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Low-Cost Hermetic Storage Super Bag's Beneficial for Small Stake Holder Farmers in India

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Abstract

The study evaluates hermetic storage methods for crops like rice, wheat, maize, pulses, coffee, cocoa, millet, peanuts, and seeds. Techniques such as PICS, GrainPro, and plastic silos effectively reduce post-harvest losses and aflatoxin contamination in hot, humid climates. These modern plastic structures ensure long-term storage, quality preservation, insect control, and condensation prevention during shipping. By managing moisture, reducing oxygen, and increasing CO_2, hermetic storage lowers losses to 1% within days, offering a viable solution for Indian farmers to combat insect damage in legumes and cereals.

Keywords: Hermetic Storage, Postharvest Losses, Food Security, Insect Control, Grain Storage, Small Stakeholders, Storage Period

1. The worldwide storage problem

Hermetic storage is increasingly popular for minimizing grain losses, especially in hot, humid climates. Villers et al. (2006b) found that while East Africa can see grain losses of over 25%, hermetic storage can cut these losses to around 1% annually. It also reduces health risks from mold and aflatoxins in maize and peanuts. Maintaining moisture levels at or below 65% relative humidity is key for safe storage. For secure international transport, the Super Grain Bag (SGB) and PICS bags are commonly used, both effective against pests like cowpea weevils. Some areas use more porous polyethylene hermetic bags, which have different preservation qualities.

1.1 Introduction

Hermetic storage (HS), introduced in the late 1980s, is now used in over 80 countries as an eco-friendly alternative to traditional storage methods. It benefits seeds, cereals, and high-value crops like coffee and cocoa by controlling moisture without pesticides or refrigeration, especially in hot, humid areas. After gaining attention in 2008 for its ability to kill insects and prevent mold, adoption increased. However, rural Indian farmers often lack the expertise for effective long-term storage, with a focus on productivity over reducing post-harvest losses. Reliance on synthetic pest control methods poses health risks and contributes to resistance. With the global population projected to reach 10.5 billion by 2050, reducing post-harvest losses is essential for food security. Improving storage infrastructure is crucial, as India stores

about 70% of its grains in homes or fields despite record production.

2. Alternatives to hermetic storage

Alternative storage methods like fumigants, cooling, freezing, and traditional open storage are used alongside hermetic storage. Fumigants struggle to fully penetrate commodities or prevent pest and mold issues effectively, leading to the phase-out of methyl bromide. Refrigeration and freezing are common but energy-intensive or costly. Traditional open storage offers minimal protection against pests and mold, leading to significant losses in humid regions. However, hermetic storage is gaining popularity and is effective for various commodities, including seeds, chocolate, coffee, rice, and staple foods.

3. Applications of Hermetic Storage

Hermetic technology is widely used for:

i. Long-term storage of cereal grains like rice, corn, barley, wheat, millet, etc.

ii. Preserving seed germination potential and vigor during storage.

iii. Ensuring quality preservation for high-value commodities like cocoa and coffee.

Moreover, newer applications for hermetic storage are emerging, including

a) Safe storage of high-moisture corn.

b) Storing challenging products like brown rice, rice bran, and basmati rice, preventing toxin growth in corn, peanuts, and coffee.

c) Hermetic storage for oily commodities like cottonseeds or peanuts prevents free fatty acid formation and rancidity.

4. Why is hermetic storage beneficial for seeds?

i. Creates low-oxygen conditions, preventing pests and mold in seeds.

ii. Maintains ideal moisture levels, preserving seed vitality.

iii. Prevents toxin-producing fungi like aflatoxins from affecting seed quality.

iv. Shields seeds from rodents and pests, ensuring long-term viability.

5. Hermetic Storage Technology

To effectively use hermetic storage, three main goals must be achieved:

1. Keeping oxygen levels low and carbon dioxide levels high to discourage infestations (like insects and mold) and oxidation.
2. Blocking moisture from entering the storage system.
3. Protect against rodent entry.

6. Oxygen Concentration

Standard storage environments have an oxygen content of 21.0%, similar to regular atmospheric levels. Initially, hermetic storage also had this oxygen level, but during storage, the oxygen content in hermetic bags dropped significantly to as low as 0.0%. This low level remained constant, indicating no external oxygen replenishment. The rapid oxygen reduction suggests high insect respiration rates, consuming significant oxygen. The hermetic bag design prevented gas exchange with the outside, limiting oxygen replenishment.

7. Technology innovators

The PICS hermetic bag system safeguards crop like cowpeas, maize, peanuts, millet, wheat, and common beans from insects (Murdock et al., 2012). These triple-layer bags create a Modified Atmosphere Storage (MAS) by reducing oxygen, and inhibiting insect development (Murdock et al., 2012). Studies confirm PICS bags can reduce aflatoxin levels in maize (William et al., 2014; Elepano and Navarro, 2008). Originally for cowpeas, PICS aids African farmers by deterring cowpea seed beetles. Proper drying and cleaning are crucial for maize storage in hot climates (Weinberg et al., 2008).

8. Economic Considerations

The economics of hermetic storage have been investigated in several circumstances. In general, two questions must be addressed:

I. How do the financial advantages stack up against the price?

II. How do they compare to other storage methods? In terms of price, the following categories of economic advantages are often implemented:

8.1 Quantitative loss prevention

India experiences annual food losses of approximately 74 million tonnes, accounting for 22% of the foodgrain output or 10% of the total foodgrain and horticulture production in the country for 2022-23. Similarly, losses due to insect activity in Africa or Mexico can range from 10% to 25% for major grain crops.

8.2 Quality loss

Improperly stored rice and other commodities like maize and wheat can lose quality and value due to aflatoxin contamination, making them difficult to sell. Premium products like coffee and cocoa are particularly sensitive to quality issues, impacting both market price and producer reputation.

9. Seasonal Price Fluctuation

One major benefit is capitalizing on significant seasonal price shifts, especially in developing areas, reaching up to 50%. Studies like the one at PhilRice compared the economics of hermetic storage with other methods, showing that while initial unprotected storage may seem cheaper, it loses effectiveness in preserving seed quality over time.

10. Limitations of Hermetic Storage

Effective hermetic storage relies on the respiration of insects, the commodity, or both, making it an organic process. It works best at room temperature and above, though it can be slower at lower temperatures. Achieving a low-oxygen environment and 100% insect mortality usually takes a few days to two weeks, depending on moisture content (Navarro et al., 2007). Coffee beans are an exception, with relatively stable oxygen levels. Successful storage depends on preventing moisture exchange and preserving volatile compounds.

11. Conclusion

Adopting hermetic storage depends on factors like the farmer's financial capacity, knowledge, expected storage duration, quantity, and available infrastructure. Studies show hermetic bags as a secure, practical solution for preserving produce, urging their use in developing nations. This eco-friendly, cost-effective system eliminates the need for pesticides and fumigants. It's adaptable to safeguard various commodities and is expected to grow in acceptance due to its advantages. Currently, hermetic storage is widely used across different applications.

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