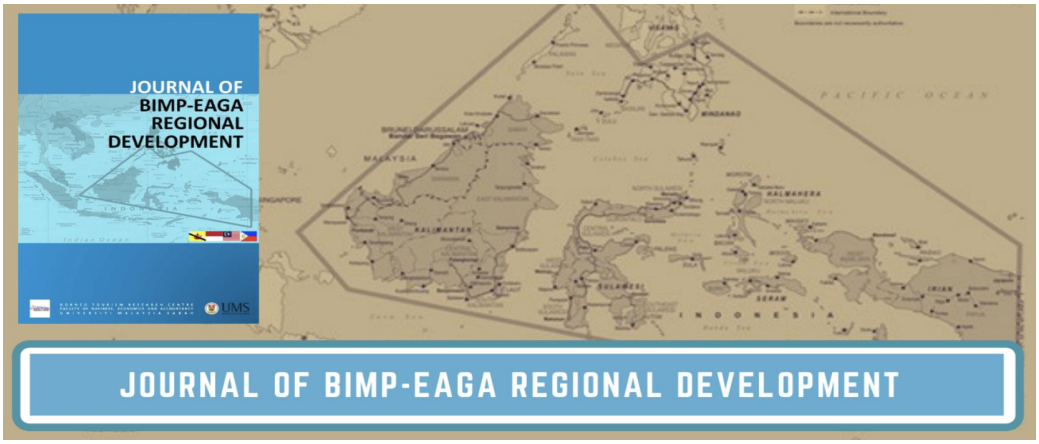

"Enhancing Rice Supply Chain Management in the Philippines: A Strategic approach for Sustainable Food Security"

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Abstract

Rice plays a multifaceted role in the lives of Filipinos, encompassing nutritional, economic, cultural, and social dimensions. The Philippines has a lot of obstacles to overcome in order to maintain food security and sustainability in the rice industry. There are notable post-harvest losses within the rice supply chain as seen by the 60% to 65% conversion rate of paddy rice to milled rice. Post-harvest losses occur between harvest and the moment of human consumption. They include on-farm losses, such as when grain is threshed, winnowed, and dried, as well as losses along the chain during transportation, storage, and processing. Postharvest procedures lose or squander about one-third of the rice produced. Storage losses of rice are playing a vital role in postharvest losses. A safe storage system of Food grain plays a vital role for ensuring food security especially for the people who are fully dependent on cultivation. Reducing postharvest losses in rice could be a sustainable way to boost food supply, ease the strain on natural resources, end hunger, and enhance farmers' livelihoods—especially in developing nations. Its importance extends beyond mere sustenance, shaping dietary habits, livelihoods, and social interactions across the country. Given its status as a staple food, ensuring a stable and sufficient supply of rice is critical for food security in the Philippines. Rice grains are produced seasonally, but their consumption is constant throughout the year. Hence storage of rice becomes necessary. Any disruptions in rice production or distribution can have significant impacts on the population's well-being. International Rice Research Institute (IRRI) Training Manual mentioned that the conversion rate in the Philippines from Paddy (Palay) to milled rice is only sixty percent (60%). Post-harvest losses can occur at various stages along the rice supply chain, leading to reduced efficiency and economic losses. Inadequate post-harvest handling and storage facilities can result in significant losses of rice due to spoilage, pests, and mold. Poor infrastructure and lack of access to modern storage technologies contribute to this problem. Addressing these challenges requires a comprehensive approach that involves collaboration among stakeholders, investment in infrastructure and technology, adoption of sustainable eco-friendly best practices in post-harvest management, implementation of quality control measures, and promotion of transparency and information sharing across the supply chain. Additionally, strategies to build resilience to environmental and climate risks are essential for ensuring the long-term sustainability of the rice supply chain. Some level of wastage and spoilage is inevitable in any supply chain. Factors such as improper handling, contamination, and deterioration over time can contribute to losses, especially if not properly managed and mitigated. Achieving food security and sustainability of rice in the Philippines requires a multi-faceted approach that addresses various challenges across the rice supply chain. Upgrade post-harvest infrastructure, including storage facilities, drying facilities, and processing mills, to reduce losses and maintain grain quality. Provide training and support to farmers on proper post-harvest handling techniques to minimize spoilage and wastage. Encourage the adoption

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of sustainable farming practices, such as integrated pest management, water-efficient irrigation techniques, and soil conservation measures, to protect natural resources and minimize environmental impact. Support agroecological approaches that promote biodiversity, reduce chemical inputs, and enhance resilience to climate change. Promote the establishment of farmers' cooperatives and collective marketing initiatives.
Keywords: *Supply; Staple; post-harvest; consumption; storage; distribution*

Introduction

Millions of Filipinos rely mostly on rice as their main source of nutrition and income, making it a staple cuisine in the country. The Philippines, being an agricultural nation with a long history of rice farming, nevertheless, confronts formidable obstacles in guaranteeing food security and sustainability in rice production.In the Philippines, rice is produced seasonally whereas its consumption is constant throughout the year. "Rice is considered a highly political and economic commodity such that an increase in its price can also prompt workers to demand for wage increases" (Dy, 2016). Its great impact to the food security of majority of the Filipinos especially the poor, highlights the importance of stabilizing rice supply. The population of the Philippines is predicted to increase to more than 140 million by 2045. The nation's rice supply is under pressure due to post-harvest losses within the supply chain, demographic trend, urbanization, and shifting dietary habits. Furthermore, typhoons and droughts, two natural calamities that can have a significant impact on rice production, are common in the Philippines. Rice production must not only meet the needs of the population, but it must also be made inexpensive and available to all in order to achieve food security. In addition, sustainable rice production is essential to prevent environmental damage and the depletion of natural resources. "Rice grain is the essential consumer goods for human, being the part of daily diet, it largely modulates economy. Hence, is the basis of social existence and development. Therefore food grain production is the key part of the economic and social development". (Hazan and Abedin, 2021). The purpose of this study is to investigate the obstacles within the supply chain management of rice in the Philippines particularly postharvest losses that affects food security and sustainability of rice. Likewise, to suggest solutions, insights and recommendations to improve rice food security and sustainability in the Philippines

Literature Review

"Effective Supply Chain Management will make the organization gain several advantages, such as: increasing profits, reducing costs, and / or reducing the delivery time. To achieve this, the rice supply chain management should be directed towards increasing the involvement of all members of the supply chain of rice and the related stakeholders sustainably. In the absence of such sustainability, the impact on improving added value for the supply chain members would be just a little.

The rice supply chain is important to achieve food security. It has various perspectives, challenges or issues that causes a complex problem in supply chain system. The existing problem are related to food

availability, inventory level, fragmented distribution, affordability of prices, accessibility, variation of business processes and the environmental impact from production and logistics system.The high domestic price of rice in the country was mostly attributed to relatively low yields, high production and marketing cost, involvement of many players and limited investment in enabling infrastructure and market support such as transport, handling, storage, drying and milling facilities" (Mataia, Beltran, et al 2020)

"In most developing countries, governments, development agencies, and private sectors recognize the role of poverty reduction and food security and, as a result, are increasingly investing in agricultural value chains, providing inputs, financing, and other services that support their development. Over the past five decades, food availability has been greatly improved through productivity gains in the agricultural sector (Baldos and Hertel 2014).

"The agricultural sector is currently under increasing pressure, i.e., (i) to be sustainably run, which implies that the sector should be able to meet the needs of the present without compromising the ability of future generations to achieve their own ends, and (ii) to provide food, energy, and industrial resources to satisfy the demand of a rising world population" (Thurzar and Broos, 2019)

"Supply Chain not only benefit the sector directly involved, they also stimulate social, economic and environmental sustainable development within a region or country. Supply Chain collaborations is of utmost importance for the connection with profitable markets and consumer demands, the flow of information, goods, technology and capital and to limit transaction cost" (Weerabahu and Nanayakkara, 2019)

"Postharvest loss includes the food loss across the food supply chain from harvesting of crop until its consumption. The losses can broadly be categorized as weight loss due to spoilage, quality loss, nutritional loss, seed viability loss, and commercial loss. Magnitude of postharvest losses in the food supply chain vary greatly among different crops, areas, and economies. In developing countries, people try to make the best use of the food produced, however, a significant amount of produce is lost in postharvest operations due to a lack of knowledge, inadequate technology and/or poor storage infrastructure" (Kumar and Kalita, 2017)

"Food security is a critical concern for emerging nations, where agriculture is a vital source of livelihood for a significant proportion of the population. However, ineffective food grain storage management (FGSM) poses a substantial threat to food security, resulting in significant post-harvest loss (PHL)" (Das, 2023)

"Post-harvest losses occur between harvest and the moment of human consumption. They include on-farm losses, such as when grain is threshed, winnowed, and dried, as well as losses along the chain during transportation, storage, and processing. Use of traditional grain storage facilities such as cribs, improved rhombus, and brick bins are ineffective against mold and insects already present in the grain before storage" (Bayode, 2021)
"The linkage between food security, agricultural potential and agricultural performance, spatial diversity of agriculture-oriented reasons for undernourishment, as well as the recognition and better understanding of the most effective interventions to solve the hunger problem under a country's unique conditions. In this way it was possible to offer a comprehensive perspective for the policy

formulation world-wide, which may be of interest to scholars and policy makers. However, the study has its limitations" (Pawlak 2020)

"Sustainable development requires a deliberate choice in the direction of societal transition, but the options are narrowed down by the obligation to feed a growing world population. At present sufficient food is produced, but large differences exist in per capita supply. Poverty prevents many people from attaining a sufficient diet, while growing economic welfare pushes meat consumption conversely. To meet the increasing demands for agricultural products, at least two options are apparent: either to expand and intensify agriculture, which already appropriates significant amounts of nature's resources or to change from resource-intensive meat consumption to more vegetarian diets" (Helms 2020)

"The growing population of the Philippines requires the conduct of a rice sustainability study. Industrialization and urbanization significantly influence the decrease in farmland and migration of farmers. The rapid population and economic growth bring about the conversion of arable lands into commercial and residential spaces. Farmers migrate and look for other jobs that could give them a more stable income, non-wage benefits, and better working conditions which are not readily available in the agriculture industry" (German, Red and Ilagan, 2022)

Methodology

The data for this study were gathered through a comprehensive review of relevant empirical and descriptive articles and documents to determine sources of rice to meet demand of Filipino consumers; likewise to review rice production process and good storage practices in a Focus-group setting, allowing for interactive discussions and diverse perspectives. Individual interviews were also conducted to delve deeper into the experiences and opinions of participants. This dual approach provided a comprehensive understanding of the rice sustainability practices from both group and individual perspectives.

A systematic approach was employed to identify and analyze literature related to the topic of interest. The recommendations provided in this study are based on a synthesis of best practices identified from the reviewed literature and based on the researcher's expertise in Supply Chain Management and their extensive work experience in food safety and management. This approach ensured that the recommendations are informed by both theoretical knowledge and practical insights. The data for this study were collected through semi-structured interviews with farmers cooperative and agencies that handles rice warehouses. Interviews were conducted to gain insights into practical and best practices.

This approach ensured that the recommendations are grounded in current best practices and established methodologies.

Findings

MMT – Million Metric Tons

	Rice Farm Land	Yield	**Paddy Rice (Palay)**	**Milled Rice**	Annual Demand	Rice Imported to meet Demand
5 year Ave	(1000 / Ha)	Tons/Ha		(1000 Tons)		
(2018- 23)	4.7	4	18.8MMT	**12.2MMT**	16MMT	3.8MMT
			Conversion 60-65%			

The yield of paddy rice from a 4.7 million hectares of farmland and an average of 4 tons per hectare gives a total of 18.8 MMT of Paddy rice (palay) and the conversion rate to milled rice is from 60% to 65%, thus total milled rice (5 years average) is 12.2 MMT. With a population of 117.3 million and an annual per capita consumption of rice in the Philippines of 136 kg the total annual demand equals to 16MMT. The total annual output of 12.2MMT is not enough to meet demand. Imports from other Southeast Asian nations have made up much of the deficiency in the Philippines' rice supply. The Philippines' two main importers of rice in 2022 are Thailand and Vietnam. It is impossible to overestimate the role that rice plays in sustaining livelihoods, fostering social cohesion, and providing sustenance for future generations. For this reason, there are several obstacles that must be overcome in order to ensure that rice remains accessible, affordable and will be less dependent on rice importation.

Research Question:

How can the production yield be improved and likewise how to increase the 60% conversion rate of paddy rice to milled rice?"

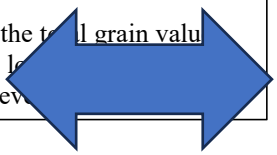
This question focuses on the specific objective of improving production yield through a targeted strategy of increasing the efficiency of the conversion process.

Reason for Post-harvest losses:

- Poor Product coming into storage.
- Poor Storage Management
- Poor Quality Paddy + Poor Milling Techniques

Present Situation:

Approx. 25 – 50% of the t l grain valu (quantity + quality) is l and consumption in dev



From International Rice Research Institute (IRRI)

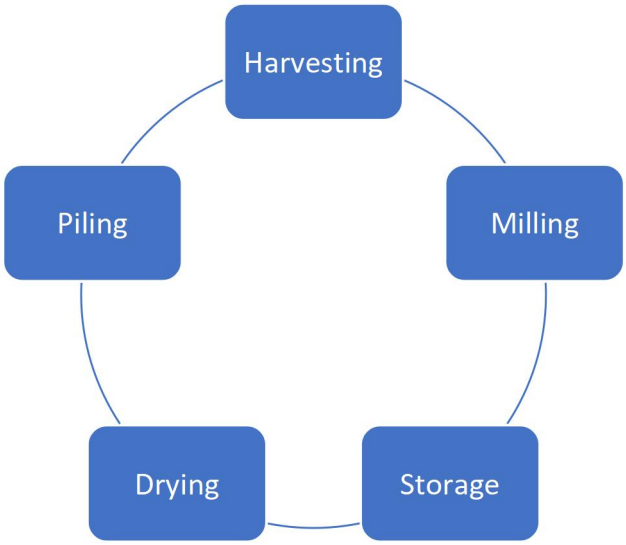
"Reducing the postharvest losses, especially in developing countries, could be a sustainable solution to increase food availability, reduce pressure on natural resources, eliminate hunger and improve farmers' livelihoods. Cereal grains are the bases of staple food in most of the developing nations, and account for the maximum postharvest losses on a calorific basis among all agricultural commodities. As much as 50%–60% cereal grains can be lost during the storage stage due only to the lack of technical knowledge". (Kumar, 2021)

In an article written by Santosh Kumar Sahu "Good storage System of Rice" he mentioned that safe storage of rice for longer periods is possible if three conditions are met:

1. Grain is maintained at moisture levels of 14% or less and seed is stored at 12% or less.
2. Grain is protected from insects, rodents and birds.
3. Grain is protected from re-wetting by rain or imbibing moisture from the surrounding air.

The longer the grain needs to be stored, the lower the required moisture content will be needed. Grain and seed stored at moisture contents above 14% may experience the growth of molds, rapid loss of viability and a reduction in eating quality.

From Harvesting to Storage



Discussion:

Result of Focus Group Discussion (FGD) with rice farmers and analysis of Documents on factors that contribute to the low conversion rate of paddy rice to milled rice in the Philippines:

Due to issues with inadequate drying of the paddi rice and a lack of storage space, farmers were compelled to sell the rice they had produced even though the targeted moisture content of 10 to 12% had not yet been reached.

Some farmers uses the open and covered courts of barangay as temporary storage facilities although it may offer some protection from the elements, they may not provide adequate ventilation or moisture control to prevent mold growth and deterioration of rice quality and also they can only accommodate few sacks of Paddy rice.

Some farmers built an extension of their house that serves as temporary shelter. If proper management of stored paddy rice is not observed this may result to post harvest losses due to infestations and poor ventilations or poor moisture control to prevent mold growth and deterioration of rice quality.

Implications:

Impact on Rice Quality: Selling rice with high moisture content can lead to quality degradation, including mold growth, spoilage, and reduced grain viability. This can affect the market value of the rice and compromise its suitability for consumption or seed purposes.

Economic Consequences: Farmers may incur financial losses by selling rice prematurely at lower prices due to the urgency to dispose of the harvest. Additionally, the reduced quality of rice may result in decreased market demand and further price depreciation.

Health Risks: Rice with high moisture content is susceptible to microbial contamination, posing health risks to consumers if consumed without proper drying and storage. Mold toxins (mycotoxins) produced during storage can be harmful if ingested.

Need for Immediate Solutions: Urgent measures are required to address the immediate storage needs of farmers, including the provision of temporary drying and storage facilities equipped with proper ventilation and moisture control systems.

Long-Term Solutions: Addressing the root cause of the lack of storage facilities requires long-term investments in infrastructure development, including the construction of community-level drying and storage facilities in rice-producing areas. Collaborative efforts involving government agencies, private sector stakeholders, and local communities are essential to mobilize resources and implement sustainable solutions.

Capacity Building: Farmer education and capacity-building programs can help raise awareness about the importance of proper postharvest handling practices, including drying and storage techniques, to preserve rice quality and maximize economic returns.

Policy Support: Government policies and programs should prioritize investments in agricultural infrastructure, including storage facilities, as part of broader efforts to enhance food security, support smallholder farmers, and promote sustainable agriculture.

By addressing the challenges of storage facility inadequacy, stakeholders can improve the resilience and sustainability of rice production systems, mitigate postharvest losses, and ensure food security for farming communities in the Philippines.

"A considerable amount of rice is lost in each stage of production especially in harvest, processing and storage. Storage losses of rice are playing a vital role in post harvest losses" (Hazan and Abedin, 2015)

Lack of Adequate Storage Facilities: Many small-scale farmers in the Philippines lack access to proper storage facilities, such as warehouses or silos, forcing them to store rice in traditional methods that are susceptible to pests, moisture, and mold.

"In order to reduce storage losses, cooperative storage structures play important role in providing facilities for the farmers to store and protect their rice grains at the time of natural disaster." (Hazan and Abedin, 2015)

Inadequate Pest Control

Without proper pest control measures, rice stored in open or traditional storage facilities is vulnerable to insect infestations, which can lead to significant losses.

"The pest control industry has seen a massive advancement in monitoring and baiting techniques over the last few decades. However, a lot of warehouses have not kept their pest control procedures up to this rapid pace (Anand, 2021).

Poor Ventilation: Improper ventilation in storage facilities can lead to the growth of mold and fungi, further reducing the quality and quantity of stored rice.
Improper Drying: Rice that is not properly dried before storage can develop mold and spoil quickly, leading to losses.
Lack of Awareness: Some farmers may not be aware of proper storage practices or may lack the resources to implement them effectively.
Typhoon: Another limiting factor in rice production. The Philippines is one of the most typhoon-prone countries in the world, experiencing an average of 20 typhoons each year, with varying degrees of severity. These typhoons are typically most active during the wet season, which occurs from June to November. The number of typhoons can vary from year to year, with some years experiencing more intense typhoon activity than others. In trying to achieve rice self-sufficiency, the Philippine is fighting a battle against nature that its exporting neighbors are spared (Dawe, 2015).
Rice is typically harvested in the Philippines twice a year, corresponding to the two main growing seasons known as "palay" seasons. The first harvest, known as the "dry season" or "summer" harvest, is usually from January to May. The second harvest, known as the "wet season" or "main" harvest, is from August to December. These harvest periods may vary slightly depending on the specific region and local growing conditions.
Poor Post-Harvest Practices: Inadequate post-harvest practices, such as improper drying can lead to losses in quality and quantity of rice.
Lack of Mechanization: The reliance on manual labor for threshing, milling, and other post-harvest processes is common in many areas, leading to inefficiencies and losses.
Infrastructure and Transportation Issues: Limited access to drying facilities, milling centers, and transportation infrastructure can result in delays and losses during the post-harvest process.
Pests and Diseases: Infestations of pests and diseases, if not properly managed, can lead to significant losses in the field and during storage.
"Rice is always stored in closed warehouses, packed in sacks, and protected through proper pesticide fumigation. However, we observed that, in some cases, rice was spoiled by birds, mice, and insects due to improper storage, handling, packaging, and movement" (Dawe 2019)

"Warehouse Plastic curtain acts as a physical barrier between workplace and the pollutants, insects and birds especially in the food sector" (Santos, 2016)
"Bird infestation poses major problems. Birds, which settle on top of stacks peck holes in sacks in order to reach the food inside cause spillage. Birds also roost and nest inside large building unless access is completely restricted." (Galero, 2014)
Climate Change: Erratic weather patterns, exacerbated by climate change, can lead to unpredictable harvests and increased post-harvest losses.
Lack of Access to Credit and Technology: Farmers may lack access to credit to invest in modern machinery and technologies that could improve post-harvest efficiencies.

Rice Food Waste

Large portion of Food is lost at the end of the supply chain known as food waste.
"Food Waste" can be defined as food discarded or alternatively the intentional non-food use of the food due to spoilage and expiration of food.
Each Filipino wastes at least two tablespoons – or 10 grams of rice – annually. The accumulated amount can feed at least 2.5 million people each year, according to the Philippine Rice Research Institute (PhilRice).
"Anti-Rice Wastage Act" which was filed by then senator Ferdinand R. Marcos Jr. in 2013. The bill seeks to impose fines on establishments that refuse to serve half-cup rice orders.

The agency, which is attached to the Department of Agriculture, has also started to disseminate data on rice wastage to food establishments to encourage them to implement measures to cut the waste.

The fact that our annual rice wastage can feed at least 2.5 million people is the focus of the "Be RICEponsible" campaign launched by PhilRice last Thursday to mark National Rice Awareness Month. Presidential Proclamation No. 524 signed in January 2004 had proclaimed November for this observance. Activities during the month aim to boost awareness not only on cutting rice wastage but also on efforts to address malnutrition and poverty, and attain rice self-sufficiency.

Tables and figures

Conceptual Framework

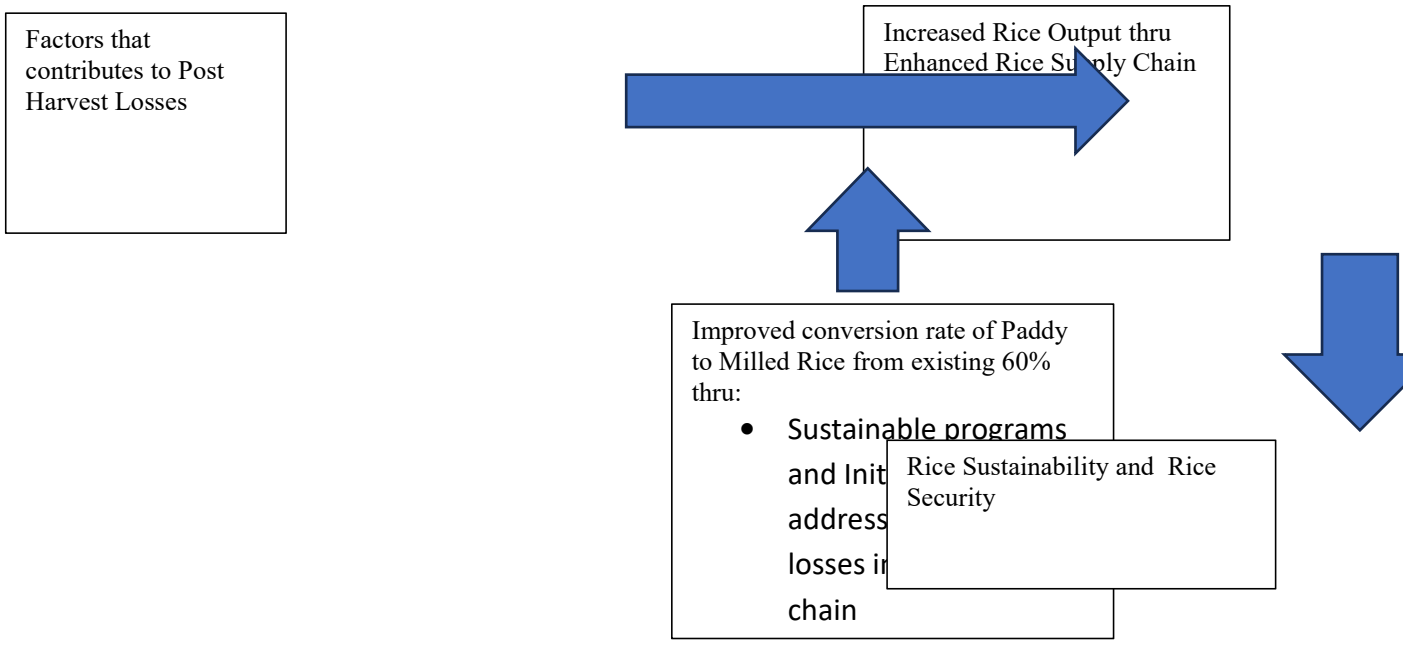


Fig. 1.

A strategic approach to enhance Rice supply Chain Management by implementing sustainable programs and initiatives to address Post Harvest losses

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Conclusion:

The production yield can be improved by addressing post-harvest losses in rice. This can be done by the implementation of an economical, practical and bio-friendly alternative processes. Some practical strategies to implement a good warehousing practices to improve storage of rice that will likewise promote sustainability.

Practical Warehouse initiatives gathered during interview to prevent pest/bird/bat infestation such as:

1. Hanging of fishnets prevents the dwelling of bats and traps birds inside the warehouse. Bird traps "pangki" made of fishnets are laid out above the piles and door entrance.

2. Tin cans tied in a rope to create noise and scare birds, bats and rodents. It is installed with long rope tied at the front to back portion, center aisle in the warehouse trances with reachable tie that when one pulls it, the tin can make a noise.
3. Madre de Cacao leaves placed in tote bags and hanged on piles to eradicate insects.
4. Regular fogging using madre cacao leaves and miracle tree leaves contribute to the maintenance and preservation of quality of stored stocks and reduce consumption of chemicals.
5. Smudging is conducted using neem tree leaves as alternate to synthetic pesticide.
6. Surrounding vegetation is planted with natural insect repellant ornamental trees (neem and eucalyptus).

Pest Management: Implementing integrated pest management practices, such as using biological controls or safe pesticides, can help reduce losses due to insect infestations. Respondent warehouses have plastic curtain in their warehouses. In lieu of a plastic curtain NFA warehouses use screen and nets to minimize the entry of birds. A screen is provided at every opening such as doors, windows, and continuous ridge vent. Respondents follow the Good Warehouse Management practices as: Opening in the floor are guarded or covered and installation of garbage bin are provided and located outside warehouse.

Advances in Insect and Pest Management Systems

Usually chemical fumigants, contact insecticides are used to control stored product pest. Increase awareness about health issues due to organic residues in food grains has enforced restrictions on one of chemical pesticides because of adverse effects of pesticides residue in grains and environment. This has resulted in imposition of strict limitations on pesticides registration by regulatory agencies.

In addition, in many countries, insects in particular have been developing resistance to contact insecticides and to the conventionally used phosphine gas.

Maintenance of Hermetic storage environment for the control of insect growth is also very effective and is possible for bulk storage system.

A **hermetic storage environment** refers to a sealed or airtight storage space that prevents the entry or exit of air, moisture, dust, or other contaminants. Such environments are often used in industries where sensitive materials, such as electronic components, chemicals, pharmaceuticals, or food products, need to be stored under controlled conditions to maintain their quality, integrity, or safety.

Hermetic storage environments help prevent oxidation, moisture damage, contamination, and degradation of stored items. They are commonly found in cleanrooms, laboratories, food processing facilities, and certain types of warehouses or storage facilities where environmental control is critical.

With the chemical insecticides being phased-out due to their residual effects on human health, the need for the hour is to maintain hygienic practice in the storage systems.

Relative humidity and Temperature monitoring thru Hygrometer

The ideal relative humidity (RH) and temperature for rice storage depend on the type of rice and the desired storage duration. However, general guidelines suggest:

Relative Humidity: The ideal RH for rice storage is around 60% to 70%. This level helps prevent the rice from becoming too dry or too moist, which can lead to quality degradation.

Temperature: The ideal temperature for rice storage is around 10°C to 15°C (50°F to 59°F). This temperature range helps slow down the aging process of rice and reduces the risk of insect infestations.

For longer-term storage, lower temperatures (below 10°C or 50°F) and lower humidity levels (below 60%) are recommended to further slow down the aging process and preserve the quality of the rice.
"Proper warehouse practices is necessary for protection of stored milled rice from certain element. Some recommendation for good warehouse management are mentioned. These are: 1) Formulation of basic general guide on warehouse practices for warehouse operators; 2) Management must provide adequate training and motivation to their staff to perform better; 3) Formulation of pest control measures and 4) Fumigants for warehouse operator as a guide for the applicants". (Aziz, 2014).

How to improve or maintain Relative Humidity and Temperatures inside a warehouse:
Maintaining and improving relative humidity (RH) and temperature inside a warehouse, especially for rice storage, can be achieved through various methods. Here are some strategies:
Proper Ventilation: Ensure that the warehouse has adequate ventilation to allow for air circulation. This can help prevent the buildup of moisture and regulate temperature.
Insulation: Proper insulation of the warehouse can help maintain stable temperatures and reduce the impact of external temperature fluctuations.
Dehumidification: Use dehumidifiers to reduce humidity levels inside the warehouse, especially in areas prone to high humidity. This can help prevent mold growth and protect stored goods.
Humidification: In dry climates or during dry seasons, humidifiers can be used to increase humidity levels inside the warehouse, especially if the air is too dry for optimal storage conditions.
Temperature Control: Install heating, ventilation, and air conditioning (HVAC) systems to regulate temperature inside the warehouse. This can help maintain optimal temperatures for storage.
Monitoring and Control Systems: Use monitoring systems to continuously track RH and temperature levels inside the warehouse. Automated control systems can adjust ventilation, heating, and cooling systems to maintain optimal conditions.
Sealing and Weatherproofing: Ensure that the warehouse is properly sealed and weatherproofed to prevent outside air and moisture from entering. This can help maintain stable RH and temperature levels.
Storage Configuration: Arrange stored goods in a way that allows for air circulation and prevents moisture buildup. Use pallets or shelves to keep goods off the floor and away from walls.
By implementing these practical and alternative processes, it is possible to reduce post-harvest losses in rice and improve food security and livelihoods for farmers.

Establish Farmers cooperative among rice farmers
Forming farmers cooperatives can bring several benefits to rice producers:
Collective Bargaining Power: By joining forces, farmers can negotiate better prices for inputs such as seeds, fertilizers, and equipment, as well as for their harvested rice.
Access to Markets: Cooperatives can help farmers access markets by pooling their resources and coordinating sales. This can lead to better prices and market opportunities.
Sharing of Resources: Cooperatives can facilitate the sharing of resources such as machinery, storage facilities, and labor, reducing costs for individual farmers.
Knowledge Sharing and Training: Cooperatives can provide a platform for farmers to share knowledge, skills, and best practices. They can also organize training programs to improve farming techniques and productivity.
"Cooperatives can help farmers benefit from economies of scale by lowering their costs of acquiring inputs or hiring services such as storage and transport. Agricultural cooperatives also enable farmers to improve product and service quality and reduce risks." (Anand 2021) https://blog.agrodoamin.com

"Cooperative could be a fundamental tool or a pillar of agricultural development to attain food security at farmer level. Farmers as members of cooperative have high participation in supporting cooperative to make products or business activities." (Sedana, 2020)

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