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Analysis on post-harvest practices of packaging in rice crop in district- Rupnagar, Punjab

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Abstract
Post-harvest management is one of the most critical stages in the agricultural value chain, particularly for staple crops such as rice, which forms the backbone of food security and rural livelihoods in Punjab. Despite being one of the leading rice-producing states in India, Punjab continues to experience significant post-harvest losses, primarily due to reliance on traditional storage practices. The present study provides a comprehensive analysis of rice post-harvest management in Punjab**.** The objectives of the study are: (i) to document the storage practices most widely adopted by farmers, (ii) to compare the efficiency of package practices. Primary data were collected from sample farmers across different villages of Rupnagar districts of Punjab through field surveys, and descriptive statistical tools were used to evaluate storage methods, costs, and outcomes. The package methods followed by farmers are mainly 1. Gunny Bags 2. Hermetic Bags 3. Grain Silo. Out of which majority 90% performed Gunny Bags as package practice and remaining 5%Grain silo and 5% perform Hermetic bags. Gunny (jute) bags, remain the most widespread practice in Punjab. As it is cost effective package practice.

Keywords: Post-harvest management, rice storage, hermetic bags, grain silos, farmer profitability

Introduction
Rice, also referred to as “the grain of life,” holds immense significance in the global food system, feeding more than half of the world’s population. In India, it is the second most important cereal crop after wheat, and within the Indian agricultural landscape, the state of Punjab occupies a central position in rice production. The Green Revolution of the 1960s firmly established Punjab as the food bowl of India, with rice and wheat forming the cornerstone of its crop rotation system. Today, Punjab continues to be a leading contributor to the national central pool of food grains, supplying rice to ensure food security for millions across the country. However, despite being a hub of agricultural production, Punjab faces pressing challenges in the domain of post-harvest management. The term “post-harvest” refers to all processes and practices applied after harvesting a crop, including drying, storage, transportation, milling, and distribution. These steps are critical because losses occurring after harvest directly undermine food availability, farmer income, and overall efficiency of the agricultural system. For rice, improper handling and storage often lead to pest infestations, moisture-related damage, contamination, and quantitative losses that significantly reduce the net returns to farmers. The Food and Agriculture Organization (FAO) estimates that post-harvest losses for cereals in developing countries can range between 10-20%, and in the case of rice in Punjab, losses of up to 12-15% have been documented when stored using traditional methods such as gunny bags (FAO, 2011) Punjab Agricultural University (PAU), Ludhiana, has long recognized the importance of post-harvest management. As one of India’s premier agricultural research institutions, PAU has conducted extensive studies on storage technologies, pest management, and value chain efficiency.
The university emphasizes that reducing post-harvest losses is as important as increasing crop productivity, since both contribute to food security and farmer profitability. For instance, saving 10% of rice from post-harvest losses could be equivalent to increasing production by several million tonnes, but at a fraction of the cost and environmental burden. (Punjab Agricultural University, 2023). Beyond the immediate economic implications, post-harvest management

in rice also has broader social, environmental, and policy dimensions. Poor storage practices not only reduce marketable surplus but also compromise nutritional quality, affecting consumers. Moreover, improper grain handling can lead to food safety concerns, including fungal infestations and aflatoxin contamination. Environmentally, the inefficiency of post-harvest systems exacerbates resource wastage, as all the water, fertilizers, and energy used during crop cultivation are effectively lost when grain spoils. From a policy standpoint, the persistence of traditional practices indicates gaps in awareness, training, and support mechanisms for farmers. (Ministry of Agriculture & Farmers Welfare, GoI, 2020)

Methodology

The methodology of this study was designed to provide a comprehensive understanding of rice post-harvest management practices in Punjab, with an emphasis on comparing traditional and modern storage methods. The approach of data collection from institutional sources such as Punjab Agricultural University (PAU), government reports, and published journals. By integrating these two forms of evidence, the study aimed to ensure both contextual accuracy and analytical rigor. (Punjab Agricultural University, 2023)

1. Research Design

The study adopted a descriptive and comparative research design. The descriptive component was necessary to document and analyse the current state of storage practices among rice farmers in Punjab, while the comparative component allowed for an evaluation of the efficiency, costs, and outcomes associated with different storage technologies. (CIPHET, 2020)

2. Sampling Framework

A purposive sampling strategy was used to identify farmers across major rice-producing districts of Punjab, including Ludhiana, Sangrur, Ferozepur, and Patiala. These districts were selected because they represent diverse agro-climatic conditions as well as different levels of technology adoption. Within each district, a representative sample of farmers was chosen to provide data on storage practices. The sample was stratified according to farm size (marginal, small, medium, and large) to ensure that variations in resources and decision-making could be captured.

In total, the survey covered 50 rice farmers with varied landholdings and socio-economic backgrounds. While the sample size is modest, it provides a reliable cross-section of practices and perceptions relevant to post-harvest management in the state. (Ramesh & Sinha, 2016,) [13]

3. Data Collection Methods

- **Data:** Information was collected through structured questionnaires, semi-structured interviews, and farm visits. The questionnaires focused on:

a) Quantity of rice stored per season.
b) Type of storage method employed (traditional vs. modern).
c) Costs associated with storage (initial investment, maintenance, pest control).
d) Perceived advantages and disadvantages of chosen methods.
e) Losses observed in terms of weight reduction, pest damage, and quality deterioration. (Affognon *et al*., 2015) Village-wise Adoption of Storage Methods:

Village Name	Gunny Bags	Grain Silo	Hermetic Bag	Total Farmers
Baroli	9	1	0	10
Choti Ghandua	10	1	1	12
Fatehpur Jattan	7	0	1	8
Thablan	8	0	0	8
Doom Cheri	7	1	0	8
Navgaon	5	0	1	6
Dholan Majra	4	0	0	4
Kishanpura	4	0	0	4
Total	54	3	3	60

Semi-structured interviews allowed farmers to provide qualitative insights into their decision-making process, cultural preferences, and awareness of PAU-recommended technologies. Farm visits were critical in verifying storage conditions and observing firsthand the challenges of pest infestations, moisture management, and structural limitations. (Punjab Agricultural University, 2021)

4. Classification of Storage Methods

For analytical purposes, storage methods were grouped into two broad categories:

- **Traditional Methods:** Gunny (jute) bags, which remain the most widespread practice in Punjab.
- **Modern Methods:** Hermetic bags, metallic bins, and grain silos. (Murdock *et al*., 2012) [10]

This classification allowed for clear comparison of performance indicators, costs, and farmer preferences.

Results and Discussion

The dataset consisted of multiple farmers storing rice through different methods. Gunny bags were the dominant method, though hermetic bags and silos were also reported. The following charts illustrate the findings: (Murdock *et al*., 2012) [10]

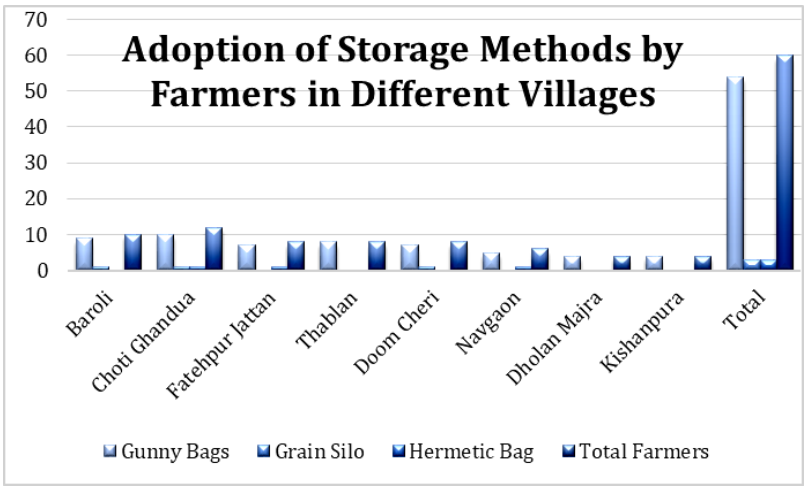

Fig 1: Rice quantity stored by different farmers.

Quantity of Rice Stored

The average quantity of rice stored per farmer varied significantly according to farm size. Small and marginal farmers stored between 10-25 quintals per season, mostly for household consumption and partial market sale, while medium and large farmers stored between 50-200 quintals, primarily for commercial sale.

Interestingly, larger farmers were slightly more inclined towards modern storage options such as gunny bags and hermetic bags, largely due to their ability to make higher upfront investments. This suggests that economic capacity directly influences technology adoption.

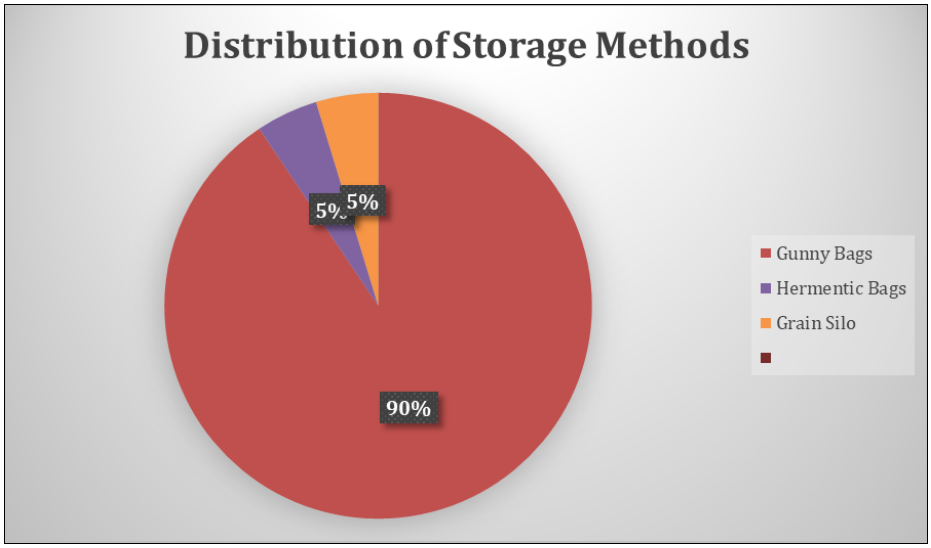

Fig 2: Distribution of storage methods among farmers.

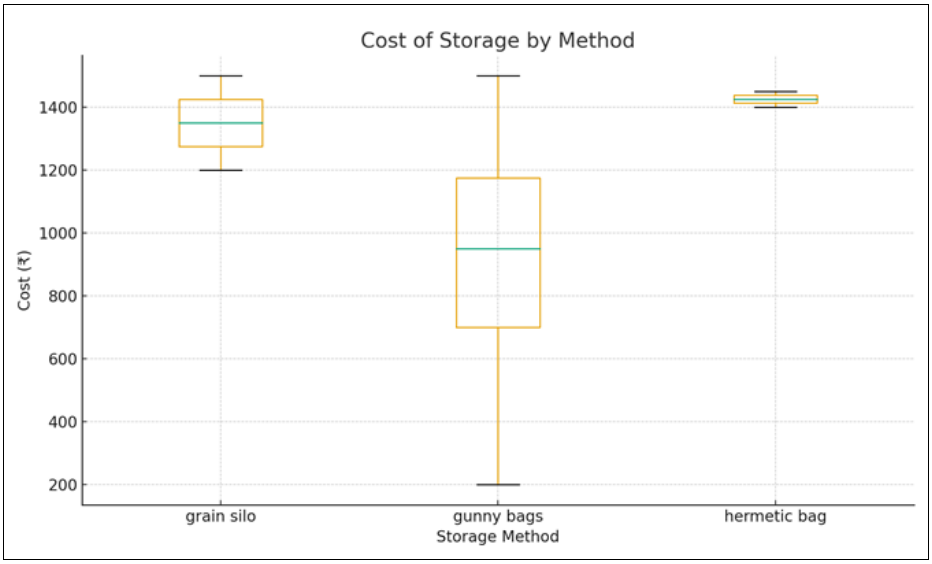

Fig 3: Comparative cost of storage across different methods.

Comparative Costs of Storage Methods

- A comparative analysis of costs revealed that while gunny bags had the lowest upfront cost (₹25-30 per bag), they were associated with higher recurring costs due to pest control measures, losses from damage, and the need for frequent replacement. On the other hand (Singh & Kaur, 2022 [15], "Post-harvest technologies for minimizing rice losses in Punjab") Hermetic Bags: Initial cost of ₹250-300 per bag, but reusable for multiple seasons with minimal additional expenses. (Murdock *et al*., 2012) [10]
- Hermetic Bags: Initial cost of ₹250-300 per bag, but reusable for multiple seasons with minimal additional expenses.
- **Metallic Bins:** Initial cost ranging between ₹5,000-8,000 depending on capacity, with long durability (5-7 years).
- **Grain Silos:** Highest initial investment, often requiring collective or institutional ownership, but offering near-zero storage losses. (Affognon *et al*., 2015) [1]

When analyzed over a 5-year period, the cost-benefit ratio favoured modern technologies, particularly hermetic bags and metallic bins. Although gunny bags appeared economical in the short term, cumulative losses often outweighed their cost advantage

Figure 2 (comparative cost analysis) demonstrates the higher long-term efficiency of modern storage methods compared to gunny bags. (Singh & Kaur, 2022) [15]

Post-Harvest Losses

The extent of losses varied sharply between traditional and modern systems: (Affognon *et al*., 2015) [1]

Gunny Bags: Average losses of 10-12% of total stored rice due

to insect infestation, rodents, and moisture. (Singh & Kaur, 2022) [15]

Hermetic Bags: Average losses reduced to 2-3%, primarily due to superior sealing that prevents oxygen entry and pest activity. (Murdock *et al*., 2012) [10]

Metallic Bins and Silos: Negligible losses (less than 1%) when properly maintained. (Affognon *et al*., 2015) [1]

This difference has major implications for food security and farmer profitability. For example, a medium farmer storing 100 quintals of rice in gunny bags could lose 10-12 quintals annually, equivalent to a financial loss of ₹15,000-18,000 at current market prices. The same farmer using hermetic bags would save nearly this entire quantity, offsetting the higher initial cost within one or two seasons. (Murdock *et al*., 2012) [10]

Farmer Perceptions and Awareness (Ramesh & Sinha, 2016) [13]

Interviews revealed a mixed perception of modern technologies:

- Farmers who had adopted hermetic bags or bins expressed high satisfaction with grain quality and ease of handling. (Murdock *et al*., 2012) [10]
- Farmers relying on gunny bags often admitted awareness of losses but cited financial constraints and habit as key reasons for not switching. (Singh & Kaur, 2022) [15]
- Awareness of PAU's recommendations was moderate: while most farmers had heard of improved storage methods during extension camps or field days, relatively few had direct access to training or demonstrations. (Punjab Agricultural University, 2021, Research Bulletin)

This highlights the gap between technology availability and technology adoption, underscoring the need for stronger extension efforts.

Sustainability and Resource Efficiency

Post-harvest losses also carry significant environmental costs. Each kilogram of rice lost represents wasted inputs of water, fertilizer, energy, and labour. In Punjab, where rice cultivation already exerts enormous pressure on groundwater resources, reducing post-harvest losses is a sustainability imperative. (Affognon *et al*., 2015) [1]

Moreover, inefficient storage often forces farmers to rely on repeated chemical fumigation to control pests, which can have harmful effects on human health, grain safety, and the environment. By contrast, hermetic storage technologies reduce or eliminate the need for chemicals, making them a more sustainable alternative. Grain silos, when managed collectively, can also lower the carbon footprint of storage by centralizing facilities and improving logistics. (Murdock *et al*., 2012) [10]

Policy Dimensions and Government Support (Ministry of Agriculture & Farmers Welfare, GoI, 2020)

The persistence of traditional storage methods also reflects broader policy and institutional gaps. Government procurement systems in Punjab are primarily geared towards milling and marketing rather than on-farm storage. As a result, farmers often feel that storage is a personal responsibility rather than a shared priority in the agricultural value chain. (Ministry of Agriculture & Farmers Welfare, GoI, 2020)

To encourage adoption of modern technologies, targeted subsidies, credit support, and training programs are essential. For example, offering subsidies on hermetic bags or low-interest loans for purchasing metallic bins could significantly accelerate adoption. Additionally, collective models such as village-level silos managed by cooperatives or FPOs can reduce individual farmer costs and enhance access to modern infrastructure. (Murdock *et al*., 2012) [10]

Policies must also integrate post-harvest management into broader agricultural sustainability strategies. Just as Punjab has been encouraged to diversify crops to save water, similar emphasis must be placed on improving storage efficiency to reduce losses. (Affognon *et al*., 2015) [1]

Conclusion

From the research we get to know dependency of farmers on the traditional method of storage, which includes gunny bags mostly. As it is cheap and effective method for packaging. It maintains the rice texture for around few months which make easy access to to the market for supply. On the other side the grain silo cylinders are mainly used by the large scale farmers. Which provides favourable conditions of storage to rice. With Hermetic bags are also useful method to storage but as it is slightly costly than gunny bags. Hermetic bags are beneficial in providing protection from water and also helpful in maintaining shelf life and texture of rice for long run.

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