Reducing Post-harvest Losses in India: Key Initiatives and Opportunities

The ROCKEFELLER FOUNDATION

intellecap

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We are grateful to all the stakeholders that gave us their time and shared information, insights and their experiences of work on the ground. This report is just a reflection of their passion, hard work and perseverance in this still evolving space. We hope our work seeds other research and promotes solutions to reduce and mitigate post-harvest losses in India.

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Contents

Introduction

Intellecap, supported by the Rockefeller Foundation, conducted in-depth research over a period of 5 months on key areas of momentum around post-harvest losses (PHL) in India. This report synthesizes insights from this research and presents the important roles the government, civil society organizations (CSO) and the private sector play in addressing PHL and improving smallholder farmer (SHF) livelihoods.

The report is divided into four main sections dedicated to key phases in the post-harvest value chain. These include harvesting and primary processing; storage and crop protection; processing; and market linkage. Each section presents an overview of sector-specific activities and identifies key factors affecting PHL, important trends and innovations, as well as opportunities and white spaces to generate social impact. An additional section covers insights around different aggregation models and mechanisms that agriculture sector actors can leverage to reduce PHL and strengthen SHF market access.

Setting the Context

As per latest estimates by the Associated Chambers of Commerce of India, India loses approximately INR 926 bn (US$ 14.33 bn) on account of PHL.[1] Crop worth approximately US$ 19.4 mn is wasted in India on a daily basis only due to rejection at the farm gate and delays in the distribution process. A country-wide study measuring crop losses revealed that 3.9% - 6% cereals, 4.3%-6.1% pulses, 2.8%-10.1% oilseeds, 5.8%-18.1% fruits, and 6.9%-13% vegetables were lost during harvesting, post-harvest activities, handling and storage.[2] Post-harvest losses in India stem from a range of factors including lack of post-harvest infrastructure, limited technical know-how on good agricultural practices, imperfect market knowledge, and inadequate market access. Fragmentation of agricultural landholdings and a post-harvest value chain that is riddled with inefficiencies cause PHL to stack up progressively throughout the value chain. SHFs, comprising 80% of India's farming community[3], are affected by the challenges of fragmentation and value chain inefficiencies in the form of weak access to markets, low investment in agriculture, low productivity and low income. India currently leads the world in producing a wide range of agricultural commodities and yet, faces the threat of food and nutrition insecurity. According to the 2014 Global Hunger Index, India ranks 55 among 120 countries with the highest food insecurity.[4] The high volume of losses, if reduced, can generate significant value and address food insecurity.

There is increasing interest and activity directed at addressing these challenges among government, civil society and the private sector. We have observed three specific trends that point to areas of dynamism

[1] Steps Taken to Reduce Post Harvest Food Losses, PIB, Feb 2016
[2] Report on Assessment of Quantitative Harvest and Post-Harvest Losses of Major Crops/Commodities in India, 2015, ICAR
[3] Small Holder Farmers in India: Food Security and Agriculture Policy, FAO
[4] Hunger in a time of plenty: The curious case of Indian food security, The Wire, July 2016

and activity that either directly impact the problem or contribute to creating an enabling environment. Firstly, momentum is evident in the public sector, with the government introducing a range of initiatives to create an enabling environment for PHL reduction and improvements in SHF incomes and livelihoods. Secondly, the government increasingly is incentivizing private sector companies to introduce technological and business model innovations to increase value chain efficiency. For instance, dynamism around policy support for the food processing sector focuses on gradually shifting trade from raw produce to processed products. Thirdly, these shifts are also prompting CSOs to adopt a more market-facing approach in their support for SHFs to improve access to information, equipment, better agricultural practices and new markets.

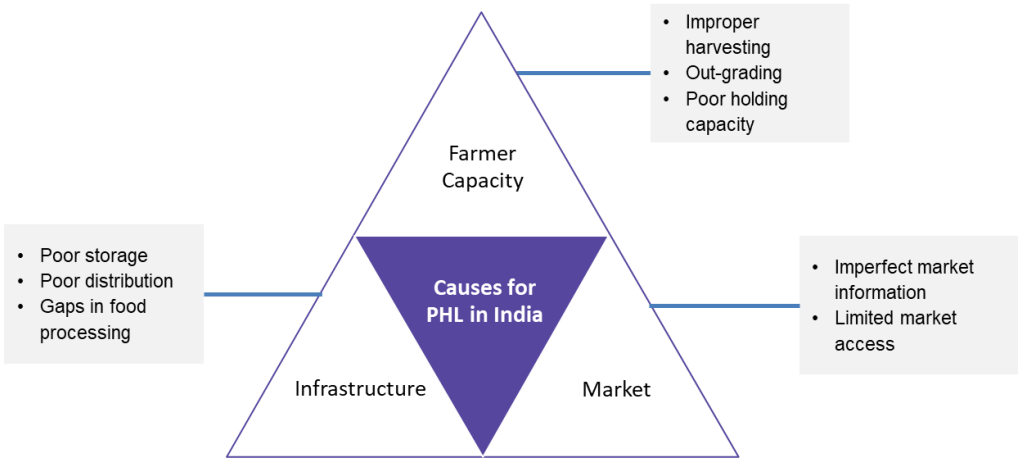
Research supported by the Rockefeller Foundation in 2016 on food loss and waste identified significant momentum around PHL in India. Building upon these findings, the Foundation supported Intellecap to undertake an in-depth exploration on activity around PHL reduction; the roles played by the various ecosystem stakeholders such as government, CSO and the private sector; the evolving innovation environment; and the importance of various farmer aggregation models in driving SHF-focused PHL reduction. This effort entailed a combination of secondary research and over 30 interviews with agriculture sector experts. Key questions explored included:

- What is the policy landscape for PHL reduction?
- What is the degree of SHF access to various public schemes and programs that have a bearing on the post-harvest phase?
- What impact do government initiatives have on post-harvest management and interventions?
- What is the potential of the private sector to reduce post-harvest losses and improve SHF livelihoods?
- What are the different farmer aggregation models and mechanisms that different sector actors adopt, with a particular focus on the post-harvest value chain?

Post-harvest losses in India

While addressing lagging production has been a longstanding priority for the government and private sector, there has been a limited focus on improving value chain efficiency or evaluating the reasons for PHL. The exhibit below highlights a number of core inefficiencies in the post-harvest value chain that contribute to PHL.

Figure 1: Core inefficiencies in the post-harvest value chain leading to PHL



Crop loss accumulates at every phase of the post-harvest value chain, and is particularly acute early in the value chain.

The post-harvest value chain has four critical phases: harvesting and primary processing; storage and crop protection; processing; and market linkage. Each of these has inefficiencies which result in crop losses. Incidence of PHL is particularly pronounced in the first two phases, with significant adverse impacts for SHF incomes.

Figure 2: Drivers of PHL across the post-harvest value chain

Drivers of PHL across the post-harvest value chain

Post-harvest Value Chain

Phases	Harvesting & Primary Processing	Storage & Crop Protection	Processing	Market Linkage
Key Activities	• Harvesting • Drying • Grading • Sorting • Produce aggregation • Loading • Transporting	• Pre-cooling • Packaging • Ripening • Cold storage • Warehousing • Quality control assessment	• Grading • Sorting • Secondary Processing	• Packaging • Branding • Transporting • Market information • Wholesale market • Retail market
Drivers of PHL	Improper harvesting leads to crop losses during and post-harvest. Lack of primary processing soon after harvesting adversely affects shelf-life and increases PHL.	Currently, there is a huge gap in infrastructure at the farm gate especially for cold storage and pack-houses. Poor storage and crop protection facilities contribute to significant spoilage and crop loss.	The huge gap in food processing significantly limits value addition. In India only 2% of the total F&Vs produced are processed currently. Inadequate processing capabilities, particularly near farm contributes significantly to PHL.	Lack of market information and linkages both contribute to PHL. Lack of information on prices and demand leads farmers to often make uninformed choices and distress sales. Farmers are not able to access the optimal price for their product within current markets.

The following exhibit shows the stage-wise accumulation of post-harvest losses in illustrative crops.[5] The figures in the exhibit indicate percentages of total production.

Figure 3: Drivers of PHL across the post-harvest value chain

Stage-wise post harvest losses in tomatoes, potatoes and onions in India (in percentage terms)

Activity / Crop	Harvesting	Collection	Grading/ Sorting	Packaging	Transportation	Farm level storage	Godown/ cold storage	Whole seller level storage	Retailer level storage	Processing unit level storage	Total loss
Tomato	1.7	1.1	3.2	0.8	3.1	0.17	0.01	1.23	0.98	0.11	12.4
Potato	3.2	0.7	2.2	0.1	0.5	0.36	0.78	0.96	0.19	0.01	9
Onion	2.7	0.2	1.6	0.1	0.4	0.54	0.38	0.81	0.56	0.01	7.3

Major contributors to post-harvest loss

Key sectors in the post-harvest value chain in India

The government, CSO and private sectors play important roles in addressing PHL to improve SHF livelihoods and achieve food security.

Government, CSO and private sector actors play critical roles in agribusiness and deploy strategies ranging from introducing enabling policies to investing in infrastructure and capacity building of SHFs.

Government Sector: While agriculture is a state subject in India, the central government plays a key role in guiding state initiatives through model acts, subsidy schemes and regulations to drive infrastructure development and create an enabling environment for PHL reduction. Recent crosscutting initiatives by the government such as the Goods and Services Tax (GST) Act promise to expand markets for SHFs, leading to better price realization, reduced price volatility and market gluts and therefore, PHL reduction. For instance, the nationwide unification of tax rates under GST will contribute to reducing the transportation time for perishables and improve market efficiencies by encouraging establishment of post-harvest infrastructure based on value chain requirements. Other relevant measures include the Contract Farming Law, the relaxation of agriculture sector Foreign Direct Investment (FDI) restrictions, restructuring of the Agricultural Produce Market Committee (APMC) Act, National Agriculture Market (e-NAM), and warehouse receipt financing.

CSO Sector: With agriculture being the predominant rural occupation, CSOs (NGOs, cooperatives, farmer producer organizations (FPOs) and self-help groups (SHGs)) support SHFs by providing knowledge dissemination, training and capacity building services across the pre-harvest and post-harvest phases. CSOs have historically played a strong role in pre-harvest capacity building, which has led to

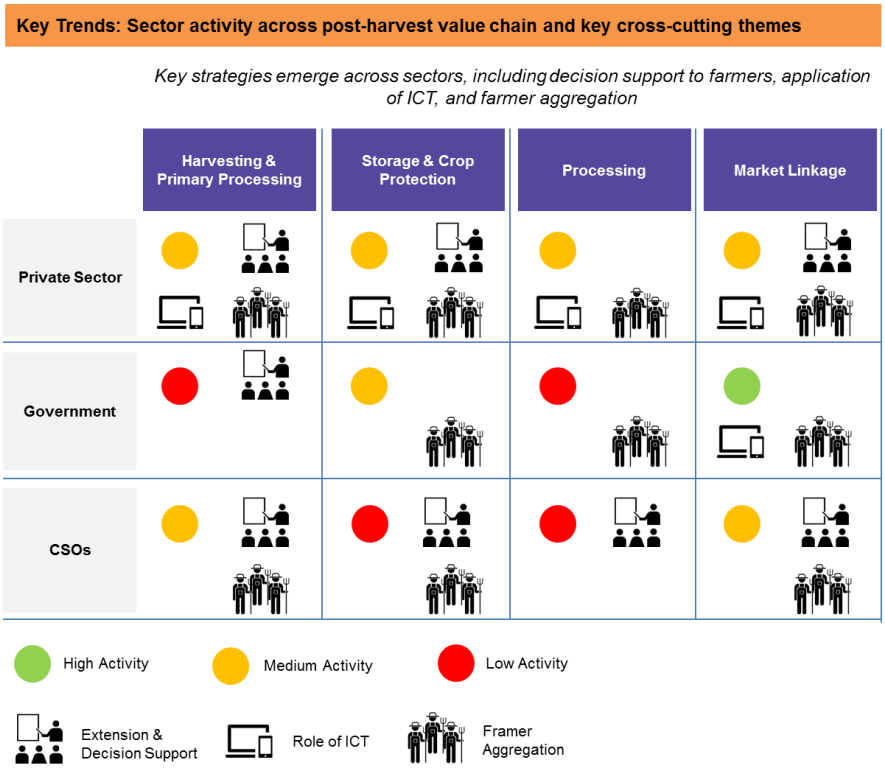
[5] Horticulture Statistics 2015, National Horticultural Mission

deep engagement with farmer communities. Given this, they play the role of influencers in decision making and gatekeepers of information for farmer households. This research focused on CSOs that directly support SHFs through post-harvest activities. Some of them strive to create necessary linkages higher up the value chain to market SHFs' aggregated produce, while a few have ventured into processing to help SHFs gain benefits of value addition. CSOs help reduce PHL and improve farmer livelihoods by leveraging their networks and deep grassroots level engagement with SHFs, serving as a vital bridge between government initiatives (as implementers) and private sector companies (as partners).

Private Sector: Given the capital intensive nature of activities in the post-harvest phase, private sector participation is critical at every stage in the value chain. Private sector companies have a preeminent role to play in promoting value chain efficiencies in order to streamline production with market demand and reduce PHL by investing in infrastructure, technology and new models of SHF engagement. They are actively involved in procurement, storage, transport, processing and retailing of produce. Companies are beginning to engage with farmers directly to ensure that market volume and quality requirements align with farmer production, which can contribute to reducing PHL.

Engagement between government, CSOs and private sectors and farmers leverage certain cross-cutting themes such as extension and decision support to farmers, application of information and communication technology (ICT) and the need for farmer aggregation.

Figure 4: Sector activity across post-harvest value chain and key cross-cutting themes



Increasing activity in agribusiness from the government, private and CSO sectors is translating into a wide range of interventions towards PHL reduction and improvement of SHF livelihoods. Key trends include:

Government sector

- Deployment of schemes and reforms with a particular focus on supporting the private sector to enhance the country's storage and processing infrastructure.
- Alternative market development and improving SHF linkages to existing markets

Private sector

- Greater participation in food processing, retail and exports, supported by government incentives
- Development of affordable solutions for farmers and efficiency improvement at every stage of the post-harvest value chain by building post-harvest infrastructure and introducing technology solutions and innovative business models.
- Increased leverage of ICT-enabled solutions and different farmer aggregation models to address challenges of last mile connectivity and market fragmentation

CSO sector

- Building SHF awareness and capacity through training and knowledge dissemination, including on good agricultural practices, mechanization and the importance of post-harvest activities like storage and primary processing
- Encouraging farmers to aggregate and to jointly invest in primary processing, storage solutions, and farm machinery and equipment
- Helping farmers create linkages with the private sector to market their produce and access equipment leasing and other post-harvest solutions

Harvesting and Primary Processing

Overview

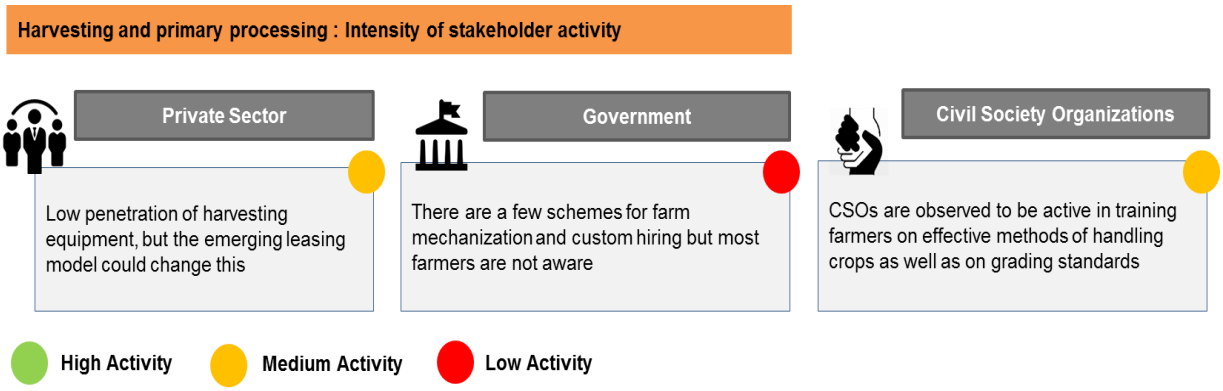
While poor and suboptimal harvesting practices and limited uptake of mechanization among SHFs are both key causes of PHL in this phase, promoting affordable mechanization arguably has the greatest strategic relevance in terms of creating impact on loss reduction.

Poor productivity and crop losses during harvest and post-harvest phases resulting from sub-optimal farming have adversely affected SHF livelihoods in India over time. Good harvesting practices and primary processing activities such as threshing, sorting and grading soon after harvesting are critical for avoiding crop damage from manual harvesting and weather-induced crop spoilage, thereby improving produce shelf-life and reducing PHL. Harvesting and post-harvest farm mechanization can save farmers time, effort and costs, contributing to improved farmer incomes. However, SHFs largely continue to depend on conventional harvesting techniques and primary processing activities, largely due to limited awareness, access and poor ability to pay for modern available solutions.

The government, CSOs and the private sector mainly seek to drive SHF focused mechanization in the agriculture sector by expanding adoption, enabling access to technologies for small farmers and product development for small farm use.

- CSOs have been working steadily to build farmer capacity through training and knowledge dissemination and by encouraging SHFs to adopt mechanization for harvesting and primary processing.
- The role of the government in this phase thus far has been limited to providing subsidies to farmers for reapers and threshers.
- Private sector actors (e.g. equipment supply and leasing companies) have recently played a more active role and are exploring new ways to reach SHFs expanding their consumer base.

Figure 5: Harvesting and primary processing: Intensity of stakeholder activity



Key Factors Affecting PHL

Barriers such as lack of awareness, limited access to finance and few near-farm markets for primary processed produce restrict SHF adoption of best practices and mechanization.

SHFs are unaware of the quality specifications required by different types of buyers, and face key barriers to adopting good practices, including affordability and availability of technology. Fear of crop loss and the short-term need for liquidity often prompts SHFs to sell their produce as soon as possible and is a constraint for investing in primary processing technologies. SHFs also do not actively seek information on mechanization to harvest, sort or grade produce. Given the market penetration and distribution of available technologies, current solutions are also not accessible, affordable or right-sized for small farm use. Further, the absence of near-farm markets for primary processed produce like dried tomatoes has restricted SHFs from overcoming challenges in the harvesting and primary processing phase.

Lack of economies of scale limits private sector participation in near-farm primary processing activities.

Primary processing can greatly reduce PHL and improve farmer incomes and livelihoods for fruits and vegetables (F&V), which represent the crop group with the highest levels of PHL. At present, however, primary processing carried out by farmers is limited to small scale efforts such as de-husking, deseeding, peeling and drying in some crops, and processing for products such as jams, jellies, dried fruits and chili powder. Private sector investment requires scale in terms of numbers of customers (farmers) and demand (number of units sold), which can be met by existing organized groups of farmers that collaborate and participate in primary processing of significant volumes of produce.. Currently, very few companies like Our Food, Connect Farmer and S4S (DesiVDesi) equip farmers with primary processing capabilities. The primary motivation for these companies has been to empower SHFs to be able to earn better prices for their produce.

Trends and Innovations

Innovations center on improving access and affordability for farmers, including approaches that expand reach and adoption of mechanization. Key companies have emerged that deploy innovative equipment leasing models, offer customization and leverage ICT.

The private sector is trying to drive adoption of mechanization by directly engaging with farmers, and partnering with financial institutions to make such solutions more affordable for SHFs.

Equipment supply and leasing companies are increasingly engaging with farmers to supply and/or lease farm equipment and machinery for harvesting or near-farm processing such as harvesters, winnowers, dryers and threshers. Most of these companies serve a mix of small and large farmers while a few of them focus particularly on SHFs. Some have partnered with financial institutions to provide equipment financing for SHFs. For instance, TAFE, an equipment supply company, has collaborated with Punjab National Bank (PNB) to provide financing facilities for equipment.

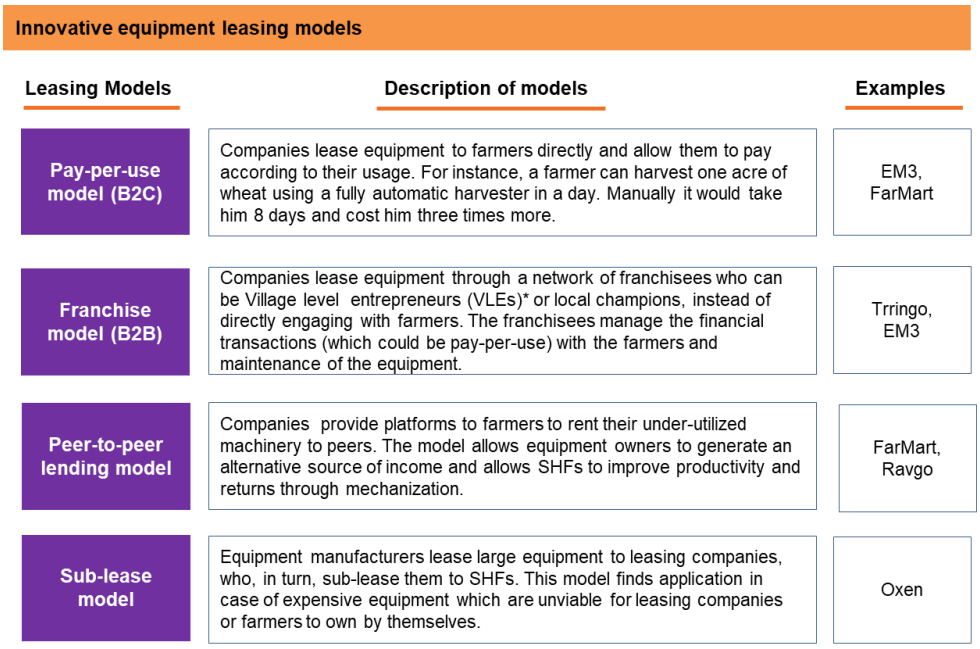
The private sector is developing near-farm processing and mechanization solutions for specific crops.

Cotton, rice, chili and tomato are examples of crops attracting private sector interest for such solutions. A few companies like Our Food and Connect Farmer are helping SHFs undertake processing of specific F&Vs like chili and tomato on a small scale at the village level. Innovative equipment supply and leasing companies such as Grobomac, Yanmar, Coromandel and Agrisolutions have developed equipment for specific crops like cotton and rice. A joint venture between Yanmar, Coromandel, and Mitsui provides SHFs with equipment such as rice transplanters, automatic seeding machines, power weeders, and harvesters. The joint venture operates through rural retail outlets for both sale and lease of the equipment.

Companies have rolled out innovative equipment leasing models to drive farm mechanization.

While equipment suppliers have traditionally catered to larger farmers, equipment leasing is steadily emerging as a viable option to provide SHFs affordable and on-demand access to harvest and post-harvest equipment. Recently, companies have deployed a number of innovative leasing solutions, including pay-per-use, franchise, sub-lease and peer-to-peer lending models.

Figure 6: Innovative equipment leasing models



** VLEs – a VLE is usually a person from the village who could be a farmer, someone who is engaged trade or employed on part time jobs. Their foray into entrepreneurship often begins by helping farmers meet their varied requirements as a means to earn additional income.*

While these models offer farmers on-demand access to equipment, companies utilizing the pay-per-use model engage farmers directly and those using the franchise model lease through VLEs. Companies have to significantly invest in awareness building and marketing under both these models, with specific investment in training VLEs in the franchise model. In the peer-to-peer lending model, companies primarily play a matchmaking role to connect existing equipment owners and SHFs by creating necessary ICT based platforms and information dissemination. In contrast to the other three models, companies primarily use the sub-lease model for expensive equipment.

Equipment supply companies are increasingly customizing and re-engineering their offerings to suit the Indian agricultural context.

Some companies have customized small-scale agricultural equipment for farmers or farmer communities and deliver them directly or through VLEs and franchisees. For example, Kamal Kisan manufactures easy-to-operate farm equipment and sells directly to SHFs who have limited knowledge and experience using mechanization. The company has also re-engineered its equipment to make them affordable for SHFs and meet their specific requirements. This equipment has minimal dependence on fuel and is easy to maintain, thus reducing the frequency of after-sales service.

Some companies leverage ICT solutions to facilitate equipment purchase and hiring by farmers.

Companies use ICT solutions such as online portals, mobile applications and WhatsApp groups to meet farmers' equipment purchase or hiring requirements. FarMart uses its online platform to facilitate peer-to-

peer equipment renting amongst farmers. Similarly, Agri Hub enables online purchase of farm equipment through its website. Companies like Kheti Gadi and Kisan Manch use mobile applications to sell new and used farm equipment.

CSOs drive adoption by leveraging their networks to train and build farmer capacities.

CSOs primarily focus on training farmers on the importance of grading and sorting, the most effective crop handling methods, and crop and buyer-specific grading standards. Apart from training and knowledge dissemination, some CSOs also provide farmers with equipment for these activities. Harnaut Kishan Producer Company Limited (HKPCL) for example, provides training on grading and sorting techniques for various crops through demonstration and workshops. CSOs like Indian Society of Agri-Business Professionals (ISAP) and Agribusiness Systems International (ASI) also provide grading and sorting equipment to farmers to enhance their awareness and comfort levels of using such technologies.

Whitespaces and Opportunities

Engagement with SHFs at an aggregated level and strategic collaborations with CSOs and other private sector companies present opportunities for equipment companies to make their solutions more affordable and widen their reach among SHFs.

Collectivizing SHFs and group leasing of equipment is critical for driving mechanization uptake.

Diminishing size of land holdings due to fragmentation implies that most SHFs will find it difficult to lease equipment as individuals. CSOs can play an important role in encouraging SHFs to come together and lease equipment as a group. Group leasing places the liability of making lease payments on the group. On the supply side, the model can confer benefits to equipment leasing companies by way of reducing transport costs and improving capacity utilization of equipment. EM3 and Zamindara are examples of companies that are innovating around group leasing for equipment.

Cross-sector collaborations can significantly enhance awareness, access and affordability of mechanization solutions for SHFs

Increasing participation from large companies in food processing, retail and exports is expected to drive efficiencies in the value chain, which in turn is projected to drive farmers' demand for mechanization in harvesting and primary processing. To affordably and sustainably cater to such demand, equipment supply and leasing companies can develop greater strategic collaborations with CSOs, financial institutions, processors, and retailers. CSOs can help equipment leasing companies generate necessary awareness about the benefits of adopting their equipment for harvesting and post-harvest activities. Similarly, equipment leasing companies can partner with large processors and retailers to facilitate SHF access to relevant equipment, while also aggregating and delivering produce.

Storage and Crop Protection

Overview

In the absence of a strong business case for farmers and companies to invest, there is a significant gap in on-farm and near farm storage and crop protection infrastructure for pre-cooling, packaging and storing produce. With growth in food processing and retail, however, investments in near farm storage and crop protection infrastructure is set to improve.

A significant proportion of post-harvest crop losses are due to decay, physical shocks, pests and diseases. To a large extent, these challenges can be addressed with proper storage infrastructure and efficient crop protection practices. They also bring efficiency in demand-supply management, as farmers are able to hold on to their produce when there is over-supply in the market. F&V, due to their perishability and short shelf life, need different storage infrastructure than that used for grains, wheat and sugar. About 75% of cold storage units in India are single commodity storages, which store only potatoes and potato seeds. Relative to available storage for potato, grains, wheat, and sugar, storage for F&V continues to be a major gap.[6] Interventions in storage can be broadly divided into warehouses and integrated cold-chains.

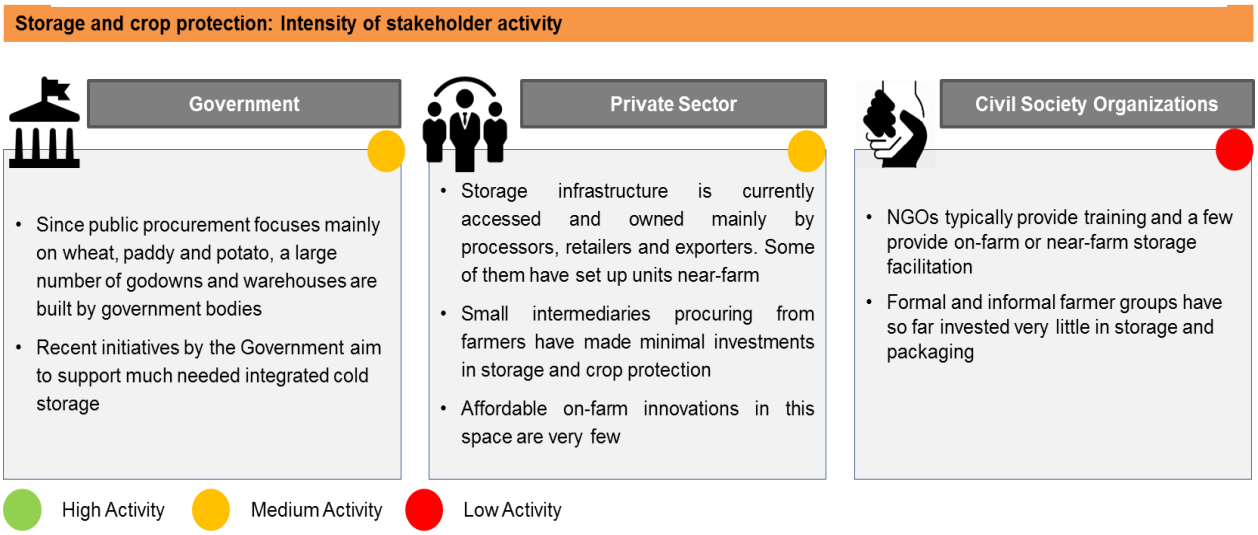
Figure 7: Types of Storage Solutions

Types of Storage Solutions		
	Warehouses	**Integrated Cold-chain**
Commodities	Most non-horticulture produce such as grains, wheat and pulses	Fruits and vegetables
Ratio of number of infrastructure facilities built by government to those built by private sector	76:24[7]	4:96[8]
Infrastructure directly impacting farmers	Farm-level storage, rural godowns	Pre-cooling, packaging, small cold storage facilities
Infrastructure higher up the value-chain	Large warehouses	Reefer vehicles, large cold-storage facilities, ripening chambers, waxing, packaging

[6] Government's Role in India's Ailing Cold Storage Sector, Centre for Public Policy Research (Dec 2016)
[7] Report by the Committee for Strengthening Negotiable Warehouse Receipts by the Warehousing Development and Regulatory Authority in the Country
[8] National Center for Cold-Chain Development (2015)

While processors, retailers and exporters own and utilize the majority of India's storage capacity, investments in storage seldom focus on SHFs. Storage is capital intensive, requires an integrated approach and is suitable for high value produce, which is why even large farmers and traders pay for storage services rather than invest in storage ownership. Pre-cooling, ripening and pack house infrastructure are mostly located at the collection center level, as they require a critical minimum volume of produce. Such near farm storage and crop protection infrastructure can grow if there is a strong business case for buyer investment.

Figure 8: Storage and crop protection: Intensity of stakeholder activity



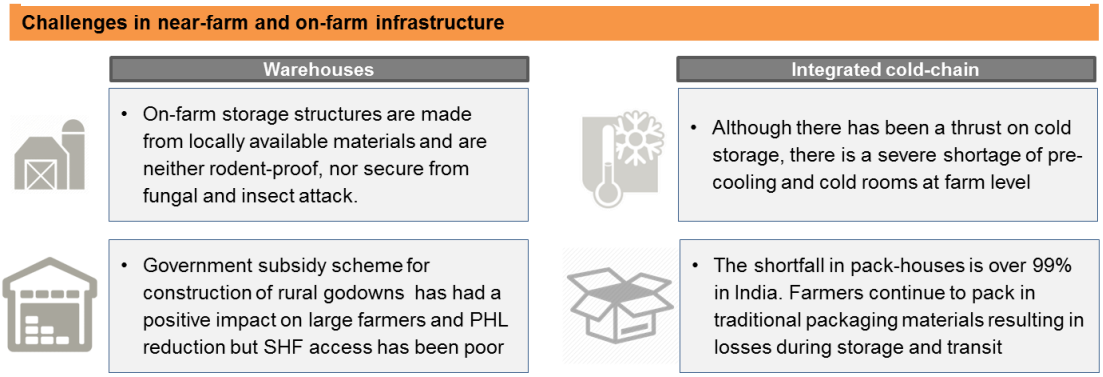
Key Factors Affecting PHL

SHFs lack access to suitable on-farm storage facilities and packaging materials. In the case of F&V, access to infrastructure is poor, both on-farm and near-farm.

While the gap in near-farm infrastructure[9] for non-horticulture produce (warehouses and godowns) is just 16%[10], on-farm structures adopted by SHFs are of very poor quality. For F&V, there is a severe shortage of integrated infrastructure. Most SHFs do not have access to cold rooms, reefer transport and packaging facilities. Even at the other end of the supply chain, in the unorganized retail market, there is a shortfall of cold storage, ripening chambers and waxing facilities. Without preconditioning, a portion of the produce is damaged even before it reaches the cold storage, and without reefer transport and ripening chambers, there are gaps in integrating the cold-chain from farm to market.

[9] This gap is measured by calculating the difference between storage capacity required for non-horticulture produce and the available storage
[10] Sub Group on Warehousing and Bulk Handling set up by the Working Group on Agricultural Marketing (2015)

Figure 9: Challenges in near-farm and non-farm infrastructure



With low adoption of and investment in best storage practices, farmers and consumers pay for food losses.

Poor packing, make-do farm storage and lack of pre-cooling and cold facilities result in losses, especially for produce that requires transportation to distant end-markets. When accounting for these losses, middlemen pay lower prices to farmers and charge higher prices from end customers. As most traders do not bear the cost of these food losses, they do not invest in packing and pre-cooling at the farm level. On the other hand, farmers are reluctant to invest as they are not sure whether they will receive higher prices for their produce.

Trends and Innovations

Proactive policy initiatives by the government coupled with growth of the food processing and retail sectors is set to drive expansion in near farm storage and crop protection infrastructure. However, the business case for SHF investment in such on-farm infrastructure continues to be weak.

The government has recently focused on providing and incentivizing near-farm access to storage facilities.

While construction of warehouses and rural godowns continues at a steady pace, most recent government initiatives are focused on establishing integrated cold-chain units. The Prime Minister's office has issued a directive to all implementing agencies to focus on creating end-to-end infrastructure in cold-chains so as to address the over 85% infrastructure gap in pack-houses, reefer transport and ripening chambers.

Further, the central government and a few state governments provide warehouse receipt financing and rebates from 10% to 30% to encourage SHF utilization. The government recently announced that it will treat Negotiable Warehouse Receipts (NWRs) based loans at par with short term crop loans. This reduced the interest rates for loans against NWRs, which led to an eightfold increase in NWR-based loans. The NWR system has also been introduced for cold storage. These measures are expected to support further development of storage solutions and making them accessible and affordable for SHFs.

Growth in retail and processing is contributing to near-farm infrastructure improvements, but there are few affordable on-farm solutions.

Participation of more formal actors in crop purchase, processing and retail is improving near-farm storage and crop protection infrastructure due to their greater focus on strengthening supply chain efficiency. While some set up warehouses and cold storage facilities close to farms, others incentivize farmers or farmer groups to invest in better storage and packing solutions through facilitating credit, guaranteeing better prices for quality and facility rental services. However, these developments are nascent; investment in scientific on-farm storage and crop protection infrastructure is very poor, particularly among SHFs. Although affordable and innovative technology solutions (e.g. Rinac's mobile pre-cooling unit, Science for Society's tomato packing technology and Tessol's solar cold rooms) may increase access for SHFs, existing solutions are very few and yet to scale.

Whitespaces and Opportunities

Providing SHFs access to appropriate financing solutions and linkages can help them leverage near farm storage and crop protection infrastructure while local entrepreneurs can be encouraged to invest in and provide access to on-farm infrastructure.

Emergence of collateral management companies, warehouse receipt finance and pledge loans promise to be strong incentives for farmers to use warehouses.

While these developments can significantly improve liquidity for farmers, they will need enabling conditions to encourage more farmers to explore NWRs. This includes encouraging formation of FPOs to achieve economies of scale in transporting produce, access to reliable market data to make informed decisions on when to store and sell, and establishing standardized certifications so that banks are less hesitant to lend to smaller private warehouses. Most importantly, banks and other stakeholders need to invest in on-boarding farmers and building trust. Ergos, one of the very few organized warehousing companies catering to SHFs, works with farmer champions, partners with local bodies and agricultural institutions, and raises awareness through videos and roadshows.

Manufacturing companies can adopt key models to improve on-farm infrastructure, including enabling farmers to collectively invest in such facilities and encouraging entrepreneurs to rent storage and crop protection facilities

Since storage infrastructure and technologies are very expensive for individual SHFs, FPOs or informal groups of farmers can collectivize demand to make the investments. For instance, of the 54 FPOs promoted by Association for Social Advancement (ASA), 33 FPOs have warehouses with 500 ton to 1000 ton storage facilities. 80% of the buyers of S4S' solar dryers comprise either FPOs or informal farmer groups. Alternatively, a local entrepreneur can make the investment, and in turn, rent out the facility or materials to farmers in his vicinity. ColdHub in Nigeria rents out cold rooms to SHFs in this manner.

Similar collective investment and rental use of equipment is also possible for other types of crop protection infrastructure like solar dryers and packaging technologies. Although different from investment in cold storage solutions in terms of the maintenance/operational cost and seasonality of use of such infrastructure, SHF uptake can increase if prices for access can be reduced. For instance, S4S is planning to examine lease models for its solar dryers and tomato packaging technologies. Some retailers and traders provide packaging materials for free or charge farmers on a rental basis for use of these materials.

In addition to developing the right technology, it is also important for innovative companies to adopt appropriate business models to address SHF resource constraints.

Only a few companies such as Rinac, Tessol and S4S have managed to develop technologies that address resource constraints that farmers face. Tessol and S4S have developed solar powered technologies to address challenges posed by frequent cuts in electricity supply. Rinac has mobile pre-cooling units considering the fragmented and dispersed markets. Ergos has built its model on leasing a number of micro-warehouses to ensure high capacity utilization and low capital investment. Given the difficulties in SHFs' access to initial capital, S4S has fine-tuned its business model from outright selling to renting.

Processing

Overview

Considerable quantity of produce is lost before it reaches distant processing units through a chain of middlemen, with SHFs facing barriers to reducing PHL due to an acute lack of near-farm processing infrastructure. Setting up processing units close to farm will not only minimize crop losses, but will also benefit SHFs by helping them get better prices and by reducing transportation and logistics expenses.

The food processing industry is one of the largest industries in India and ranks fifth in terms of production, consumption and exports. However, processing of perishable produce in India is just 7%, which is very low when compared to other countries such as US, China and Philippines.[11] Besides food losses, the absence of processing facilities at the farm gate leads to farmers earning lower incomes, as the benefits of value addition mostly accrue to middlemen and large private sector firms. Processing near the farm-gate can improve the value of agriculture produce, ensure remunerative prices for farmers and minimize losses.

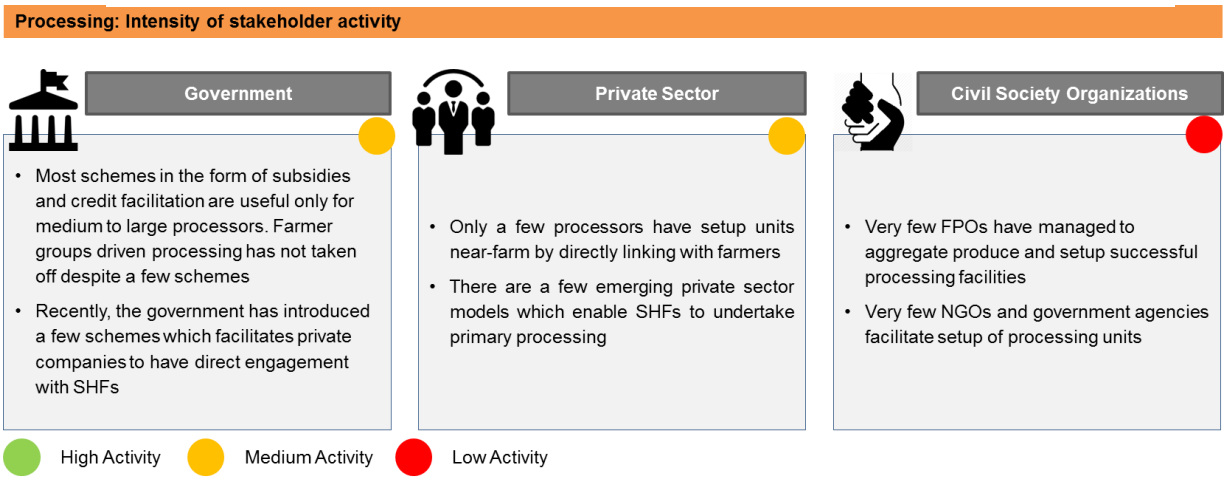
The food processing industry in India is highly fragmented, with the unorganized sector accounting for 70%[12] of the total market. The unorganized sector is dominated by a large number of small scale companies. Recognizing that improving the food processing sector can drive agriculture sector development, the government has designed a number of schemes and interventions to support the growth of the industry. Given the scale of investment required, most of these schemes leverage the presence of larger private sector players and impact SHFs indirectly.

The sector has also received a boost due to changing consumer preferences and rising demand for Indian products in international markets, leading to a recent spurt in private sector interest. Heightened participation from the organized private sector is expected to expand direct engagement between the industry and farmers.

This chapter analyzes existing challenges and emerging trends in on-farm and near-farm processing, and examines models that strive to make near-farm processing a viable option for farmers and companies. The chapter also highlights opportunities for the government, CSO and private sectors to further engage with farmers for near farm processing.

[11] Food processing sector – Challenges and growth enablers, Grant Thorton, February 2017

Figure 10: Processing: Intensity of stakeholder activity



Key Factors Affecting PHL

Farmers and farmer collectives find it challenging to invest in processing units and operating them sustainably.

Most farmers have very limited knowledge about processing, branding and marketing of processed foods. Even large farmers find it unviable to invest in most types of processing activities due to the required scale and cost of operations. Given the fragmented nature of the market, farmers can only undertake processing if they collaborate and collectivize. However, despite government schemes to promote establishment of processing facilities, uptake by farmer collectives has been very limited due to the factors illustrated below:

Figure 11: Factors restricting farmers and farmer collectives from investing in processing infrastructure

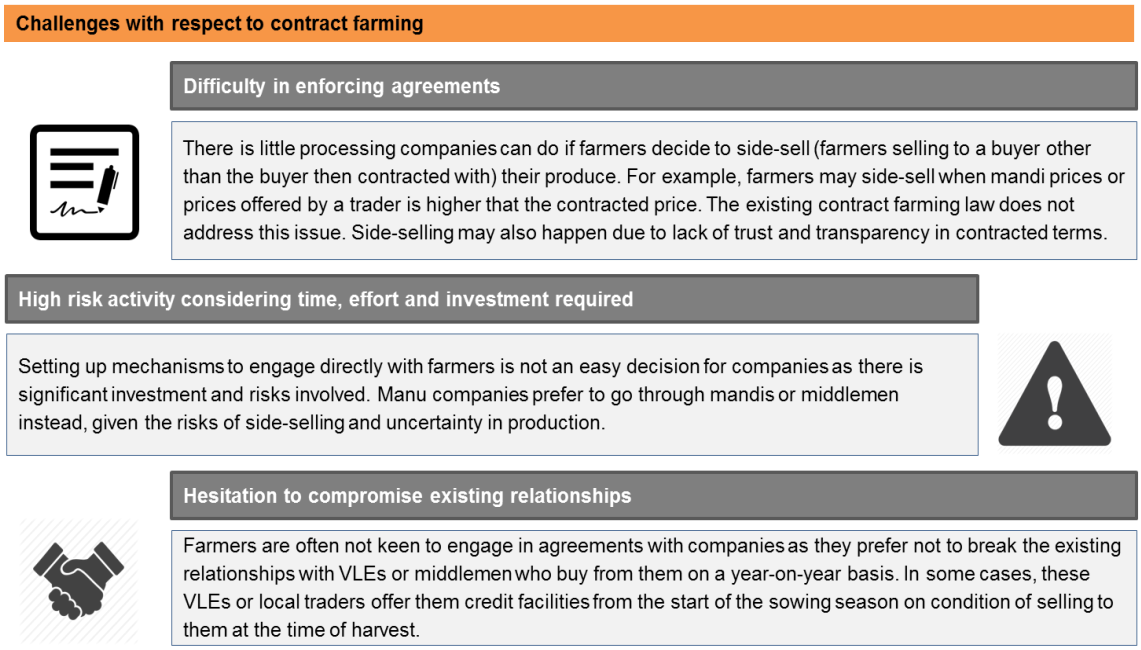
Factors restricting farmers and farmer collectives from investing in processing infrastructure

Lack of awareness and know-how	Lack of marketing and business skills	Weak economic status
• Farmers usually do not look beyond cultivation. This is because they lack awareness of the benefits and the process of setting up a processing unit. • Basic handholding is essential for farmers who want to get into processing. This handholding is currently being provided by manufacturers of low-cost processing technologies and CSOs but is however, not at the required scale.	• Lack of marketing and business know-how to connect with buyers and manage operations efficiently are key factors which restrict farmers and farmer groups from setting up processing units. • There are only a few farmer collectives that have successfully marketed and branded their produce. • In the absence of buyers who are guaranteed to buy at good prices, investing in processing units becomes a very risky proposition.	• Farmers and farmer groups are unable to make investments in food processing units due to poor access to credit, inability to bear investment risk and inability to raise funds. • Even with government subsidies, investments are low as the subsidies are back-ended. • Moreover, due to the small scale of operations compared to their private counterparts, production, transaction and marketing costs are high.

Companies find it difficult to directly link with farmers and set up near-farm processing units.

SHFs contribute significantly to India's overall agricultural output and therefore, emerge as an important producer segment.[13] However, very few processing companies engage directly with SHFs due to key challenges including their inability to guarantee output quality, absorb price declines and invest in farm inputs and operations. While leveraging aggregation models can address some of these challenges, processing companies need to overcome challenges pertaining to contract enforceability, SHF resistance to shifting buyer relationships, and risks related to viability of their investment.

Figure 12: Challenges with respect to contract farming



Trends and Innovations

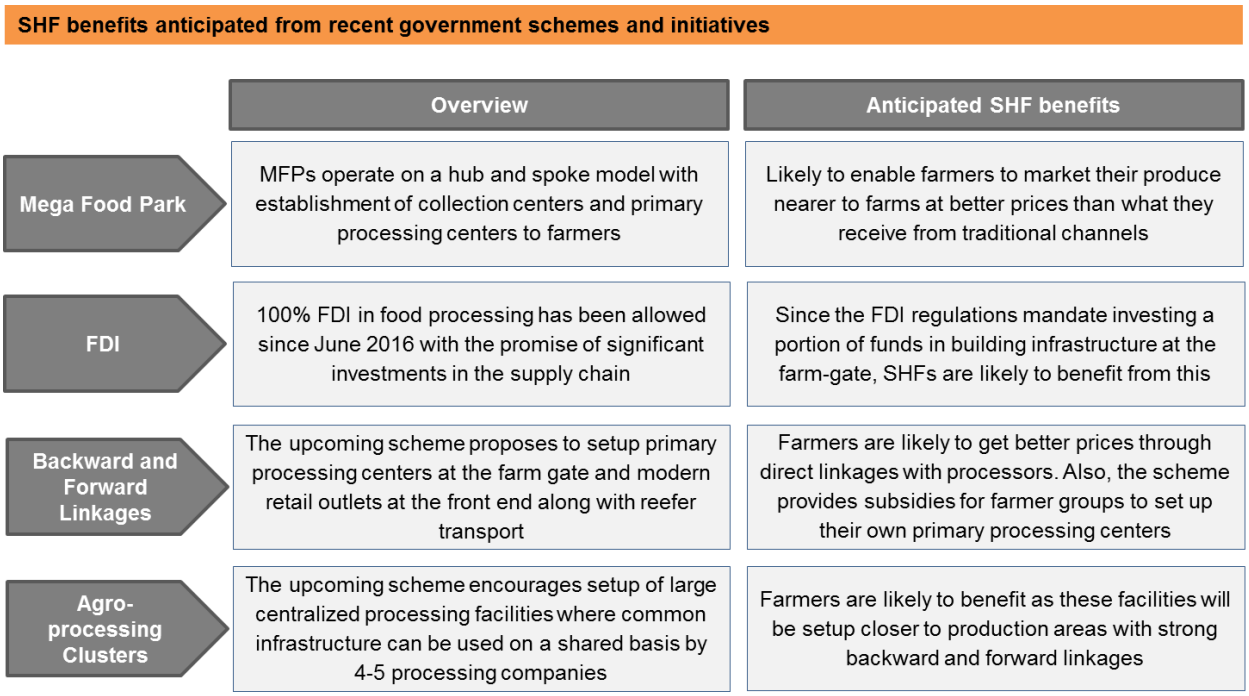
In recent years, the government and private sector focused on bringing processing infrastructure closer to farmers through new schemes and innovative models..

Recent government schemes and initiatives aim to facilitate creation of processing infrastructure closer to farms, thereby enabling SHFs to directly engage with processors.

Earlier food processing government schemes provided grants to establish medium to large processing units, with a limited focus on enabling SHF's leadership or streamlining the value chain. However, recent government initiatives promise to confer greater direct benefit to SHFs.

[13] Role of financial agencies in integrating small farmers into a sustainable value chain, Shridhar Pati, Aditya and Ajay K. Jha

Figure 13: SHF benefits anticipated from recent government schemes and initiatives

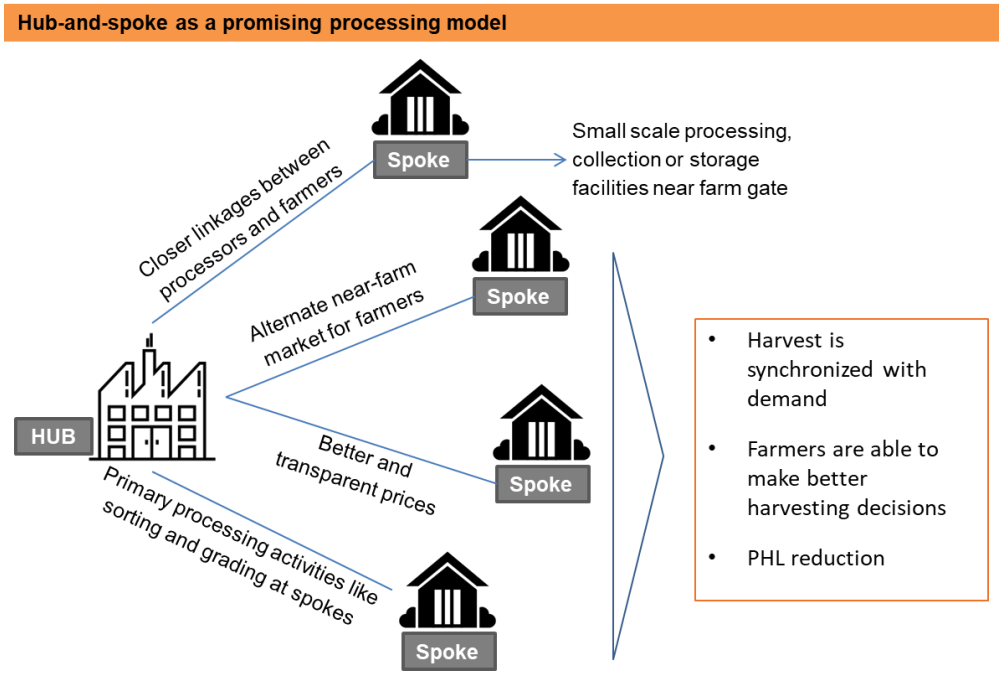


The hub and spoke model for processing activities promises to become a viable and efficient model for direct engagement between companies and farmers.

Companies adopting this model operate through centralized hubs and decentralized spokes. This model can be adopted by a single company as in case of Our Food or by multiple companies as in case of Mega Food Parks that are being established across the country. This model promises to work particularly well for company clusters as they can reap economies of scale and optimal capacity utilization by sharing capital intensive facilities such as cold storages, blast freezers and warehousing. They can also jointly invest in building necessary infrastructure such as roads, water supply systems and power back-up.

In this model, small-scale processing and temporary storage activities are carried out near the farm gate, while large scale storage and processing facilities are centrally located at hubs. The hubs are strategically located to provide easy access to both farms as well as markets. Some food parks such as India Food Park encourage small-scale processing by farmer groups by offering facilities along with technical assistance.

Figure 14: Key takeaways that make hub-and-spoke a promising model



Some private companies enable SHFs or small groups of farmers to undertake small-scale processing near farm, and share the benefits of value addition with them.

The near-farm processing sector is nascent with few companies enabling farmers to undertake small-scale processing at the village level. These companies have identified products that need minimal investments such as kokum juice, jams and jellies and dried fruit chunks. They advise farmers on equipment and processing practices, and usually undertake packaging, branding and marketing after they procure the processed products from the farmers. The model is asset light for the company as farmers undertake processing. However, given the high costs for on-boarding farmers and advertising to end consumers, the uptake and sustainability of this model remains to be seen.

Whitespaces and Opportunities

Key measures can contribute to addressing the gap in processing, including accompaniment for SHFs by CSOs and government agencies, innovative financing to enable SHFs access to public schemes, and private sector adoption of best practices for SHF engagement.

CSOs and government extension service providers can play a critical role in awareness generation about the benefits of such value addition through small-scale processing.

Once farmers see the benefits of small-scale processing by way of improved income, they tend to be more open to investing in processing technologies. Indian Society of Agribusiness Professionals (ISAP), BAIF Development Research Foundation and Nandi Foundation are amongst the very few CSOs that

provide farmers access to their processing facilities and help in marketing and branding of the processed produce.

Investment in small-scale processing units is likely to be more viable for SHF collectives rather than individual SHFs. CSOs that facilitate formation of FPOs can help such FPOs establish near-farm processing units, and develop the necessary market linkages to sell the processed products. For instance, ISAP has connected FPOs to consumers in housing societies in Delhi, which has enabled farmers to secure three to four times the price they would have received from middlemen.

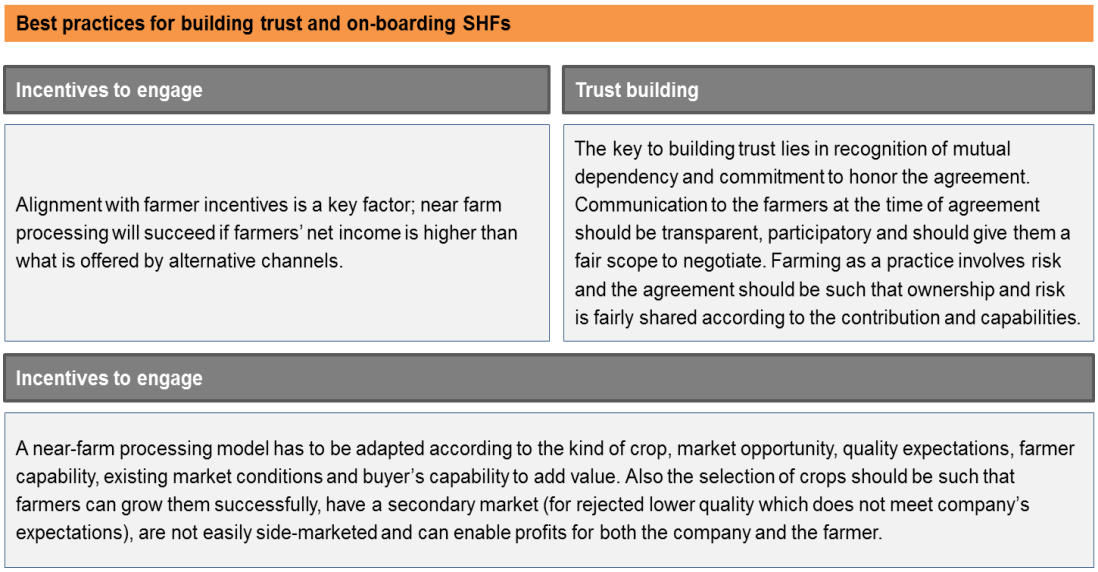
Since most government schemes offer back-ended subsidy support, bridge financing support can enable access for farmer groups.

Under back-ended subsidy schemes applicants receive subsidies only after the processing unit has been established; farmer groups may struggle to make the upfront investment and SHFs are unlikely to benefit from such schemes. . Bridge finance support for farmer groups to access such schemes can help farmer cooperatives and FPOs to set up processing plants. The advance funding can be returned as and when the back-ended subsidies are realized.

The rising demand for processed food in India incentivizes companies to scale their businesses. With the adoption of key SHF engagement best practices, they can optimize returns by working directly with SHFs for near farm processing.

A few processors such as Galla Foods, Mapro Farms, Junak Foods and Inspira Farms have successfully set up near-farm processing units. Successful near-farm processing agreements require that farmer groups produce according to the company's requirement, selling exclusively to that company. However, on-boarding SHFs and building trust is not an easy task and hinges on the following best practices.

Figure 15: Best practices for building trust and on-boarding SHFs



Market Linkage

Overview

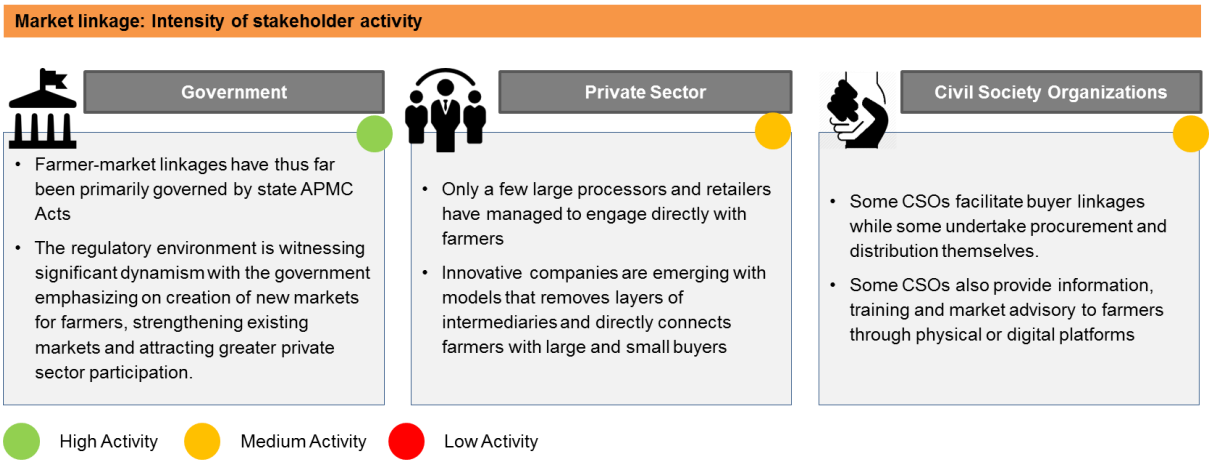
Lack of SHF access to market information and linkages with buyers builds inefficiencies in the value chain leading to PHL and adversely impacts SHF incomes. The recent trend of the government and the private sector proactively supporting direct market linkages is a win-win for all market actors.

The weak market orientation of SHFs in India stems from 1) an acute lack of timely market and demand information and 2) limited avenues to sell their produce beyond mandis and local middlemen. Farmers need seamless and efficient access to markets to drive growth, benefit from remunerative prices and reduce post-harvest losses. Middlemen currently bridge the gap between farmers and markets, earning margins at every stage of the distribution chain, leaving very little for the farmers on one hand and over-charging the end consumers on the other. The unorganized supply-chain is characterized by inefficiencies in logistics and storage resulting in food losses in the post-harvest stage. Farmers have limited visibility on demand, causing frequent over-supply or shortages, which impacts prices and exacerbates crop wastage.

In response to these challenges, the private sector and the government have been very active in this space. The government has introduced a series of reforms which promise to help improve SHF's margins and reduce PHL by creating greater direct linkages to markets. Considerable private sector activity is also noticeable in the post-harvest phase, with new and innovative models emerging over the past few years. Some CSOs have expanded their role in the post-harvest phase - they aggregate farmers, facilitate buyer linkages and undertake procurement and distribution.

This chapter discusses trends and opportunities around improving SHF market access and participation, with a focus on PHL reduction.

Figure 16: Market Linkage: Intensity of stakeholder activity

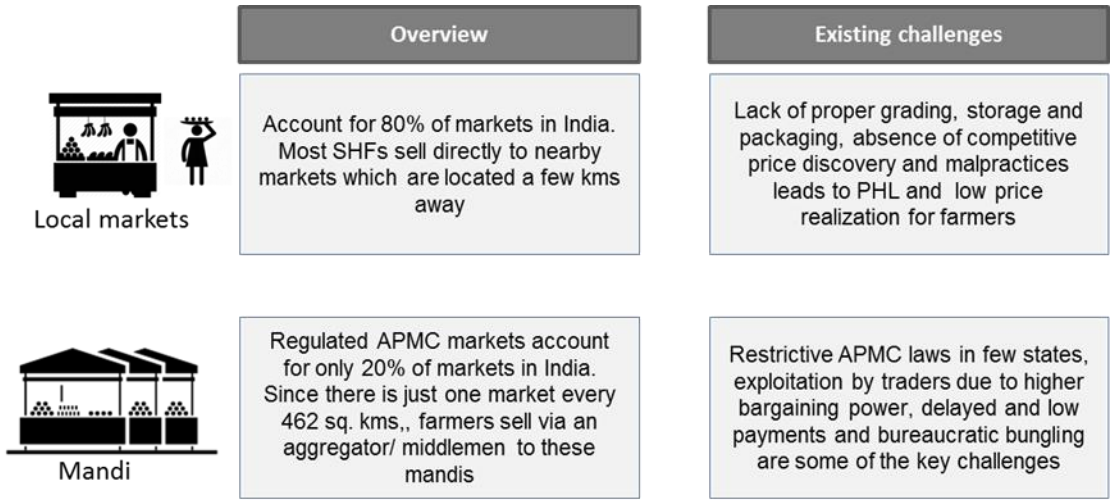


Key Factors Affecting PHL

Farmers have limited avenues to sell their produce, resulting in low bargaining power and overdependence on middlemen.

Agriculture marketing in India is largely governed by state level APMC Acts. Currently, farmers rely on middlemen or sell in unregulated local markets as a regulated market is present every 462 sq km area, while ideally there should be one for every 5 sq km.[14] In addition, there are restrictions on farmers for selling outside APMC mandis in several states. Traders at APMC mandis, therefore, enjoy disproportionately high bargaining power, defeating the very purpose of establishing these regulated mandis. The limited routes to market contribute to value chain inefficiencies, PHL and poor price realizations for farmers.

Figure 17: Challenges associated with existing agricultural markets in India



Farmers base crop selection decisions on prevailing prices rather than projected market demand, resulting in oversupply.

The recent agricultural crisis in India, which peaked June 2017, resulted in widespread agitation by farmers across several states demanding loan waivers and an increase in MSP to overcome the harsh economic impact of crop failures and supply gluts. The crisis is characterized by oversupply of crops such as potato and chilly leading to low prices for farmers. Such oversupply does not impact urban market prices significantly as middlemen are able to store and maintain reasonably high prices in end user markets. When farmers cannot earn enough to cover their cost of production, and markets cannot absorb the excess supply, there is wastage. These inefficiencies in the supply chain are a result of vertically fragmented markets which makes it difficult to project the demand of crops in advance, even before the sowing season for respective crop. Currently, sector actors are unable to address this information asymmetry and inform farmers of demand estimation.

[14] As per Union Agriculture Minister – Radha Mohan Singh

Post-harvest management is poor as the layers of small intermediaries in the supply chain invest very little in quality storage, packaging and transportation infrastructure.

According to Ninja Cart[15], traditionally on an average there are 4-5 middlemen to take the produce from farms to retailers over a distance of 100-200 kms. Most of these middlemen do not invest in proper packing, storage and transport infrastructure as they simply pass on the costs resulting from the expected wastage to the farmers and end consumers. The lack of infrastructure and inefficiencies in the distribution chain also result in considerable wastage.

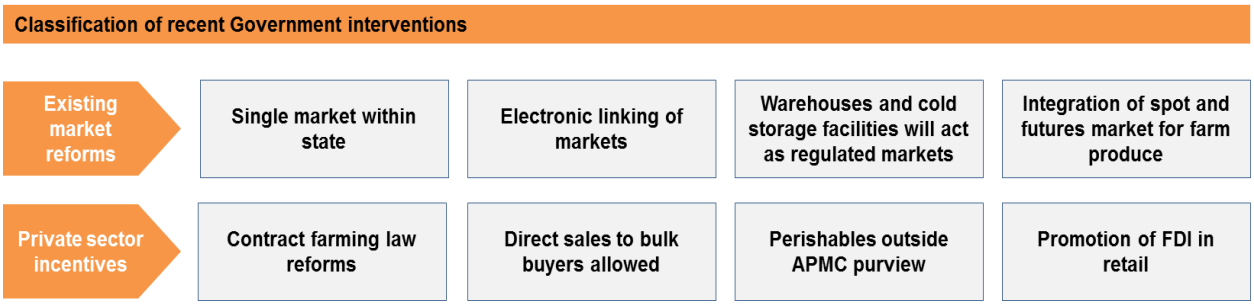
Trends and Innovations

Government focus on market creation has incentivized the private sector to step up efforts to build value chain efficiency and introduce innovations to open up new markets, create necessary market linkages and provide market information to farmers. These trends have the potential to streamline value chains; buyers will, however, continue to rely on more efficient intermediaries to procure from SHFs.

The government is taking steps to augment the current APMC system with alternative channels and incentivize private sector participation.

The government is seeking to strengthen the farmer-market linkage and boost private sector activity through amendments to the APMC Act and contract farming law, promotion of FDI in retail, development of futures and spot exchanges, and online trade mechanisms. As major shifts in the APMC system will take hold in the medium-term, the recently amended APMC reform allows for warehouses and cold storages to act as APMC mandis. This changing ecosystem has attracted investment from innovative companies.

Figure 18: Classification of existing government interventions



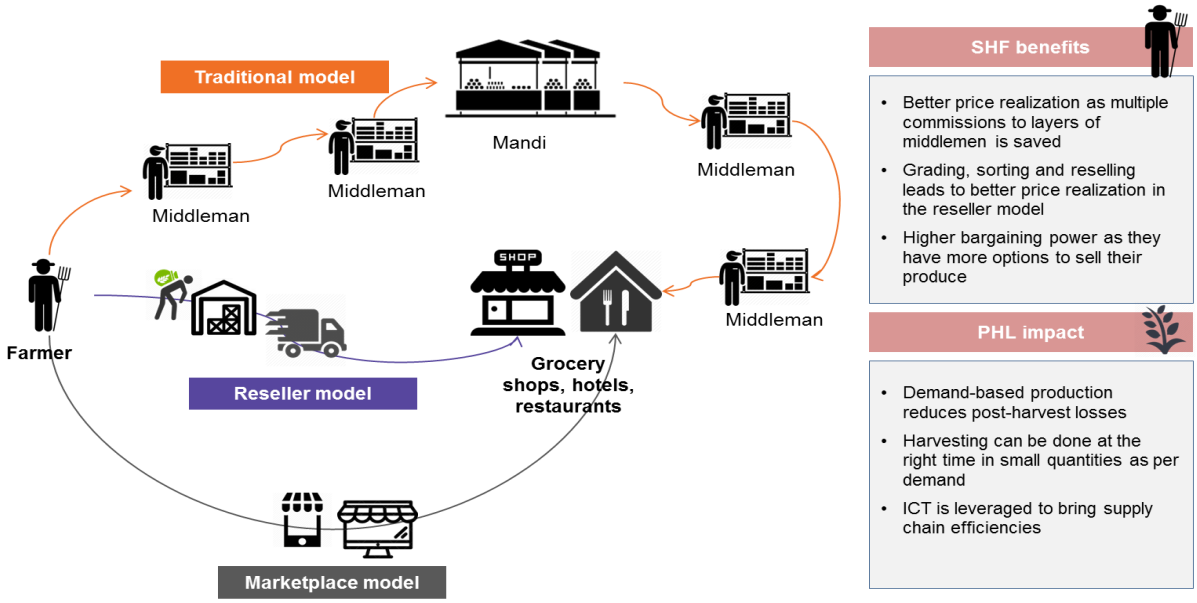
In the past few years, private sector companies have adopted new models to improve supply chain efficiency, reducing layers of middlemen in the process.

Since 2010, two new models – resellers and marketplace - have emerged to connect SHFs with hotels, restaurants and small shops. Some companies adopt the reseller model to purchase from farmers and

[15] Interview with Ninja Cart, 24th June 2017

then package, market and transport the produce to restaurants and super markets.[16] The marketplace model, on the other hand, is a digital platform which enables farmers to connect with small shops and hotels near the SHFs.[17] Apart from gaining better prices, SHFs also save on time and effort in transporting the produce to distant mandis. These models are effective in ensuring minimal wastage as they enable on-time harvesting by predicting and matching daily customer demand to SHF supply.

Figure 19: SHF benefits and PHL impact associated with of alternative market linkage models



CSOs partner with private companies to expand market linkages for their wide networks of farmers.

CSOs can help the private sector connect with wide farmer networks to ensure sufficient and regular supply, which is one of the key bottlenecks facing scalable private sector interventions. Some new companies such as Crop Connect prefer to work directly with established FPOs that aggregate large groups of farmers; this helps them to procure produce from a single source instead of on-boarding and entering into agreements with individual farmers. FarmMobi and Farmily engage with NGOs and foundations who can provide access to large networks of farmers in a region.

Initiatives that promote entrepreneurship in villages can create win-win situations for all concerned sectors - the private sector gains access to large farmer networks, farmers benefit from new avenues to sell their produce as well as better prices and the entrepreneurs secure steady incomes. Syngenta Foundation for instance, recently launched a training program for rural youth to cater to farmer needs. These youth are trained on crop-specific issues, ICT and book-keeping in an entrepreneurship program. They then train farmers in their villages and also provide private sector linkages for marketing output and

[16] NinjaCart, CroFarm and WayCool are examples of companies adopting the reseller model
[17] Farmily, FarmMobi, and VegFru are examples of companies which adopt the marketplace model

facilitating credit. The youth earn commissions from private companies on establishing successful linkages.

Companies have found innovative ways to secure farmer buy-in and reduce information asymmetry to support better decision making by farmers.

Engaging with SHFs is not an easy task as they are often highly skeptical about partnering with private companies. Also, SHFs typically do not invest in storage, packing and crop protection. However, a few companies have overcome these barriers effectively by adopting innovative mechanisms and best practices.

Figure 20: Innovative approaches for farmer outreach and securing farmer buy-in

Companies need to effectively manage farmer outreach as costs can escalate

Enlisting agricultural students (e.g. Farmily) or rural youth (FarmMobi and Connect Farmer) as village champions to regularly conduct village contact programs or leveraging digital platforms can help on-board farmers in a cost effective manner.

- Rural youth who hail from within the farming communities can be instrumental in winning farmers' trust
- Similarly agricultural students work on project/internship mode and at affordable stipends to connect with farmers and secure their buy-ins
- Leveraging digital platforms such as Whatsapp and YouTube ca help reach out to farmers by sharing videos and addressing queries in a cost effective manner

Predictive analytics and efficient operations can effectively address PHL without significant investment

Unlike large processors and retailers, small intermediaries and startups find it unviable to invest in integrated cold chains. There is an opportunity to leverage data and predictive analysis instead to address this barrier.

- **NinjaCart** for instance has an efficient supply chain which takes only 14 hours on an average to transport produce from harvest to the market.
- They are able to minimize PHL even without investing in cold chain because they have built systems which can predict daily customer demands and link it to produce which is just about to be harvested.

Whitespaces and Opportunities

States must implement Central policy mandates and leverage farmer aggregation models to deepen the private sector's direct engagement with and fast track market creation for SHFs. These changes promise to have a significant impact on PHL and SHF livelihoods

Proactive implementation of policy reforms by states can significantly improve farmer access to alternate markets.

Recent reforms such as e-NAM, FDI, model APMC Act and contract farming law amendments by the Central government have the potential to generate benefits for SHFs, but states must drive implementation at scale. The share of alternate markets and direct selling to private companies needs to grow significantly, to improve price realization for SHFs at scale. State governments have an opportunity to change this by implementing central reforms with suitable contextual modifications to promote private

sector investment in the post-harvest phase. States also need to improve coordination between its various departments and agencies for reform implementation.

The private sector and government can cater to the vast SHF market by empowering farmers.

Many private sector companies go through layers of middlemen as it is difficult for them to engage with individual farmers directly. The Central and state governments can play an important role in promoting FPO and FPC formations; creating an enabling environment for farmers to trade and helping them access credit. NGOs and the private sector can partner to raise awareness, on-board farmers and provide extensions services to enable quality in production as well as post-harvest management. Farmers benefit as they get direct access to large buyers and can retain margins for themselves which otherwise get passed on to middlemen.

Effective Approaches for Farmer Aggregation

Effective farmer engagement is critical for the success of interventions to address PHL. Farmer aggregation is a pre-requisite for enhancing direct market linkages, providing farmers training and extension services, and effectively introducing new technologies. Effectively engaging farmers at an aggregated level can help various sectors within the agricultural system overcome barriers such as landholding fragmentation, low production volumes, limited skills and awareness about modern farming techniques, and high individual costs incurred by farmers for product transportation and distribution.

Aggregation models and mechanisms can prove instrumental in establishing greater alignment between demand (markets) and supply (farmers). They can 1) provide greater visibility to farmers on what to produce, in what quantity and of what quality by facilitating access to required data and information, and 2) create and strengthen linkages with markets and platforms to sell such produce by facilitating necessary collaborations. Additionally, aggregation models:

- Facilitate greater direct engagement between the private sector and farmers, promising to foster greater efficiencies in the post-harvest value chain.
- Enable SHFs to share assets like farm equipment costs associated with logistics and marketing.
- Enhance SHFs' potential to reap benefits of value addition by enabling them to invest in small-scale near-farm processing.
- Strengthen the business case for private sector companies to invest in near farm storage and processing infrastructure by bringing together a large number of farmers and ensuring necessary volumes of produce.
- Allow SHFs to partner with market actors and gain better access to information to reduce PHL by ironing out demand and supply imbalances.

Aggregation is either driven by farmers (often catalyzed by CSOs) or by private sector actors. FPOs, Self Help Groups & Farmer Interest Groups (SHG/FIG) and Agricultural Entrepreneurs (AE) are three key aggregation models that enable farmers to reap the benefits of collective size and strengthen the business case for engaging SHFs directly. In addition to these aggregation models, stakeholders such as government, CSOs and private sector also leverage key mechanisms to scale their interventions, namely Primary Collection Centers, Contractual Agreements and Digital Platforms.

Aggregation Models

Aggregation models aim to achieve two key objectives. First, they help SHFs access and implement PHL reduction solutions such as mechanization, storage and primary processing. Second, they are a pre-requisite for direct private sector engagement and creation of market linkages for SHFs.

Farmers perceive investment in solutions such as storage and crop protection as costs that primarily generate long-term benefits. Aggregation models that can demonstrate benefits of such solutions, such as combinations of AE and SHGs, are best suited for such solutions. Solutions such as primary processing and equipment leasing on the other hand, are likely to be served better by the AE mode as farmers expect near-term gains from these solutions.

FPOs

FPOs are legally registered collectives of farmers which focus on enhancing farmer incomes.

Key attributes:

- There are two key variants to the FPO model – co-operative society and farmer producer company (FPC). While cooperatives can only have a transactional relationship with other entities, FPCs can form joint ventures and alliances for the purpose of attracting investments in their business.
- FPOs are often formed by CSOs who play the role of a facilitator and advisor until the organization stabilizes.
- The formation of an FPO is driven by the farmers in order to reap economies of scale. In the post-harvest stage, such collectivization of farmers, especially when SHFs are involved, enables investments which would have been unviable for individual farmers.
- FPOs enable SHFs to add value before selling the produce, ensuring that they earn higher prices. FPOs also provide a range of support to member farmers such as access to quality inputs at lower costs, capacity building, knowledge and awareness for scientific farming, good agricultural practices in the post-harvest phase and market linkages.

Key offerings:

Since they aggregate large numbers of farmers and have a well-defined leadership, they can influence farmers. Following are the activities that FPOs are well positioned to undertake to advance PHL reduction:

- Piloting mechanization solutions and encouraging SHFs to adopt such solutions
- Partner with private sector organizations to enable farmers to lease farm equipment at an affordable cost. For example, FPCs promoted by Association for Social Advancement (ASA) collaborate with companies like Mahindra and Mahindra's Trringo to facilitate equipment leasing by farmers.

- Encourage farmers to invest in storage and small-scale processing initiatives such as establish pack-houses, undertake pulse milling and mechanized grading and sorting. FPOs promoted by Indian Society of Agribusiness Professionals (ISAP) for example, are undertaking these activities to benefit member farmers.
- Facilitate training and capacity building of SHFs on post-harvest good practices
- Facilitate creation of market linkages for farmers' produce by tying up with private sector buyers
- Advance access to finance by creating linkages with banks and other financing institutions

Effectiveness and constraints:

- The biggest challenge in establishing an FPO is to educate farmers about the benefits of collectivization, and especially through a legal structure.
- Initial share capital of FPOs is usually very limited. In addition, FPOs cannot raise equity funds like private agro-processing companies, though they can create special purpose vehicles through joint venture that can be used to attract equity investments.
- Since farmers need cash on a daily basis, the requirement for liquidity is very high in an FPO.[18]

Self Help Groups (SHGs) and Farmer Interest Groups (FIGs)

SHGs and FIGs are voluntary collectives of a small number of farmers. These groups work collectively towards a common goal which is established through discussion and mutual consensus.

Key attributes:

- Since each SHG or FIG ideally comprises 7 to 20 members, each member SHF has substantial participation and power in decision making.
- SHGs and FIGs do not necessarily require external support for the formation. However, external agencies like development organizations and NGOs are often mandated to establish SHGs and FIGs as building blocks to set up FPOs in the future.
- Given their informal (non-legal) structure, they are free from strict legal requirements and display a high degree of cohesiveness and common purpose. The time taken to adapt GAPs and other interventions is also lesser, which enhances the capacity of such models to drive PHL reduction.

Key offerings:

- When farmers work collectively as an SHG or FIG, they get access to a wide range of services such as technical assistance, crop planning and harvesting support and better market linkages.
- SHGs and FIGs can raise awareness about and help roll out PHL reduction solutions such as mechanization and equipment leasing among farmers.

[18] From farmer to businessman, The Hindu, April 2016

- They can encourage member SHFs to collaboratively undertake primary and small-scale basic processing to improve their incomes.
- SHGs and FIGs can adapt to best practices in storage and packaging quickly as it is a small cohesive group of farmers.
- SHGs and FIGs may choose to set up a savings mechanism of their own, through which collateral free loans are provided to their members at very low interest rates.
- Like FPOs, they can help facilitate sampling and conducting surveys to gather baseline and test data.

Effectiveness and constraints:

- Effectiveness of SHGs and FIGs can be constrained by their size and quality of leadership. In the absence of effective leadership, member farmers may not have the competency to engage in financial transactions or execute buyer contracts.
- Lack of strong organizational structure and influence by dominant voices from within the group can often lead to disputes and long-run instability in the model.
- SHGs and FIGs face challenges in fully meeting high demand for partnerships due to their low absorptive capacity. Nonetheless, private sector companies, particularly those seeking contractual agreements like Mother Dairy prefer this aggregation model over FPOs as it helps them avoid legal complications.

Agricultural Entrepreneurs

The agricultural entrepreneur (AE) model is predominantly buyer and intermediary-driven and includes progressive farmers, VLEs, village merchants and local traders.

Key attributes:

Private sector companies leverage AEs to procure produce from framers and provide products and services such as inputs, equipment and other post-harvest services to them. Unlike the FPO and SHG/FIG models, AEs display strong profit orientation and either work independently or through contracts with companies.

- AEs primarily engage with SHFs for aggregating produce and selling to buyers, and leasing of equipment. The role of SHFs in this model is limited to supplying produce and/or making equipment lease payments to the AEs.
- AEs usually buy the produce from the farm-gate and often have access to temporary storage facilities which enables them to sell produce at a later date when the prices are right. They bear transportation costs, but build it into the prices which they pay to farmers or seek from buyers.
- Since AEs have the option of transacting with many buyers (processors, retailers, intermediaries as well as number of traders at the mandi), they typically do not prefer to be tied to any one buyer.

Key offerings:

- Given their understanding of farmers' situation and needs, AEs are able to provide right-fit solutions.
- AEs leverage their understanding of farmers to give them credit at the time of sowing season and while selling inputs to farmers. AEs provide spot payment which is crucial for farmers as many traders in mandis delay payments.
- Since SHFs cannot individually take their produce to the distant mandis and by selling via AEs, they save on time, effort and money in storing and transporting.
- AEs can provide SHFs affordable access to equipment for cultivation and harvesting.

Effectiveness and constraints:

- As individuals, AEs have different levels of education, financial strength and incentives to invest in business. For instance, quality of produce may differ and while procuring from different AEs. Their ability to grade, store and package the produce may also differ.
- Lack of capital constrains AEs' ability to invest in quality storage or near-farm processing infrastructure.
- The community trust enjoyed by AEs is limited to their personal networks. Even a successful AE may find it difficult to scale if his network does not grow.

Aggregation Mechanisms

Three aggregation mechanisms namely, Primary Collection Centers, Contractual Agreements and Digital Platforms, can facilitate direct market linkages for farmers, and help improve value chain efficiency, reduce crop losses and improve farmer incomes. Private sector companies largely bear the costs of establishing and operating these mechanisms, and therefore the associated risks. The role of farmers in these mechanisms is primarily limited to either ensuring delivery of quality produce to buyers or adopting and paying for post-harvest solutions such as farm equipment offered by companies. Limited or inconsistent participation by farmers and frequent farmer drop-offs represent a common barrier to scale.

Primary Collection Centers (PCC)

Key characteristics:

- PCC is a farmer aggregation mechanism mainly used by the private sector to aggregate produce. It is a physical space and acts as a near-farm market where farmers can sell their produce. Farmers are responsible for getting the harvest from the farm gate to the PCC.
- PCCs are managed by trained staff who offer technical assistance to farmers as and when required.
- PCC offers a way to take the formal supply chain closer to farmers and allows for primary processing activities including sorting, grading and weighing.

- The potential of the mechanism remains under-explored as it has thus far been adopted only by a few large companies like Mother Dairy and ITC e-Choupal Sagar.

Effectiveness and outcomes:

- Large-scale processors of F&Vs have popularized PCCs to encourage farmers to trade with them directly. Offering an alternative market for farmers, PCCs greatly reduce travel time and cost, while also reducing dependence on middlemen.
- PCCs can significantly contribute to improvement in farmers' income and margins by guaranteeing better prices. Farmers benefit from sorting and grading facilities at the PCC resulting in transparency with respect to payments they receive.
- Besides fair prices, direct market linkage and faster payments, PCCs provide a host of extension services to farmers including guidance on good agricultural practices, which helps them improve productivity, improve quality and reduce PHL.
- Some companies communicate their procurement plan in advance. Based on such information, farmers are able to synchronize the amount of produce that is harvested, hence, overcoming potential oversupply and rejection due to early harvesting. This greatly helps in reducing PHL.

Application:

- PCCs have the potential to complement and strengthen contractual and digital platform based farmer engagement mechanisms. PCCs augment such mechanisms by providing a near-farm collection point for facilitating the supply transactions.
- PCC as a farmer aggregation mechanism is replicable across geographies and is particularly relevant for areas characterized by small fragmented farms.

Dependencies for implementation:

- Accessibility is a pre-condition to incentivize SHFs to use PCCs as it saves on transportation costs. While it is necessary for PCCs to be established in areas that can supply a viable minimum output, it is also necessary for these centers to be near farms and easily accessible by road.
- Transparency in weighing produce and ascertaining quality is as important as price discovery in order to keep farmers incentivized to trade through PCCs.
- The introduction and scale-up of Mega Food Parks (MFPs) is likely to boost the relevance and adoption of PCCs.

Key constraints and limitations:

- The PCC mechanism does not pass on the benefits of value addition to farmers.
- As there are no restrictions on intermediaries trading at PCCs, they can completely overshadow the intended benefits for SHFs.

- PCCs set up by the private sector will be located where there is critical mass of produce. Hence, PCCs cannot be seen as a means to prioritize improvement of SHF livelihoods over commercial viability.

Contractual Agreements

Key characteristics:

- Contractual agreements enable companies to purchase a pre-determined quantity of output at a future date. Such an agreement mechanism may or may not fix prices beforehand and could be either a formal written contract or an informal agreement (such as verbal commitments).
- Such agreements are mostly used when the buyer requires a defined quality and quantity of output as well as consistent supply. Companies adopting contractual agreement mechanisms work very closely with a captive group of farmers to ensure quality of produce.
- Companies usually adopt the mechanism on or near-farm. Once the company procures the produce, it carries out all the other activities in the post-harvest value chain.

Effectiveness and outcomes:

- The main benefit for farmers is that they have an assured market for their produce.
- The contractual agreement reduces the supply risk for the company along with minimizing the market risk for the farmer.
- Farmers are able to enjoy some predictability in terms of specific crops and variety (on advice from buyers), which result in high economic yields and better prices.
- Since companies work with a captive group of farmers, they can drive efficiency improvement interventions and promote good agricultural practices. In order to ensure quality output, the company engages with farmers for advising them on crop practices, providing inputs and setting up near-farm processing and storage facilities.

Application:

- Processors who work with specific crops in a region so as to ensure optimal utilization of their infrastructural capacity would benefit by this mechanism
- Contract farming in India is mainly practiced for sugar, barley and medicinal plants where farmers have very limited options to sell their produce in traditional markets.
- Farmers practicing organic farming benefit by engaging with companies through contracts as companies provide the organic certification.

Dependencies for implementation:

- A contractual agreement mechanism will succeed if the farmer gets a net income which is higher than what he can earn through alternate channels.

- The key to building trust lies in the design of the agreement, recognition of mutual dependency and commitment to honor the contract. Transparent communication and a participatory approach to negotiate and draft the agreement between the company and farmers are key success factors for contractual agreements.
- A contractual agreement has to be adapted according to the kind of crop, market opportunity, quality expectations, farmer capability, existing market conditions, and the buyer's capability to add value.
- The selection of crops should be such that farmers can grow it successfully, and have a secondary market for rejected, lower quality produce which does not meet the company's specifications.

Key constraints and limitations:

- The scalability and impact of the mechanism has been limited mainly due to issues related to trust and enforceability, particularly for written contractual agreements.
- In case of verbal agreements built on trust where both parties have the freedom to procure or sell to others, farmers are wary of investing in new crops or crop varieties in the absence of a guaranteed buyer.
- Farmers are often not keen to engage in agreements with companies as they prefer not to break the existing relationships with VLEs who regularly buy from them.

Digital Platforms

Key characteristics:

- Companies are leveraging ICT to develop digital platforms that aggregate farmers to procure produce from them or sell inputs and equipment to them.
- The mechanism enables farmers to connect with restaurants, grocery stores, catering businesses etc. in their vicinity to sell their produce. It also enables farmers to access equipment and machinery for cultivation and harvesting through direct selling, leasing or peer-to-peer lending.
- Digital planforms enable farmers to access information and advice in the pre and post-harvest phases of the value-chain.

Effectiveness and outcomes:

- The mechanism enables farmers to connect with buyers in their vicinity, enabling better market and price discovery.
- It also enables farmers to harvest the produce when required and supply it to buyers nearby mitigating the need for early harvesting, expensive storage infrastructure, and thereby, reducing wastage and transportation expenses.

- Companies with marketplace solutions support and facilitate transactions by arranging for logistics and helping farmers to aggregate if required.
- Equipment leasing companies give farmers the option to connect through the contact person on-ground, via the app or via phone.
- The mechanism enables companies providing extension and decision support services to develop content in multiple languages and provide voice based support to expand their farmer reach.

Application:

- Marketplace solutions for produce usually works well in a B2B (farmer to bulk buyer) arrangement. Companies leveraging this mechanism often facilitate matchmaking, and subsequently leave it to the buyer and farmer to negotiate offline.
- The mechanism is applicable in areas where leveraging ICT can significantly optimize costs and linkages.
- The mechanism is particularly useful in villages which are in close vicinity of towns and cities to facilitate faster collection and delivery.

Dependencies for implementation:

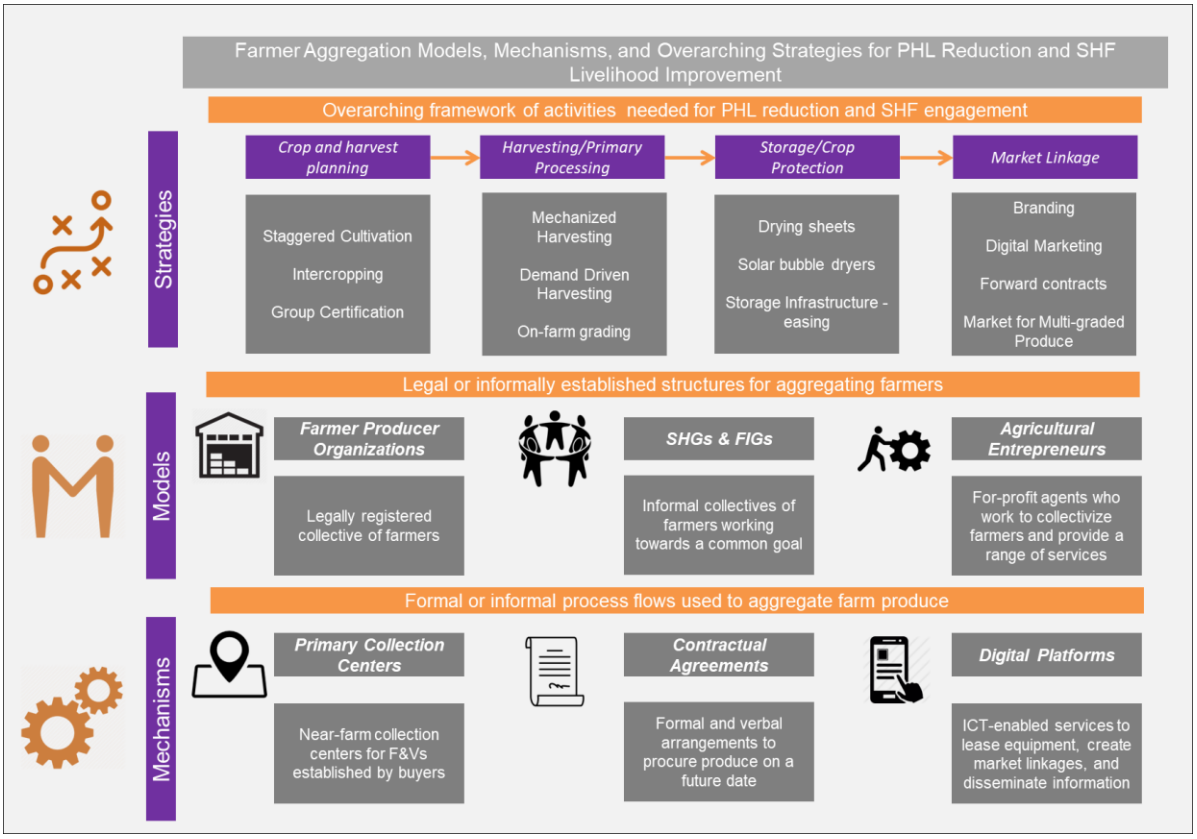
- On-ground presence for awareness building and training to use the platform effectively is much needed to on-board farmers. Usability aspects designed for farmers who are not well-versed with technology should be simple and straightforward.
- Bundled services help address different challenges users have as well as reduces reliance on a particular revenue stream. In the marketplace model for example, some companies are building an online marketplace for ancillary services for storage, packaging, transport and financing. This enables farmers to address most challenges in selling directly to buyers.

Key constraints and limitations:

- Many farmers are averse to adopting new technology and do not own smartphones to engage via digital platforms.
- Concerns about quality assurance of produce in case of marketplace solutions and equipment leasing, constrains buyers from engaging with sellers on digital platforms.
- Expenses associated with raising awareness and enabling farmers to engage are high, particularly given the low revenues through commissions, advertisements and subscriptions in the initial stages.
- Although digital platforms can reach farmers rapidly, making these platforms economically sustainable is currently a challenge. User behavior, equipment preference, crop types, technology adoption and advisory support needs vary from region to region, making it difficult to standardize and replicate the solution beyond a limited set of similar markets.

- These platforms currently do not segregate SHFs from other larger farmers or traders, hence their services are not designed to meet the specific needs of SHFs.

Figure 21: Farmer aggregation models, mechanisms and overarching strategies for PHL reduction and SHF livelihood improvement



Way Forward

We expect that dynamism in the post-harvest space will drive efficiencies across key value chains, leading to PHL reduction and improvements in SHF livelihoods. However, our research identified variance in the level of momentum observed in each phase of the post-harvest value chain. While significant policy momentum is centered in the storage and processing phases, private sector innovation is centered in the harvesting, primary processing and market linkage phases. Given that agriculture is a state subject, state-level commitment is needed to successfully implement Central policies and regulations. Despite limited near-farm or SHF-focused dynamism in the storage and crop protection phase, SHF-focused innovations are emerging.

Key insights generated through this research include:

- We expect that increasing adoption of farm mechanization among farmers will drive the momentum in the harvesting and primary processing phase. Innovative equipment leasing models will increasingly make farm mechanization accessible and affordable for farmers. Equipment companies are expected to scale their operations by customizing their offerings, leveraging ICT and increasingly engaging with SHFs at aggregated levels to enhance affordability of mechanization equipment.
- The storage and crop protection phase exhibits limited dynamism and considerable whitespaces, particularly with respect to on-farm and near-farm storage and crop protection activities. Farmers are unable to hold on to their produce and improve price realization due to the gap in adequate, on-farm and near-farm storage and crop protection capabilities. This compromises potential gains from on-farm PHL reduction efforts.
- Potentially transformational policy measures (e.g. relaxation of FDI norms, introduction of GST and revamping of the contract farming law and APMC Act) will incentivize investment in food processing. We expect that these policy shifts will significantly boost participation of large processors and retailers, which in turn can drive efficiencies to reduce PHL. The trickle-down effect of these developments to SHFs, however, may take longer.
- Increasingly direct engagement between buyers (such as exporters, retailers and processing companies) and farmers is one development that can hasten the trickle down of efficiency gains to SHFs. Mechanisms like MFPs will encourage companies to create deeper backward linkages, step up their efforts to take their processing infrastructure nearer to the farm or adopt hub and spoke models to streamline direct procurement from farmers. This in turn, is expected to help partially bypass the gap in on-farm and near farm storage and crop protection infrastructure, while also allowing farmers to sell their produce to these companies at better prices.

- Initiatives like the FDI and APMC reforms and e-NAM, along with the private sector thrust on direct procurement, will continue to open up new avenues and strengthen linkages with existing markets for farmers to sell their produce. This phase of the post-harvest value chain will also witness the continued emergence of new innovative companies who specialize in leveraging ICT based digital platforms to create direct market linkages for farmers. Many of these companies source directly from the farm-gate and deliver to a range of different types of buyers and in the process, help farmers maneuver the gap in on-farm and near-farm storage and crop protection infrastructure.
- Across the post-harvest value chain, companies are expected to more effectively engage with farmers by leveraging aggregation models such as AEs, FPOs and SHGs and mechanisms like PCCs, contractual agreements and digital platforms to engage with farmers. However, most of these models and mechanisms are still evolving, with key challenges that must be addressed to ensure optimal use. While challenges such as limited farmer awareness and contract enforceability can be ironed out as actors align around win-win objectives, addressing challenges related to leadership and governance will likely require additional concerted efforts.

Priorities for further research

Given that much of the activities and solutions across clusters are crop-specific, a few areas require further investigation. Several trends in policy, private sector participation and collaborations across sectors are unfolding at the time of this research. Their impact on the landscape and on SHF engagement will provide insights for all sectors in agriculture. Key research priorities and underlying questions that would need further exploration include:

- **Solution development around suitable agricultural value chains**
    - Why have certain agricultural value chains seen robust activity with established forward and backward linkages?
    - How can the success parameters and best practices from these value chains be replicated in other value chains?
- **SHF-focused financing for post-harvest investments and activities**
    - How can the gap in SHF-focused financing of key on-farm and near-farm PHL reduction measures be bridged?
    - What are the different financing and payment models that can facilitate investment in and sharper uptake of near farm storage, processing and mechanization solutions?
    - What are the solutions that can be developed and delivered to improve access to finance channels across the sector?

- **Innovations in information and decision analytics**
    - What are the innovations unfolding in areas such as information for crop selection and decision analytics?
    - What business models support their wide application and what impact do they have on SHF engagement and livelihoods?
    - What are the existing and potential use cases of such innovations and how can they be piloted?

Annexure

Annexure 1: Glossary

Terminology/Acronyms	Description
SHF	Fragmentation of reduction of landholdings by farmers. Smallholder farmers (SHFs) constitute almost 80% of India's farming community. SHF are farmers who hold about 2 to 5 acres of land.
CSO	Civil Society Organizations (CSO) are not-for-profit organizations that engage with farmers in a range of rural development and livelihood enhancing areas. CSO is an umbrella term which covers non-governmental organizations (NGO), Farmer Producer Organization (FPO) and Cooperatives.
FPO	A Farmer Producer Organization (FPO) is a legally registered collective of farmers formed with the objective of enhancing farmer incomes through the multiple benefits associated with aggregation. Member farmers are shareholders, who decide and share a part of the organization's profit, while retaining a surplus for the development of the organization. The minimum number of members required for setting up an FPO in India is 10 and each member should be above 18 years of age. Although farmers are critical stakeholders in the operations of an FPO, an external agency can be responsible for its promotion. This agency is responsible for assisting in the mobilization, registration, business planning, and supervising the operations of the FPO.
Cooperatives	A cooperative society is a type of FPO which is registered under The Co-operatives Societies Act of 1912 or the autonomous Cooperative Societies Acts of individual states. They can be either single-purpose cooperatives or multi-purpose cooperatives. Single purpose cooperatives are established to perform one particular activity such as bee keeping or dairy cooperatives while multi-purpose cooperatives perform a wide range of functions such as input provision, credit supply, marketing of end products and also dispute resolution amongst members. In a co-operative society, each farmer has only one vote and all members own the same number of shares. Only a member farmer can be a shareholder and the shares cannot be sold or transferred to a non-member. This is the reason why cooperatives in India cannot attract any equity investments. The Registrar, Cooperatives is the not only the authority which registers Cooperatives but also the one with all the judicial powers to settle intra and inter cooperative disputes. Registrar's interference in the functioning of these cooperatives has been identified as the single most important reason for these institutions failing in large numbers across the country. One advantage, however, of registering under the Cooperatives Act is their eligibility to access grant funding from the government.

FPC	A Farmer Producer Company (FPC) is a type of FPO which is registered under the amended Companies Act of 1956. FPCs are more popular than cooperatives because of their legal framework. While the membership of the cooperatives is restricted to any individual or cooperative, the membership of FPCs is open only to producer members or producer agencies like cooperatives (for example, a BAIF promoted FPC aims to brand and market the produce aggregated by the member cooperatives and other informal groups of farmers). Unlike cooperatives, FPCs can co-opt professionals on their board. While cooperatives can only operate within a state, an FPC can have pan India operations. FPCs can form joint ventures and alliances for the purpose of attracting investments, while cooperatives can only have a transactional relationship with other entities. FPCs are mandated to share their profits proportionate to the patronage after making provision for retained earnings. They also have to strictly adhere to the norms prescribed by the Companies Act. FPCs (as well as cooperatives) cannot offer equity; however, in terms of their ability to access debt, the FPCs score heavily over cooperatives.
SHG	Self-Help Groups (SHGs) and Farmer Interest Groups (FIGs) are voluntary collectives of a small number of farmers, the formation of which may or may not be catalyzed by an external stakeholder. Originally formed with livelihoods as the core objective, SHGs have been leveraged as an aggregation model for a number of interventions, including financial inclusion and agriculture improvements. According to the Bharat Microfinance Report 2016, 103 million families had been covered under the SHG-Bank Linkage Program (SBLP); there were 7.9 million SHGs with savings worth INR 137 billion (US $ 2.01 billion) as of March 2016. The SHG model of aggregation gradually found credence in agriculture where farmers came together to form small groups which worked towards a common objective, and were referred to as FIGs. SHGs and FIGs are the building blocks of FPOs. Once SHGs and FIGs are well established, they also have the option to come together and form a federation, which is informal and does not require legal incorporation.
Primary Processing	Primary processing include activities such as threshing, drying, sorting, and grading which are conducted by farmers immediately after harvest for improving the shelf life of produce and reducing post-harvest losses. Primary processing activities do not lead to change in form of the produce.
Secondary Processing	Secondary processing of produce is characterized by change in form of the produce with substantial value addition. Secondary processing is predominantly conducted by companies in the organized sector. However, farmers and farmer collectives may also conduct small-scale secondary processing near farm.
GST	GST is a critical reform that will create a unified indirect tax system in India with the state boundaries dissolving for application of indirect taxes (on all goods and services) that would only be payable at the point of final consumption with the actors in the value chain being liable to pay taxes only on the value added by them. The initiative is likely to eliminate tax evasion, strengthen the government's ability to broaden the tax base and migrate to a more competitive tax rate.

Contract Farming law	Contract farming currently falls under the purview of APMC act 2003. However, to address issues, the NITI Ayog is currently drawing a separate law on contract farming. The new law on contract farming, unlike the current law, will cover all the agriculture commodities instead of just one or two commodities. Besides, it will also cover farming right from the distribution of seeds to marketing of the final produce.
e-NAM	e-NAM is the Pan-India electronic trading portal launched in 2016, networks the existing APMC mandis to create a unified national market for agricultural commodities. e-NAM will enable farmers to reach out to buyers across the country.
NWR	Farmers are unable to hold on to their produce due to financial constraints and end up selling in distress to middlemen. To address this issue, the Minister of Consumer Affairs, Food and Public Distribution introduced a Negotiable Warehouse Receipt (NWRs) system in 2011. NWRs can be traded, sold, swapped and used as collateral to support borrowing. With NWRs, farmers can obtain pledge financing for their post-harvest needs from banks to the extent of 70-75% of the value of the commodity after depositing the harvested crop at a warehouse close to his farm.
MFP	The Mega Food Parks (MFP) Scheme of the GoI provides grants to consortia of private sector to build cluster of Primary Processing Centers (PPC) and Central Processing Centers (CPC). Each MFP has a minimum land requirement of 50 acres and has about 30 to 35 processing centers, with different features and equipment. Though the scheme was initiated in 2008, it is only post 2014 that one can discern strong dynamism with respect to the scheme. MFPs are characterized by the presence of CPCs that cater to numerous industries in the MFP. The scheme provides 50% of the total project cost as grant in normal areas and 75% of the project cost in other specified areas, both capped at INR 500 mn (US$ 7.8 mn).

Annexure 2: Companies referenced in the report

Organization	Website Link
Harvesting and Primary Processing	
EM3 Agri	http://www.em3agri.com/
Farmart	http://www.farmart.co/
Trinngo	https://www.trringo.com/
Ravgo	https://www.ravgo.com/
Tafe	https://www.tafe.com/
Yanmar	https://www.yanmar.com/in/
Kamal Kisan	http://kamalkisan.com/
The Agri Hub	http://www.theagrihub.com/
Kisan Manch	http://kisanmanch.com/
Storage and crop protection	
Rinac	http://www.rinac.com/
S4S Technologies	http://s4stechnologies.com/
Tessol	https://www.tessol.in/
Ergos	http://ergos.in/
ASA India	http://www.asaindia.org/
Cold Hubs	http://www.coldhubs.com/
Processing	
OurFood	http://www.ourfood.net.in/
Connect Farmer	http://www.connectfarmer.com/
DesivDesi Foods	http://desivdesifoods.com/
Indian Society of Agribusiness Professionals (ISAP)	http://www.isapindia.org/
BAIF Development Research Foundation	http://www.baif.org.in/
Nandi Foundation	http://www.naandi.org/
Galla Foods	http://www.gallafoods.com/
Mapro Farms	http://www.mapro.com/homepage.html

Inspira Farms	http://www.inspirafarms.com/
Market Linkage	
CroFarm	http://crofarm.com/aboutus.html
NinjaCart	http://ninjacart.in/
Farmily	https://farmily.com/en/
VegFru	https://vegfru.com/
Crop Connect	http://www.cropconnect.in/
Aggregation Models and Mechanisms	
Association for Social Advancement (ASA)	http://www.asa.org.bd/
Mother Dairy	https://www.motherdairy.com/
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