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Post-Harvest Challenges and Opportunities in Banana Supply Chain

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INTRODUCTION

Banana is one of the world's top five fruit crops in terms of production and consumption. It is a perishable commodity with limited shelf life, and post-harvest characteristics are strongly affected by environmental factors, handling practices, and logistics infrastructure. Weak post-harvest management leads to spoilage, value shrinkage, and economic wastefulness especially in smallholder-based production systems.

Estimated post-harvest losses of bananas vary between 20–30% in developing countries, mainly because of improper harvesting techniques, poor storage, and suboptimal logistics. Therefore, it is absolutely necessary that the post-harvest management system be strengthened in order to enhance profitability, customer satisfaction, and sustainability of the banana industry.

Banana (*Musa* spp.) is a highly valued fruit crop grown throughout India and other tropical nations and is placed high on the list of area, production, and demand. Its nutritional value, affordability, and constant availability lead to its universal demand. Yet, though it is an economically valuable crop, banana is extremely perishable and susceptible to post-harvest losses, and so efficient handling is important in order to reduce losses.

2. Banana Supply Chain Post-Harvest Problems

2.1. Handling and Physiological Losses

Bananas are physiologically active post-harvest, meaning they respire and generate heat even after the harvest period. This high rate of respiration, especially under hot and humid environments, causes the banana fruit to ripen quicker and result in premature senescence, thus decreasing the storage life of the fruit.

Mechanical damage is prevalent in harvesting and due to the application of sharp implements or faulty handling methods like dropping or dragging the banana hands. Such damage leads to cuts, bruises, and skin puncturing, which render the fruit more prone to microbial invasion and quick spoilage.

In addition, inadequate handling during some of the post-harvest processes, such as loading, unloading, and transportation, worsens the issue. Fruits tend to split, blacken, or become infected by fungal pathogens as a result of careless handling and unsanitary conditions. These injuries greatly lower the shelf life, appearance, and general marketability of bananas.

2.2. Inadequate Infrastructure

The post-harvest infrastructure in the banana value chain of most areas is severely lacking, and it significantly impacts the quality and shelf life of the produce.

On-farm packhouses for cleaning, grading, and pre-cooling bananas do not exist in most banana-producing clusters. If such facilities are not available, farmers cannot retain fruit quality immediately after harvest. Cold storage facilities, which are very important in prolonging shelf life and retarding ripening, are either in short supply or economically not available for small and marginal farmers. Consequently, bananas tend to ripen early and are prone to microbial spoilage.

Apart from that, ripening activities in most regions are unhygienic and unregulated. Large-scale use of calcium carbide for forced ripening is a matter of serious concern. The chemical not only poses risks to human health, but also leads to irregular ripening, low texture, and off-flavors, ultimately impacting consumer satisfaction and safety.

2.3. Transportation and Logistics Issues

Exporting bananas is usually carried out in open or poorly ventilated trucks with no temperature or humidity control. Such poor means of transportation result in most post-harvest loss. Fruits tend to overheat as a result of exposure to sunlight for extended periods and as a result of the buildup of ethylene gas within closed containers, both of which cause ripening. Furthermore, mechanical injury is common as a result of overloading, vibration, and absence of proper cushioning. Logistics inefficiencies like road conditions, traffic congestion, and absence of coordinated collection points further extend the travel time and risk of fruit decay.

Packaging procedures are usually old and inadequate. Bananas tend to be loaded in gunny bags or loosely heaped in trucks, which offers minimal or no protection against physical damage when being moved. This results in a high percentage of the fruit becoming unsellable by the time it arrives at the market.

2.4. Absence of Grading and Standardization

Grading and standardization are vital for guaranteeing consistency in quality, enhancing market acceptability, and facilitating premium pricing. Yet, in the majority of banana production regions, this post-harvest handling operation is neglected or suboptimal.

Bananas are generally marketed in mixed lots and consist of fruits of different sizes, ripeness levels, and extent of physical blemish. This absence of sorting leads to a heterogenous product that commands lower prices and lowers its appeal to domestic as well as export markets. Additionally, the lack of compliance with international phytosanitary and quality standards does not allow Indian bananas to compete effectively in high-value export markets. Not satisfying requirements like freedom from pests, strict weight and color specifications, and standard maturity restricts global trade.

The supply chain is also devoid of barcoding, labeling, and traceability systems that are critical to brand identity, product recall management, and quality control. This deficiency is inhibiting branding and certification, thus limiting farmers and exporters from accessing premium and certified market segments.

2.5. Price Volatility and Market Gluts

The banana industry is often prone to price instability, primarily resulting from seasonal surpluses and the perishable character of the fruit. During periods of peak production, the sudden arrival of bananas in regional markets results in over-supply, with sharp drops in prices and plenty of produce going to waste.

Because of inadequate cold storage and processing facilities, the farmers are forced to vend their produce shortly after harvesting, usually at unrewarding prices. It has the effect of

significantly undermining their income stability and discouraging investment in quality output. In addition, the supply chain is largely controlled by intermediaries that drive price determination and procurement. This control decreases farmers' bargaining capacities, trims their profit margins, and escalates price asymmetry between retail and farmgate markets. The absence of transparency among price discovery mechanisms adds to the economic susceptibility of banana producers.

3. Opportunities and Interventions

3.1. Adoption of Scientific Harvesting Techniques

Scientific and timely harvesting of bananas at their proper maturity level is important to ensure post-harvest quality. Use of proper instruments and techniques while harvesting minimizes mechanical damages like bruising, splitting, and skin piercing.

Farmers' training in scientific harvesting practices such as recognition of maturity indices, wearing padded gloves, and bunch handling will significantly lower post-harvest losses. The methods ensure that the fruit maintains its structural integrity and aesthetic qualities, which are critical for both local and export markets.

3.2. Packhouse and Cold Chain Development

The provision of packhouses on-farm with facilities for washing, grading, cleaning, and packing constitutes an important intervention in enhancing post-harvest handling. The infrastructure enables the fruits to be processed immediately and hygienically once they are harvested, and thus the quality is maintained.

Investment in cold chain equipment such as pre-cooling units, cold storage facilities, and refrigerated transport can significantly increase the shelf life of bananas. These technologies retard the ripening process and check microbial rot, thereby allowing bananas to be transported to far-off markets in the best condition. Public-private collaborations, government programs, and cooperative models can be used to provide cold chain technology to smallholder farmers.

3.3. Utilization of Green Ripening Technologies

The application of ethylene-based ripening rooms is a safe, controlled, and uniform banana ripening environment. The rooms enable superior control of temperature, humidity, and gas concentration, leading to uniform fruit quality. Substitution of the risky use of calcium carbide with ethylene gas not only mitigates health concerns but also improves consumer confidence and acceptability of the product. Small-scale traders and wholesalers can be encouraged by using subsidies, information campaigns, and technical capacities to adopt environmentally friendly ripening technologies.

3.4. Enhanced Packaging Solutions

Special protective and innovative packaging is important in reducing mechanical damage in handling and transportation. Ventilated plastic crates and cushioned corrugated fiberboard boxes are more protective compared to jute sacks or loose stacking. Sophisticated packaging technologies like Modified Atmosphere Packaging (MAP) and active packaging systems assist in the regulation of the internal gas composition, thus delaying ripening and microbial development. Such systems have the potential to greatly improve the shelf life and export quality of bananas.

3.5. Price Forecasting and Digital Market Access

E-marketing solutions and digital platforms give farmers instant access to markets, minimizing the use of intermediaries and facilitating improved price realization. Mobile applications, agri-tech start-ups, and online marketplaces increasingly offer buyers' connections and real-time price information. The use of artificial intelligence (AI) and machine learning (ML) in price prediction and demand forecasting can enable farmers to make informed decisions where and when to harvest and sell their crops. These technologies assist in reducing the effects of market gluts and instances of distress sales.

3.6. Processing and Value Addition

Production of surplus and low-grade bananas into value-added banana chips, pulp, puree, flour,

vinegar, and beverages can go a long way in avoiding post-harvest losses. These products have increasing domestic and export market demand, particularly in the snack and health food industries. Value addition is a channel for diversification of income and job creation, especially in rural regions. Capacity building in terms of setup of micro-processing units, credit access, and market linkages can further enhance the banana processing sector.

3.7. Export Market Development

There is immense scope for Indian bananas in export markets, if quality, hygiene, and certification requirements are complied with. Upgradation of export clusters with grading, packaging, phytosanitary inspection, and traceability facilities is critical to realize this potential.

Compliance with international standards like GLOBALG.A.P., organic produce, and residue-free products improves the marketability of bananas in Europe, the Middle East, and East Asia. Government support through export promotion councils, training in post-harvest protocols, and infrastructure development at ports and airports can significantly improve export volumes and farmer incomes.

4. Policy and Institutional Support

4.1. Government Schemes and Initiatives

Government schemes have been initiated to confront post-harvest losses and enhance value chain efficiency in horticulture. Under the Mission for Integrated Development of Horticulture (MIDH), financial and technical assistance is provided for the creation of infrastructure like packhouses, cold storages, and ripening chambers. This scheme promotes integrated post-harvest management systems at the cluster level and at the farm level.

The Pradhan Mantri Formalisation of Micro Food Processing Enterprises (PMFME): scheme facilitates micro-enterprises that are involved in banana processing by providing training, credit support, and branding services. It facilitates the formalization of banana-driven micro-units with increased capacity and competitiveness.

The Agriculture Infrastructure Fund (AIF): is a major funding facility to facilitate farmers, cooperatives, and agribusinesses to invest in post-harvest infrastructure such as warehouses, cold chains, and primary processing units. These facilities are necessary to preserve banana quality and increase the shelf life of bananas. Through these schemes, stakeholders in the banana supply chain can develop strong infrastructure, minimize wastage, and enhance income realization.

4.2. Role of Farmer Producer Organizations (FPOs)

Farmer Producer Organizations (FPOs) are an important key to enhancing the banana value chain through the formation of farmers into groups. Through cooperation, FPOs are capable of obtaining economies of scale in the procurement of inputs, harvesting, storage, marketing, and value addition.

FPOs can be the forerunners in setting up common facility centers with washing, grading, ripening, and packing units. FPOs can also set up training programs in best post-harvest practices, quality control, and export norms compliance. FPOs can also negotiate better prices from buyers, thereby eliminating exploitation by intermediaries. Strengthening FPOs with technical assistance, market linkages, and finance is needed to empower banana farmers and enhance their post-harvest performance.

4.3. Public Private Partnerships (PPPs)

Public Private Partnerships (PPPs) provide a strategic route towards banana value chain modernization by engaging private sector investment, innovation, and efficiency. PPPs allow the government to partner with agribusiness companies, logistics companies, and food processors to establish cold chains, processing facilities, and export infrastructure.

Such collaborations can also introduce latest technologies in ripening, packaging, and traceability. For instance, banana export companies can collaborate with farmer clusters to impart technical expertise, maintain standards, and grant farmers direct access to international markets. Incentivizing PPPs through open

policies, fiscal incentives, and reforms to ease doing business can hasten the upgradation of post-harvest operations in banana supply chains and make Indian fruits more competitive in the international market.

5. CONCLUSION

The banana supply chain suffers from a variety of post-harvest problems, varying from physiological losses and mechanical damage to inadequate infrastructure, inefficient transport, and non-standardization. These, in combination, result in high economic losses for the farmers as well as lowering the quality and quantity of bananas available in the market. At the same time, these challenges also open up a transformative window of opportunity. Through the application of scientific methods of harvesting and handling, enhanced infrastructure like pack houses and cold chains, the use of environmentally friendly ripening technologies, and advanced packaging procedures, post-harvest loss reduction can be substantially realized. The use of digital marketing tools, value addition through processing, and access to export markets can enhance profitability and competitiveness substantially as well. Public support from government initiatives, farmer organization through FPOs, and new public private partnerships can give the value chain the boost it so urgently needs to become more modern. In the future, what is needed is a concerted and integrated strategy with farmers, policymakers, private sector actors, and researchers to develop a robust, effective, and inclusive banana value chain. Improving these connections will not only increase farm incomes and minimize food losses but also play a significant role in food security, environmental sustainability, and rural growth.

REFERENCES

Al-Dairi, M., Pathare, P. B., Al-Yahyai, R., Jayasuriya, H., & Al-Attabi, Z. (2023). Postharvest quality, technologies, and strategies to reduce losses along the supply chain of banana: A review. *Trends in Food Science & Technology*, *134*, 177-191.

Fernando, I., Fei, J., Stanley, R., Enshaei, H., & Eyles, A. (2019). Quality deterioration of bananas in the post-harvest supply chain-an empirical study. *Modern Supply Chain Research and Applications*, *1*(2), 135-154.

Kikulwe, E. M., Okurut, S., Ajambo, S., Nowakunda, K., Stoian, D., & Naziri, D. (2018). Postharvest losses and their determinants: A challenge to creating a sustainable cooking banana value chain in Uganda. *Sustainability*, *10*(7), 2381.

Mohapatra, D., Mishra, S., & Sutar, N. (2010). Banana post harvest practices: Current status and future prospects-A review. *Agricultural Reviews*, *31*(1), 56-62.

Sugianti, C., Imaizumi, T., Thammawong, M., & Nakano, K. (2022). Recent postharvest technologies in the banana supply chain. *Reviews in Agricultural Science*, *10*, 123-137.

Wasala, W. M. C. B., Dissanayake, C. A. K., Dharmasena, D. A. N., Gunawardane, C. R., & Dissanayake, T. M. R. (2014). Postharvest losses, current issues and demand for postharvest technologies for loss management in the main banana supply chains in Sri Lanka. *Journal of Postharvest Technology*, *2*(1), 80-87.