markets. Approximately 8,000 reefer containers are exported per annum by India. Besides cultivation, the cooperative structure has allowed farmers the capacity to take custody of post-production activities including the loading and dispatch of reefer containers to markets.

This example has shown how the farmers' involvement in additional value chain segments of the post-production supply chain, can bring about greater wealth creation and economic benefits. Selling volumes were increased, design capacity utilisation of infrastructure achieved, marketing expanded into other regions, and total value realisation enhanced.

The solution of aggregating the fresh produce close to farm-gate and attending to its pre-conditioning for market dispatch, has allowed the farmers to harvest as per demand, sow as per demand and become a stakeholder in the overall supply chain.

6.6.2. Milk

India continues to be the largest milk producing nation in the world with a total milk production of 155.5 MT (2016), accounting for 18.5 per cent of world milk production. The annual growth rate of India's milk production is 6.27 per cent, which is more than double the world average milk growth rate of 3.1 per cent. Global prices of milk are dipping because of overcapacity, while the Indian market is still growing, both for fresh milk as well as for value-added products.

Domestic demand is primarily centred on fresh milk, and some value added products such as powdered milk is a result of milk surplus being converted into long term storable format. The per capita availability of milk is 337 gm per day, which is higher than the level recommended by the Indian Council of Medical Research (ICMR). Indian milk economy is worth Rs. 5 lakh crore, growing at 15 to 16 per cent per annum, of which the processed milk economy is estimated at Rs. 80,000 crore.

As per the annual report (2015-16) of National Dairy Development Board (NDDB), almost 80 per cent of the milk procured by cooperatives is marketed as liquid milk. In 2015-16, the dairy cooperatives collectively procured 15.58 million tonnes of milk, of which liquid milk marketing stood at 12.08 million tonnes (an increase of around 2.73 per cent over the previous year). The report indicates situation of overcapacity as both domestic and international prices declined, resulting in accumulation of stocks of conserved commodities. Nevertheless, the 50 per cent drop in price of liquid milk in some international markets is not similarly reflected in domestic market, which indicates sustained demand within the country.

The post-production activities for milk are well exemplified in the supply chain model deployed. The model includes provision of village level pooling/collection points which initiate the post-production market linkage. The pooling points are strengthened by supporting village level capital items like bulk milk coolers, milk cans, etc. This system has resulted in greater transparency and fairness in milk procurement, as well as improvement in quality of milk. In this same sector, private companies also exist and compete with farmers. The competition has also brought greater transparency and economic benefits to the farmers. The use of appropriate technology, has ensured that the milk can safely travel to destination – to processors, markets and consumers over longer distances, thereby expanding the selling reach of the farmers and incomes thereof.

The farmers' cooperatives have taken responsibility of pooling and chilling the milk, and in some cases, even the processing, packaging and retailing is taken up by cooperatives. The milk is sold in multiple formats, the form varying from liquid milk to ghee, butter, beverage, sweets, etc. The market is pan-India and the supply chain is dynamic with fresh milk supplies replenished twice daily at times.

In the milk trade, farmers took charge of additional value chain segments of the associate market supply chain, including retail, and are equal beneficiaries in this value system.

6.6.3. Banana

India produces about 32 per cent of the world's bananas. As per a study by CII-FACE on banana trade in Tamil Nadu, the main problem faced by the farmers is linking their production with consumers in the rest of the country. The report assessed the need for logistics linkage, such that the freshly harvested bananas can be linked with markets in the northern parts of the country. Due to dearth of such linkage in the form of pack-houses, transport and receiving ripening chambers, the fresh produce mainly finds sales in the local markets or gets converted into chips as long holding convenience food. Of note is the progressive organisation of its supply chain, undertaken by the Tamil Nadu Banana Growers Federation (Trichy), which has resulted in creation of a modern pack-house. The pack-house has a pre-cooling system, adjoining a buffer cold store, as well as ripening chambers. As a result of this intervention, these farmer groups are able to control their post-harvest activities and supply good quality fruit into Delhi and some export markets.

The Trichy Federation is now pursuing improved rail connectivity into northern markets, so as to scale up and fully benefit from the acceptability established for their produce. The farmers in Trichy have also taken to improved cultivation practices to enhance their yields, now that market expansion and associated income growth has happened. The TN Banana Federation took the initiative, in April 2017, to enter into a tripartite MoU with a Zurich based importer and an Indian exporter to supply export quality bananas. Additionally, they have entered into an MoU, in June-2017, with Port System Authority of Trieste, University of Udine & TNAU to develop a rope conveyor system for post-harvest handling of the banana, from field to pack-house, for subsequent dispatch of the fruit to EU. In order to support productivity and production increases, the CII-FACE study reports that there is no shortfall of planting material with almost 20 number of tissue culture units in the region, capable of meeting the demand.

The famers are increasingly taking better control of the value system. **It is clear that market expansion and linkage has sufficiently empowered the Trichy farmers to take self-driven development initiatives.**

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In Surat, the Mahavir Banana Ripening and Cold Storage facility operates a producer/owner business model. Banana is procured directly from approximately 700 farmers and about 3000 acres of farms are associated. The banana is aggregated into market lots and ripened depending on planned market movement. The business originated about 15 years ago with one (1) ripening chamber and now has 19 such chambers under its operation. The growth has been multi-fold in recent years.

Exclusively handling banana, these are sourced in full bunches from farms, and bunches are cut into transport lots (hands) at farm-gate, utilising farm labour. The procurement price ranged

from Rs.4.5 to Rs.10.5 per kg depending on season. An average of 60 to 70 tons of ripened bananas is handled by this business for 365 days of the year. Peak load of 100 tons per day was reported for a period of 4 to 5 months, targeting the wider region around Surat. In addition, 60 tons of raw (unripened) bananas is dispatched daily to wholesale markets in Rajasthan, UP, Delhi, Mumbai and other regions. The cost of transport was reported at Rs.2 per kg to Mumbai and Rs.2.5 per kg to Delhi. No Branding of fruit was being done, yet the initiative comprising first mile handling, aggregation at a pack-house and onwards connectivity, has made this facility an important market channel for the banana growers in the region. The farmers in the region have instinctively undertaken efforts to increase productivity on their farms. The business employed 150 workers at their facility and non-availability of workers was reported as the main stricture for further expansion.

Collaboration between aggregator and cultivator, in activities to prepare the produce into market lots, enabled farmers to partake & grow this conduit for regular inter-state trade.

The organised flow of produce to markets, has communicated market demand to farms, giving impetus to gainful productivity at the farms.

6.6.4. Potato

In 2015, surplus production of potato was predicted in Gujarat. Expecting a higher yield, the local producers and traders were worried of possible shortage of cold storage capacity; and demand for new creation of storage capacity was projected, requiring additional budgetary allocation under the ongoing subsidy scheme.

However, the State Horticulture Mission of Gujarat, on realising that creating new storage capacity, in reaction to one-off surplus production, could lead to under-used capacity in the future, looked for other solutions.

An innovative approach was adopted to handle the produce being harvested in the starting months of 2015. The Horticulture Mission promoted liaison with existing consumption centres for the table variety potato. A freight support mechanism was initiated, wherein the potato of Gujarat was trucked to these demand centres in other States and the cold storage capacities available with the wholesalers in other states were linked with the potato produced in Gujarat.

The program was initiated in the financial year 2014-15 (March 2015 harvest) for the first time. It was not implemented in March 2016 as this movement was self-initiated after the next harvest season, which moved the local prices higher. However, the facilitation had to be repeated in March 2017 as overall production of potato was higher in country. This is an innovative and cost-effective example of a mechanism, used only when required to mitigate fluctuations in supply and in prices to farmers.

The potatoes were transported to Tamil Nadu, Karnataka, Maharashtra & Rajasthan. The total cost incurred in two years was less than Rs. 3.77 crore to move 29,147 tons in the first year and 21,076 tons in 2017 – a cost of only 75 paise per kg of potato.

The freight support facilitated advance shipping of a total of 50,224 tons of potato out of Gujarat into cold stores in other states in last two years. The support was availed by 1,156 beneficiaries (from Districts of Banaskatha, Mahesana, Gandhinagar and Kheda).

This approach alleviated a larger cost (estimated at Rs.40 crore) to create cold stores, and the State Horticulture Mission (SHM) was able to assist the farmers of Gujarat without needing to build large storage capacities locally. This brought vacant storage capacity in other states into use and avoided capacity and cost overruns in Gujarat while minimising the chance of losses due to lack of storage. Importantly, for the receiving States, the ensuing supply brought the crop closer to consumer and optimised its availability and lessened the risk of price fluctuations from any unforeseen logistical inadequacies at a later date.

Period Year (Harvest Season)	Production in (lakh tons)	% Increase in Production
2014-15 (Mar-15)	30.97	-
2015-16 (Mar-16)	35.49	14.59
2016-17 (Mar-17)	38.44 *	8.31

**Primary data from SHM Gujarat*

The Gujarat SHM is of opinion, that on account of this direct linkage with markets in other States, the producers were motivated to increase production, whereas earlier, the availability of cold stores in their immediate vicinity was one of the influencing factors in their crop planning. It also reports that this has also helped to develop a long term buyer relationship for the coming years.

Market linkage facilitated cross regional trade and have a favourable impact in ramping up production, both of which add to the farmers' income.

6.6.5. SAFAL (Fruits & Vegetables)

SAFAL is the Fruit and Vegetable arm of Mother Dairy Fruit & Vegetable Pvt Ltd. (a wholly owned subsidiary of NDDB) and services the Delhi/NCR region with a supply of various fruits and vegetables. SAFAL operates by consolidating the demand from consumers, through approximately 390 retail outlets. The requirement is sourced from 16 States, from farmers associations and regional *mandis*.

SAFAL deals with approximately 180 farmer associations (having approx. 8000 farmers as members). There is no formal contracted arrangement between SAFAL and farmers. The associations aggregate the produce at area-stations established by them, where sorting of fresh produce by the desired quality is undertaken. The farmers' association independently manages the local procurement and the connecting transportation to the SAFAL facility in Delhi. SAFAL supports these associations by facilitating their transaction with the transport services where needed, as well as for selection of crates and weighing machines for their use. The associations run each area-station at their own cost and maintain their business records.

SAFAL also has agriculture extension functionaries on call to support the farmers linked to the area-stations by providing extension services on good agricultural practises, thereby ensuring constant feedback on quality preferences of consumers.

SAFAL provides an assured market channel for the associated farmers, who in turn are directly guided in their practices by market demand. This is made sustainable because of demand side consolidation which allows the supply side to aggregate viable transport loads. A minimum load of one truck is necessary for the area-stations to link in a viable manner with the SAFAL receiving centre. As the linkage is daily and a short run, the transport can be of mixed loads.

SAFAL mainly procures directly from farmers (individual, association, group) and retails exclusively through its owned outlets only. SAFAL has special waiver from mandi commission. Price discovery, is centred on those quoted at Azadpur mandi, which are ascertained on a daily basis. The farmer associations see SAFAL as an assured buyer, and an alternate to other wholesale buyers (Azadpur mandi).

The SAFAL model is primarily a market linking operation that facilitates peri-urban or city proximate farms to access the urban demand, in substantial volumes. The post-production life cycle from farm-to-consumer, of fresh produce procured in neighbouring states, is mainly handled in the open ambient, without any pre-cooling at the area stations (collection centres). This is possible as the farm to consumption handling is fast-tracked in timeline of less than a 48 hours. However, SAFAL can use reefer transport and associated handling when the demand for quality is a priority or for frozen products that it also handles.

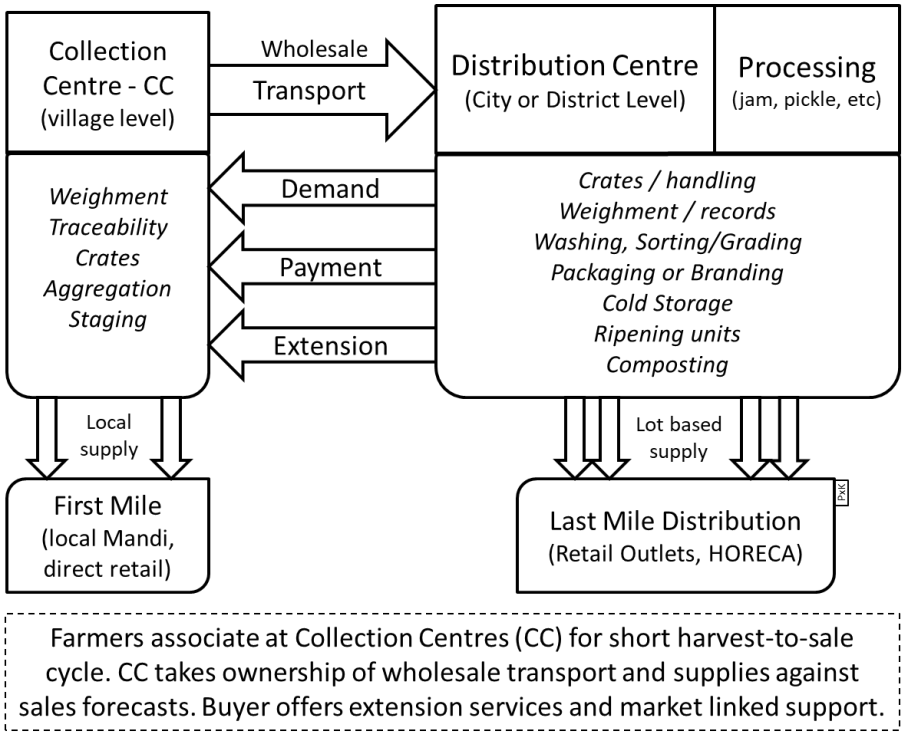


Figure 6.2 Typical peri-urban market linking operations (SAFAL model)

SAFAL's operations differs slightly from Mother Dairy's other arm that deals with milk and milk products, which sources from dairy cooperatives, and markets through multiple retail channels, besides owned branded outlets.

A comparison between Mother Dairy's Milk model and Vegetable Model (SAFAL) is tabled:

Model	Description
NDDB – Dairy model	Production to retail is operated by Coops/Federations. Raw milk is sourced from producing organisations/SHGs from village centres. Homogeneous produce undergoes treatment or is processed into milk products. Coop manages branding and market connectivity. Marketing is through multiple retail channels.
SAFAL – Vegetable model	De-risked from production as farmers are paid on successful delivery to city centre. Farmers associations manage back-end aggregation and transport against an assured market demand. Onward last mile distribution through owned outlets of SAFAL.

The success of SAFAL as a market channel is assessed to arise from communicating information on quality, advance determination of volume required through sales forecasting, assured payment schedule and its captive retail network to consolidate the demand. **SAFAL supplies only about 4 per cent of Delhi-NCR's consumption need (about 315 to 350 tons per day). It has however, maintained this status quo for almost a decade and the enterprise foot-print can be considered for upscaling or for replication in other cities.**

SAFAL is effectively the largest vegetable retail network in Delhi-NCR and is frequently used as a benchmark for price setting purposes by many other retailers. Though the price to farmers is directly linked to the prices at Azadpur *mandi*, their management of the logistics (aggregation, cartage) till Delhi allows the farmers to capture more value, besides maintaining a share of market demand.

Consolidation of market demand through a single market channel has allowed farmer associations to manage activities of aggregation and transport to the wholesale buyer and hence capture greater value in the supply chain.

6.6.6. Kinnow

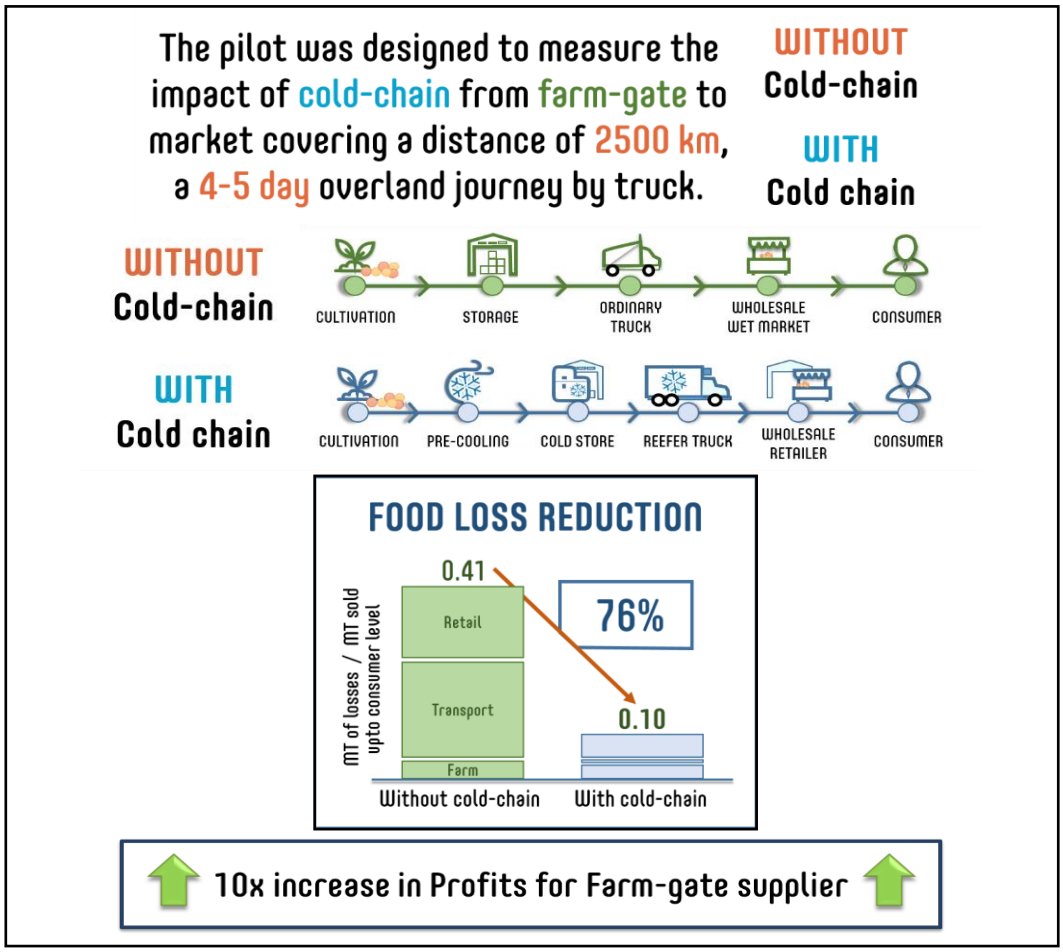
Kinnow is a low-cost, high-yield mandarin variety, mostly produced in Punjab area and usually sold locally and in adjoining States. The fruit could not access demand in other States due to its high perishability and as a result, after catering to demand within reach of the producing areas, large quantity was left unharvested or discarded every season. Attempts at processing the fruit into juice did not meet much success due to various reasons, and the merchandising of fresh juice is the acceptable norm. The farmers also prefer the opportunity in the open market as the fresh market fetches a higher price for large sized kinnow.

The local farmer-producer and aggregators had attempted to take advantage of temperature controlled storage at a local refrigerated warehouse. The use of the cold store environment,

without any pre-cooling, only added about 15 days to its saleable life. And, the selling range, or market, continued to remain local to that region, which was already well supplied due to staggered harvest patterns. The kinnow harvest season is spread from December till February and sales can continue upto early March.

A pilot was conceived by the National Centre for Cold-chain Development (NCCD) in 2015 to expand its marketing range. The pilot targeted the supply of fresh kinnow in 2016, from Abohar in Punjab to the Bengaluru wholesale market. The local farmer and aggregator set up a modern pack-house with pre-cooling system and both the cold-chain and ordinary logistics system were compared[23] - the supply was undertaken both by reefer vehicle and ordinary truck for full comparisons.

Figure 6.3 Kinnow Marketing Pilot (2016)



The supply of kinnow, across 2500 kms to Bengaluru was initiated in February 2016. Multiple supplies were carried out and studied, as the use of pre-cooling extended the selling period till May of 2016. A report was published by Carrier Transicold (member of NCCD) in December of 2016. The operations for this project were funded by the farmers and aggregators.

The result of using a pack-house to pre-condition the produce prior to storage and market

[23] Kinnow Cold Chain Study, www.nccd.gov.in

linkage, was extension of holding life by 70 days. The entire production was not hoarded for selling after expiry of the 70 days holding period. Instead, the supply was commenced to distant markets, at regular intervals throughout this extended holding period. Pre-conditioned produce also benefited from higher quality retention and better ability to withstand the rigours of travel.

The produce was readily accepted at destination (Bengaluru consumers) and selling price ranged from Rs 40/kg to Rs 105/kg with a weighted average of Rs 60/kg. The pilot project bridged the distance, between distant consumers with surplus production, as well allowed for higher price realisation and greater off-take of the production, than was possible at farm-gate.

This pilot emulated the operations necessary to link cross-regional markets with producers. Unlike the earlier enumerated SAFAL model, this operation requires a greater interface with technology, to extend the holding life of the produce being handled. The pilot also expanded to supply Mumbai market, though this was taken up as an immediate opportunity on demand from wholesale buyer for the higher stock left in hand.

In the 2017 season, it is reported that the Abohar region has since developed 9 such pack-houses, where there existed none before. As a result of this concept proving pilot, approximately 90 container loads of kinnow have since been exported from Abohar into Middle East and Europe and almost 350 reefer trucks were deployed to service the domestic kinnow trade. The appropriate infrastructure provided the relevant tools to access hitherto un-tapped markets. **The extended life span of the produce was utilised to target the markets across longer distances, instead of waiting for local demand to recover from the available surplus.**

Agriculture need not merely be the business of cultivation. The next level activities to efficiently link the supply to consumers can also be developed as the farmer's business.

Key Extracts

- Production at farms is not the sole measure of achievement. There is need to measure and quantify the outcomes after marketing and monetising the output.
- Post production activities provide producers with the choice to sell their produce across place, time and forms (distance arbitrage, time arbitrage and processing).
- Infrastructure development interventions that target these three results, need to be assessed against market expansion, throughput achieved and the revenue generated.
- Various examples indicate the path to ensure that farmers can extract the most from their produce, consumers' get access to steady supply of food, and the resources that go into agriculture are not wasted.
- Agriculture is to redefine itself from conventional cultivation based activities to include post-production & marketing activities, with the prime outcome being greater value realisation to farmers and socio-economic growth for the nation.

Chapter 7
Recommendations

This chapter highlights some key recommendations for the perishable and non-perishable agricultural produce segments. The full compilation of all related recommendations are placed in Volume IV.

7.1. Synopsis

India's agriculture is undergoing a realisation of a rapidly shifting challenges. The old sufferance of a lack of sufficient marketable surplus, has these days become a dichotomy of glaring surplus (77 million tonnes of buffer stock), alongside malnutrition and frequent food inflation. The existing market network does not allow an eased flow of produce, that balances supply with demand, causing localised gluts and shortfalls in far areas. The post-production supply chain system is not developed to cope with the ever growing distances between farm supply and consumer demands.

Agricultural markets require to operate as a single integrated logistics network, and not merely as isolated locations for conducting on-off local transactions. It is essential to give a fillip to agri-logistics, to promote safe handling and cross-geographical interconnectivity, along with modernisation of infrastructure. Logistics intervention is made viable by the aggregation of quantities into storable and transportable lots. To achieve an efficient and minimum scale of operations, farmers too would need to operate in groups. Without the integration of farmers to consolidate at village level, there is a sustained a multi-layered and inefficient mode of operations in marketing.

The affirmation of a one-nation agricultural market will require opening up and a graded deregulation of marketing activities. National level initiatives to ramp up development of post-production handling including agri-logistics is indispensable to take agriculture beyond the confines of the fields. The mode of facilitation depends on the type of produce and its differentiated market linkages. A general balancing of the price dispersion and price wedges across the country can be resulted, provided the markets function as a gateway to one another.

7.1.1. Non-Perishable farm produce

In case of the majority of non-perishable produce, the demand from consumers is increasingly communicated through the processing industry. This is evident in produce like cotton, tea, coffee, oilseeds, leather, sugarcane and most foodgrains. As market channels for such farm produce, many have developed as large industries in their own right. In most cases, the end-user does not consume agricultural produce from farms, but a product of industry. These agro-industries are one of the primary users (markets) of farmers' produce.

The volumetric and qualitative requirement from agro-processor (miller, product manufacturer, etc.) is usually channelled down to farmers through commodity traders and layers of other supply chain intermediaries. However, the demand generated is closely linked to that from end-consumers as the user (processing) industry is typically organised in its forward marketing. Whether small scale or of large industrial scale, they frequently compete for consumer attention

by innovating their final product. The demand for certain commodities for crops like cotton, tea, tobacco, etc., is also influenced by global inventory status and extra-national competition.

Private sector participation in hardy commodities has progressed to notable scale, though they remain influenced by the various controls of the Government. Agricultural marketing regulations and trade policies have an impact on the freedom to transact and further expand their markets and bring greater growth in the trade. The surplus inventory of such storable commodities needs to find markets wherever possible. There is need to reconsider policies so as to open the agri-business stakeholders to be more readily responsive to market dynamics, and in turn link production with a larger market demand, including for exports. Private sector participation in farm-gate purchase of commodities can be scaled up, provided certain inventory restrictions and controls are eased.

The Indian farmer is normally driven by price signals, including MSP based procurement by Government and State agencies. However, the major procurement for central pool are largely limited to select foodgrains, namely, wheat and paddy. The onus of post-harvest handling tends to pass on to the procurement agencies. Modernising the central pool infrastructure and strategic cycling of stock into distribution and marketing channels is recommended. The liquidation of excess central pool inventory at regular cycles is an obvious and common recommendation. Releasing existing storage capacity for the new procurement cycle will free the capital which is normally being invested to build excess capacity for the surplus being procured. This capital should be directed into other forms of infrastructure necessary for post-production marketing and market linkage. Government agencies also procure a few other crops, such as oilseeds, pulses and cotton. In case of sugarcane the procurement by sugar mills is also directed at specified MSP linked rates.

The MSP linked procurement for food reserves is a predetermined demand signal for the farmer. Procurement in addition to desired strategic buffer norms, was intended as a stop-gap arrangement to offset any temporary fall in price. However, MSP procurement (wheat and paddy), surplus to the desired reserves, is now carried out as a matter of normal course for various reasons. MSP procurement was also intended to promote production of certain crops, bearing greater scope of contributing to food security requirements. To keep this strategic purpose alive, the MSP linked expenditure on stock of wheat and rice, beyond the buffer norms, can be diverted to other crop types where such inducement in production is felt necessary. The targeted crops should be ascertained on the basis of demand trends. A two year advance notice of crops that will actually be procured under MSP should be implemented. This should be announced with sum total of procurement expenditure for coming two years.

Expanding the MSP based procurement system to private sector participation is also an option to consider. The procured stock can be exempt from controls to allow the procuring agencies to trade freely. This will enable a spread in the impact of MSP as desired.

7.1.2. Products of processing industry

The agriculture allied processing industry outputs multiple products for consumers. A set of various consumer products, including those of the food processing industry, have distinct demand-supply relationship with the end-consumers. As is the case with all industry types, the dynamics is manifest in the form of small scale, medium scale and large commercial scale enterprises. As their feedstock, or source raw material, is farming linked, these are important buyers of agricultural produce. Competition is fierce in the industry and innovation to create new products to capture the consumers is the norm. The food processing industry also faces added competition from the prevailing wide network of the fresh produce market.

The raw materials used in some of these industry sectors are also facing competition from synthetics and composites. However, technological advancements work both ways, and agricultural output is also finding new uses. The use of produce as biofuel and examples of bamboo based textiles and composite materials are common illustrations. Raw material as by-products from various agricultural processes is also used as biomass, building material, plastics, cosmetics, organic fertilizers, etc. Technology has expanded the uses of agricultural material and greater consumer awareness about sustainable living also gives stimulus to new uses.

In the food sector, the industry uses special cultivars to suit the processing technology in use. The industry is not only constrained in sourcing raw material, categorised by its processing and non-processing varieties, but also by qualitative conditions to comply with the extant food safety norms. State governments are recommended to promote cultivation of processing variety crops, to suit the qualitative needs of the local food processor, which will help farmers to vertically integrate with an assured buyer. Regulated Agricultural Markets in states must enter into understanding with nearby or co-located processing units, to efficiently serve as a channel of demand from these processors to the farming catchment. Demand information and any extension work for these processing units can be channelled through the near-farm markets.

Recovering value from culled produce in the form of pickles, jams, dried items and the like, is a small scale aspect of food processing, but contributes the most to mitigate food loss, especially if established at first mile (village level). These small scale processing units should ideally be co-located with produce handling pack-houses and assembly markets, where non-marketable produce is initially segregated. The spin-off effect of this approach is generation of cottage scale industries and farm/home level jobs and incomes.

Many products of the processing industry are also segregated as organic and non-organic. The organised marketing of the processing industry can therefore support the country's unique '*Paramparagat Krishi Vikas Yojna*', an initiative that has long term sustainability outcomes.

Products from what are traditionally called coarse cereals, are actually high-nutrition foods. Marketing system under food processing can benefit farmers by rebranding coarse cereals as nutri-cereals, including increasing their use in a wide variety of food products. These have an important role to play in addressing the nutritional balance of the average Indian diet.

7.1.3. Perishable produce

India has witnessed a marked increase in production of perishable high nutrition products like fruits, vegetables, fish, meat and poultry products etc. However, the development of the associated supply chain infrastructure, for post-harvest handling and to convey these perishable products to markets, was not always strategically directed, except in the dairy sector. This has led to a concomitant demand-supply mismatch across these agricultural commodities, reflected in the frequent and widespread price fluctuations and inflation in the face of increasing production. This shortfall between demand and supply is coincident to food losses because of discards that occur at farm-gate, along with hunger and nutritional deficit at consumer-end. Poor handling due to lack of suitable packaging and transport also contributes to additional food loss en-route to markets.

Perishable food items are always susceptible to higher risk and are constrained by time taken to markets. Easier access to cross-regional markets needs to be facilitated. The measures to determine achievements by developing agencies, should also account for whether the total quantity of production is monetised, and whether the value realised is across incremental distances, so as to drive an agenda to capture markets across State border. To drive the efforts in this direction, the budgetary allocation to implementation agencies can accordingly be linked to the revenue generated from existing farm production of the region. This will also provide impact measure on actions taken to double the farmers' income.

Horticulture, animal husbandry and fisheries are particularly suited to small and marginal farmers who have less land, but have more family labour. Various schemes of the Central and the State Governments have been very useful in helping farmers gain access to affordable technologies and skills through subsidy and loans. Besides, promoting optimal cultivation practices, in the post-production stage this support largely targeted building storage to offset seasonal harvests, but did not address the post storage link with consumption points. The financial assistance by government for marketing infrastructure, focussed primarily on building cold storage capacity.

"The majority of cold storages set up for storing fresh fruits & vegetables, in warehousing business model in the country, have been constructed on the basis of *ad hoc* advice of suppliers of plant & machineries for refrigeration & cooling system and thermal insulation materials under consultancy services provided by chartered accountants who prepared bankable projects for securing bank loans" [24]. "The push to build up storage capacity through cold chains has not been successful in vegetables and is limited for fruits" [24]. The focus on storage alone has not proved successful, bereft of other aspects that complete the chain. There is need to re-evaluate the post-harvest market connectivity, to bring gainful productivity to farming and find solutions to minimise food loss, as also to ensure nutritional security. Future initiatives should consider the real need for holding space, versus promoting direct delivery systems.

[24] Planning Commission, Committee on Encouraging Investments in Supply Chains Including Provision for Cold Storages for More Efficient Distribution of Farm Produce (Dr. Saumitra Chaudhari report, May 2012)

The lack of holistic logistics, connecting as a bridge between demand and supply, also allows for easy manipulation and monopoly in sensitive crops like onion, potato and tomato. Further, lack of adequate pre-conditioning facilities at farm-gate, is a hindrance for translating efforts to increase production into the desired socio-economic growth, which needs the produce to reach selling points safely and in full. The infrastructure in the form of cold storages, has so far only fulfilled the requirement for potato, dried chillies and the like, which can be held and marketed without any other specialised interventions such as pre-cooling or refrigerated transport. These crops do not need the complete cold-chain for their marketing.

The large bulk of fruits and vegetables has different post-harvest supply chain requirement, one that not only temporarily extends the holding life of the produce, but also complements with its onwards safe linkage to city hubs. Consumer demand is channelled through wholesaler down to farmers through layers of intermediary *mandis*, aggregators and agents. However, in this chain, the farming community has the option to directly link with wholesalers by employing the intermediary services. There is opportunity to the farmers to take on the next level value chain activity segments. The task will involve close working by development agencies with the farming community, in developing the most suited and critical infrastructure items, at farm gate (village level).

To immediately expand demand, it may also be worth examining linking local production of perishables like vegetables to supply schools (for mid-day-meal), *anganawadis*, hospitals and hostels. Such practices have found favourable acceptance in Brazil and worth replicating in India. Maximising on local consumption will proportionately square off the magnitude of evacuation concerns, and reduce some of the transaction costs to the farmer-producer.

Demand expansion, is therefore, impacted by deficiencies in the logistics connectivity developed so far, leaving the supply chain for perishable horticultural produce extremely short. **The inadequacy of technology aided farm-to-market logistics, contributes to high food losses especially in case of perishable foods.**

Excelling at cultivation, to add to yields, is bound to result in wasted resources if the output is not finding access to markets. In fact, non-marketed surpluses end up adding to the net cost of food and feed inflationary pressures. Waste and rejected produce, needs to be recovered and monetised through food and non-food processing. Processing units can be supported by guiding in-range farmers to produce the necessary processing variety crops for use as dedicated raw material for making other finished products.

It is safe to conclude, that higher production (without the appropriate market linkages) does not translate into higher returns to the producer, and neither are the benefits of higher production being fully passed on to the consumer.

The bulk of logistics globally, is linked to moving agricultural produce and products. A national policy to streamline logistics, with special emphasis on agri-logistics is recommended.

7.2. Strategy recommendations

The broad strategic direction emanating from the prime objective to double the income of the farmers, in effect, requires ramping up their selling volumes by doubling the market access. This must be done so as to tap into existing consumer demand, and keeping the supply side market linked. On the whole, the physical access of produce to markets to monetise larger volume of produce is a key objective. Planning and implementing agencies, especially at State level are recommended to consider following in the context of doubling farmers' income:

A. Farmer's income is directly related to the selling volume of the harvested produce. The ability to convey more volume of production to markets will have an immediate transformative impact on farmers' income.

B. The ability to recover value from full quantity of production is directly related to the total time available to transact the post-harvest sales. Inventory-turns of stock held need to be within such timelines. This time period is reduced in case of the perishable crops.

C. The ability to directly link farm-gate with more markets, empowers the farmer or farm-gate aggregator with a choice of buyers and option to take up other post-harvest operations. This ability is also directly related to the crops' post-harvest holding time.

D. Increasing the density of markets will not be a solution by itself, unless the markets are networked through transport services. Each market should have a function to open a gateway to another, and not merely be the first and only point of sale for farmers.

E. The farmer's income comes from multiple sources. Creating infrastructure and jobs, for near-farm functions that aid the primary business of selling farm produce, triggers a virtuous cycle and a multiplier effect on overall income of farmers. Hence, capital expenditure into agriculture allied infrastructure at village or block level is preferred.

F. Logistics can be strengthened by setting up modern aggregation points at Panchayat or Block Samiti level. These aggregation centres will serve as the farm-gate loading points for the onwards wholesale market connection in the supply chain. The collection and supply into these aggregation centres can be facilitated by individual Panchayats or FPOs/VPOs or Primary Agriculture Cooperative Societies (PACS).

G. While cultivation is bound by agricultural land and is a subject of the State, the marketing interventions may be addressed at the National Level for a unified market. Item 33 of the Concurrent List includes trade and commerce in, and the production, supply and distribution of foodstuffs (besides others). As such, a centrally driven and monitored initiative to link surplus produce of farmers with cross geographical markets is preferred.

H. Increase crop productivity only to free up land and not to add to production. The freed land can be diverted to other high value crops, livestock, poultry and market linkage.

Basic guidelines to adopt in relation to post-production market linkage:

I. Ascertain the safe holding life cycle of the crop being considered. Take this time period as the total time in hand to monetise the produce. In generic terms, halve the time in hand

to target the market, so as to have sufficient time left on shelf. For example, grains that have a normal holding life of 18 months in normal warehouses, should be planned to exit storage for final monetisation in 9 to 10 months. Similarly, if banana has a maximum holding life of 20 days, it should immediately move to reach consumers much before expiry of this time period.

J. Production that is estimated in surplus to near-farm consumption, must be planned in advance for post-production interventions – to connect with demand centres further afield, in other regions and States and/or to extend holding life for a later transaction.

K. Assess the technology available to extend marketable life of each crop type. Establish post-production set of activities with associated infrastructure to allow farmers to link with buying centres, at a distant. Reaching a market, in advance of expiry is important.

L. Work out the consumption volume within a 24 hour radius of source. NSSO household consumption data will provide the consumption for the population within this range.

M. Learn the buying patterns of intermediary consumers or wholesale market within range. Where possible this market linkage may be formalised for local FPOs / VPOs / PACS and other types of farmers groups for quality and volume. Pricing can be left to market dynamics, yet price forecast information to farmers be facilitated.

N. Allocate budgetary and knowledge support to transform the market linking capacity of farmers groups. Modernise infrastructure to serve as a transport hub from farms and develop small and medium agro-processing units at first mile.

Short term objectives for planning and implementing agencies:

O. Develop small-load transport facilities as a service to connect block level aggregation yards directly with consumption points. Preferably involve rural youth as driver entrepreneurs. Example of milk pickup run by dairy cooperatives can be emulated.

P. Adopting the Model APLM Act, 2017, including the provision for automatic notification of agri-produce warehouses and cold stores as markets will facilitate more immediate access of storage facility instead of perforce having to transit through APMC yards. It will also help expand the market network.

Q. Establish modern pack-houses on a priority at horticulture producing areas, with aim to move the aggregated and pre-conditioned produce directly to terminal markets.

R. All new agriculture allied infrastructure to be assigned a minimum throughput volume as a development target. This will incentivise activities to bring about better capacity utilisation, for more frequent delivery based transactions and drive the supply network to be more dynamic.

S. Budgetary allocation to enhance productivity must be linked to market demand assessments, and linked to market connectivity (minimal storage and more transport).

T. Offer special status to Start-Ups and other enterprises that directly purchase from farmers. Facilitation of support be fast-tracked for such enterprises.

U. Set up local teams to measure and assess food loss quantities in the supply chain, so that infrastructure development agencies can incorporate outcome targets, gauged by the incremental reduction in physical losses of agricultural produce over next 4 years.

7.3. National Level Platform for DFI

To guide and monitor the interventions undertaken to double farmers' income, a nodal Executive body or Secretariat for Doubling Farmers' Income (DFI) is recommended. The agenda should be to adopt and implement activities to enhance post-production marketing at the National, State and District level. Therefore, the body would serve like a steering committee for Doubling Farmers' Income (DFI). The secretariat would adopt a market linked, agri-value system approach. Since the agri-value system includes input providers, farmers, transporters, warehousing, food and agro-processors, retailers, developing collaborations for cohesive supply chains will also require the integration of the support mechanisms provided to each partnering activity. The recommendations of the body would therefore be used to dovetail the ongoing government support through multiple schemes. This body will also coordinate a multi-stakeholder partnership which would allow government, industry, think-tanks and NGOs to work together under a common platform, as a working group.

The partnership platform envisaged, would primarily focus to strengthen the market linkages of farmers, along with development of required logistics infrastructure like cold-chains, market yards and warehousing. Interested stakeholders, across sectors, would collaborate through this platform to fast-track the necessary development, such as grain silos, integrated pack-houses, transport linkages, container handling facilities, agro-processing units, etc. The broad framework and concept is discussed in detail in DFI Volume IV (Agricultural Marketing).

7.4. Jai Kisan Jai Jawan

Marketing and post-production activities require differentiated skill sets including understanding of industrial machines and disciplined operations. The organised marketing also requires disciplines regarding food safety and quality assessments. There is advantage to induct retired personnel from defence and para-military services into post-production activities and other areas like Hi-tech and High Value Agriculture. The operational skills of the retired personnel from armed forces (army, air force, navy and para-military) will be a value addition to the supply chain operations.

Approximately, more than 60,000 personnel retire from the armed forces every year, and a large number are from rural India. In non-commissioned ranks, the retirement from services is at a younger age and they seek other fruitful opportunities. Post-production and agriculture allied services can be a good option for self-employment or for secondary employment after retirement. Inducting such skill sets, having past exposure to hi-tech equipment and machines, would fast track the needed growth in post-harvest management and farm-gate productivity.
Shortly prior to leaving service, the retiring personnel may be given exposure to related government schemes and the scope of specific areas such as pack house management, project maintenance among others. Exposure to pre-production activities (protected cultivation, bee-

keeping, etc.) can also be provided. The interested personnel can be provided additional training and support to implement the projects selected by them.

For such exposure and training, the existing infrastructure of the Regimental HQ, ICAR Centres, State Agriculture Universities (SAU), Krishi Vikas Kendras (KVKs), Central Agriculture Universities, various Centres of Excellence (CoE) set up by States, and other such facilities can be used. The existing technical resource persons of ICAR, SAUs and SHMs can be availed for providing relevant training of these personnel. Attracting retired soldiers into agriculture and allied activities is expected to lead to greater professionalism in the sector. The interested individuals can take advantage of ongoing schemes of the government to set up and/or manage value chain systems and can also be participate in extension and ATMA services.

7.5. Demand versus Price signals

The current method of monitoring price is insufficient to address the inefficiencies of the agri-supply chain. A price signal is an ex-post facto information, as the price only indicates the current status of transactions. At best, a price signal will indicate a short term trend and at worst can result in over supply to a demand centre crashing the price in subsequent transactions. Price variations occur when unfettered supply is done to market locations where the consumer base can no longer absorb the supply. Thereafter, another layer of activity is undertaken to connect with yet another market centre, the result being multiple handling, losses and yet another undirected movement to push into the next market.

There is a need to assess and project demand signals, where the measure will be the quantum of demand at each wholesale or trading point. Demand signals are ex-ante indicators and will help take agriculture into agri-business mode. Demand quantification will allow the post-production activities to plan the flow of goods, deploy suitable capacity and bring stability to the capacity utilisation and the costs involved.

Demand quantification also allows effective balancing with supply and will minimise the risk of excess supply into markets, leading to inefficient price discovery. Demand projections will also help extension workers and farmers to plan their pre-production and production activities to suit quantity and quality to suit the expected demand. Demand signals will also allow for traders and market channels to direct the flow of produce as per requirement at consumption centres, thereby stabilising the price variations. Demand signal is market intelligence.

It is recommended that at a national level, market intelligence system be created, to assess consumption trends and thereafter, project required demand in quantities. The demand projection must cover periods in advance of sowing cycle; annual, bi-annual, monthly and weekly and can initially target the top 10 cities of the country. Market surplus (excess supply at the market level) must also be evaluated, besides marketable and marketed surplus.

7.6. Other Recommendations

A full set of recommendations are listed at the end of Volume IV. Those that are specific to post-production activities, are positioned here.

i. Creation of a specialist Division or Body for doubling farmers' income, to supervise and monitor related implementation. This should at first instance focus on post-production interventions with the mandate to expand cross regional supply chains with private sector involvement. The Body would also monitor development of basic support systems such as irrigation, roads, electrification in the less endowed areas.

ii. Create a DFI corpus to manage and utilise funds to provide extension support for improving post-production management and marketing of agriculture produce. A share of CSR funds can also be allocated. Individual tax payers be allowed to donate vide opening of section 35CCC of IT Act for contributing to the dedicated corpus.

iii. The DFI corpus can also be funded through a special fund to which any tax paying entity can contribute deposits. The sum deposited would earn interest at 4 per cent but the principal and interest may be considered for income tax deduction (similar or higher than the concession provided for housing loans).

iv. All Krishi Vikas Kendras (KVK), Central Agriculture Universities (CAUs) and State Agriculture Universities (SAU) can adopt local aggregation centres (rural market yards and/or aggregation and pack-houses) to increase market linkages and develop the commercial competitiveness of each such centre. The measures to be outcome oriented, including capacity utilised, revenue added and loss mitigated.

v. Farmer Producer Organisations (FPOs) have been initiated to mobilise the farmers. This mobilisation of FPO's needs to translate into crop specific cultivation on contiguous parcels of land. There is need for FPOs to group contiguous land parcels to achieve desired benefits. Developing entire village zones as Village Producer Organisations (VPOs), to collaborate and produce one or two crops can be considered. This will bring suitable scale on production side and to the post-production activities.

vi. Market yards are constrained in their ability to handle growing flow of perishable produce types. Separate development for such produce in the form of modern aggregation and preconditioning units (modern pack-houses) to be done at primary level at villages. Having capability of post-harvest handling at village level, will give impetus to cluster based approach in cultivating specific crops for fresh market.

vii. Rural electrification targets may include mandatory supply to the local agriculture market infrastructure, especially integrated pack-houses, besides school and post office. Similarly, in villages that have been electrified, supply for post-production activities must be taken up as a priority.

viii. Land parcel for aggregation centres and pack-house be identified at the village level. Pre-designating a land parcel will allow for faster permits; and Change Land Use (CLU) can be waived for near farm facilities such as pack-houses and small processing units.

ix. Rationalise the regulatory framework under the Essential Commodities Act so as to clearly distinguish between opportunistic hoarders and those who hold inventory to feed a steady captive supply to end-use, to encourage supply chain efficiencies.

x. Promote opportunity for rural youth to own and operate village pack-houses or as driver-entrepreneurs to operate distribution transport. With villages as the source of transport, reverse logistics to supply consumer goods to rural areas will also benefit.

xi. Currently the system of individually prepared project reports, tends to deter credit offtake. Identified components, capped at a specific cost and for purpose of aggregating, or transporting produce, may be considered under a prescribed format that is simple to fill for purpose of availing priority sector credit. Banks may create product lines (formulate ready to use loan application forms) to ease access to credit for various equipment and components that help to modernise existing post-harvest infrastructure.

xii. All support for production growth to be directly linked to market demand assessments. The states must identify the target market and the required market linkage. Increasing production and covering more area, without market links being planned, only adds to costs and non-marketable outputs, adding to farmers' distress. States are recommended to create agribusiness and marketing policy with an inverse fork-to-farm approach.

xiii. Ongoing fiscal incentives be directed for purpose to promote and support the private sector in interacting with FPOs/VPOs or PACS. FPOs/VPOs/PACS can certify the farm collaboration or procurement by private sector enterprises, and the incentives be linked to these operations.

xiv. Waiving the fees for National Permits for reefer transport (approx. Rs 16,000 per year) is recommended to encourage investment in reefer transport. Currently, the Motor Vehicle Act does not maintain records of reefer trucks and it is estimated country has about 10,000 units only, a shortfall of 85 per cent against minimum requirement. The waiver can have a sunset clause, to end after 7 or 10 years.

xv. Rationalise the subsidy schemes and strategically allocate more share to develop the weaker links in the supply chain, especially those that boost investment in infrastructure and assets at village level. The capital goods used for creation of, and to modernise the agricultural logistics, such as pre-coolers, integrated pack-houses, reefer vehicles, reefer containers, warehousing, silos, cold stores, etc., can be exempt from GST to reduce the cost burden, as these were previously exempt from excise duty.

xvi. Promote energy saving systems for energy intensive post-production activities, like hybrid energy sources for milk chillers, program logic control systems, thermal storage banks and technologies that promote more sustainable energy uses in transportation and other logistics.

xvii. Develop organised retail for the promotion of more 'SAFAL' type organisations so as to consolidate consumer demand in major cities. Special status be given to start-ups that plan businesses related to agriculture logistics and marketing. A start-up incubator to support and promote enterprises involved in post-production activities be established

by the government.

xviii. Establish front line demonstrations and a centre of excellence in cooperation with domestic and international technology providers, with specific focus on long term sustainable solutions to the energy based applications in post-production activities.

xix. A pan-India agri-logistics and marketing cooperative/company can be encouraged. This can be promoted under NCDC and equity can be held by various stakeholders such as MARKFEDS, IFFCOA, GCMMF, IPL, etc.

xx. A major business deterrent is the freight cost for spearheading small volumes when first accessing and testing markets. A domestic freight subsidy for FPOs to ship produce over road, rail and waterways can be considered. The discounted freight can be for a fixed volume and value of produce being transported. On achieving critical mass, the subsidy for that lane be stopped. Support to be applicable only when shipment is initiated by FPO / PACS, or a village or block level assembly or aggregation centre or pack-house.

xxi. Agricultural markets must also be facilitation centres for farmers, and not only a point of sale. Each regulated market may consider to provide a service to farmers, to deliver the produce to transact at other markets in a radius of 500 kms. Operation of a regular transport schedule to other market centres, for a minimum aggregated quantity can be considered. Farmers can share loads or collaborate to build larger truck loads, and hence connect to cross regional sales. Markets can charge fees for the link service.

xxii. Dedicated focus is needed to initiate rail based, multi-modal transportation for sensitive agricultural produce. A low volume freight scheme especially for agri-logistics be considered, to strategically develop regular and large volume movement on rail modes. Regular scheduled runs on container trains can be announced, provided produce is packaged and safe for long distance travel.

Post-production activities transfer value; across place, time and form; for every grain, every ounce and every drop produced. Agricultural marketing is the intellect behind this transfer, so that post-production value is can be optimally monetised and expedited, to the benefit of farmers and consumers.

Agricultural marketing has two facets, the first is to intelligently bridge demand with supply and this is driven by commercial interests and market forces. This balance is enabled through post-production activities and the supply chain. The other side of agricultural marketing is from aspect of government interventions, the regulations and policies that are strategically positioned for the purpose of development and welfare of farmers. Volume IV of this report details the various aspects of agricultural marketing in relation to doubling farmers' income.

-- X --

Annexures

Abbreviations

APEDA - Agricultural and Processed Food Products Export Development Authority

APMC - Agricultural Produce Market Committee

APMR - Agricultural Produce Market Regulation Act

CACP - Commission on Agricultural Cost and Price

CLU - Change of Land Use

CWC - Central Warehousing Corporation

DACFW - Department of Agriculture, Cooperation & Farmers' Welfare

DAHDF - Department of Animal Husbandry, Dairying & Fisheries

DFI - Doubling Farmers' Income

e-NAM - Electronic National Agricultural Market

FCI - Food Corporation of India

FDI - Foreign Direct Investment

FIGs - Farmer Interest Groups

FLW - Food Loss & Waste

FPC - Farmer Producer Company

FPO - Farmer Producer Organization

GBY - Grameen Bhandaran Yojana

GCF - Gross Capital Formation

GDP - Gross Domestic Product

GST - Goods and Service Tax

ICAR - Indian Council of Agricultural Research

ICT - Information and Communication Technology

ISAM - Integrated Scheme for Agricultural Marketing

MIDH - Mission for Integrated Development of Horticulture

MIS - Market Infrastructure Scheme

MoAFW - Ministry of Agriculture and Farmers Welfare

MoFPI - Ministry of Food Processing Industries

MSP - Minimum Support Prices

NABARD - National Bank for Agriculture and Rural Development

NCCD - National Centre for Cold-chain Development

NCDC - National Cooperative Development Corporation

NDDB - National Dairy Development Board

NGO - Non Government Organization

NHB - National Horticulture Board

NHM - National Horticulture Mission

NITI - National Institution for Transforming India

NWRS - Negotiable Warehouse Receipt System

OWS - Other Welfare Schemes

OECD - Organization for Economic Co-operation and Development

PACS - Primary Agriculture Cooperative Societies

PEG - Private Entrepreneurs Guarantee

PPP - Public Private Partnership

PPPIAD - Public Private Partnership for Integrated Agricultural Development

PSL - Priority Sector Lending

PSS - Price Support Scheme

RKVY - Rashtriya Krishi Vikas Yojana

SFAC - Small Farmer Agribusiness Consortium

SHGs - Self Help Groups

SWC - State Warehousing Corporations

UTs - Union Territories

VPO - Village Producer Organisation

WDRA - Warehouse Development and Regulation Authority

WP - Wholesale Price Index

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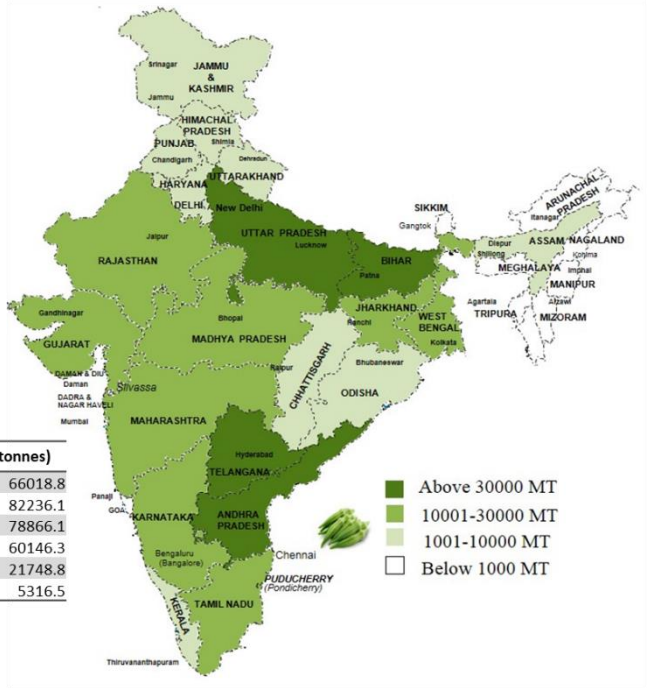
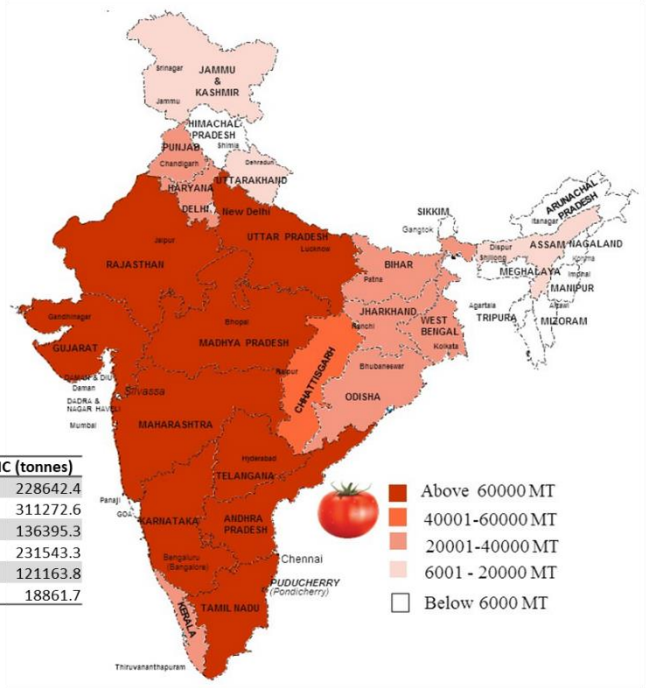
Monthly Average Consumption by Regions (indicates monthly volumetric demand of produce - tons)

Total Monthly Consumption Profile of Okra



Zones	TMC (tonnes)
North	66018.8
South	82236.1
East	78866.1
West	60146.3
Central	21748.8
North-East	5316.5

Total Monthly Consumption Profile of Tomato



Zones	TMC (tonnes)
North	228642.4
South	311272.6
East	136395.3
West	231543.3
Central	121163.8
North-East	18861.7

Total Monthly Consumption (TMC) of Okra in MT

State	TMC
Andhra Pradesh	38881
Arunachal Pradesh	163
Assam	3965
Bihar	41788
Chhattisgarh	7840
Delhi	4962
Goa	312

State	TMC
Gujarat	17672
Haryana	6443
Himachal Pradesh	1971
J & K	2641
Jharkhand	10958
Karnataka	10957
Kerala	8991
Madhya Pradesh	13909

State	TMC
Maharashtra	27565
Manipur	164
Meghalaya	209
Mizoram	124
Nagaland	35
Odisha	8099
Punjab	8569
Rajasthan	14597

State	TMC
Sikkim	46
Tamil Nadu	23406
Tripura	610
Uttar Pradesh	38792
Uttarakhand	2640
West Bengal	18020
All India	316578

Total monthly consumption of okra is highest in the state Bihar (41788 MT) and in Andhra Pradesh, Uttar Pradesh, Maharashtra, Tamil Nadu, West Bengal, Gujarat, Rajasthan, Madhya Pradesh, Jharkhand and Karnataka (ranked in descending order), each with total monthly consumption of more than 10000 MT.

Total Monthly Consumption (TMC) of Tomato in MT

State	TMC
Andhra Pradesh	123912
Arunachal Pradesh	799
Assam	12166
Bihar	38617
Chhattisgarh	45428
Delhi	18628
Goa	1325

State	TMC
Gujarat	61225
Haryana	31786
Himachal Pradesh	5940
J & K	11414
Jharkhand	28615
Karnataka	70895
Kerala	23864
Madhya Pradesh	75736

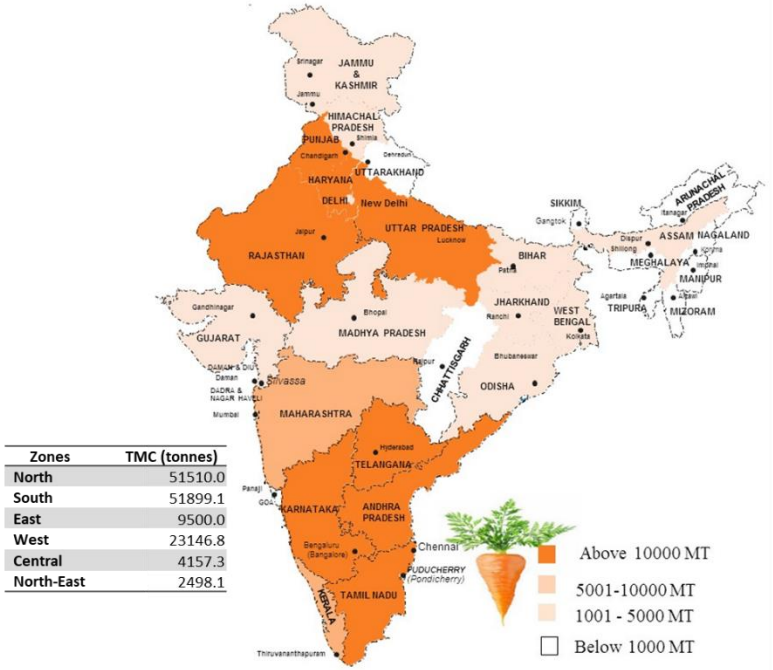
State	TMC
Maharashtra	101577
Manipur	613
Meghalaya	1674
Mizoram	394
Nagaland	1205
Odisha	37477
Punjab	23278
Rajasthan	67416

State	TMC
Sikkim	441
Tamil Nadu	92602
Tripura	1569
Uttar Pradesh	128776
Uttarakhand	8820
West Bengal	31687
All India	1061454

Total monthly consumption of tomato is highest in the state Uttar Pradesh (128776 MT) and in the states Andhra Pradesh, Maharashtra, Tamil Nadu, Madhya Pradesh, Karnataka, Rajasthan and Gujarat (ranked in descending order), each with monthly consumption of more than 60000 MT.

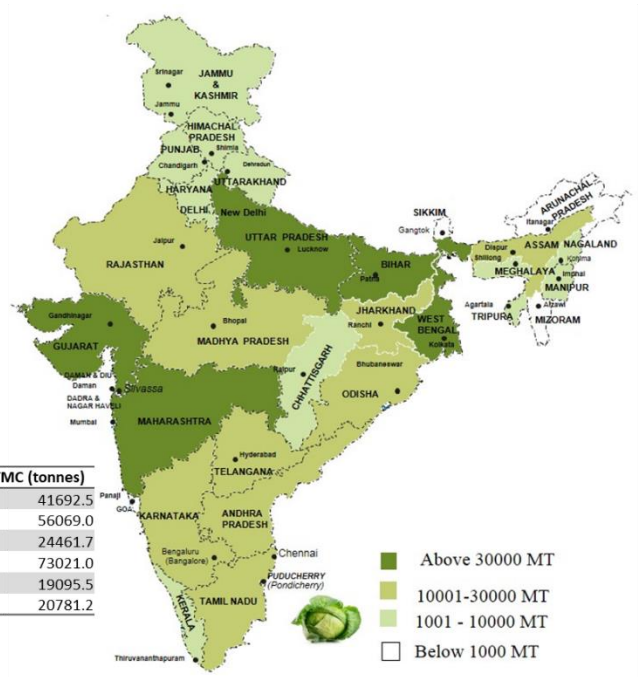
Source: Extracts from NCCD.2015 AICIC Study; NSSO data

Total Monthly Consumption Profile of Carrot



Zones	TMC (tonnes)
North	51510.0
South	51899.1
East	9500.0
West	23146.8
Central	4157.3
North-East	2498.1

Total Monthly Consumption Profile of Cabbage



Zones	TMC (tonnes)
North	41692.5
South	56069.0
East	24461.7
West	73021.0
Central	19095.5
North-East	20781.2

Total Monthly Consumption (TMC) of Carrot in MT

State	TMC
Andhra Pradesh	10561
Arunachal Pradesh	50
Assam	1754
Bihar	3676
Chhattisgarh	787
Delhi	4032
Goa	87

State	TMC
Gujarat	3659
Haryana	12139
Himachal Pradesh	1434
J & K	2270
Jharkhand	1255
Karnataka	11633
Kerala	8361
Madhya Pradesh	3370

State	TMC
Maharashtra	7269
Manipur	153
Meghalaya	240
Mizoram	56
Nagaland	83
Odisha	1053
Punjab	12250
Rajasthan	12132

State	TMC
Sikkim	10
Tamil Nadu	21344
Tripura	152
Uttar Pradesh	18389
Uttarakhand	995
West Bengal	3516
All India	142711

Total monthly consumption of carrot is the highest in the state Tamil Nadu (21334 MT) and in the states Uttar Pradesh, Punjab, Haryana, Rajasthan, Karnataka, and Andhra Pradesh (ranked in descending order) each with total monthly consumption of more than 10000 MT.

Total Monthly Consumption (TMC) of Cabbage in MT

State	TMC
Andhra Pradesh	15767
Arunachal Pradesh	462
Assam	14102
Bihar	29724
Chhattisgarh	8688
Delhi	3878
Goa	578

State	TMC
Gujarat	25854
Haryana	4677
Himachal Pradesh	2182
J & K	3001
Jharkhand	13723
Karnataka	12571
Kerala	8355

State	TMC
Madhya Pradesh	10407
Maharashtra	33748
Manipur	1544
Meghalaya	1485
Mizoram	391
Nagaland	1041
Odisha	15375
Punjab	1791
Rajasthan	12841

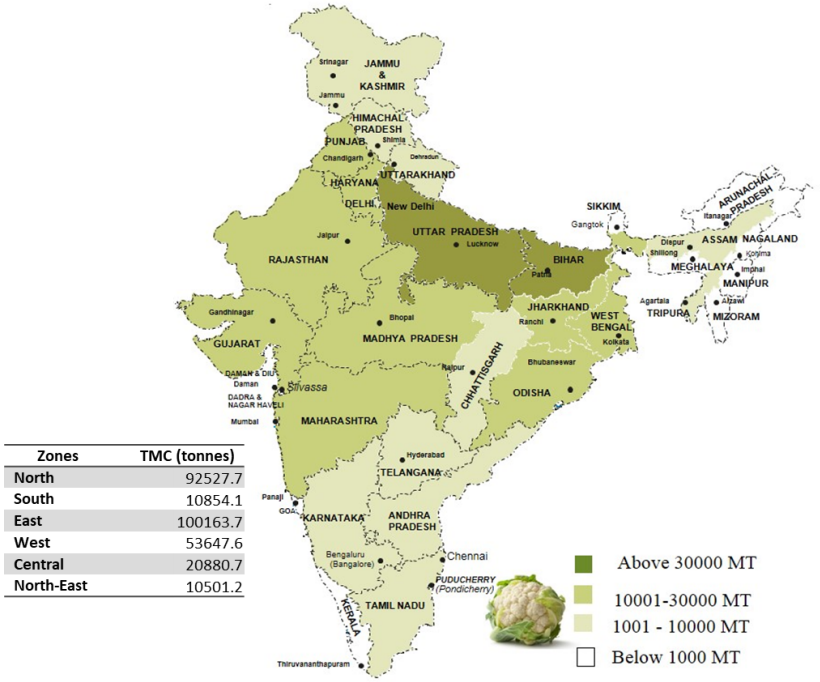
State	TMC
Sikkim	342
Tamil Nadu	19376
Tripura	1414
Uttar Pradesh	23665
Uttarakhand	2497
West Bengal	39026
All India	308557

Total monthly consumption of cabbage is the highest in the state West Bengal (39026 MT) and in the states Maharashtra, Bihar, Gujarat and Uttar Pradesh (ranked in descending order), each having total monthly consumption of more than 20000 MT.

Monthly Average Consumption by Regions

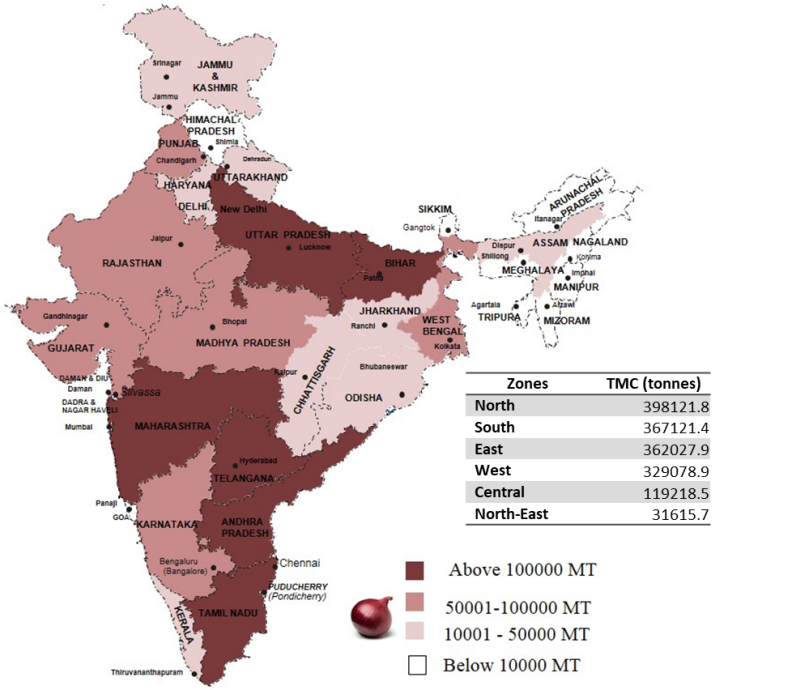
Source: Extracts from NCCD.2015 AICIC Study; NSSO data

Total Monthly Consumption Profile of Cauliflower



Zones	TMC (tonnes)
North	92527.7
South	10854.1
East	100163.7
West	53647.6
Central	20880.7
North-East	10501.2

Total Monthly Consumption Profile of Onion



Zones	TMC (tonnes)
North	398121.8
South	367121.4
East	362027.9
West	329078.9
Central	119218.5
North-East	31615.7

Total Monthly Consumption (TMC) of Cauliflower in MT

State	TMC	State	TMC	State	TMC	State	TMC
Andhra Pradesh	5305	Gujarat	14414	Maharashtra	24704	Sikkim	165
Arunachal Pradesh	110	Haryana	10930	Manipur	285	Tamil Nadu	3049
Assam	8060	Himachal Pradesh	3566	Meghalaya	400	Tripura	1261
Bihar	53701	J & K	4800	Mizoram	38	Uttar Pradesh	53854
Chhattisgarh	5977	Jharkhand	11459	Nagaland	182	Uttarakhand	4625
Delhi	2869	Karnataka	2080	Odisha	10908	West Bengal	24096
Goa	154	Kerala	420	Punjab	11885	All India	283729
		Madhya Pradesh	14903	Rajasthan	14376		

Total monthly consumption of cauliflower is the highest in the state Uttar Pradesh (53584 MT) followed by Bihar, Maharashtra, West Bengal, Gujarat, Madhya Pradesh, Rajasthan, Punjab, Jharkhand, Haryana, Odisha, (ranked in descending order), each with total monthly consumption of more than 10000 MT per month.

Total Monthly Consumption (TMC) of Onion in MT

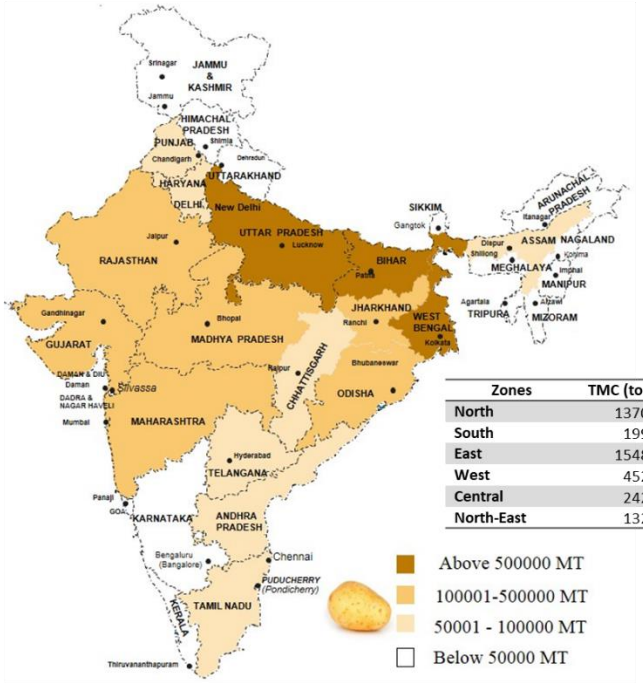
State	TMC	State	TMC	State	TMC	State	TMC
Andhra Pradesh	135901	Gujarat	71511	Maharashtra	158736	Sikkim	426
Arunachal Pradesh	850	Haryana	43058	Manipur	1194	Tamil Nadu	102118
Assam	23190	Himachal Pradesh	9362	Meghalaya	1999	Tripura	2514
Bihar	171740	J & K	17662	Mizoram	545	Uttar Pradesh	229735
Chhattisgarh	30096	Jharkhand	45958	Nagaland	898	Uttarakhand	13096
Delhi	23512	Karnataka	85113	Odisha	45733	West Bengal	98596
Goa	2752	Kerala	43990	Punjab	61697	All India	1612406
		Madhya Pradesh	89122	Rajasthan	96079		

Total monthly consumption of onion is the highest in the state Uttar Pradesh (229735 MT) and in the states Bihar, Maharashtra, Andhra Pradesh and Tamil Nadu (ranked in descending order), each consuming more than 100000 MT onion per month.

Monthly Average Consumption by Regions

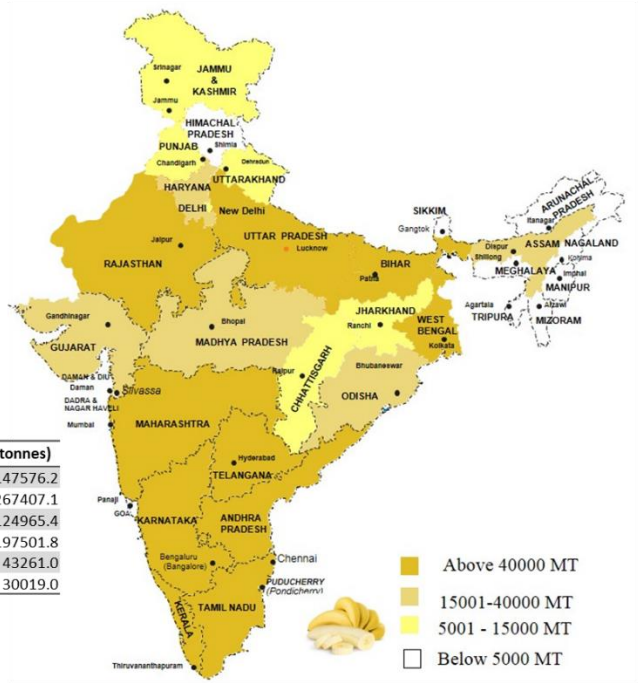
Source: Extracts from NCCD.2015 AICIC Study; NSSO data

Total Monthly Consumption Profile of Potato



Zones	TMC (tonnes)
North	1370917.0
South	199033.2
East	1548233.3
West	452474.9
Central	242481.0
North-East	132606.3

Total Monthly Consumption Profile of Banana



Zones	TMC (tonnes)
North	147576.2
South	267407.1
East	124965.4
West	197501.8
Central	43261.0
North-East	30019.0

Total Monthly Consumption (TMC) of Potato in MT

State	TMC	State	TMC	State	TMC	State	TMC
Andhra Pradesh	74061	Gujarat	149874	Maharashtra	164957	Sikkim	1736
Arunachal Pradesh	3623	Haryana	84428	Manipur	5111	Tamil Nadu	58331
Assam	95836	Himachal Pradesh	17436	Meghalaya	7634	Tripura	10903
Bihar	621223	J & K	26052	Mizoram	2848	Uttar Pradesh	1062987
Chhattisgarh	63706	Jharkhand	179435	Nagaland	4914	Uttarakhand	33872
Delhi	53998	Karnataka	42287	Odisha	159966	West Bengal	587609
Goa	1556	Kerala	24353	Punjab	92143	All India	3881674
		Madhya Pradesh	178775	Rajasthan	136088		

Total monthly consumption of potato is the highest in the state Uttar Pradesh (1062987 MT) followed by Bihar, West Bengal, Jharkhand, Madhya Pradesh, Maharashtra, Odisha and Rajasthan, (ranked in descending order) , each consuming more than 100000 MT potato per month.

Total Monthly Consumption (TMC) of Banana in MT

State	TMC	State	TMC	State	TMC	State	TMC
Andhra Pradesh	86164	Gujarat	38913	Maharashtra	116155	Sikkim	137
Arunachal Pradesh	999	Haryana	22628	Manipur	1252	Tamil Nadu	71066
Assam	20135	Himachal Pradesh	4200	Meghalaya	1076	Tripura	3881
Bihar	58014	J & K	5675	Mizoram	540	Uttar Pradesh	81772
Chhattisgarh	6704	Jharkhand	6411	Nagaland	1999	Uttarakhand	6829
Delhi	11618	Karnataka	65971	Odisha	17697	West Bengal	42843
Goa	1666	Kerala	44206	Punjab	14854	All India	825253
		Madhya Pradesh	36557	Rajasthan	40768		

Total monthly consumption of banana is the highest in the state Maharashtra (116155 MT) and in the states Andhra Pradesh, Uttar Pradesh, Tamil Nadu and Karnataka (ranked in descending order), each with total monthly consumption of more than 60000 MT.

Monthly Average Consumption by Regions

Source: Extracts from NCCD.2015 AICIC Study; NSSO data

Trends and Patterns in Consumption

Item group	Share in total consumption expenditure (%)									
	Rural					Urban				
	1993-94	1999-00	2004-05	2009-10	2011-12	1993-94	1999-00	2004-05	2009-10	2011-12
Consumption pattern of major items (Per person per month)										
Cereals (Kg)	13.4	12.72	12.12	11.35	11.22	10.6	10.42	9.94	9.37	9.28
Pulses (Kg)	0.76	0.84	0.71	0.65	0.78	0.86	1.00	0.82	0.79	0.90
Milk (Litre)	3.94	3.79	3.87	4.12	4.33	4.89	5.10	5.11	5.36	5.42
Egg (Number)	0.64	1.09	1.01	1.73	1.94	1.48	2.06	1.72	2.67	3.18
Fish (Kg)	0.18	0.21	0.20	0.27	0.27	0.20	0.22	0.21	0.24	0.25
Mutton (Kg)	0.06	0.07	0.05	0.05	0.05	0.11	0.10	0.07	0.09	0.08
Chicken (Kg)	0.02	0.04	0.05	0.12	0.18	0.03	0.60	0.85	0.18	0.24
Consumption expenditure on major categories (MPCE Value shares)										
Cereals	24.2	22.2	18.0	15.6	12.0	14.0	12.4	10.1	9.1	7.3
Gram	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1
Cereal substitutes	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1
Pulses & products	3.8	3.8	3.1	3.7	3.1	3.0	2.8	2.1	2.7	2.1
Milk & products	9.5	8.8	8.5	8.6	9.1	9.8	8.7	7.9	7.8	7.8
Edible oil	4.4	3.7	4.6	3.7	3.8	4.4	3.1	3.5	2.6	2.7
Egg, fish & meat	3.3	3.3	3.3	3.5	3.6	3.4	3.1	2.7	2.7	2.8
Vegetables	6.0	6.2	6.1	6.2	4.8	5.5	5.1	4.5	4.3	3.4
Fruits & nuts	1.7	1.7	1.9	1.6	1.9	2.7	2.4	2.2	2.1	2.3
Sugar	3.1	2.4	2.4	2.4	1.8	2.4	1.6	1.5	1.5	1.2
Salt & spices	2.7	3.0	2.5	2.4	2.4	2.0	2.2	1.7	1.5	1.7
Beverages, etc.	4.2	4.2	4.5	5.6	5.8	7.2	6.4	6.2	6.3	7.1
Food total	**63.2**	**59.4**	**55.0**	**53.6**	**48.6**	**54.7**	**48.1**	**42.5**	**40.7**	**38.5**
Pan, tobacco, intoxicants	3.2	2.9	2.7	2.2	2.4	2.3	1.9	1.6	1.2	1.4
Fuel & light	7.4	7.5	10.2	9.5	9.2	6.6	7.8	9.9	8.0	7.6
Clothing & bedding	5.4	6.9	4.5	4.9	6.3	4.7	6.1	4.0	4.7	5.3
Footwear	0.9	1.1	0.8	1.0	1.3	0.9	1.2	0.7	0.9	1.2
Misc. goods & services	17.3	19.6	23.4	24.0	26.1	27.5	31.3	37.2	37.8	39.7
Durable goods	2.7	2.6	3.4	4.8	6.1	3.3	3.6	4.1	6.7	6.3
Non-food total	**36.8**	**40.6**	**45.0**	**46.4**	**51.4**	**45.3**	**51.9**	**57.5**	**59.3**	**61.5**
Total expenditure	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Volume-I of DFI report

Value Share of Crop Categories, Livestock and Fisheries to Total VOP at 2004-05 Prices

Produce	Pre-green revolution period (1960-61/1968-69)	Early green revolution period (1968-69/1975-76)	Wider technology dissemination (1975-76/1988-89)	Period of diversification (1988-89/1995-96)	Post-reform period (1995-96/2004-05)	Recovery period (2004-05/2014-15)
Paddy & wheat	18.15	20.22	21.23	21.80	19.88	17.87
Nutri-cereals	6.90	6.25	4.97	3.85	3.02	2.74
Pulses	7.25	6.06	4.97	4.08	3.33	2.97
Oilseeds	7.07	6.93	6.33	7.84	6.82	6.71
Sugars	4.52	4.57	4.14	4.15	4.73	4.50
Cotton and Jute	2.88	2.60	2.38	2.55	2.28	3.34
Condiments & Spices	1.66	1.59	1.72	1.88	2.15	2.61
Fruits & Vegetables	10.56	13.92	14.67	14.13	16.80	18.80
Floriculture	0.25	0.35	0.37	0.36	0.61	0.93
All crops	77.14	78.20	75.36	72.19	70.01	69.58
Livestock	20.01	18.59	21.38	23.74	25.28	25.78
Fisheries	2.85	3.21	3.26	4.08	4.72	4.65

Source: Volume-I of DFI report

Historical Growth Rates of Crop Categories, Livestock and Fisheries in India, based on VOP at 2004-05 Prices

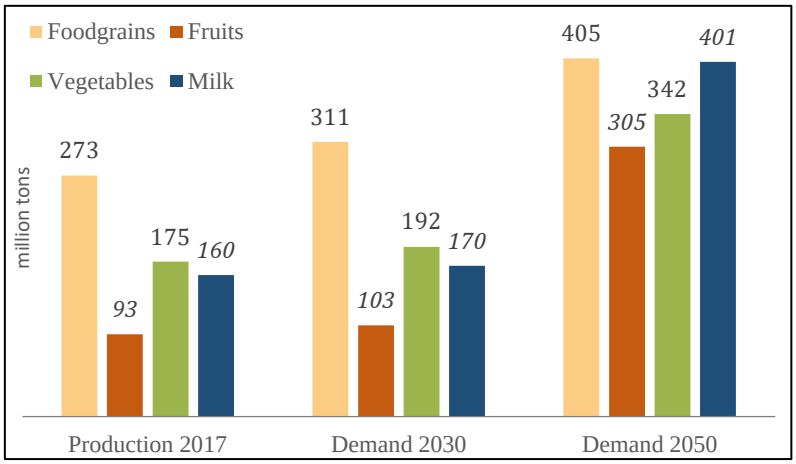
Produce	Pre-green revolution period (1960-61/ 1968-69)	Early green revolution period (1968-69/ 1975-76)	Wider technology dissemination (1975-76/ 1988-89)	Period of diversification (1988-89/ 1995-96)	Post-reform period (1995-96/ 2004-05)	Recovery period (2004-05/ 2014-15)
Paddy and wheat	1.53	2.49	3.34	2.20	0.40	2.40
Nutri-cereals	1.11	0.79	-0.29	-1.21	0.44	2.60
Pulses	-2.23	0.26	0.79	-0.86	0.22	2.63
Oilseeds	0.40	2.99	3.49	3.38	-0.78	1.45
Sugar	1.48	1.64	1.68	3.05	3.70	2.69
Cotton and Jute	-0.59	1.51	1.82	4.30	-0.31	5.35
Condiments & spices	0.65	3.62	4.24	3.24	4.95	5.58
Fruits & vegetables	5.44	5.16	3.08	4.07	3.38	4.85
Floriculture	4.60	5.70	3.41	5.29	10.15	6.44
All crops	1.14	2.15	2.57	2.04	1.78	3.10
Livestock	0.35	2.98	4.87	4.12	3.41	4.92
Fisheries	3.98	4.37	3.63	7.11	3.11	3.59
Overall	**1.07**	**2.37**	**3.09**	**2.73**	**2.27**	**3.61**

Source: Volume-I of DFI report

Projected Demand of Major Food Commodities in India (million tons)

Commodity	Projected Demand	
	2030*	2050**
Cereals	284	359
Pulses	26.6	46
Edible Oils	21.3	39
Vegetables	192	342
Fruits	103	305
Milk	170.4	401
Sugar	39.2	58
Meat	9.2	14
Egg	5.8	10
Fish	11.1	22

Source : **Kumar et al. (2016) for projected demand in 2030*
***NCAP Vision 2050 for projected demand in 2050*



Projected Growth in Demand of Major Food Commodities in India

Commodity	Demand in 2009-10 (~mill tons)	Current Production (~mill tons)	Growth in demand projected viz current production (%)		Growth in Demand between 2030 to 2050
			2030	2050	
Cereals	**196**	**250**	13.6	43.5	**26.4%**
Pulses	**18**	**22**	18.8	105.4	**72.9%**
Edible Oils	**16**	**8**	184.0	420.0	**83.1%**
Vegetables	**132**	**175**	9.7	95.4	**78.1%**
Fruits	**71**	**93**	11.0	228.7	**196.1%**
Milk	**112**	**160**	6.5	150.6	**135.3%**
Sugar	**22**	**20**	93.1	185.7	**48.0%**
Meat	**6**	**7**	31.4	100.0	**52.2%**
Egg	**3**	**4**	41.5	143.9	**72.4%**
Fish	**7**	**11**	2.8	103.7	**98.2%**

By 2050, the population of India is projected to increase to 1.62 billion, with urban population up to 55 per cent from current 33 per cent.

Rural Electrification in India (as on 30.4.2017)

State	Total Inhabited Villages	Un-Electrified Villages	Proportion of Electrified Villages (%)	Total Rural Households (millions)	Households Electrified (millions)	Balance Rural Households to be Electrified (millions)	Proportion of Un-Electrified Households (%)
Andhra Pradesh	26286	0	100	111.8	111.8	0	0.0
Bihar	39073	424	99	122.56	55.16	67.4	55.0
Chhattisgarh	19567	321	98	45.17	38.66	6.51	14.4
Gujarat	17843	0	100	66.94	66.94	0	0.0
Haryana	6642	0	100	34.18	27.12	7.06	20.7
Himachal Pradesh	17882	0	100	14.56	14.42	0.14	1.0
Jammu & Kashmir	6337	102	98	12.88	10.18	2.7	21.0
Jharkhand	29492	579	98	56.82	22.58	34.24	60.3
Karnataka	27397	25	100	96.08	83.95	12.13	12.6
Kerala	1017	0	100	70.97	70.73	0.24	0.3
Madhya Pradesh	51929	52	100	113.61	67.74	45.87	40.4
Maharashtra	40956	0	100	140.16	118.02	22.14	15.8
Odisha	47677	555	99	84.05	45.62	38.43	45.7
Punjab	12168	0	100	36.89	36.89	0	0.0
Rajasthan	43264	1	100	91.09	68.79	22.3	24.5
Tamil Nadu	15049	0	100	102.85	102.85	0	0.0
Uttar Pradesh	97813	6	100	304.87	147.78	157.09	51.5
Uttarakhand	15745	53	100	17.02	14.83	2.19	12.9
West Bengal	37463	5	100	138.13	136.85	1.28	0.9
N.E States							
Assam	25372	558	98	51.85	27.49	24.36	47.0
Arunachal Pradesh	5258	1229	77	2.32	1.51	0.81	34.9
Manipur	2379	77	97	3.88	2.81	1.07	27.6
Meghalaya	6459	230	96	4.63	3.24	1.39	30.0
Mizoram	704	18	97	1.08	0.97	0.11	10.2
Nagaland	1400	4	100	1.6	0.72	0.88	55.0
Sikkim	425	0	100	0.37	0.32	0.05	13.5
Tripura	863	0	100	7.96	5.73	2.23	28.0

Source: Deendayal Upadhyaya Gram Jyoti Yojana (Scheme of Govt. of India for Rural Areas)

State wise distribution of registered factories in food processing sector for 2013-14

Name of the State/UTs	Number of registered units
Andhra Pradesh	5,739
Bihar	794
Chhattisgarh	1,049
Goa	86
Gujarat	1,904
Haryana	631
Himachal Pradesh	172
Jammu & Kashmir	144
Jharkhand	198
Karnataka	2,033
Kerala	1,460
Madhya Pradesh	672
Maharashtra	3,040
Orissa	932
Punjab	2,786
Rajasthan	862
Tamil Nadu	5,204
Telangana	3,850
Uttar Pradesh	2,037
UttraKhand	380
West Bengal	1,739
N.E States	
Assam	1,294
Arunachal Pradesh	5739
Manipur	21
Meghalaya	18
Nagaland	15
Sikkim	21
Tripura	71
Union Territories	
A. & N. Islands	5
Chandigarh	19
D. & N. Haveli	3
Daman and Diu	31
Delhi	166
Pudducherry	69

Source: Ministry of Food Processing Industries, Annual Report 2016-17

Details of wholesale, Rural Primary and Regulated Markets in Different States/UTs

(As on 31.03.2015) and number of markets per lakh gross cropped area

	Number of Markets				Regulated Markets			
States/UTs	Whole-sale	Rural Primary	Total	Total markets per lakh gross cropped area	Principal markets	Sub Market Yards	Total	Regulated markets per lakh gross cropped area
Andhra Pradesh	190	157	347	4.3	190	157	347	4.3
Bihar	325	1469	1794	23.7	-	-	-	-
Chhattisgarh	2	1132	1134	19.9	69	118	187	3.3
Goa	4	24	28	17.7	1	7	8	5.1
Gujarat	205	129	334	2.7	213	187	400	3.2
Haryana	281	195	476	7.4	107	174	281	4.3
Himachal Pradesh	42	35	77	8.2	10	44	54	5.7
Jammu & Kashmir	0	8	8	0.7	11	0	11	1.0
Jharkhand	201	602	803	48.0	28	173	201	12.0
Karnataka	315	730	1243	10.1	157	356	513	4.2
Kerala	348	1014	1362	52.1	-	-	-	-
Madhya Pradesh	0	0	0	0.0	254	284	538	2.2
Maharashtra	881	3500	4381	18.8	305	603	908	3.9
Odisha	398	1150	1548	30.0	54	382	436	8.4
Punjab	424	1390	1814	23.1	150	274	424	5.4
Rajashthan	446	312	758	2.9	134	312	446	1.7
Tamil Nadu	0	0	0	0.0	277	6	283	4.8
Telangana	150	110	260	4.1	150	110	260	4.1
Uttar Pradesh	584	3464	4048	15.6	250	365	615	2.4
Uttarakhand	36	30	66	6.0	26	32	58	5.3
West Bengal	279	3250	3529	36.7	20	464	484	5.0
N.E States								
Assam	405	735	1140	27.8	20	206	226	5.5
Arunachal Pradesh	5	66	71	24.0	0	0	0	0.0
Manipur	24	95	119	31.6	-	-	-	-
Meghalaya	35	85	120	35.0	2	0	2	0.6
Mizoram	7	218	225	197.6	-	-	-	-
Nagaland	19	174	193	38.7	18	0	18	3.6
Sikkim	7	12	19	12.9	-	-	-	-
Tripura	84	470	554	-	21	0	21	-
Union Territories								
A & N Islands	0	28	28	115.3	-	-	-	-
Chandigarh	1	0	1	51.2	1	0	1	51.2
D & N Haveli	0	0	0	0.0	-	-	-	-
Daman & Diu	0	0	0	0.0	-	-	-	-
Delhi	30	0	30	84.9	7	8	15	42.5
Lakshadweep	0	0	0	0.0	-	-	-	-
Pudducherry	4	5	9	35.6	4	5	9	35.6

Note: - Based on Information received from various States/UTs Authorities

Number of Cold Storages and Capacity (in metric tons) in India

States/UTs	2014		2015		2016		2017	
	Number	Capacity	Number	Capacity	Number	Capacity	Number	Capacity
Andhra Pradesh & Telengana	404	1577828	413	1622320	426	1729286	432	1757785
Bihar	303	1406395	304	1411395	305	1416095	305	1416095
Chhattisgarh	89	427766	97	470546	98	484557	98	484557
Goa	29	7705	29	7705	29	7705	29	7705
Gujarat	560	2030873	625	2323175	692	2570973	753	2875713
Haryana	295	588649	307	638601	318	695795	336	741446
Himachal Pradesh	32	38557	34	53009	53	105726	63	119167
Jammu & Kashmir	28	64769	29	69769	33	100976	36	112206
Jharkhand	55	217280	56	221680	57	226680	58	236680
Karnataka	189	526752	192	536333	193	548001	194	553401
Kerala	197	78355	197	78355	196	78105	196	78105
Madhya Pradesh	260	1097168	275	1168321	294	1253715	294	253715
Maharashtra	540	706303	555	762798	575	881860	581	896730
Orissa	111	326639	120	366699	167	523139	170	538139
Punjab	606	2004778	617	2051377	655	2152003	655	2152003
Rajasthan	154	480032	157	490888	159	521387	161	527893
Tamil Nadu	163	295671	165	304771	168	316583	168	316583
Uttar Pradesh	2176	13633039	2209	13807762	2250	13978608	2285	14139098
Uttrakhand	28	84545	30	89689	44	148921	45	151421
West Bengal	502	5901925	506	5912237	511	5940511	511	5940511
N.E States								
Assam	34	119652	35	126179	35	152706	36	157906
Arunachal Pradesh	1	5000	1	5000	1	5000	1	5000
Manipur	1	2175	1	2175	1	3000	1	3000
Meghalaya	4	8200	4	8200	4	8200	4	8200
Mizoram	3	3931	3	3931	3	4471	3	4471
Nagaland	2	6150	2	6150	2	6150	2	6150
Sikkim	2	2000	3	2100	2	2100	2	2100
Tripura	13	39181	14	45477	14	45477	14	45477
Union Territories								
A. & N. Islands	2	210	2	210	2	210	2	210
Chandigarh	6	12216	7	12462	7	12462	7	12462
Delhi	97	129857	97	129857	97	129857	97	129857
Lakshadweep	1	15	1	15	1	15	1	15
Pudducherry	3	85	3	85	3	85	3	85
All India	**6,891**	**31,823,701**	**7,091**	**32,729,271**	**7,395**	**34,050,359**	**7,543**	**34,673,886**

Includes Bulk storage and Distribution hubs *Source: Ministry of Agriculture & Farmers Welfare, Govt. of India.*

Marketed Surplus Ratio (MSR) and Production Growth of Important Agricultural Commodities in India

	Production growth (2004-05 to 2013-14)	Marketed Surplus Ratio			
		1999-00	2004-05	2013-14	2014-15
I. Foodgrains : Cereals					
Rice	2.0	60.32	71.37	82.00	84.35
Wheat	4.3	54.48	63.33	73.11	73.78
Maize	6.4	62.79	76.22	86.98	88.06
Jowar	-3.8	46.83	53.44	65.25	66.64
Bajra	1.6	65.22	69.39	71.11	68.42
Ragi	-2.8	41.15	57.74	44.11	47.60
II. Pulses					
Arhar	1.1	62.93	79.52	86.99	88.21
Gram	6.5	65.63	93.76	89.58	91.10
Urad	4.4	80.91	85.76	80.71	85.56
Moong	4.6	70.13	76.79	92.22	90.65
Lentil	1.7	59.87	85.86	90.23	94.38
III. Oilseeds					
Groundnut	0.5	63.34	88.75	95.20	91.63
Rapeseed & Mustard	-1.1	71.57	89.66	94.49	90.94
Soybean	8.0	94.95	94.99	95.23	71.00
Sunflower	-12.3	99.30	98.32	65.42	89.14
Sesamum	1.3	84.45	87.38	92.91	93.80
Safflower	-26.5	86.80	91.34	-	100.0
IV. Other Commercial Crops					
Sugarcane	3.7	82.5	98.23	21.62	18.94
Cotton	10.3	94.58	94.94	97.32	98.79
Jute	1.0	97.5	90.72	100.00	98.59
V. Vegetables					
Onion	12.9	-	82.91	99.29	91.29
Potato	10.6	45.90	85.00	61.35	71.51

Source: DACNET & Agricultural Statistics at a Glance

There is a general increase in the ratio between the output-marketed to output-produced, over the years. However, the marketed surplus may not be finding optimal value because it is monetised at the first available instance, at nearby markets. These markets may not necessarily have sufficient demand from its consumer catchment, to absorb the entire supply. Therefore, the value gets pushed down in the local market's downwards price discovery process. It is important that besides marketed surplus, the market surplus is also monitored. Farmers should have ability to direct their supply to markets that are optimal – i.e. have sufficient demand in their catchment, or have ready links to other consumption centres. When optimal value is not realised, motivation to grow production fades away.