

Boosting India's Agricultural Economy: Transforming India's Growth through Post-Harvest Management and Agro-Processing

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INTRODUCTION

Agriculture has always been the backbone of the Indian economy. This sector plays a central role in India's economy, contributing about 18 percent to its GDP and providing employment to almost half of the population (GoI, 2024). However, the demands of a growing population, changing climate patterns, and evolving consumer preferences have necessitated innovative solutions in agriculture. Therefore, improving agricultural productivity, sustainability, and food security becomes essential as the country progresses towards economic development. Agricultural Engineering, as an interdisciplinary branch that integrates various engineering technologies into agricultural practices, has played a pivotal role in transforming agriculture in India. From basic mechanization and irrigation systems to advancements in crop protection and precision farming, agricultural



engineering has contributed significantly to India's agricultural growth, sustainability, and economic development. Agricultural engineering, with its focus on applying engineering principles to farming, is one of the key drivers of transforming subsistence Indian agriculture into a commercialized one. Among the diverse aspects of agricultural engineering, post-harvest management and agro-processing serve as critical areas that can enhance

productivity, and generate economic value from agricultural outputs with the minimization of post-harvest food loss. The share of the food processing sector is about 32 per cent of the value-added food in the grocery market and the annual growth rate is about 8 per cent since 2014. The food processing sector is the fifth-largest industry in terms of production, consumption, and exports and there is growth potential. The food processing industry has significantly empowered women by providing employment opportunities, enhancing economic independence, and fostering entrepreneurship. In India, women constitute approximately 21 percent of the workforce in food processing industries, engaging in roles such as handling raw materials and packaging finished products. Such ventures not only offer financial stability but also elevate women's social status, enabling them to contribute meaningfully to their communities and the economy at large. Therefore, the agro-processing

sector has received increased attention in India due to its ability to directly influence the country's agricultural efficiency, food security, employment potential, and economic stability.

POST-HARVEST MANAGEMENT IN AGRICULTURAL ENGINEERING

Post-harvest management refers to the handling, storage, processing, and transportation of agricultural products after harvest. In India, a country with diverse climatic conditions and a massive agricultural base, post-harvest losses are a major concern. Figure 1 compares post-harvest losses (PHL, %) in 2014 and 2022 based on ICAR-CIPHET and NABARD (NABCONS) studies, respectively. It shows reductions across all categories, with the most significant decrease in oilseeds and pulses. Fruits and vegetables still face the highest losses, though reductions are evident. Advances in storage, processing, and supply chain management have contributed to minimizing losses and improving food security and efficiency. Post-harvest losses are estimated to be around 10-15 per cent of total food production, primarily due to improper handling, storage, and transportation.

Engineering interventions have played a crucial role in minimizing these losses by developing on-farm processing and handling machines, better storage solutions, cold chain infrastructure, and packaging technologies. Cold storage and refrigeration systems have helped preserve perishable crops like fruits, vegetables, meat, fish and dairy products, reducing wastage and ensuring that the food reaches consumers in optimal conditions.

The growth of the food processing industry in India is another testament to the role of engineering technologies in value addition to

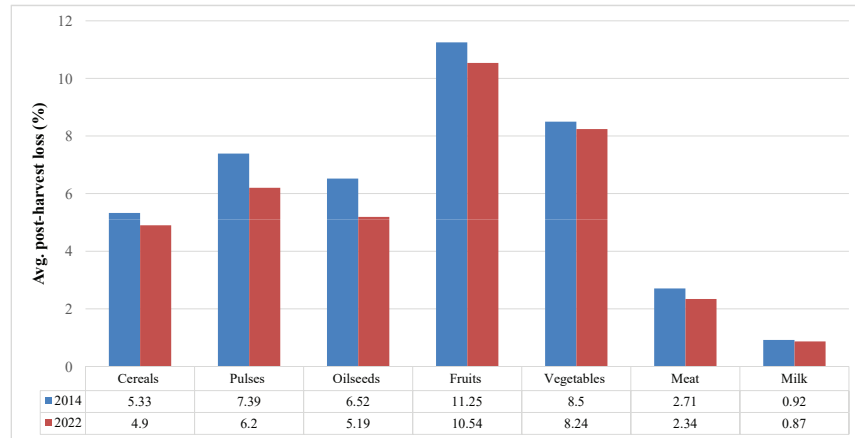


Fig 1: Comparison between the PHL levels between 2014 and 2022

Sources: Jha *et al.*, 2015 and NABCONS, 2022

various agricultural commodities. The sector has contributed significantly to both economic growth and rural employment by improving processing methods and creating new products. Government initiatives like Production Linked Incentives and Mega Food Parks boost growth. Rising demand, urbanization, and exports drive expansion, making it a key economic pillar. The Fig 2 shows India's food processing growth from 2010-11 to 2018-19. Cereals and pulses saw significant improvements, reaching 69 per cent and 62 per cent, respectively. Meat and fish processing improved notably, while oilseeds declined. Fruits, vegetables, and milk

processing remained low, highlighting the need for further investment in infrastructure and the value chain.

The establishment of cold chain networks, particularly in states like Uttar Pradesh, Punjab, and Maharashtra, has seen a rise in exports of fruits, vegetables, and processed food items. This helps farmers tap into global markets and gain better prices for their produce.

BEYOND THE HARVEST: THE ESSENTIALS OF POST-HARVEST MANAGEMENT

Post-harvest management is a critical component of India's agricultural

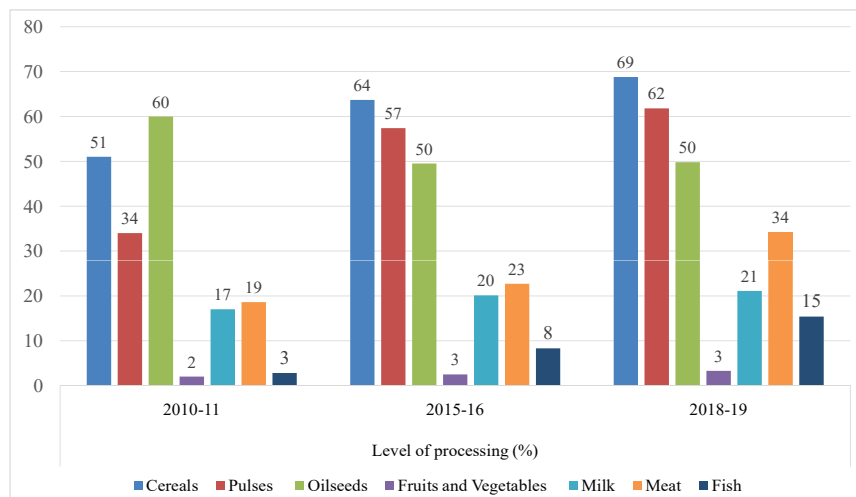


Fig 2: Trends in the level of food processing in India (%)

Source: MOFPI, 2022

sector, encompassing various stages from harvesting to the final delivery of produce to consumers. Each stage *i.e.* harvesting and handling, storage infrastructure, processing and packaging, transportation, and distribution, plays a vital role in minimizing losses and enhancing the value of agricultural products.

✓ Harvesting and Handling Technology

Advanced harvesting techniques, including mechanized harvesters, are essential for reducing labor costs and minimizing crop damage. Adopting such technology has been associated with increased efficiency and reduced post-harvest losses. The initial investment in mechanized equipment can be substantial; however, the long-term benefits include labor cost savings and higher crop yields, which can offset the initial costs over time.

✓ Storage Infrastructure

Proper storage facilities are crucial to prevent spoilage and wastage. The Indian cold chain market, a significant segment of storage infrastructure, was

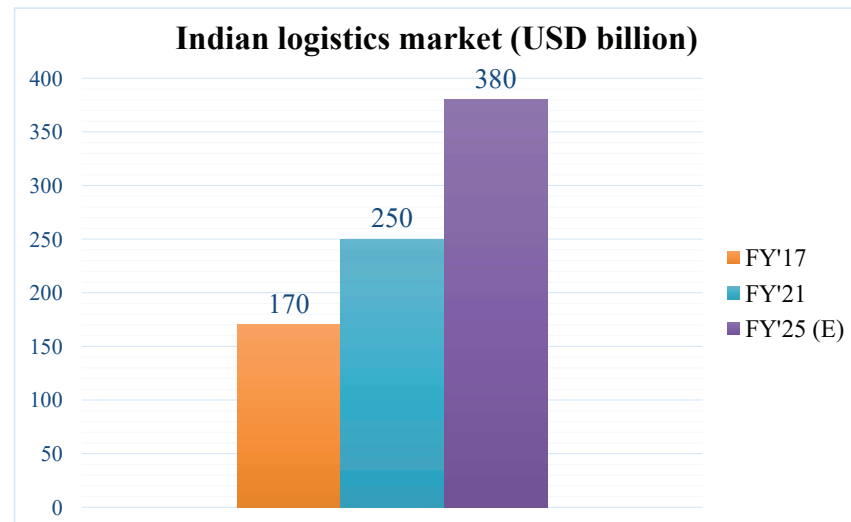


Fig 3: Status of the Indian logistics market

Source: IBEF, 2024

valued at approximately INR 2,287.5 billion in 2024 and is projected to reach INR 6,061.7 billion by 2033, growing at a Compound Annual Growth Rate (CAGR) of 10.86 per cent during 2025-2033 (IMARC, 2024). Government initiatives, such as the Pradhan Mantri Kisan Sampada Yojana (PMKSY), have been pivotal in promoting investment in storage infrastructure. Under this scheme, financial assistance is

provided for the development of cold chain infrastructure, including cold storage facilities and refrigerated transportation. The scheme aims to leverage investments of INR 11,095.93 crore, benefiting approximately 2.85 million farmers and generating over 540,000 direct and indirect employment opportunities by 2025-26.



✓ Processing and Packaging

Processing and packaging add significant value to raw agricultural products. The food processing industry in India has been growing steadily, with the cold chain logistics market expected to reach a valuation of USD 52.96 billion by 2032, up from USD 16.4 billion in 2023. Innovative packaging technologies, such as vacuum and modified atmosphere packaging, have been instrumental in extending the shelf life of products and reducing spoilage. Their adoption has been linked to reduced post-harvest losses and improved product quality, leading to better market prices and increased profitability for producers.

✓ Transportation and Distribution

Efficient transportation and distribution systems are vital for maintaining the quality of perishable goods. Investments in refrigerated transportation, including reefer vehicles, are essential to support this growth. India's logistics market is expanding rapidly, growing from \$170 billion in FY'17 to a projected \$380 billion in FY'25 (Fig 3). Efficient logistics is critical for the post-harvest sector, reducing food wastage and improving supply chains. Cold storage, warehousing, and transportation advancements are key to strengthening India's agricultural value chain and exports.

ECONOMIC IMPACT AND INVESTMENT POTENTIAL

Post-harvest losses in India are substantial, with estimates suggesting annual losses of around INR 1,52,000 crore (NABCONS, 2022), primarily due to inadequate storage and inefficient supply chains. Addressing these challenges through investment in post-harvest infrastructure offers significant economic benefits. Agricultural research and development

Table 1: Government Initiatives

Sl No	Schemes	Initiated in	Features
1.	Pradhan Mantri Kisan Sam-pada Yojana (PMKSY)	2016	flagship initiative by the Government of India aimed at improving agricultural processing and promoting food security focuses on creating a robust food processing infrastructure viz. mega food parks, cold chains, agro-processing clusters, and the creation of forward and backward linkages.
2.	Production Linked Incentive Scheme for Food Processing Industry (PLISFPI)	2021	aims to support food manufacturing entities by expanding processing capacity and promoting Indian food brands globally. focuses on segments like RTC/RTE foods, processed fruits, marine products, and mozzarella cheese, offering incentives for investment, branding, and international marketing to boost exports and farmer incomes.
3.	Pradhan Mantri Formalisation of Micro Food Processing Enterprises (PMFME)	2020	aimed to support and enhance the growth of micro food processing enterprises across the country. designed to encourage formalization and modernize small food processing units, helping them scale up their operations and integrate into the organized sector. expected to help over 2 lakh micro food processing units across the country in modernizing their operations, improving food quality, and promoting sustainable and profitable practices in the food processing industry.
4.	Agricultural Marketing Infrastructure (AMI)	2014	aims to improve market infrastructure and provide better storage, grading, and processing facilities. supports the development of infrastructure for rural agricultural markets, ensuring efficient marketing, reducing post-harvest losses, and enhancing farmers' income by connecting them to better marketing channels and infrastructure.
5.	Agriculture Infrastructure Fund (AIF)	2020	provides financial support to develop and upgrade agricultural infrastructure. offers low-interest loans for projects like warehouses, cold storage, processing units, and other facilities.
6.	Sub Mission on Agricultural Mechanisation (SMAM)	2014	Provides subsidies for the purchase of farm machinery and equipment Supports the establishment of CHCs to allow small and marginal farmers access to high-cost machinery on a rental basis Training & Skill Development: Post-Harvest & Residue Management



have demonstrated high returns on investment. According to the Economic Survey 2023-24, every rupee invested in agricultural research yields a return of ₹13.85, which highlights the potential gains from investing in advanced post-harvest technologies and infrastructure. Enhancing post-harvest management in India through targeted investments in technology, infrastructure, and logistics can significantly reduce losses, improve food security, and increase profitability for stakeholders across the agricultural

value chain.

GOVERNMENT INITIATIVES SUPPORTING POST-HARVEST MANAGEMENT AND AGRO-PROCESSING

The Government of India has introduced several schemes to improve the efficiency of post-harvest management and agro-processing industries. The brief details of the schemes are presented in Table 1.

AGRO PROCESSING CENTERS: CATALYSTS FOR RURAL GROWTH AND AGRICULTURAL TRANSFORMATION

Agro Processing Centers (APCs) are pivotal in transforming India's agricultural landscape by enhancing rural economies, reducing food miles, minimizing post-harvest losses, generating employment, ensuring mechanized and hygienic production of local consumables, and boosting the export potential of ethnic food products. These centers serve as hubs where agricultural produce is processed, packaged, and distributed, thereby adding value to raw products and extending their shelf life. The establishment of APCs stimulates rural economies by creating direct and indirect employment opportunities. Processing units require a workforce for operations, maintenance, and management, while ancillary sectors such as packaging, logistics, and supply chains also experience growth. This employment surge leads to increased income levels in rural areas, fostering economic development and reducing migration to urban centers. By situating processing facilities close to production areas, APCs significantly reduce food miles *i.e.* the distance food travels from farm to consumer. This proximity not only lowers transportation costs and associated emissions but also ensures fresher products reach consumers.



Moreover, localized processing curtails post-harvest losses, which, in India, account for substantial food loss due to inadequate storage and handling infrastructure (MoFPI, 2022). The Ministry of Food Processing Industries (MoFPI) has been instrumental in promoting such initiatives, aiming to increase the processing of perishables and reduce wastage.

APCs introduce mechanization and standardized protocols in the processing of food products, ensuring consistency, quality, and hygiene. This mechanized approach replaces traditional, labor-intensive methods, leading to increased efficiency and scalability. The emphasis on hygiene and quality control makes the products more appealing to health-conscious consumers and aligns with international standards, thereby enhancing marketability. APCs play a crucial role in tapping into the export potential by processing and packaging these products to meet global standards. The government's focus on boosting agricultural exports is evident in its plans to increase farm

exports to \$80 billion by 2030, up from the current \$50 billion. This strategic push not only opens new markets for processed food products but also enhances the global presence of India's food industry. Thus, the APCs enhance rural economies, reduce food wastage, generate employment, ensure the production of hygienic food products, and unlock the export potential. Continued investment and supportive policies in this domain are essential for sustaining growth and ensuring the holistic development of rural India.

ROLE OF FPOs AND PACSS IN PROMOTING AGRO-PROCESSING IN INDIA

Farmer Producer Organizations (FPOs) and Primary Agricultural Credit Societies (PACS) play pivotal roles in promoting primary and secondary processing of agricultural commodities within production catchments, thereby enhancing value addition and improving rural economies. FPOs, as collective entities formed by farmers, facilitate the aggregation of produce, enabling members to undertake activities such

as sorting, grading, and packaging activities. This collective approach not only reduces individual costs but also improves bargaining power in the marketplace. For instance, the Small Farmers' Agribusiness Consortium (SFAC) has been instrumental in supporting FPOs to establish processing units, thereby enabling farmers to move up the value chain (NABARD, 2015). PACS, as grassroots-level cooperative credit institutions, provide essential financial services to rural communities, including short-term and medium-term loans tailored for agricultural activities. Beyond credit, many PACS have diversified to offer services such as the supply of agricultural inputs and marketing of produce. By extending credit for purchasing machinery and establishing processing facilities, PACSs empower farmers to engage in both primary and secondary processing activities. This financial support is crucial for setting up infrastructure like mini rice mills or pulse processing units, which add significant value to raw produce. The collaboration between FPOs and PACS fosters an environment favorable to mechanized and hygienic production processes. By providing resources and accessing credit, farmers can invest

in modern equipment and adhere to standardized protocols, ensuring the quality and safety of processed products. This not only meets local consumption needs but also tapping into global markets and increasing farmers' income. Government initiatives, such as the promotion of 10,000 new FPOs, further enhances this ecosystem by providing financial assistance and capacity-building measures, aiming to enhance the processing capabilities at the production catchment level. The collaborative efforts of FPOs and PACS in encouraging primary and secondary processing within production catchments lead to reduced post-harvest losses, lower food miles, employment generation, and the production of value-added products suitable for both domestic and international markets.

CONCLUSION

Post-harvest management and agro-processing are crucial to boosting India's agricultural economy by reducing wastage, enhancing value addition, and ensuring better market access for farmers. Strengthening APCs, FPOs and PACS services can drive this transformation by providing collective bargaining power, improving

rural credit access, and facilitating efficient processing infrastructure. APCs play a vital role in minimizing food miles, enhancing shelf life, and generating rural employment, while PACS support farmers with financial aid for storage, logistics, and processing. Government initiatives, technological advancements, and private investments are further catalyzing growth in this sector. By fostering innovation, improving infrastructure, and encouraging farmer participation in value chains, India can strengthen its agro-processing industry and reduce post-harvest losses. A robust ecosystem integrating these stakeholders will position India as a global leader in agriculture while ensuring sustainable growth and prosperity for its agrarian community.

